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SHAVING HEAD AND PROCESS FOR PEELING OF CYLINDERS,
CYLINDER TUBES AND THE LIKE

The invention relates to a shaving head and process for peeling cylinders, cylinder tubes and the like, making use of a shaving head, whereby the shaving
5 head is provided with a number of peeling blades arranged radially and floating in the shaving head.

Such processes and shaving heads are known, for example, from DE 22 23 969 or DE 27 23 622. They serve in the machining, and in particular the fine machining, of cylindrical hole walls such as are found, for example, in hydraulic
10 cylinders and cylinder tubes. Such hole walls are fine-machined most economically by peeling and smooth-rolling. Initial materials are, as a rule, drawn precision steel tubes or soft steel tubes with prepared by boring out, with a small machining tolerance of approx. 0.3 to 1 mm in diameter. These tubes feature straightness errors incurred by manufacturing, which are not detrimental
15 to the purpose of the tubes and which therefore do not need to be corrected by the peeling process.

However, the surface of the hole wall must be peeled and smooth-rolled over the full surface even with cambered cylinders. Under the given conditions, a precondition for this is that the peeling blade follows the macroform of the tube
20 at almost constant chip depth. To achieve this, peeling blades arranged in floating fashion have proved their worth, such as are known, for example, from DE 27 23 622 or DE 25 18 170 already referred to. The shaving head in this situation is capable of free radial movement in two planes in relation to the tool, and the peeling blade(s) is/are in addition capable of radial movement.

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The known arrangement of the peeling blades guarantees the self-centering of the blades due to the passive cutting forces of both cutting edges even when the shaving head is not rotating centrically due to the effect of outside forces. A disadvantage with this arrangement, however, is that the peeling blades, 5 equipped with two mutually-opposed cutting edges, does not necessarily create a circular hole. Rather, such peeling blades can carry out a radially floating movement during the rotation of the shaving head, and in this situation create a hole cross-section which deviates from the circular. This movement can be incurred due to an error in roundness already present in the tube, or a slight 10 disturbance in the balance of force, possibly due to fluctuating passive cutting force with regular intentional chip breakage; and may build up and propagate over the entire machining length.

Characteristic of such hole profiles is that the hole, measured between two mutually-opposed points, may indeed feature a constant diameter, but that the 15 interior enveloping circle is smaller and the outer enveloping circle larger than the peeling diameter measured in the two-point process. In this situation "polygons" may be formed, with 3, 5, 7 or more "corners". These errors in roundness may lead to problems with the assembly of pistons and seals. The error in roundness frequently runs over the length of the tube with an angle 20 offset from one tool revolution to the next, with the result that a helical contour of the cylinder hole is obtained, which as a rule is regarded as a quality deficiency.

Tools without floating blades are also known. These include the reamers such as are described in DE 19 62 181 B, DE 16 52 790 A, DE 73 21 746 U, and 25 US 26 38 020. The reamer blades are all only capable of adjustment jointly, by the same dimension in relation to the basic structure of the tool, and are



therefore not installed in a radially floating manner. Reamers are conceptually designed to produce holes with the smallest possible errors in straightness. The further continuation of machining is therefore effected in continuation of the previous direction of the hole bore. If the previous bore was cambered, it is
5 expected of the reamers that they will as far as possible eliminate this cambering.

Cylinder tubes are manufactured from drawn precision steel tubes with a length of up to 10 metres. Due to the chipless manufacturing process employed hitherto, these tubes feature errors in straightness of up to 2 mm/m. At the same
10 time, however, for reasons of costs and in order to save material, work is carried out with machining tolerances of less than 1 mm in the diameter. This means that insufficient machining tolerance is provided to make a straight hole out of the cambered hole. To achieve this, with the camber indicated heretofore, a machining tolerance of at least 4 mm in the diameter would be required. Tools
15 which, like the reamers described earlier, are designed for the manufacture of the straightest possible holes, would in some situations reduce a great deal of material to chips, and in return would leave other places unmachined. Accordingly, the requirement is imposed on a shaving head for the peeling of cylinders, cylinder tubes, and the like, for the shaving tool to follow the
20 macroform of the hole during machining, and accordingly repeats the existing errors in straightness. The reamers do not meet this requirement.

Taking this as a basis, the problem of the invention is of providing a shaving head and process for peeling which will allow for errors in roundness to be eliminated as far as possible, and to prevent the occurrence of helical waves.



The problem is resolved by a shaving head with peeling blades arranged radially floating in the shaving head, in which at least three peeling blades are provided for. With such an arrangement of the shaving head, both the requirement for self-centering of the peeling blade set as well as circular peeling geometry with
5 constant cutting depth will be fulfilled.

In addition to this, the invention has the great advantage that due to the provision of at least three peeling blades the peeling capacity can be increased in relation to known shaving heads with only two peeling blades.

In a preferred embodiment of the invention, in which the shaving head features
10 a central axis, provision is made for adjacent peeling blades seen in the direction of the central axis of the shaving head to be arranged in each case at similar angular distances to one another. This guarantees the greatest possible centering probability in every rotation position of the shaving head. The angular distance would accordingly be 120 degrees with three peeling blades, 90 degrees with
15 four peeling blades, 72 degrees with five peeling blades, and 60 degrees with six peeling blades. These angles may vary slightly from sector to sector if appropriate in order to avoid shatter marks.

In another preferred embodiment of the invention, in which the shaving head has a central axis and each peeling blade featured at least one cutting edge,
20 provision is made for at least three cutting edges of different peeling blades to be arranged rotationally symmetrically to the central axis of the shaving head, which means that to one cutting edge of a peeling blade corresponding cutting edges of up to at least two other peeling blades are provided for, so that corresponding points of corresponding cutting edges define a plane which runs
25 perpendicular to the central axis of the shaving head. Because the central axis of



the shaving head is the main axis of rotation during the operation of the head, this arrangement of the cutting edges likewise has a positive effect on the centering of the shaving head in the hole which is to be peeled out.

The peeling capacity can be further increased by each peeling blade featuring at
5 least two cutting edges.

In a particularly advantageous embodiment of the invention, all peeling blades are supported directly or indirectly by a common conical or pyramidal body arranged in a displaceable manner in the shaving head, and can be displaced by means of this body radially to the shaving head. In this situation, depending on
10 the design of the shaving head, the body may also take the form of a cone or truncated cone as well as of a pyramid or truncated pyramid, whereby the term pyramid is not restricted here in the conventional sense to such regular polyhedra as have a square base and four congruent isosceles triangles as side surfaces, but is to be understood in the meaning of the geometric definition, and
15 in particular may have a base with as many sides as peeling blades are provided.

Both a conical and pyramidal body allow to advantage, by simple displacement of the body along the central axis of the shaving head, for the peeling blades to be pressed radially outwards, and in this way the corresponding peeling diameter can be adjusted in a particularly simple manner.

20 In this situation it has proved particularly advantageous in operation for the conical or pyramidal body to be arranged floating in the shaving head. To advantage also is the provision of means for the changeable determination of a first relative position of the conical or pyramidal body relative to the peeling blades, whereby the conical or pyramidal body can be subjected to preliminary
25 tension by appropriate spring media into the first relative position. This first



relative position is as a rule the operating position of the shaving head, in which the peeling blades are therefore adjusted to the desired peeling diameter.

In order to be able to withdraw the shaving head from the peeled-out body easily and without the occurrence of markings, the conical or pyramidal body
5 can be designed in such a way that it is capable of being moved against the preliminary tension by the use of an outer force, and a hydraulic force in particular, into a second relative position relative to the peeling blades, whereby this second relative position corresponds to the withdrawn position of the peeling blades, so that this is accordingly no longer located close to the surface
10 to be peeled out and the shaving head is capable of being moved and positioned in the body which is to be peeled out.

In order to guarantee that the peeling blades are always in contact satisfactorily, directly or indirectly, in the conical or pyramidal body, and therefore, by changing the relative position of conical or pyramidal body and peeling blades,
15 follow the desired setting of the peeling diameter, provision can be made to advantage of spring media which subject the peeling blades to preliminary tension against the conical or pyramidal body.

It is to advantage if these second spring media are arranged in such a way that their direction of effect does not run through the center of the tool.

20 In order to prevent the tilting of the peeling blades, it is further proposed that the peeling blades be guided in guides, of which the length to breadth ratio is greater than 1.5, and for preference greater than 2. The ratio of length to breadth may even reach 4 or 5 in order to achieve good guidance effect. In this context, the term length is to be understood to mean the extension of the guide in the



radial direction, while the term breadth is to be understood to mean the extension of the guide in the axial direction.

The problem in question is further resolved by a process for peeling out a cylinder, cylinder tube, or the like by means of a shaving head introduced into
5 the body which is to be peeled out with a central axis and a number of peeling blades, whereby a shaving head is used with at least three peeling blades radially movable relative to the central axis of the shaving head.

In a preferred embodiment of the process, whereby each peeling blade used features at least one cutting edge, provision is made for the radial distance
10 between the cutting edges and the central axis of the shaving head, and therefore the shaving diameter, to be adjusted by means of a conical or pyramidal body arranged so as to be capable of movement in the shaving head.

Further details and advantages of the invention are derived from the following description, purely exemplary and not restrictive, of an embodiment of a
15 shaving head according to the invention, in conjunction with the drawings, in which

Fig. 1 shows a shaving head according to the invention in a partially sectional side view along the central axis,

Fig. 1a is a detailed view of the shaving head shown in Figure 1, in the
20 area of the blades,

Fig. 2 is a partially sectional view of the shaving head according to Fig. 1, seen in the direction of the central axis,



Fig. 3 illustrates the means of effect of the centering forces during the operation of the shaving head, and

Fig. 4 shows an alternative embodiment of a shaving head in a partially section side view along the central axis.

- 5 In Figures 1 to 3 a shaving head is shown designated in its entirety by 9, in which a total of six peeling blades 10 are arranged in a radially displaceable manner in a cylindrical housing 11.

Each peeling blade 10 is provided in this embodiment with two cutting edges 3 and 3'. The peeling blades 10 are guided in guides 10' with large length-to-
10 breadth ratios, which prevent the tilting of the peeling blades. In the embodiment shown, this guide is more than three times longer than wide, and to be precise even more than five times.

As indicated in Fig. 2 with only one blade, each peeling blade 10 is pressed by spring media, in this case in the form of pressure spring elements 13, radially
15 inwards against a conical body serving to adjust the peeling diameter, in this case in the form of a truncated cone 12. For this purpose each peeling blade 10 features a mounting 13' for one pressure spring element 13 in each case, whereby it is emphasised once again at this point that, as a departure from Fig. 2, each peeling blade 10 is subjected to preliminary tension by means of a
20 pressure spring element 13 in the direction onto the cone, as indicated by the arrows 13" in Figures 2 and 3, of which only a few have been provided with reference indicators for the sake of easier overview.

The pressure spring elements 13, during the peeling process and in the introduced state, in which the peeling blades are located in a withdrawn position



seen in a radial direction seen towards the central axis, provide for sustained contact of the blades 10 with the truncated cone 12.

To determine a first relative position of the truncated cone 12 and peeling blades 10, a screw- spacer element combination 15 is provided for. Spring media, in this case in the form of a coil spring 14, tension the truncated cone
5 into this relative position, which corresponds to the operating position in which the tool is ready to carry out peeling.

By the application of a force in the direction of the arrow 16, for example by means of an inherently known hydraulic system, not shown here in any greater
10 detail, the truncated cone 12 can be displaced along the common central axis 16' of shaving head 9 and truncated cone 12 against the preliminary tension of the spring 14, as a result of which the peeling blades 10 move radially inwards into a withdrawn position.

The truncated cone 12 is arranged floating in the shaving head 9. As shown in
15 Fig. 3, an error in straightness of a cylinder tube which is to be peeled out by the dimension 19 means a change in the hole contour 17 and the hole axis 17a by the dimension 19 into the position 18 or 18a respectively. This leads to an increase in the passive cutting forces of all the cutting edges operating in the drawing above the center, and at the same time to a decrease in the lower forces
20 in the drawing. The truncated cone 12 reacts to this with a radial downwards movement 20 by the dimension 19. In this way the entire blade set centers itself, while maintaining the envelope geometry onto the new tube center. Accordingly the requirements for the self centering of the peeling blade set, circular peeling geometry, and consistent cutting depth are fulfilled. The compensation
25 movement is effected under the rotation of the peeling tool or continuously with



the tool at a standstill and with the tool rotating, and can be carried out in any desired direction depending on the tube camber.

Figure 4 shows an embodiment in which the force 16" engages on the broad side of the truncated cone 12" and the coil spring 14' engages by means of the screw-spacer combination 15' on the smaller diameter of the truncated cone 12". This arrangement also incurs a displacement of the cutting edges 3" and the peeling blade 10' relative to the housing 11'.

Numerous divergences and further embodiments are possible within the framework of the concept of the invention, which relate, for example, to the number and arrangement of the peeling blades and cutting edges. It is possible, for example, in particular for peeling out large diameters, to use shaving heads which feature more than the three peeling blades shown by way of example. Central to the invention in any event is the fact that provision is made for more than two peeling blades, which clearly reduces the probability of occurrence of unintentional radial oscillation.

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CLAIMS

1. A shaving head (9) for peeling out of cylinders, cylinder tubes and the like, with peeling blades arranged floating in the shaving head, characterized in that at least three peeling blades (10) are provided for.
- 5 2. A shaving head according to Claim 1, whereby the shaving head features a central axis (16'), characterized in that adjacent peeling blades (10) are arranged at similar angular distances to one another seen in the direction of the central axis (16') of the shaving head (9).
- 10 3. A shaving head according to Claim 1 or 2, whereby the shaving head (9) features a central axis (16') and each peeling blade (10) at least one cutting edge (3, 3'), characterized in that at least three cutting edges of different peeling blades are arranged rotationally symmetric to the central axis of the shaving head.
- 15 4. A shaving head according to one of Claims 1 to 3, characterized in that all peeling blades (10) are supported directly or indirectly by a common conical or pyramidal body (12) movable arranged in the shaving head, and are capable of being moved by said body radially in relation to the shaving head.
- 20 5. A shaving head according to Claim 4, characterized in that the conical or pyramidal body (12) is mounted floating in the shaving head (9) with two degrees of freedom (12, 12').
6. A shaving head according to Claim 4 or 5, characterized in that means (15, 15') are provided for the changeable determination of a first relative



position of the conical or pyramidal body (12) relative to the peeling blades (10).

7. A shaving head according to Claim 6, characterized in that first spring media (14) are provided for the preliminary tensioning of the conical or pyramidal body (12) into the first relative position.
8. A shaving head according to Claim 7, characterized in that the conical or pyramidal body is capable of being moved against the preliminary tension by the application of an external force (16), in particular a hydraulic force, into a second relative position.
9. A shaving head according to one of Claims 4 to 8, characterized in that second spring media (13) are provided for the preliminary tensioning of each peeling blade against the conical or pyramidal body (12).
10. A shaving head according to Claim 9, characterized in that the second spring media (13) are arranged in such a way that their direction of effect does not run through the center of the tool.
11. A shaving head according to one of the preceding claims, characterized in that the peeling blades (10) are guided in guides (10'), of which the ratio of length to breadth is greater than 1.5, and for preference greater than 2.
12. A process for the peeling out of a cylinder, cylinder tube or the like, by means of a shaving head introduced into the body to be peeled out, with a central axis and a number of peeling blades, characterized in that a shaving head is used with at least three peeling blades capable of movement radially to the central axis of the shaving head.

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13. A process according to Claim 12, whereby each peeling blade features at least one cutting edge, characterized in that the radial distance between the cutting edges to the central axis of the shaving head is adjusted by means of a conical or pyramidal body arranged movable in the shaving head.
14. A process according to Claim 13, characterized in that the peeling blades are subjected to preliminary tension against the conical or pyramidal body.
15. A process according to Claim 13 or 14, characterized in that the conical or pyramidal body is subjected to preliminary tension into a first relative position (operating position) relative to the peeling blades.
16. A process according to Claim 15, characterized in that, to displace the shaving head in the peeled-out body without machining the body, the conical or pyramidal body is pressed into a second relative position by the imposition of an external force, and a hydraulic force in particular, against the preliminary tension, in which position the radial distance between the cutting edges and the central axis of the shaving head is smaller than in the operating position.
17. Bodies, in particular cylinders and cylinder tubes, with a cylindrical cavity, characterized in that the cavity was machined with the use of a shaving head according to one of Claims 1 to 11 and/or in accordance with a process according to one of Claims 12 to 16.

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