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(54) **Mixing tool**

(57) The invention relates to a mixing tool 1 for mixers with a mixing container.

In order to realize energy-efficient mixing with a high mixing performance, it is proposed to provide on the mixing tool 1, seen in the direction of rotation, a mixing member 4 with an opening 2, with the mixing member 4 pref-

erably being configured in such a way that a converging flow of the mixing material opposite to the direction of rotation of the mixing tool can be generated. The mixing tool is particularly suitable for mixing solids, such as bulk material, and on the whole leads to reduced energy requirements.

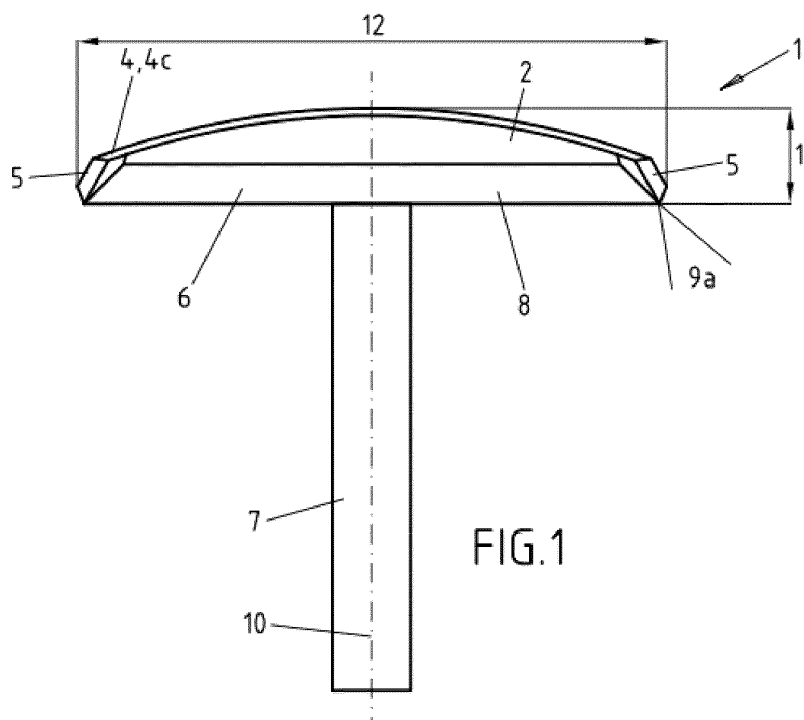


FIG.1

Description

[0001] The invention relates to a mixing tool according to the preamble of claim 1.

[0002] The mixing tool concerned is suitable for mixing solids, solid-liquids or also liquids. The mixing of solids, such as bulk materials, results in particularly high requirements as regards the mixing tool. The high mechanical resistances cause correspondingly high breakaway torques for starting the mixing process, so that a high power consumption on the drive of the mixer is the result. Accordingly, an efficient operation of the mixer is not possible.

[0003] As a rule, attempts are being made to obtain a good mixing performance with suitable mixing tools and high torques on the drive shaft. For this purpose, it is necessary to design the mixer, the drive means and the mixing tool so as to be capable of dealing with correspondingly high loads in order to meet the high mechanical requirements particularly when mixing solids.

[0004] The achievable mixing effect, the long operating time and, not least, the low wear are essential criteria in the design of mixing tools of the type concerned ,

[0005] Mixing tools designed like ploughshare blades, as they are disclosed in DE 1 276 986, are known. They comprise a mixing tool for mixers with a, for example, drum-shaped mixing container, in which the mixing tool revolves with its edges spaced a short distance from the mixing container wall. Lifting ribs that enable a high specific mixing effect are provided at the rear end of the mixing tool by means of cutouts in the upper region of the lateral surfaces. However, the ploughshare-like mixing tool is not satisfactory with regard to energy efficiency.

[0006] Furthermore, a shearing/mixing tool is known from DE 10 2009 01817 A1, which comprises a shearing/throwing blade, an arm and a preferably triangular opening interposed therebetween. The opening serves for the improved fluidization in the drying phase and, if necessary, a better thorough mixing of the components during the mixing process. The shearing/mixing tool is primarily designed to achieve, in addition to a mixing effect, a restructuring of the material in the mixing material. For this purpose, the arm is straight, bent and/or slanted in order to promote the shearing action of the shearing/mixing tool.

[0007] The invention is based on the object of improving and further developing the known mixing tool, particularly with regard to the energy efficiency during mixing,

[0008] The object is achieved with a mixing tool according to claim 1. Advantageous embodiments and developments are apparent from the dependent claims.

[0009] What is essential is the idea of providing an opening on the mixing member that goes through in the direction of rotation. Preferably, the opening is configured in such a way that a converging flow of the mixing material opposite to the direction of rotation can be generated with the mixing member. "Flow" means the quantity of substance passing through the opening of the mixing mem-

ber, wherein substances in gaseous, liquid and/or solid states of aggregation can, in principle, be used as starting materials for the mixing material.

[0010] The proposed solution is advantageous in that a considerably lower resistance, particularly when starting the mixing process, is obtained by means of the mixing member with the opening. Consequently, the breakaway torque is reduced. The weight reduction in the mixing tool, which is additionally achieved by means of the opening in the mixing member, and the moment of inertia altered thereby also has an effect on the general mixing operation. Thus, the power consumption of the drive means during mixing can be reduced, so that the overall energy requirements are reduced, irrespective of the filling level of the mixing container. At the same time, it was found that the mixing effect and achievable mixing quality is maintained, so that a good specific mixing performance is made possible in an efficient manner. Seen over the entire operating time, large energy savings can thus be accomplished.

[0011] In a preferred embodiment of the invention, the opening of the mixing member is configured in an arc-shape or circular-arc shape at least in some regions, preferably on the side of the mixing member facing away from the supporting arm. In conjunction with the, in particular cylindrical, mixing container, an optimum adaptation of the mixing member to the mixing container thus becomes possible. Thus, product depositions or caking of the mixing material to the walls of the mixing container can be prevented in an improved manner.

[0012] In a particularly preferred configuration, the mixing member comprises an arc-shaped section, at least one lateral rib and/or one central rib. In this way, a particularly rugged and load-adapted configuration of the mixing member, particularly for mixing solids, can be obtained.

[0013] In a further improved configuration, an inflow side on the mixing member has a larger cross section than an outflow side. Alternatively or additionally, the opening of the mixing member is configured to taper in an opposite direction to the direction of rotation. In that case, the mixing member is preferably equipped with slanted inner faces, for example on the arc-shaped section, on the lateral rib and/or the central rib. The cross section of the inflow side, which is larger in comparison with the outflow side, provides for a converging flow of the mixing material on the mixing member. If a substance to be mixed gets into the opening of the mixing member, a converging flow is generated by the rotation of the mixing tool in the direction of rotation. The converging flow can be adjusted in a specific manner by means of the slanted inner faces on the mixing member. The substances of the mixing material, e.g. particles of a bulk material, are then reflected or deflected correspondingly on the inner faces of the mixing member. At higher rotational speeds of the mixing tool in the mixing container, the reflection of the mixing material on the inner faces causes a reduced influence of the opening on the overall mixing

effect, just as if it was not present. Thus, the mixing effect can be adjusted in a specific manner depending on the rotation of the mixing tool. It is advantageous, in particular, that the breakaway torque during the start as well as the power consumption during the mixing process are reduced by the proposed mixing tool. Accordingly, the mixing member, the mixing tool and the drive means are subjected to lower torques and can be dimensioned accordingly. With regard to the production process, the mixing tool can be manufactured with a reduced material thickness. Excess capacities and reactive current components can also be reduced in the case of drive means, such as electric motors.

[0014] In another embodiment, the distance between the Inflow side and the outflow side of the mixing member is at least 20 mm, more preferably at least 40 mm. Such a distance thus improves the conveying characteristics for a converging flow on the mixing member. Given a correspondingly fast rotation of the mixing tool, the specific mixing performance is improved at the same time.

[0015] In order to optimize the resistance of the mixing tool, in particular of the mixing member, the mixing member can expediently also be configured in a substantially shovel-shaped manner, with the opening in that case forming a cutout on the inside of the shovel shape.

[0016] In a preferred embodiment, the height of the mixing member, seen from the front, is smaller than the width of the mixing member, preferably by at least 30 %, more preferably by at least 50 %. The resistance during the mixing process can thus be optimized even further. Alternatively or additionally, the mixing member can also comprise on the inflow side a frontal edge which is preferably formed, seen in the direction of rotation, in the shape of a blade edge, in particular so as to taper to a point.

[0017] It is particularly advantageous to dispose the mixing member, seen from the side of the mixing tool, at an angle on the supporting arm. Preferably, the mixing member forms an angle of 10 ° to 50 °, more preferably of 20 ° to 40 ° to the supporting arm axis. The slanted arrangement of the mixing member on the supporting arm enables defined conveying characteristics of the mixing material. Product depositions or caking of the mixing material to the walls of the mixing container can also be prevented in an improved manner with the optionally protruding arc-shaped section of the mixing member.

[0018] Preferably, the opening of the mixing member is oriented substantially perpendicular to the plane of rotation of the mixing tool. The advantageous mixing characteristics of the mixing member can thus be realized particularly effectively when mixing in the direction of rotation.

[0019] Preferably, the arrangement of the mixing tool in the mixing container is designed such that the mixing member ends at a short distance from the wall of the mixing container. Depending on the application, preferably several mixing tools are attached to the drive shaft. Particularly preferably, the individual mixing tools are dis-

posed on the drive shafts in such a way that the individual mixing members of the mixing tools sweep over substantially the entire inner surface of the mixing container during a rotation of the drive shaft of 360 °, so that no volume regions of the mixing container are left out during the mixing process. As a result, a homogeneous, uniform mixture can be obtained which, seen in the individual regions, has identical product properties.

[0020] The invention will be explained in more detail below with reference to drawings that represent merely an exemplary embodiment. In the drawings

Fig. 1 shows a schematic front view of a mixing tool, Fig. 2 shows a perspective view of the mixing tool, and Fig. 3 shows a rear view of the mixing tool.

[0021] It may be remarked that the proposed mixing tool can be applied in all conceivable areas, such as chemistry, pharmaceutical industry, food and building materials industry. In a preferred embodiment, the proposed mixing tool is used for mixing solids, for example in the treatment of bulk materials, wherein liquids may also be added in order to humidify the mixing material.

[0022] Particularly preferably, the mixing tool is used in conjunction with a horizontally or vertically oriented cylindrical mixing container in which a drive shaft is then correspondingly disposed in a concentric manner. The size, number and arrangement of the proposed mixing tools on the drive shaft can then be expediently matched to the respective application in order to achieve a desired mixing effect. Apart from a rotation of the one or more mixing tools in the mixing container, it is also possible to configure the mixing container itself so as to be rotatable.

[0023] The mixing tool 1 concerned is equipped, as shown in Figures 1 to 3, with a supporting arm 7 for connection to the drive shaft as well as with a mixing member 4. As is apparent from Fig. 1, the mixing member 4, seen from the front, has an opening 2, which in this case is preferably configured in a circular-arc shape. Accordingly, the mixing member 4 comprises an arc-shaped section 4c. In that case, the mixing tool 1 can be disposed for example in a cylindrical mixing container in such a way that the distance between the mixing member 4 and the wall of the mixing container is as small as possible, in order thus to prevent product depositions or caking of the mixing material to the wall.

[0024] What is now essential is that the mixing member 4 with the opening 2 attains a lower resistance in the mixing material, so that, in particular, the breakaway torque of the mixing tool 1 when starting is reduced. Smaller torques are also obtained during the mixing process itself, so that the power consumption on the drive means is reduced. The overall energy requirements can thus be reduced.

[0025] Preferably, the mixing member 4 comprises, at each of the two sides of the arc-shaped section 4c, lateral ribs 5c that are connected via a central rib 6 attached to

the supporting arm 7. In that case, the supporting arm 7 is connected accordingly to the drive shaft of the mixer. The attachment of the supporting arm 7 to the drive shaft can be realized in a detachable manner, or the supporting arm 7 can be welded to the drive shaft. The inner faces 8 of the mixing member are preferably configured as slanted inner faces. For this purpose, the lateral rib, for example, has a slant 9a, seen in the circumferential direction 3. With this, the opening 2 of the mixing member 4 can be specifically adjusted to obtain a converging flow of the mixing material. The details regarding the inner faces 8 and the configuration of the opening 2 are explained further below.

[0026] The height of the mixing member 11 is in this case configured to be smaller than the width of the mixing member 12. Preferably, the height of the mixing member 11 is smaller than the width of the mixing member by at least 30 %, more preferably by at least 50 %. Given this ratio of height to width of the mixing member 11, advantages can be obtained as regards the flow.

[0027] It is apparent from the illustration in Fig. 2 that the mixing member 4 is in this case configured in a substantially shovel-shaped manner, with the opening 2 forming a cutout on the inside of the shovel shape. The direction of the arrow 3 indicates the direction of rotation of the mixing tool 1 in the mixing container. Thus, the result is an inflow side 13 on the mixing member 4, which serves for the entry of the mixing material into the opening 2, and an outflow side 14, from which the entered portion of the mixing material exits from the opening 2. Preferably, the inflow side 13 of the mixing member 4 has a larger cross section than the outflow side 14. Accordingly, the opening 2 of the mixing member 4 is configured in such a way that the opening 2 tapers in a direction opposite to the direction 3 of rotation. In that case, the inner faces 8 of the mixing member 4 are slanted accordingly. The slant of the central rib 9b or of the arc-shaped section 9c in this case preferably relates to a straight line perpendicular to the plane of the opening 2. Preferably, the central rib 9b, the arc-shaped section 9c and/or the lateral rib 9a are slanted at an angle of 30° to 60°. This ensures that the substance particles of the mixing material are specifically reflected or deflected on the inner faces of the mixing member 4. At higher rotational speeds of the mixing tool, the influence of the opening 2 on the mixing effect is thus reduced in an improved manner. Since, owing to the high breakaway torque, the highest torques are required particularly when starting the mixing process, the proposed mixing tool enables an energy-efficient start of the mixing process. As the rotational speed of the mixing member 1 increases, a good specific mixing is then made possible due to the specific converging flow in the mixing member, because the influence of the opening 2 on the mixing effect decreases depending on the rotational speed.

[0028] Expediently, the mixing member 1 can also have a frontal edge 4a on the inflow side 13 which can be formed with the shape of a blade edge. In particular

to reduce the resistance. The opening 2 of the mixing member is preferably oriented perpendicular to the plane of rotation of the mixing tool 1. This is important for the mixing characteristics of the mixing member.

[0029] As is apparent from Figs. 2 and 3, the mixing member 4, seen from the side, is preferably provided at an angle on the supporting arm 7. Particularly advantageously, the mixing member forms an angle of 10° to 50°, more preferably of 20° to 40°, to the supporting arm axis 10. Given this arrangement of the mixing member 4, advantages can be obtained with regard to the conveying characteristics of the mixing tool 1.

[0030] It is also particularly advantageous to dispose the mixing member 4 at an angle of inclination to the wall of the mixing container. Accordingly, the arc-shaped section 4c of the mixing member 4 then forms an, in particular wedge-shaped, gap with the wall of the mixing container. In that case, the arc-shaped section 4c is preferably spaced closer to the wall of the mixing container in the front region, i.e. at the inflow side 13, than in the rear region, i.e. at the outflow side 14 of the mixing member. In this manner, the angle of inclination between the mixing member 4 and the wall of the mixing container can be specifically adjusted. Due to the angle of inclination being open in a direction opposite to the direction 3 of rotation, compactions of the mixing material between the wall of the mixing container and the mixing member can be avoided. This also makes it possible to keep the energy consumption of the drive shaft low. Depending on the product-specific properties of the mixing material, the angle of inclination and the distance of the mixing member 4 from the wall of the mixing container can be specifically optimized.

[0031] The mixing tool 1 is illustrated in a rear view in Fig. 3. The rear of the mixing member 4b is preferably flat. It is apparent from the illustration in Fig. 3 that the arc-shaped section 4c is in this case preferably configured as a bent plate, in particular with a thickness of at least 5 mm. Accordingly, the arc-shaped section 4c on the whole can be configured as a slanted plate, seen in the direction of rotation. This permits a slant of the inner face 8 on the arc-shaped section 4c and at the same time, towards the outside, a suitable angle of inclination of the mixing member 4 on the wall in the mixing container.

[0032] The mixing tool 1 preferably consists of steel, particularly preferably of stainless steel, in order to obtain a wear-adapted configuration.

[0033] In a preferred embodiment, several proposed mixing tools 1 are disposed on a drive shaft. In particular, the mixing tools 1 are disposed on the drive shaft in such a way that the individual mixing members of the mixing tool sweep over substantially the entire inner surface of the mixing container during a rotation of the drive shaft of 360°. It is thus ensured that no volume region of the mixing container is left out during the mixing process.

[0034] It was found in tests with the proposed mixing tools that the breakaway torque when starting the mixer

is reduced compared with conventional mixing tools already in the case of unfilled mixing containers. In tests with different filling levels (in this case using quartz sand) and different rotational speeds of the mixing tool, it was found that, in the proposed mixing tool, not only the break-away torque is lower when starting the mixing process, but the mean torque is also reduced as a whole. At the same time, the mixing quality in the different samples that were produced with the proposed mixing tools and the conventional mixing tools exhibited no significant differences with regard to the extinction determined by means of an extinction measurement using a photometer ($\lambda = 690 \text{ nm}$). Depending on the filling level, power savings of up to 20 % as compared to the conventional mixing tools could be found.

Reference numerals

[0035]

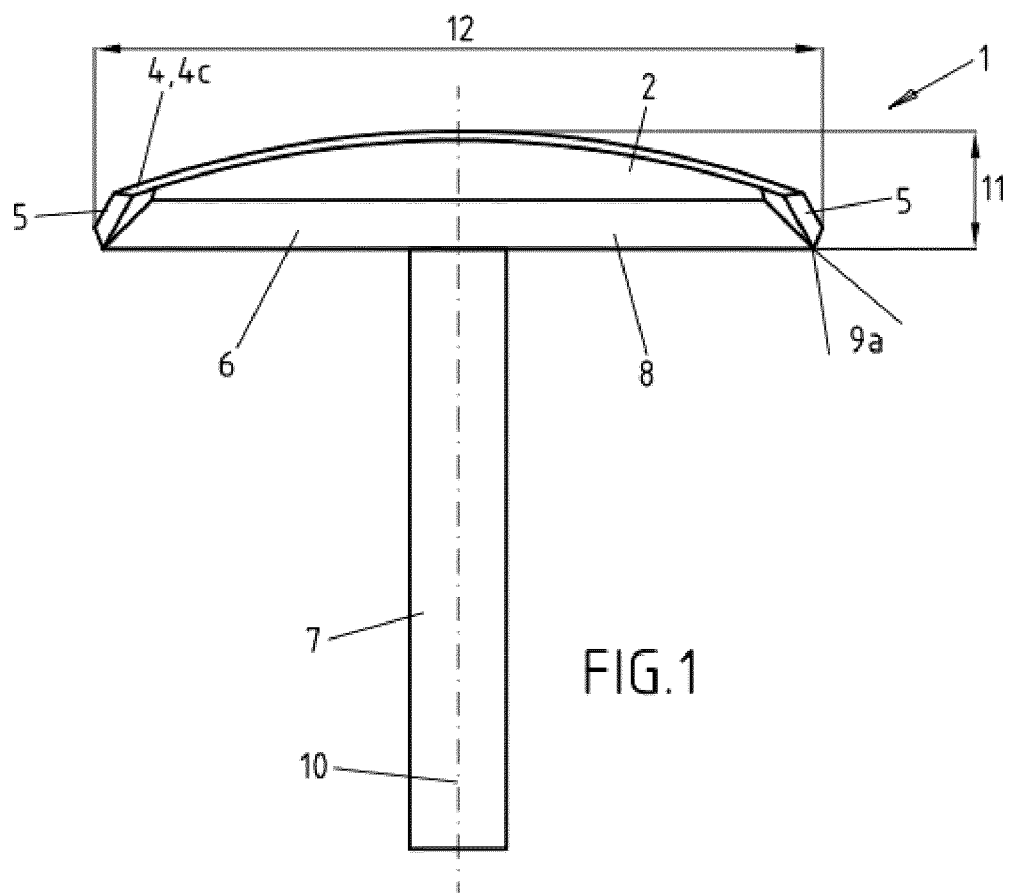
- 1 Mixing Tool
- 2 Opening
- 3 Direction of rotation
- 4 Mixing member
- 4a Frontal edge of the mixing member
- 4b Rear of the mixing member
- 4c Arc-shaped section
- 5 Lateral rib
- 6 Central rib
- 7 Supporting arm
- 8 Inner face of the mixing member
- 9a Slant of the lateral rib
- 9b Slant of the central rib
- 9c Slant of the arc-shaped section
- 10 Supporting arm axis
- 11 Height of the mixing member
- 12 Width of the mixing member
- 13 Inflow side on the mixing member
- 14 Outflow side on the mixing member

Claims

1. A mixing tool for mixers with a mixing container, which can be attached by means of a supporting arm (7) to a drive shaft extending through the mixing container, comprising a mixing member (4) disposed on the supporting arm (7), **characterized in that** the mixing member (4) has an opening (2) that goes through in the direction (3) of rotation, preferably in such a way that a converging flow of the mixing material opposite to the direction (3) of rotation can be generated with the mixing member (4).
2. The mixing tool according to the preceding claim, **characterized in that** the opening (2) of the mixing member (4) is configured in an arc-shape or circular-arc shape at least in some regions, preferably on the

side of the mixing member (4) facing away from the supporting arm (7).

3. The mixing tool according to any one of the preceding claims, **characterized in that** the mixing member (4) comprises an arc-shaped section (4c), at least one lateral rib (5) and/or one central rib (6).
4. The mixing tool according to any one of the preceding claims, **characterized by** an inflow side (13) on the mixing member (4) that has a larger cross section than an outflow side (14).
5. The mixing tool according to any one of the preceding claims, **characterized in that** the opening (2) of the mixing member (4) tapers in a direction opposite to the direction (3) of rotation, preferably with slanted inner faces (8) on the mixing member (4).
6. The mixing tool according to any one of the preceding claims, **characterized in that** the distance between the Inflow side (13) and the outflow side (14) of the mixing member (4) is at least 20 mm, more preferably at least 40 mm.
7. The mixing tool according to any one of the preceding claims, **characterized in that** the mixing member (4) is configured in a substantially shovel-shaped manner, with the opening (2) forming a cutout on the inside of the shovel shape.
8. The mixing tool according to any one of the preceding claims, **characterized in that** the height of the mixing member (11), seen from the front, is smaller than the width of the mixing member (12), preferably by at least 30 %, more preferably by at least 50 %.
9. The mixing tool according to any one of the preceding claims, **characterized in that** the mixing member (4) comprises on the inflow side (13) a frontal edge (4a) which is preferably formed, seen in the direction (3) of rotation, in the shape of a blade edge, in particular so as to taper to a point.
10. The mixing tool according to any one of the preceding claims, **characterized in that** the mixing member (4), seen from the side, is disposed at an angle on the supporting arm (7), preferably in such a way that the mixing member (4) forms an angle of 10° to 50° , more preferably of 20° to 40° to the supporting arm axis (10).
11. The mixing tool according to any one of the preceding claims, **characterized in that** the opening (2) of the mixing member (4) is oriented substantially perpendicular to the plane of rotation of the mixing tool (1).



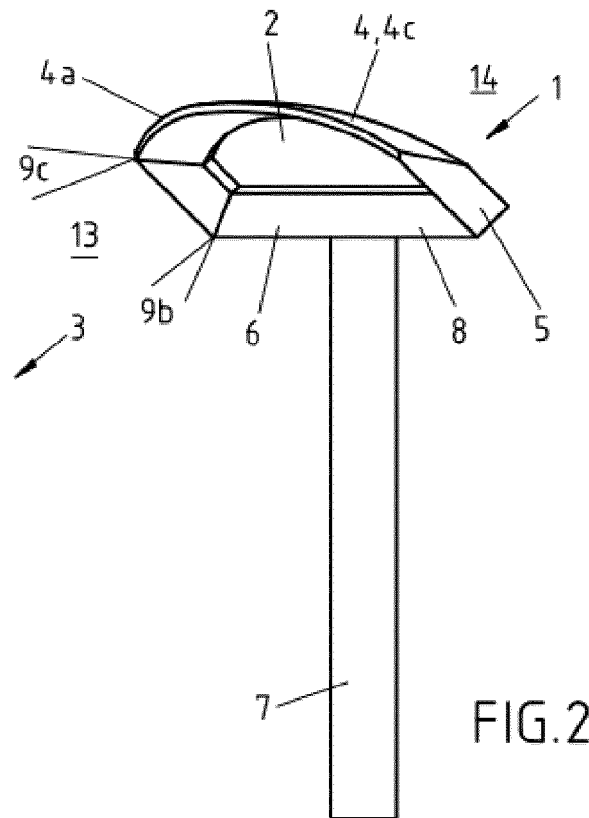


FIG.2

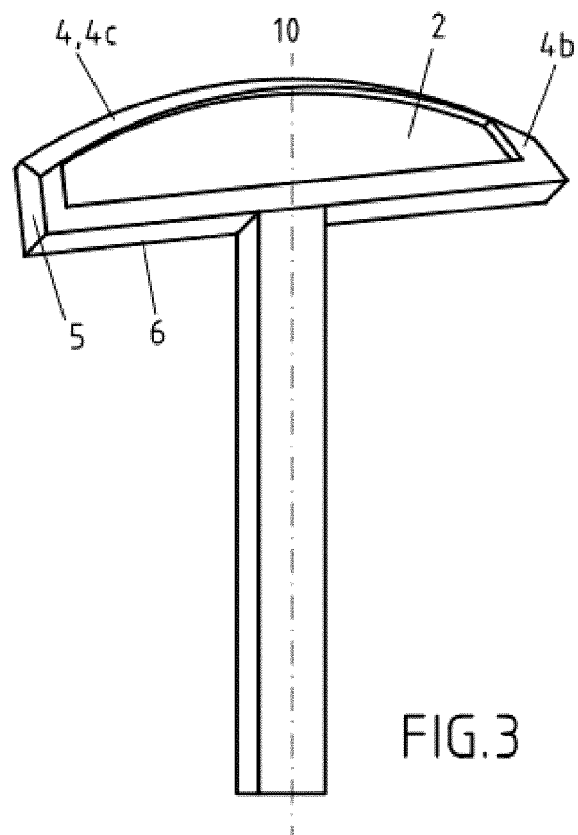


FIG.3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 1276986 [0005]
- DE 10200901817 A1 [0006]