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(54) **PRESS HARDENING TOOL**

(75) Inventor: **Markus Löcker**, Finnentrop (DE)

(73) Assignee: **KIRCHHOFF AUTOMOTIVE DEUTSCHLAND GMBH**, Attendorn (DE)

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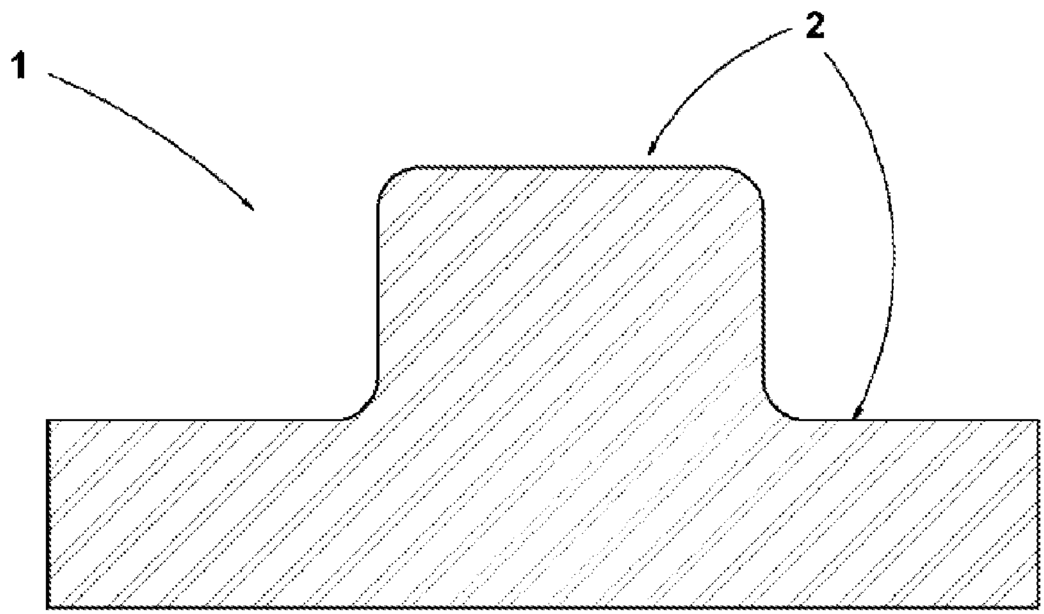
(57) **ABSTRACT**

The invention relates to a press hardening tool having a shaping surface (**2**) that is used to shape a blank. The shaping surface (**2**) of the tool (**1**) is micro-structured at least in some areas by micro-recesses (**3**) introduced into the shaping surface (**2**). In said areas, the contact surface between the shaping surface (**2**) of the tool (**1**) and the surface of a blank is limited to the surface portions (**4**) located between the recesses (**3**) of the forming surface (**2**) and raised with respect to the recesses (**3**).



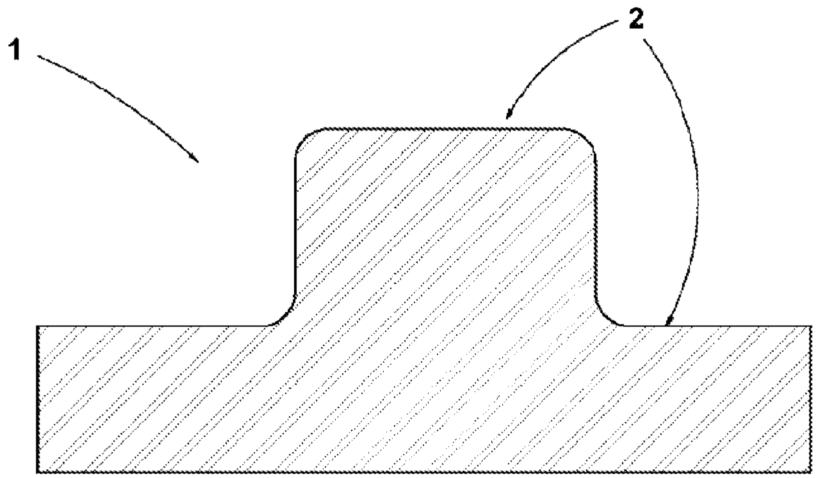


Fig. 1

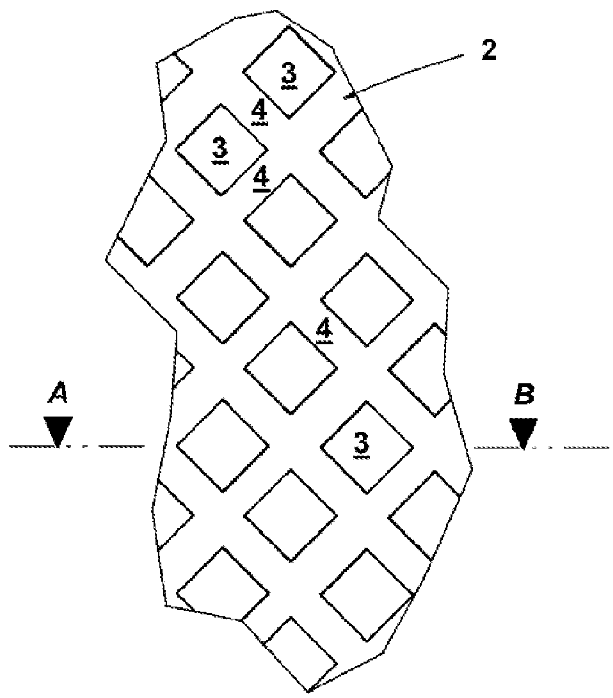


Fig. 2

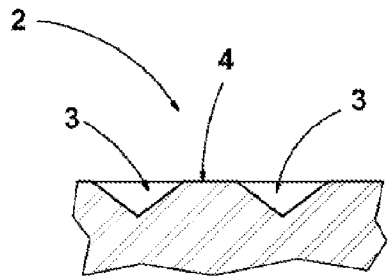


Fig. 3

PRESS HARDENING TOOL

[0001] The invention relates to a press hardening tool having a shaping surface that is used for forming a blank.

[0002] Press hardening tools are tools which are used to form and harden metal blanks. Depending on the design of the method, an appropriately preheated blank is supplied to the press hardening tool for hardening purposes, is formed therein, and then quenched sufficiently rapidly during the forming process for hardening the same. Such press hardening tools are used to produce structural components of motor vehicles, for example. The blanks are typically sheet steel blanks.

[0003] The forming rates of the blanks to be formed by such a press hardening tool are at times considerable. In addition, the formed blanks can have narrow radii. For corrosion protection purposes, the steel blanks to be subjected to the forming process are coated with a metallic anti-corrosive coating, for example they are galvanized or coated with zinc/nickel or with zinc/aluminum, and thus comprise a coating, which is subjected to the forming and hardening process together with the steel blank. When such corrosion-protected blanks are used, however, it has been found that these can be formed only to a limited degree of deformation before the zinc coating becomes damaged. In particular microcracks develop in the metallic anti-corrosive coating on sheet steel thus coated, which can extend through the entire anti-corrosive layer and penetrate as far as into the base material. Under certain conditions, this may impair the function of the component. Compared to an anti-corrosive coating of the press-hardened semi-finished product, the use of galvanized sheets as blanks is preferred.

[0004] A press hardening tool, as has been described above, is disclosed in DE 10 2009 025 821 A1 in connection with a method for producing a metal component.

[0005] Proceeding from this described related art, it is therefore the object of the invention to refine a tool described at the outset in such a way that the same can also be used to form or press harden zinc-coated steel sheets as blanks using higher forming rates and relatively narrow radii. The microcracks primarily develop in those areas where tensile and compressive stresses are superimposed during forming.

[0006] This object is achieved according to the invention in that at least some regions of the shaping surface of the tool are microstructured by micro-recesses introduced into the forming surface, and that, in these regions, the contact area between the forming surface of the tool and the surface of a blank is limited to those area portions that are located between the recesses of the forming surface and raised relative to the recesses.

[0007] This tool has a microstructured surface at least in some regions. If such a microstructuring does not cover the entire forming surface of the tool, the microstructured regions in any case are located in those forming surface regions on which the regions of the blank that are typically subject to damage of the zinc coating are seated. The microstructuring is achieved by micro-recesses that are introduced into the forming surface. The microstructuring is typically designed in such a way that the surface structure of the blank thus does not differ from, or at least does not visually perceivably differ from, the surface that is achieved using a conventional tool without such microstructuring. As a result of this measure, the effective contact area between the forming surface and a blank is limited on this tool to the regions that are raised relative to the recesses. The effective contact area of the microstructured forming surface with the blank is thus reduced as compared to the area of the microstructured forming surface region. As a result of the reduced contact area, the friction acting on the surface of the blank seated thereon is thus also accordingly lower. It is assumed that this constitutes the advantages that can be achieved by the tool. Surprisingly it was found that, when using such a forming surface, it is also possible to subject zinc-coated steel sheets to a press hardening process, in which considerable forming rates and workpieces having narrow radii can be achieved, without the zinc coating exhibiting impermissible damage.

[0008] The microstructuring of the forming surface, or of the forming surface region or regions, is typically created by way of a microforging method, for example by way of a knocking process. The advantage of such a process is that it is not only possible to introduce the micro-recesses per se into the tool surface, but at the same time this process results in strain hardening, and thus in additional hardening, of the forming surface region thus treated. The knocking process can be described particularly well with the method described in WO 2007/016919 A1, however in contrast to the spherical knocking tool described in this prior art, a pointed knocking tool is employed. By this explicit reference to WO 2007/016919 A1, the knocking method described therein is incorporated in the disclosure of this description.

[0009] Such a knocking tool provided with a point may be designed as a conical point, pyramidal point or the like. An embodiment that is preferred is one in which the knock body, and accordingly the micro-recesses generated therewith, have equilateral contour areas, and therefore are designed to be square or in the manner of a rhombus. It is likewise possible to design depressions having more than four sides. The result of a concept design of recesses having straight lateral faces is that the lands remaining between the recesses, which are raised regions, have a uniform land width. The effective contact area between two recesses over the extensions thereof, and thus the friction between these sections and the blank to be formed, is thus the same.

[0010] The recesses can typically be designed in the manner of a geometric grid, or at least substantially close to such a grid. Depending on the configuration of the grid, and hence the size of the recesses in terms of the diameter and the distance of the recesses from each other, the effective contact area of the microstructured forming surface region or regions can be adjusted. It goes without saying that even small reductions in the effective contact area result in reduced friction, and thus in the option of forming, for example, zinc-coated steel sheets using higher forming rates. On the other hand, it becomes understandable that the lands which remain between the recesses, and the upper faces of which represent the effective forming surface, cannot be reduced to an absolute minimum because then the forming surface would no longer exhibit the necessary tool strength. It has been found that a reduction in the effective contact area of the microstructured forming surface regions to 70% would allow semi-finished products having the desired forming rates and the desired, even narrow, radii, to be produced, without the zinc coating of the corrosion protection experiencing adverse changes. A contact area that corresponds to 60% to 65% of the microstructured forming surface region is considered to be particularly advantageous. In the event that the forming process is carried out with the assistance of lubricants, the microstructured forming surface regions must only have an effective contact area of 80% to 85% of the microstructured forming surface region.

[0011] Further advantages of the embodiment of the invention will be apparent from the following description of one exemplary embodiment with reference to the accompanying drawings, in which:

[0012] FIG. **1**: shows a schematic side view of a tool as part of a press hardening tool;

[0013] FIG. **2**: shows a drastically enlarged top view onto a section of the forming surface of the tool of FIG. **1**; and

[0014] FIG. **3**: shows a sectional view through the section of the forming surface along line A-B of FIG. **2**.

[0015] A tool **1** is part of a press hardening tool, which otherwise is not shown in greater detail and is provided, for example, for producing a structural motor vehicle component. The press hardening tool is used to form and harden a blank in one operation, which in the present case is a galvanized steel sheet blank. The tool shown in FIG. **1** has a forming surface **2**, which in the exemplary embodiment shown has a simple geometry. The forming surface **2** of the tool **1** can be used to produce U-shaped beams from flat steel sheets as the blanks using a complementary counter-tool, which is not shown.

[0016] The concept design of the forming surface **2** is a special characteristic of the tool **1**. This surface is microstructured by way of a microforging method, and more particularly, as is apparent from FIG. **2** in a drastically enlarged top view onto the forming surface **2** of the tool **1**, by introducing square or rhombic micro-recesses **3**. The recesses **3** are evenly spaced from each other, leaving a land **4** in each case. The recesses **3** are arranged in the manner of a grid with respect to each other. In the exemplary embodiment shown, one corner of the recesses **3** is pointed into the anticipated movement direction of a blank to be formed on the forming surface **2**. The micro-recesses **3** of the exemplary embodiment shown have a diameter of approximately 5 μm.

[0017] FIG. **3** is a cross-sectional view of the section of the forming surface **2** having the micro-recesses **3** introduced therein and the lands **4** located between the micro-recesses **3**. The upper faces of the lands **4** constitute raised regions and represent the original forming surface **2** before the micro-recesses **3** were introduced therein.

[0018] In the exemplary embodiment shown, the entire forming surface **2** of the tool **1** is microstructured in the described manner. It goes without saying that, in general, it is sufficient to provide only those regions or sections of the forming surface of such a tool with such microstructuring on which particular friction is to be expected between the forming surface **2** and the surface of a blank to be formed by way of the tool **1**.

[0019] In the exemplary embodiment shown, the microstructuring introduced by the recesses **3** was introduced into the original forming surface of the tool **1** by way of a knocking method. For this purpose, the method described in WO 2007/016919 A1 using a pyramidal knocking tool was employed.

[0020] During use of the tool **1**, the blank is seated only against the raised regions of the forming surface **2** which are formed by the lands **4**. As a result of the dimensioning of the recesses **3**, the blank **3** is not pushed into the recesses **3** during the pressing and forming operation. The surface of the blank—in particular a galvanized steel sheet—to be press-hardened by way of the tool **1** rather remains unchanged, at least visually. The top view onto a drastically enlarged section of the forming surface **2** in FIG. **2** demonstrates that, as a result of the micro-recesses **3**, the effective contact area, which is formed by the upper faces of the lands **4** and which provides the forming surface **2** and against which a blank is seated or becomes seated for forming the same, is quite significantly reduced as compared to the area proper of the forming surface **2**.

[0021] The micro-recesses **3** of the exemplary embodiment shown are provided in the manner of a grid, and thus in a regular arrangement. It goes without saying that the same advantages can also be achieved with a tool in which the micro-recesses have an irregular distribution on the microstructured surface of the tool.

[0022] Using the tool **1** as part of the press hardening tool, it is possible to produce the structural motor vehicle components to be generated from galvanized steel sheets because of the microstructuring of the forming surface **2**, wherein the zinc coating experiences no—if any—intolerable damage in the course of the press hardening process.

[0023] In one embodiment, which is not shown in the figures, it is provided to introduce a lubricant into the micro-recesses, which further reduces the friction between the forming surface and the blank to be formed. In this exemplary embodiment, the micro-recesses **3** are thus used to reduce the effective contact area as compared to the original area of the forming surface, and also as a reservoir for a lubricant. In this embodiment it is therefore not absolutely necessary to additionally introduce a lubricant into the press hardening operation, should this be desired.

[0024] The invention was described based on one exemplary embodiment. A person skilled in the art will infer further options from the disclosure of the present description as to how the invention can be implemented within the scope of the present claims, without the need for describing this in detail.

LIST OF REFERENCE NUMERALS

[0025] **1** tool

[0026] **2** forming surface

[0027] **3** recess

[0028] **4** land

1. A press hardening tool having a shaping surface (**2**) used for forming a blank, characterized in that at least some regions of the shaping surface (**2**) of the tool (**1**) are microstructured by micro-recesses (**3**) that are introduced into the forming surface (**2**) and, in these regions, the contact area between the forming surface (**2**) of the tool (**1**) and the surface of a blank is limited to those area portions (**4**) that are located between the recesses (**3**) of the forming surface (**2**) and are raised relative to the recesses (**3**).

2. The tool according to claim **1**, characterized in that the micro-recesses (**3**) are arranged in the manner of a grid with respect to each other.

3. The tool according to claim **1** or **2**, characterized in that the recesses (**3**) have an angular, in particular equilateral, contour geometry, for example a rhombic contour geometry.

4. A tool according to any one of claims **1** to **3**, characterized in that the effective contact area of the forming surface (**2**) is less than 70 percent of the microstructured region.

5. A tool according to any one of claims **1** to **4**, characterized in that only certain forming surface regions of the tool are microstructured.

6. A tool according to any one of claims **1** to **5**, characterized in that the microstructured forming surface region or regions of the tool are created by way of a microforging method, in particular by way of a knocking method.

7. A tool according to any one of claims **1** to **6**, characterized in that the micro-recesses are applied in the manner of an irregularly designed arrangement and surface texture.

8. A tool according to any one of claims **1** to **7**, characterized in that added solid and/or liquid lubricants are tapped into the micro-recesses.

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