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(54) BREAKING TOOL, BREAKING HAMMER AND METHOD OF MAINTAINING SHAPE OF BREAKING TOOL

(57) A breaking tool, breaking hammer, and method of maintaining shape of a breaking tool. The breaking tool (6) comprises a functional part (Fp) at its tip portion and a wearing portion (Wp) extending a distance from the functional part towards an impact end (8) of the tool. An outer surface (S) of the tool comprises zones having different values in hardness. There may one or more softer zones (Sz1) and one or more harder zones (Hz) for maintaining original shape of the tool despite of wearing.

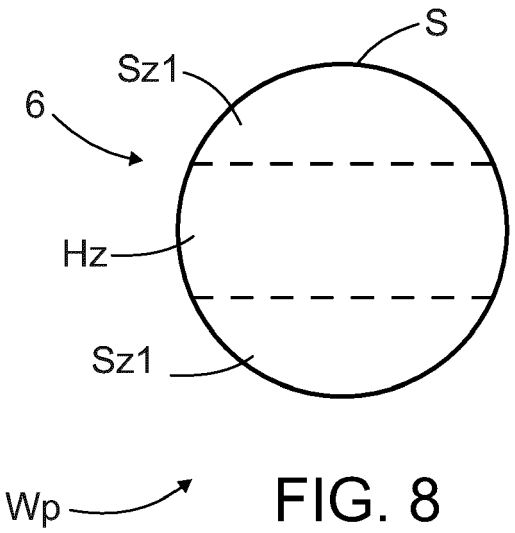

FIG. 8

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Description

Background of the invention

[0001] The invention relates to a breaking tool of a breaking hammer.

[0002] The invention further relates to a breaking hammer and to a method for maintaining shape of breaking tool.

[0003] The field of the invention is defined more specifically in the preambles of the independent claims.

[0004] Breaking hammers are used to break hard materials, such as rock, concrete, and the like. The breaking hammer comprises a percussion device for generating impact pulses to a breaking tool connectable to the breaking hammer.

[0005] The breaking hammers are used in demanding conditions and in different applications wherefore breaking tools of the breaking hammers are subjected to high stresses and other damaging phenomena. There are different tool designs of breaking tools for different use. The breaking tools may be provided with a functionally shaped tip portion. However, the tip of the tool wears and the original shape of the tool is lost. Therefore, there is a need to reshape the tip portion of the breaking tool several times during its service life. Since the tool is made of hardened steel material, machining of the tool is difficult and time consuming.

Brief description of the invention

[0006] An object of the invention is to provide a novel and improved breaking tool and breaking hammer, and further to provide a novel and improved method of keeping a desired shape of a breaking tool during use.

[0007] The breaking tool according to the invention is characterized by the characterizing features of the first independent apparatus claim.

[0008] The breaking hammer according to the invention is characterized by the characterizing features of the second independent apparatus claim.

[0009] The method according to the invention is characterized by the characterized features of the independent method claim.

[0010] An idea of the disclosed solution is that a basic structure of a breaking tool comprises an elongated shaft, an impact end at a first end of the shaft for receiving impact pulses, and a functional portion extending a first distance from a second end towards the first end. The tool is made of one steel material and is quenched and tempered for providing increased hardness. Further, the shaft comprises a wearing portion extending a second distance from the functional portion towards the first end. An outer surface of cross section of the wearing portion of the tool comprises at least two zones having different hardness.

[0011] In other words, tool has a desired tool design at the wearing portion, and the outer surface of the wearing portion has deviating hardness distribution on the outer surface of the cross section.

[0012] An advantage of the disclosed solution is that the tool can maintain its original shape at a tip part of the tool due to the zones with the different hardness. The hardness distribution is selected in accordance with the designed cross sectional shape of the tool. Harder zones are placed at areas which need to remain longer in use, and softer zones are placed at areas which are allowed to wear quicker. It has been noted that hardness of the material correlates well to capability to resist wearing, especially when rock breaking tools are considered. Then the tool may have a self-dressing or self-shaping feature wherefore there is no need to process the tool with any separate apparatuses and no separate service breaks are needed.

[0013] It can be considered that the purpose of the disclosed solution is to avoid the shaped tool to become a conventional blunt tool due to the wearing during the use. This way the functionally shaped tool can serve in the intended usage for its entire useful life.

[0014] According to an embodiment, the cross section of the functional portion is provided with an outer surface having a shape which is non-rotationally symmetrical.

[0015] According to an embodiment, the cross section of the wearing portion is round.

[0016] According to an embodiment, the cross section of the wearing portion comprises varying hardness profile inside the second distance.

[0017] According to an embodiment, the cross section of the wearing portion comprises a core part surrounded by a surface part. The surface part comprises at least two zones with different hardness, whereby there is at least one harder zone and at least one softer zone. The core part is provided with hardness greater than hardness of the softer zone on the surface part.

[0018] In other words, the cross section of the wearing portion comprises one or more harder surface zones and the harder core part, as well as one or more softer surface zones. Then the wearing portion can wear at the softer zones and resist the wearing at the core part and the designed harder zones, whereby the designed shape of the tool can be maintained.

[0019] According to an embodiment, the tool is of flat chisel type. Then the cross section of the wearing portion comprises one harder zone extending transversally from edge to edge of the outer surface, and two softer zones on opposing sides of the harder zone.

[0020] According to an embodiment, the softer zones are positioned perpendicularly relative to the harder zone.

[0021] According to an embodiment, the tool is of pyramid type. Then the cross section of the wearing portion comprises four harder zones and four softer zones. The softer zones are positioned perpendicularly relative to each other. In other words, the harder zones form edge-like zones on the surface whereas the softer zones form wearable segments between the edge-like zones.

[0022] According to an embodiment, there is a harder core part and the four harder edge-like zones which all together form a harder substantially rectangular cross sectional structure for the tool.

[0023] According to an embodiment, the wearing portion comprises at least one groove-like softer material zone in longitudinal direction of the tool.

[0024] According to an embodiment, the groove mentioned in the previous embodiment is a dust removal groove or flushing groove.

[0025] According to an embodiment, the tool has a primary hardness generated by quenching and tempering and extending through the entire cross section of the tool. Then the cross section of the wearing portion comprises at least one annealed zone wherein hardness of the material is reduced when compared to the mentioned primary hardness. In other words, the primary hardness is generated by means of a heating and cooling process for the entire tool and thereafter a heat treatment is subjected to selected limited surface areas of the tool to soften the material from the primary hardness. Thus, the annealing prepares the selected surface areas for the wearing process.

[0026] According to an embodiment, the difference in hardness values of the at least one harder zone and the hardness of the at least one softer zone is at least 7 HRC. The difference in hardness values is generated intentionally and is not based on any inaccuracies in the manufacturing process and the base material.

[0027] According to an embodiment, the difference in hardness values of the at least one harder zone and the hardness of the at least one softer zone is at least 10 HRC.

[0028] According to an embodiment, the core part and the selected harder area on the surface have hardness values of at least 48 HRC; and the at least softer area has hardness value of maximum 40 HRC.

[0029] According to an embodiment, the solution relates to a rock breaking hammer comprising: an elongated body; an impact device arranged inside the body and configured to generate impact pulses; and a breaking tool. The breaking tool is in accordance with the features and embodiments disclosed in this document.

[0030] According to an embodiment, the solution relates to a method of maintaining shape of a breaking tool of a breaking hammer during its service life. The method comprises: forming the tool of one steel material and heat treating the tool to have designed hardness; and providing the tool with a functional end part at an end part opposite to an impact end. The method further comprises: providing the tool with a wearing portion extending an axial distance from the functional end part towards the impact end; and providing the outer surface of the tool with at least one harder zone and at least one softer zone at a cross section of the wearing portion of the tool.

[0031] According to an embodiment, the disclosed method comprises reducing hardness of material of at least one zone on the surface of the wearing portion by means of induction heating. An advantage of the induction heating is that it is a fast and efficient contactless method for heating conductive steel materials by applying a fluctuating magnetic field. Induction heating provides improved control for the annealing process. Repeatable heating profiles can easily be obtained by precise regulation of the heating power. Since the workpiece is directly heated by the magnetic field, a faster response can be achieved. Moreover, the induction annealing may be accomplished without a controlled atmosphere.

[0032] According to an embodiment, the induction heating device comprises induction coils and number of these induction coils directed to a cross section of the wearing portion defines number of softer zones being created. Ranges of the coils effect on the shape of the harder zone of the wearing portion. The process may be called as an induction zone annealing.

[0033] According to an embodiment, alternatively laser technology or other zone annealing techniques, processes and apparatuses may be implemented for creating the wearable annealed softer zones on the tool.

[0034] According to an embodiment, annealing thickness i.e., thickness of the softer zone can be adjusted for producing desired hardness profiles. The wearing portion may have different annealing thickness when examined in longitudinal direction of the tool, for example.

[0035] According to an embodiment, the disclosed method comprises providing the functional end part with a cross-sectional shape having an outer surface shape which deviates from a circular shape.

[0036] The above-disclosed embodiments can be combined to form desired solutions provided with necessary features disclosed.

Brief description of the figures

[0037] Some embodiments are described in more detail in the accompanying drawings, in which

Figure 1 is a schematic side view of an excavator, which is provided with a breaking hammer,

Figure 2 is a schematic and cross-sectional view of an impact device of a breaking hammer and provided with a breaking tool,

Figures 3 - 5 are schematic axial views and side views of breaking tools with different designs at their functional portions,

Figure 6 is a schematic cross-sectional view of breaking tool at a wearing portion,

Figure 7 is a schematic view showing a principle of an induction zone annealing executed with two opposite induction coils,

Figure 8 is a schematic cross-sectional view of a breaking tool at its wearing portion after being induction annealed in accordance with Figure 7,

Figure 9 is a schematic view showing a principle of an induction zone annealing executed with four crossing induction coils,

Figure 10 is a schematic cross-sectional view of a breaking tool at its wearing portion after being induction annealed in accordance with Figure 9, and
Figure 11 is a schematic graph showing measured hardness of material of a breaking tool at different distances from an outer surface.

[0038] For the sake of clarity, the Figures show some embodiments of the disclosed solution in a simplified manner. In the Figures, like reference numerals identify like elements.

Detailed description of some embodiments

[0039] Figure 1 shows a breaking hammer 1 arranged on a free end of a boom 2 in a working machine 3, such as an excavator. Alternatively, the boom 2 may be arranged on any movable carriage or on a fixed platform of a crushing apparatus. The breaking hammer 1 comprises an impact device 4 for generating impact pulses. The breaking hammer 1 may be pressed by means of the boom 2 against material 5 to be broken and impacts may be simultaneously generated with the impact device 4 to a breaking tool 6 connected to the breaking hammer 1. The tool 6 transmits the impact pulses to the material 5 to be broken. The impact device 4 may be hydraulic, whereby it may be connected to the hydraulic system of the working machine 2.

[0040] Figure 2 discloses a hydraulic impact device 4 which is configured to generate impact pulses by means of a percussion element, such as percussion piston 7, that may be moved back and forth in the impact direction and return direction under the influence of hydraulic fluid. The percussion piston 7 is configured to strike an impact surface or impact end 8 which is located at a first end of a breaking tool 6. The breaking tool 6 may be connected to a body 9 of the impact device 4 by means of transverse locking pins 10, for example. The breaking tool 6 protrudes partly out of the body 9 and thus comprises a protruding portion Pp at its second end portion. The protruding portion Pp is divided into a functional portion Fp at a tip part of the breaking tool 6, and into a wearing portion Wp extending from the functional portion Fp towards a first end of the breaking tool 6. The functional portion Fp and the wearing portion Wp are as it is disclosed in this document.

[0041] Figures 3 - 5 disclose three breaking tools 6 with different designs at their functional portions Fp and wearing portions Wp. On left side of each Figure 3 - 5 the tool is seen in axial direction and on right side the same tool is seen from side. The functional portion Fp extends a first distance L1 from a second end towards the first end, and the wearing portion Wp extends a second distance L2 from the functional portion Fp towards the first end.

[0042] Figure 3 discloses a flat chisel type breaking tool 6 comprising a flat middle portion 11 on its functional portion Fp. Then, the cross section of the wearing portion Wp comprises one harder zone extending transversally from edge to edge of the outer surface, and two softer zones on opposing sides of the harder zone, as it is shown in Figures 6, 7 and 8. Thus, an outer surface of cross section of the wearing portion Wp of the tool 6 comprises at least two zones having different hardness.

[0043] Figure 4 discloses a pyramid type breaking tool 6 comprising four sloped surfaces 12 on the functional portion Fp. Then, the cross section of the wearing portion Wp comprises four harder zones and four softer zones. The softer zones are positioned perpendicularly relative to each other, as it is shown in Figures 9 and 10.

[0044] Figure 5 discloses a breaking tool 6 comprising an axial groove 13 on its functional portion Fp. Further, the functional portion Fp may comprise a conical tip 14. Then, the wearing portion Wp comprises at least one groove-like softer material zone 13a in longitudinal direction of the tool 6. When the tool 6 wears and becomes shorter during the use, the groove feature remains despite of the wearing because of the softer material zone 13a. This way the groove may be utilized for example for dust removing and flushing purposes for the entire service life of the tool 6.

[0045] Figure 6 discloses a cross-sectional view of a chisel-type breaking tool 6 at its wearing portion Wp. After the wearing portion Wp is treated with an annealing process there are two opposing annealed softer zones Sz1 with reduced hardness when compared to intermediate zones Iz between them. The mentioned softer zones Sz1 are designed to wear out and to thereby expose a new middle portion 11a for the flat chisel-type tool. As can be seen, the intermediate zones Iz typically comprises several zone layers with slightly different hardness since the annealing temperature effects differently at different distances from the outer surface of the tool.

[0046] Figure 7 discloses a principle of induction zone annealing by means of two opposing induction coils 15 directed transversally towards an outer surface S of the tool 6 so that the coils 15 can threat two opposing zones 16 in a cross-section of the tool 6. Between the treated zones 16 there remains an untreated zone 17.

[0047] Figure 8 discloses a result of the treatment shown in Figure 7. The cross-section comprises two softer zones Sz1 and a harder zone Hz between them.

[0048] Figure 9 discloses induction zone annealing executed by means of four induction coils 15. Then the coils 15 can treat four zones 16 and at central part there is an untreated zone 17.

[0049] Figure 10 discloses a result of the treatment shown in Figure 9. The cross-section comprises four softer zones Sz2 and a harder zone Hz surrounded by them. The harder zone Hz may comprise a hard core Hc and four hard edge zones Hez.

[0050] Figure 11 discloses a graph of measuring results of hardness in function of distance from an outer surface of a wearing portion. As can be seen the hardness values increase at desired zones towards an inner structure of the tool because the annealing is designed to reach only desired deepness of the material so that

the core can remain at designed hardness.

[0051] The drawings and the related description are only intended to illustrate the idea of the invention. In its details, the invention may vary within the scope of the claims.

Claims

1. A breaking tool of a breaking hammer, wherein the tool comprises:

   an elongated shaft;
   an impact end at a first end of the shaft for receiving impact pulses;
   a functional portion (Fp) extending a first distance (L1) from a second end towards the first end;
   and wherein the tool (6) is made of one steel material and is quenched and tempered for providing increased hardness;
   characterized in that
   the shaft comprises a wearing portion (Wp) extending a second distance (L2) from the functional portion (Fp) towards the first end; and
   an outer surface (S) of cross section of the wearing portion (Wp) of the tool (6) comprises at least two zones having different hardness (Sz, Hz).

2. The breaking tool as claimed in claim 1, **characterized in that**

   the cross section of the wearing portion (Wp) comprises a core part surrounded by a surface part;
   the surface part comprises at least two zones with different hardness, whereby there is at least one harder zone and at least one softer zone;
   and wherein the core part is provided with hardness greater than hardness of the softer zone on the surface part.

3. The breaking tool as claimed in claim 1 or 2, **characterized in that**

   the tool (6) is of flat chisel type; and
   the cross section of the wearing portion (Wp) comprises one harder zone (Hz) extending transversally from edge to edge of the outer surface (S), and two softer zones (Sz1) on opposing sides of the harder zone (Hz).

4. The breaking tool as claimed in claim 1 or 2, **characterized in that**

   the tool (6) is of pyramid type; and
   the cross section of the wearing portion (Wp) comprises four harder zones (Hez) and four softer zones (Sz);
   and wherein the softer zones (Sz) are positioned perpendicularly relative to each other.

5. The breaking tool as claimed in any one of the preceding claims 1 -4, **characterized in that**
   the wearing portion (Wp) comprises at least one groove-like softer material zone (13a) in longitudinal direction of the tool (6).

6. The breaking tool as claimed in any one of the preceding claims 1 -5, **characterized in that**

   the tool (6) has a primary hardness generated by quenching and tempering and extending through the entire cross section of the tool (6);
   and the cross section of the wearing portion (Wp) comprises at least one annealed zone wherein hardness of the material is reduced when compared to the mentioned primary hardness.

7. The breaking tool as claimed in any one of the preceding claims 1 -6, **characterized in that**
   difference in hardness values of the at least one harder zone and the hardness of the at least one softer zone is at least 7 HRC.

8. A breaking hammer (1), comprising:

   an elongated body;
   an impact device (4) arranged inside the body and configured to generate impact pulses; and
   a breaking tool (6);
   ch aracterized in that
   the breaking hammer (1) is provided with a breaking tool (6) which is in accordance with claims 1 - 7.

9. A method of maintaining shape of a breaking tool (6) of a breaking hammer (1),
   wherein the method comprises:

   forming the tool (6) of one steel material and heat treating the tool (6) to have designed hardness; and
   providing the tool (6) with a functional end part (Fp) at an end part opposite to an impact end (8);
   characterized by
   providing the tool (6) with a wearing portion (Wp) extending an axial distance from the functional end part (Fp) towards the impact end (8); and
   providing an outer surface (S) of the tool (6) with at least one harder zone (Hz) and at least one softer zone (Sz) at a cross section of the wearing portion (Wp) of the tool (6).

10. The method as claimed in claim 9, **characterized**

by reducing hardness of material of at least one zone (16) on the surface of the wearing portion (Wp) by means of induction heating.

11. The method as claimed in claim 9 or 10, **characterized by**
providing the functional end part (Fp) with a cross-sectional shape having an outer surface shape which deviates from a circular shape.

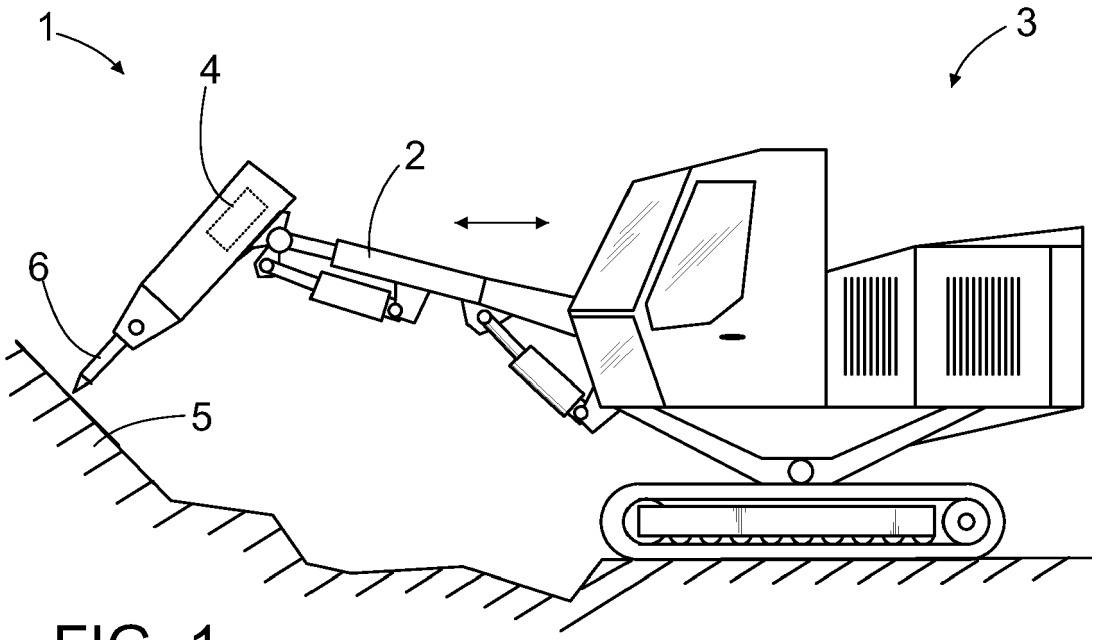

FIG. 1

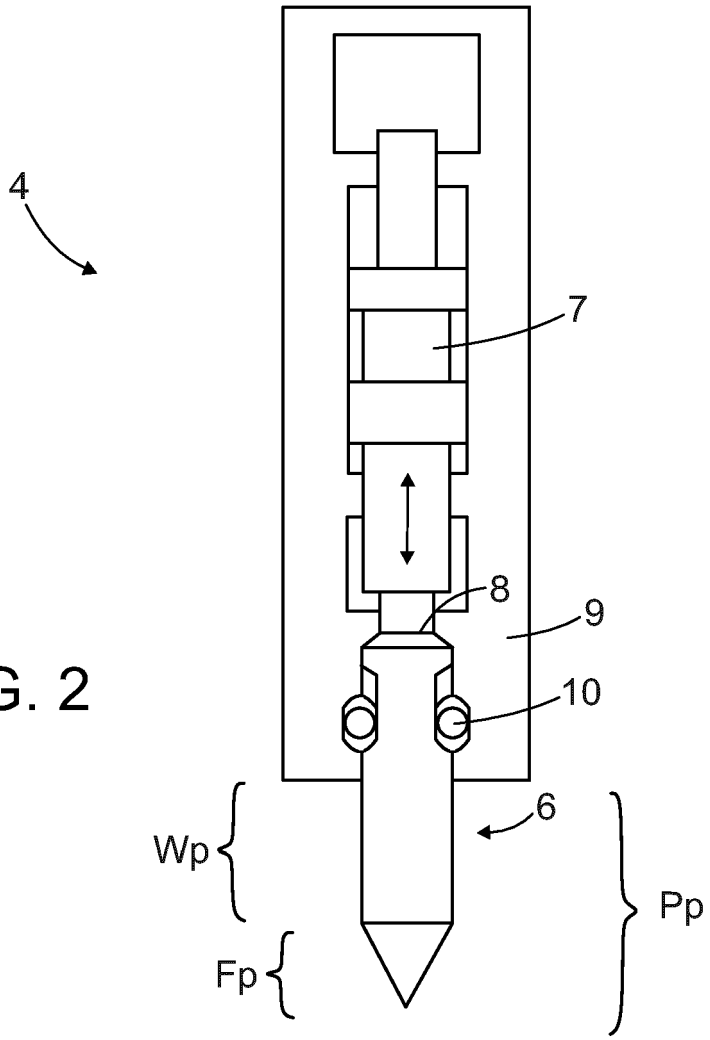

FIG. 2

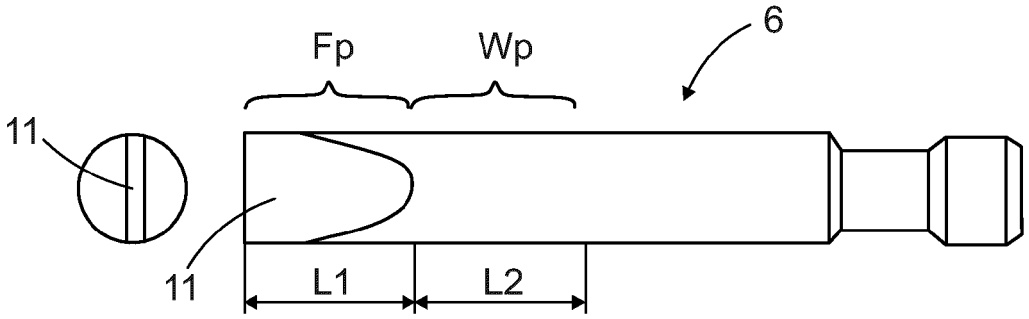

FIG. 3

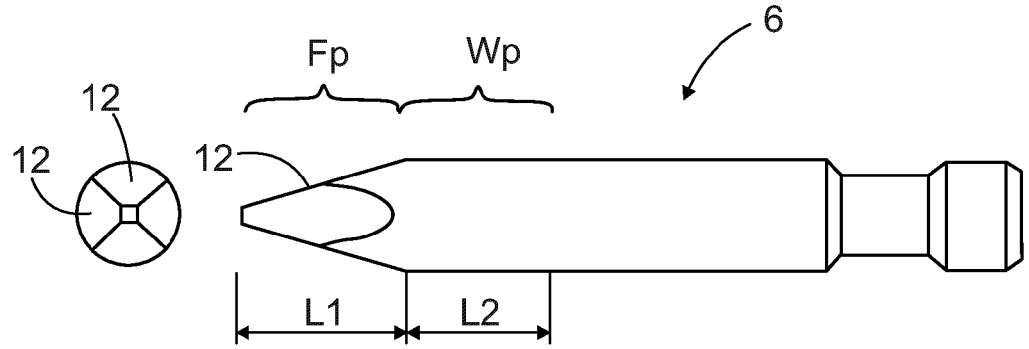

FIG. 4

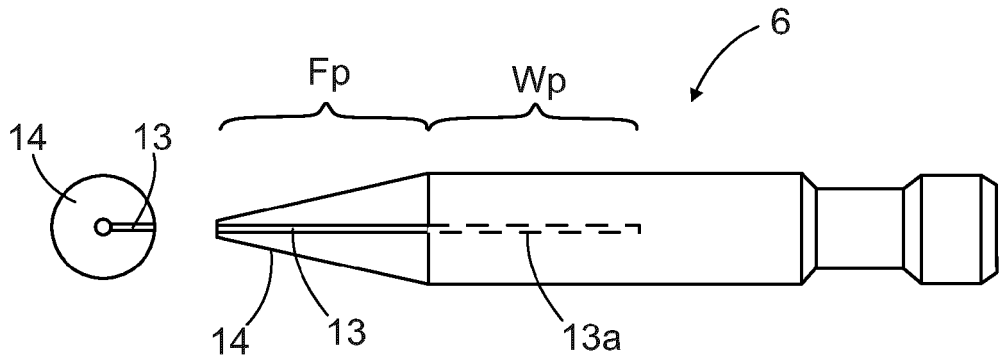

FIG. 5

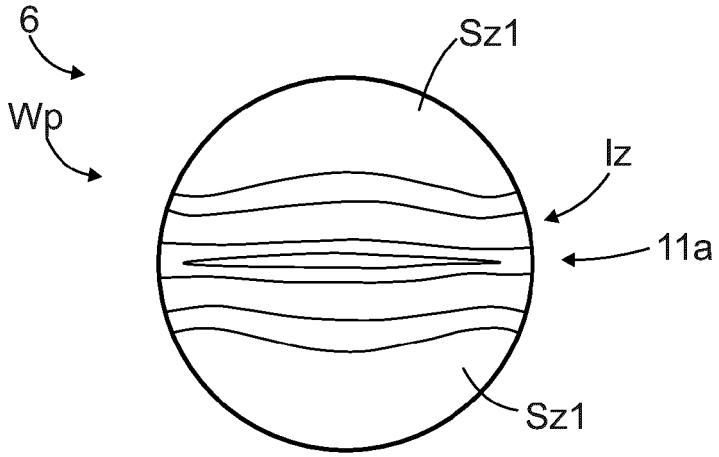

FIG. 6

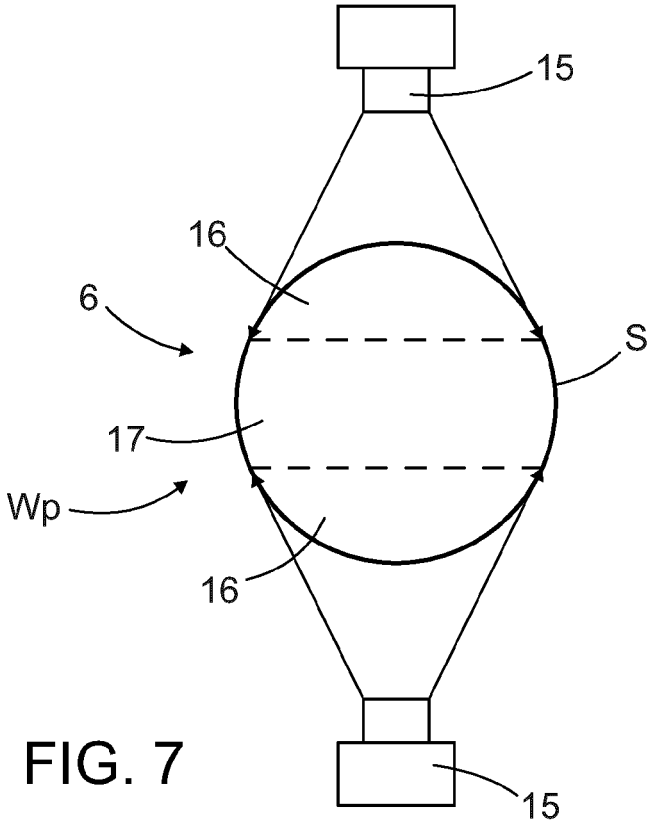

FIG. 7

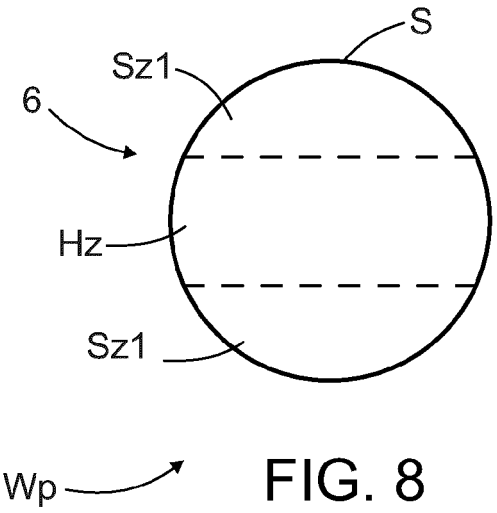

FIG. 8

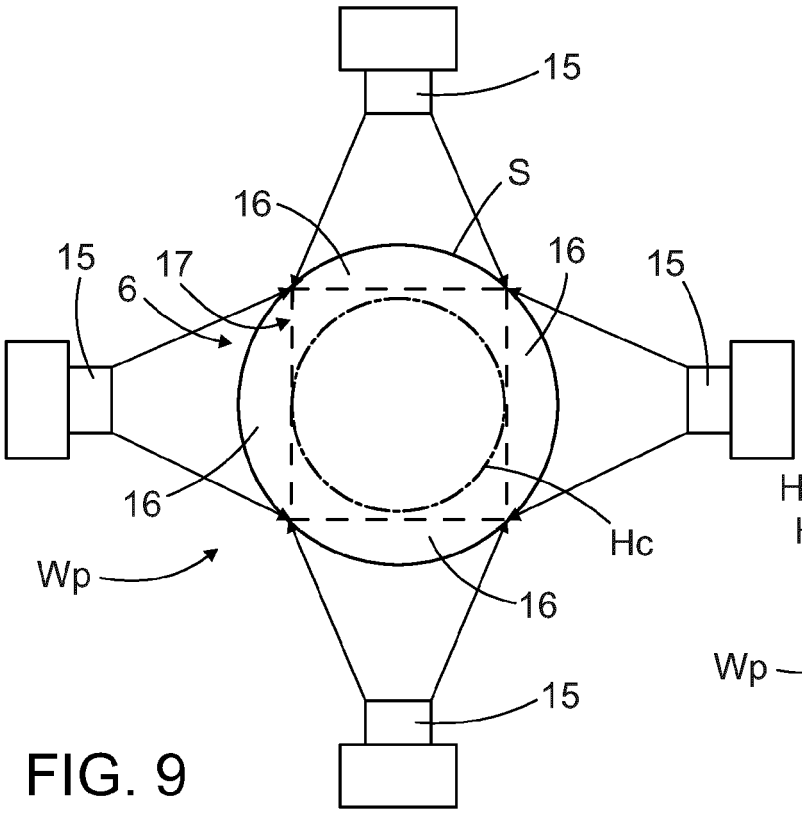

FIG. 9

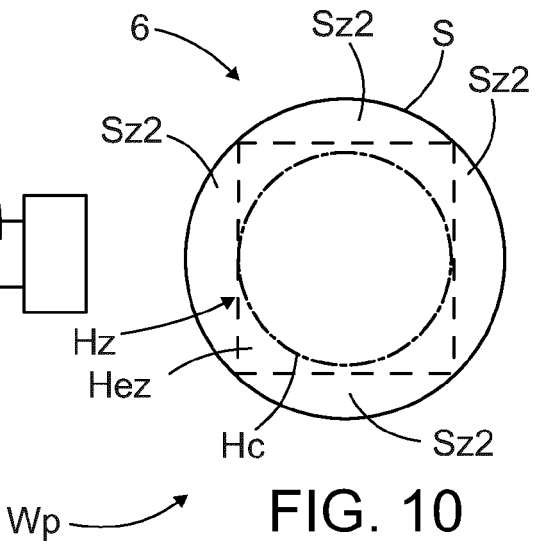

FIG. 10

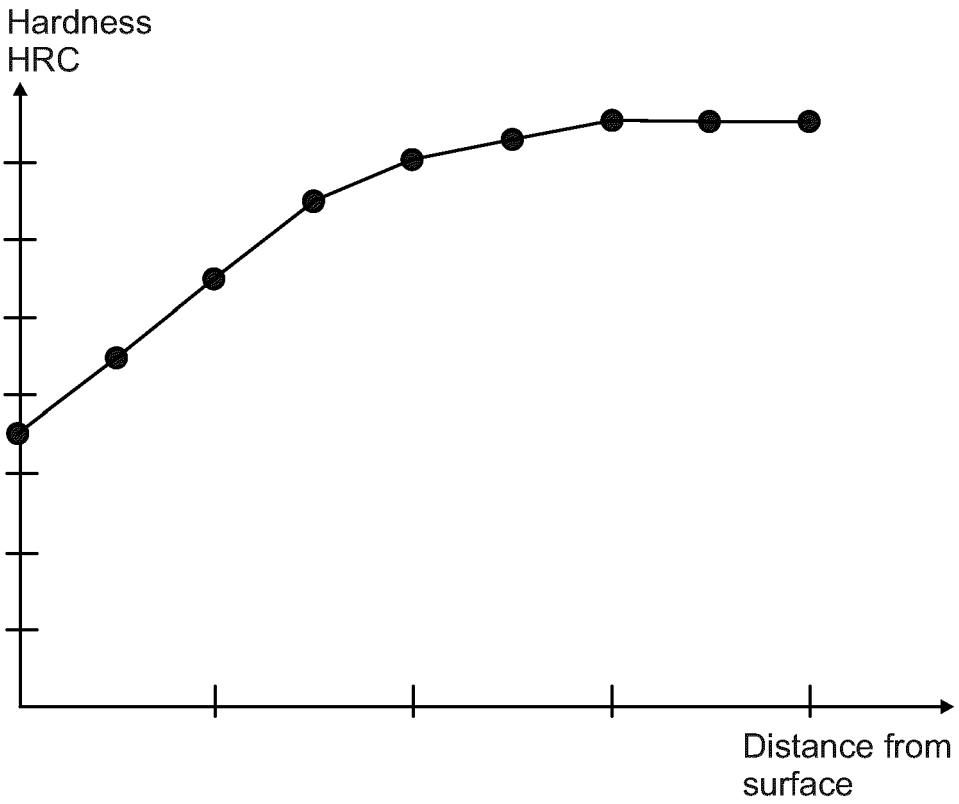

FIG. 11

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EUROPEAN SEARCH REPORT

Application Number
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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
Munich	25 August 2022	Schulz, Andreas

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