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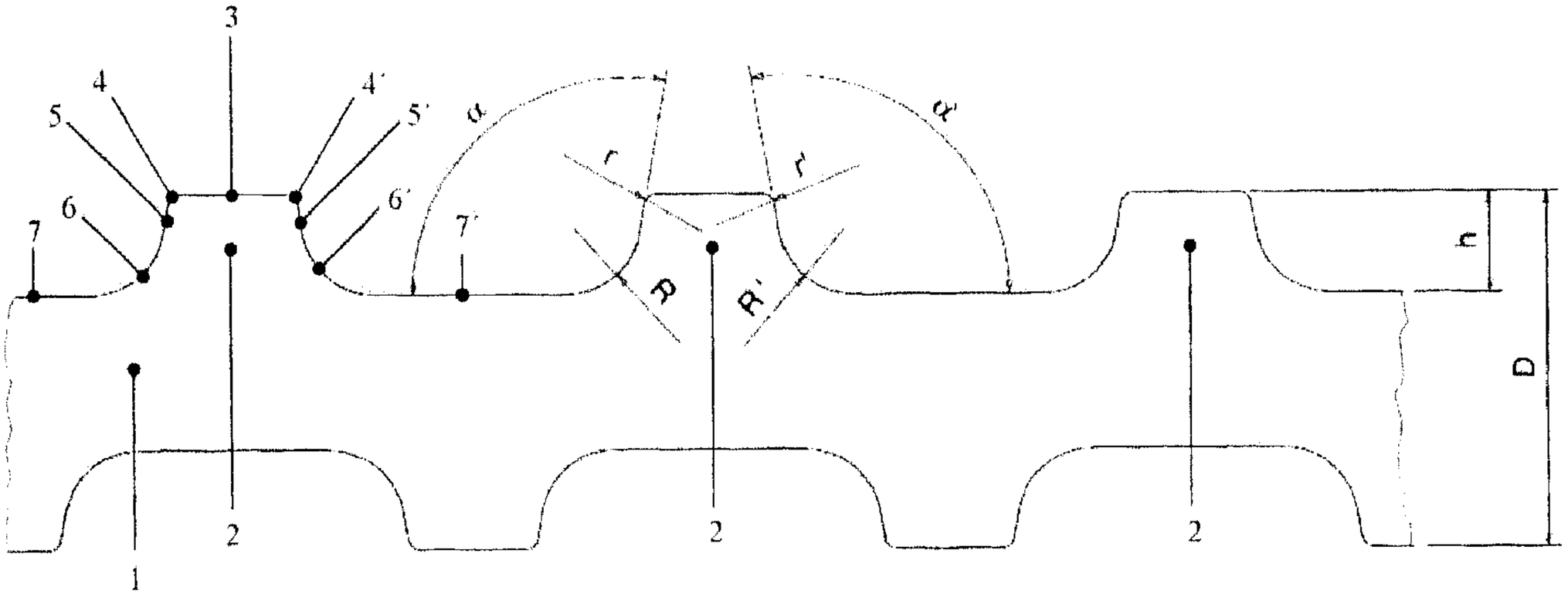

(57) Abrégé/Abstract:
The invention describes a shaped part, in particular an interconnector or an end plate for a fuel cell stack, which is produced by pressing and sintering a pulverulent starting material. The shaped part consists of a disc-shaped or plate-shaped basic body -1- having a multiplicity of knob-like and/or ridge-like elevations -2- with a height h. In cross section, each elevation -2- has two inclined side flanks which lead, proceeding from an end contour -3- of the elevation -2-, via rounded corner portions -4-, -4'- with a radius r or r' directly or via intermediate rectilinear portions -5-, -5'- into curved portions -6-, -6'- with a radius R or R', which in turn merge into the surface contour -7-, -7'- of the basic body -1-. The rectilinear portions -5-, -5'- or, in the case of a direct transition of the rounded corner portions -4-, -4'- into the curved portions -6-, -6'-, the tangents at the point of the transition, have an angle of inclination a or a' with respect to the surface contour -7-, -7'- in the range of 95° to 135°. According to the invention, the radius R or R' is in the range of 0.15 to 1 mm and the height h is dimensioned such that the ratio R: h or R' : h is in a range of 0.25 to 1.

Abstract

The invention describes a shaped part, in particular an interconnector or an end plate for a fuel cell stack, which is produced by pressing and sintering a pulverulent starting material.

The shaped part consists of a disc-shaped or plate-shaped basic body -1- having a multiplicity of knob-like and/or ridge-like elevations -2- with a height h.

In cross section, each elevation -2- has two inclined side flanks which lead, proceeding from an end contour -3- of the elevation -2-, via rounded corner portions -4-, -4'- with a radius r or r' directly or via intermediate rectilinear portions -5-, -5'- into curved portions -6-, -6'- with a radius R or R', which in turn merge into the surface contour -7-, -7'- of the basic body -1-. The rectilinear portions -5-, -5'- or, in the case of a direct transition of the rounded corner portions -4-, -4'- into the curved portions -6-, -6'-, the tangents at the point of the transition, have an angle of inclination α or α' with respect to the surface contour -7-, -7'- in the range of 95° to 135°.

According to the invention, the radius R or R' is in the range of 0.15 to 1 mm and the height h is dimensioned such that the ratio R : h or R' : h is in a range of 0.25 to 1.

SHAPED PART

A shaped part which is produced by pressing and sintering a pulverulent starting material and consists of a disc-shaped or plate-shaped basic body having a multiplicity of knob-like and/or ridge-like elevations with a height h and with in each case, in cross section, two inclined side flanks which lead, proceeding from an end contour of the elevation, via rounded corner portions with a radius r or r' directly or via intermediate rectilinear portions into curved portions with a radius R or R', which merge into the surface contour of the basic body, wherein the rectilinear portions or, in the case of a direct transition of the rounded corner portions into the curved portions, the tangents at the point of the transition, have an angle of inclination α or α' with respect to the surface contour in the range of 95° to 135°.

A shaped part of this type in the form of an interconnector or of an end plate for a fuel cell stack is described, for example, in AT GM 6.260 or in US 2008/0199738.

Interconnectors or end plates in a fuel cell stack have the function of current collectors and have to simultaneously ensure reliable separation of the reaction gases between the anode side and the cathode side and also the conduction of these reaction gases. In order to achieve this object, the interconnectors or end plates are designed as metallic plates or discs having knob-like and/or ridge-like elevations. These elevations are formed on one side of the basic body in the case of

end plates and on both sides of the basic body in the case of interconnectors. The overall thickness of such interconnectors and end plates is in practice between 1 and 5 mm. The elevated structures are electrical contact regions with the electrochemically active cell. The interstices between the individual knob-like and ridge-like elevations then serve for conduction of the reaction gases. Overall, the interconnector or the end plate has to have a high degree of sealing over the entire dimensions, in order to ensure the reliable separation of the reaction gases between the anode side and the cathode side.

The production of the final shape of such interconnectors and end plates by a material-removing machining process from semifinished product is very costly, and therefore it is necessary to strive for production by powder metallurgy, by pressing pulverulent starting materials as far as possible into the final shape and then sintering the pressed shaped parts.

Inherently rectangular cross sections would be optimal for the geometric form of the cross sections for the gas conduction, since these form a good compromise in terms of maximum contacting area while providing, at the same time, a sufficiently large cross section for the gas conduction. However, such shapes cannot be produced in practice by powder metallurgy, and therefore in practice trapezoidal cross sections having rectilinear, inclined flanks and small transition radii both between the end contours of the elevations and the inclined flanks and between these and the surface contour of the basic body have become established.

A further problem with production by a powder metallurgy process is that alloys having high chromium contents are frequently used as the material, particularly in the

-case of interconnectors and end plates which are used in oxide-ceramic high-temperature fuel cell stacks (solid oxide fuel cell or SOFC). However, alloys of this type are extremely brittle at low temperatures and can only be pressed with great difficulty.

In order to ensure sufficient density and homogeneity of the finished interconnectors and end plates despite these poor pressing properties, AT GM 6.260 proposes a two-stage pressing process under very specific conditions. This process is disadvantageous because such a pressing process is costly and the homogeneity of the component which is achieved is still not optimal.

Embodiments of the invention may provide a complex, structured shaped part, in particular an interconnector or an end plate for a fuel cell stack, which is produced by pressing and sintering, can be produced at low cost and, at the same time, has a high density combined with the greatest possible homogeneity.

According to an embodiment of the invention, this is achieved in that the radius R or R' is in the range of 0.15 to 1 mm and the height h is dimensioned such that the ratio R:h or R':h is in a range of 0.25 to 1.

It has surprisingly been realized that a very high density with relatively low density gradients and therefore a very uniform homogeneity of the shaped part are also achieved by virtue of a single-stage pressing process in the event that the transition radii of the inclined side flanks toward the basic body of the shaped part are enlarged, with the height h of the ridge-like or knob-like elevations simultaneously being reduced within a very specific range, during the production of the shaped part. The transition radius r or r' of the end contours of the elevations to the inclined side surfaces is not so significant here; in practice, it will be in a range between 0.1 and 0.5 mm. At the same time, the configuration according to an embodiment of the invention has positive effects on the dimensional stability and planarity of the shaped part during the subsequent process steps.

If the shaped part is designed outside the limits defined according to an embodiment of the invention, the density and homogeneity decrease significantly, and therefore it is no longer ensured that the shaped part can be produced by a single-stage pressing process.

In a preferred embodiment of the invention, the angle of inclination α or α' is in the range of 95° to 120°, the radius R or R' is in the range of 0.3 to 1 mm and the ratio R:h or R':h is in a range of 0.5 to 1.

Under these conditions, very good values are obtained in terms of the density and homogeneity of the shaped part.

In a particularly preferred configuration of the invention, the angle of inclination α or α' is in the range of 95° to 110°, the radius R or R' is in the range of 0.3 to 1 mm and the ratio R:h or R':h is in a range of 0.7 to 1.

Under these conditions, the best values are obtained in terms of the density and homogeneity of the shaped part.

It is particularly advantageous if the configuration of a shaped part according to an embodiment of the invention is used for interconnectors or end plates of fuel cell stacks. In this case, the degree of sealing of the component required for interconnectors and end plates for the reliable gas separation is also ensured, by the high achievable density of the shaped part, if an inexpensive production process is employed.

Furthermore, the configuration of the shaped part according to an embodiment the invention is particularly advantageous if the pulverulent starting material used is an alloy having a chromium content of at least 20% by weight, in the case of interconnectors and end plates in particular an alloy comprising 20 to 30% by weight chromium and 70 to 80% by weight of a prealloy of iron comprising 0.5 to 0.8% by weight rare earth metals, in particular yttrium, or an alloy comprising 95% by weight

chromium and 5% by weight of a prealloy of iron comprising 0.5 to 0.8% by weight yttrium.

In one particular aspect, there is provided a shaped part which is produced by pressing and sintering a pulverulent starting material and consists of a disc-shaped or plate-shaped basic body having a multiplicity of knob-like and/or ridge-like elevations with a height h and with in each case, in cross section, two inclined side flanks which lead, proceeding from an end contour of the elevation, via rounded corner portions with a radius r or r' directly or via intermediate rectilinear portions into curved portions with a radius R, R', which merge into a surface contour of the basic body, wherein the rectilinear portions or, in the case of a direct transition of the rounded corner portions into the curved portions, the tangents at the point of the transition, have an angle of inclination α or α' with respect to the surface contour in the range of 95° to 135°, wherein the radius R or R' is in the range of 0.15 to 1 mm and the height h is dimensioned such that the ratio R:h or R':h is in a range of 0.5 to 1.

In the text which follows, embodiments of the invention are explained in more detail with reference to figures.

Figure 1 shows the density distribution of an interconnector according to the invention, which was determined by a simulation calculation.

Figure 2 shows the density distribution of an interconnector according to the prior art, which was likewise determined by a simulation calculation.

The simulation calculations for investigating the compaction properties for the interconnector according to the invention and for the interconnector according to the prior art were carried out by FEM (Finite Element Method) simulation with the aid of the Drucker-Prager Cap model. The basic data used for both simulations were the characteristic values of the starting powder of an alloy comprising 95% by weight

chromium and 5% by weight of a prealloy of iron comprising 0.8% by weight yttrium, such as cohesion and angle of internal friction, and also the kinematic description of the pressing operation, which were the same for both simulations. In addition, the different geometrical configuration features according to the table below were used.

Configuration feature	According to the invention (Figure 1)	Prior art (Figure 2)
r	0.05 mm	0.05 mm
R	0.35 mm	0.01 mm
h	0.4 mm	0.6 mm (top side) 0.5 mm (bottom side)
D	2.5 mm	2.5 mm
R : h	0.875	0.017 (top side) 0.020 (bottom side)
α	95°	135°

The simulation results obtained were then shown with an identical grey scale in Figure 1 and Figure 2. The comparison shows that the geometry according to the invention, as shown in Figure 1, has a higher pressed density in the unstructured basic body than the geometry according to the prior art, as shown in Figure 2. The regions of particularly high density close to the base of the channel are likewise larger for the geometry according to the invention than for the prior art. There is therefore firstly an increased absolute pressed density in the entire region of the basic body of the geometry according to the invention, and this results in an improvement in the degree of gas-tightness. On the other hand, the density gradient is very low over wide regions of the basic body, and this reduces the tendency for a curvature to be formed in the subsequent process steps, for example the sintering process.

The results clearly show that it is possible to achieve a significant increase in the pressed density and also the density homogeneity in the basic body of an

interconnector by virtue of the geometry according to the invention. The geometry according to the invention therefore improves the degree of gas-tightness of the overall component, without being reliant upon a two-stage pressing process.

Figure 3 schematically shows, on an enlarged scale and in section, a detail of an interconnector according to the invention for a fuel cell stack. The interconnector with an overall thickness D has

a plate-shaped basic body -1- with elevations -2- on both sides. The sectionally trapezoidal elevations -2- with the height h, which can be formed in a knob-like manner, in a continuously ridge-like manner or else in a ridge-like manner in segments over the entire extent of the interconnector, form, by virtue of their interstices, the channels for the gas conduction of the interconnector. The end contour -3- of each elevation -2- merges via rounded corner portions -4- or -4'- with a radius r or r' into inclined side flanks with a rectilinear portion -5- or -5'-. The rectilinear portions -5- or -5'- then merge into curved portions -6- or -6'- with a radius R or R'. These then in turn merge, without interruption, into the surface contour -7- or -7'- of the basic body -1-. The inclined side surfaces include an angle α or α' with the surface contour -7- or -7'- of the basic body -1-. It would likewise be conceivable for the rounded corner portions -4- or -4'- to lead directly without the intermediate rectilinear portions -5- or -5'- into the curved portions -6- or -6'- if there are curved portions -6- or -6'- having very large radii R or R' and small height dimensions h of the elevations -2-. In this case, the tangents at the transitions of the rounded corner portions -4- or -4'- into the curved portions -6- or -6'- include the angle of inclination α or α' with the surface contour -7- or -7'- of the basic body -1-.

Figure 4 schematically shows, on an enlarged scale and in section, the detail of an end plate according to the invention for a fuel cell stack. The elevations are formed

just the same as for the interconnector shown in Figure 3; but in contrast thereto only on one side of the basic body.

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CLAIMS:

1. Shaped part which is produced by pressing and sintering a pulverulent starting material and consists of a disc-shaped or plate-shaped basic body having a multiplicity of knob-like and/or ridge-like elevations with a height h and with in each case, in cross section, two inclined side flanks which lead, proceeding from an end contour of the elevation, via rounded corner portions with a radius r or r' directly or via intermediate rectilinear portions into curved portions with a radius R, R', which merge into a surface contour of the basic body, wherein the rectilinear portions or, in the case of a direct transition of the rounded corner portions into the curved portions, the tangents at the point of the transition, have an angle of inclination α or α' with respect to the surface contour in the range of 95° to 135°, wherein

the radius R or R' is in the range of 0.15 to 1 mm and the height h is dimensioned such that the ratio R:h or R':h is in a range of 0.5 to 1.

2. Shaped part which is produced by pressing and sintering a pulverulent starting material according to Claim 1, wherein the angle of inclination α, α' is in the range of 95° to 120°, and the radius R or R' is in the range of 0.3 to 1 mm.

3. Shaped part which is produced by pressing and sintering a pulverulent starting material according to Claim 1, wherein the angle of inclination α, α' is in the range of 95° to 110°, the radius R or R' is in the range of 0.3 to 1 mm and the ratio R:h or R':h is in a range of 0.7 to 1.

4. Shaped part which is produced by pressing and sintering a pulverulent starting material according to one of Claims 1 to 3, wherein the shaped part is an interconnector or an end plate of a fuel cell stack.

5. Shaped part which is produced by pressing and sintering a pulverulent starting material according to one of Claims 1 to 4, wherein the pulverulent starting material is an alloy having a chromium content of at least 20% by weight.

6. Interconnector or end plate as a shaped part according to Claim 4, wherein the pulverulent starting material consists of 20 to 30% by weight chromium and 70 to 80% by weight of a prealloy of iron comprising 0.5 to 0.8% by weight rare earth metals.

7. Interconnector or end plate as a shaped part according to Claim 4, wherein the pulverulent starting material consists of 20 to 30% by weight chromium and 70 to 80% by weight of a prealloy of iron comprising 0.5 to 0.8% by weight yttrium.

8. Interconnector or end plate as a shaped part according to Claim 4, wherein the pulverulent starting material consists of 95% by weight chromium and 5% by weight of a prealloy of iron comprising 0.5 to 0.8% by weight yttrium.

Application number / numéro de demande: 2724350

Figures: 1-2

Pages: 1/2

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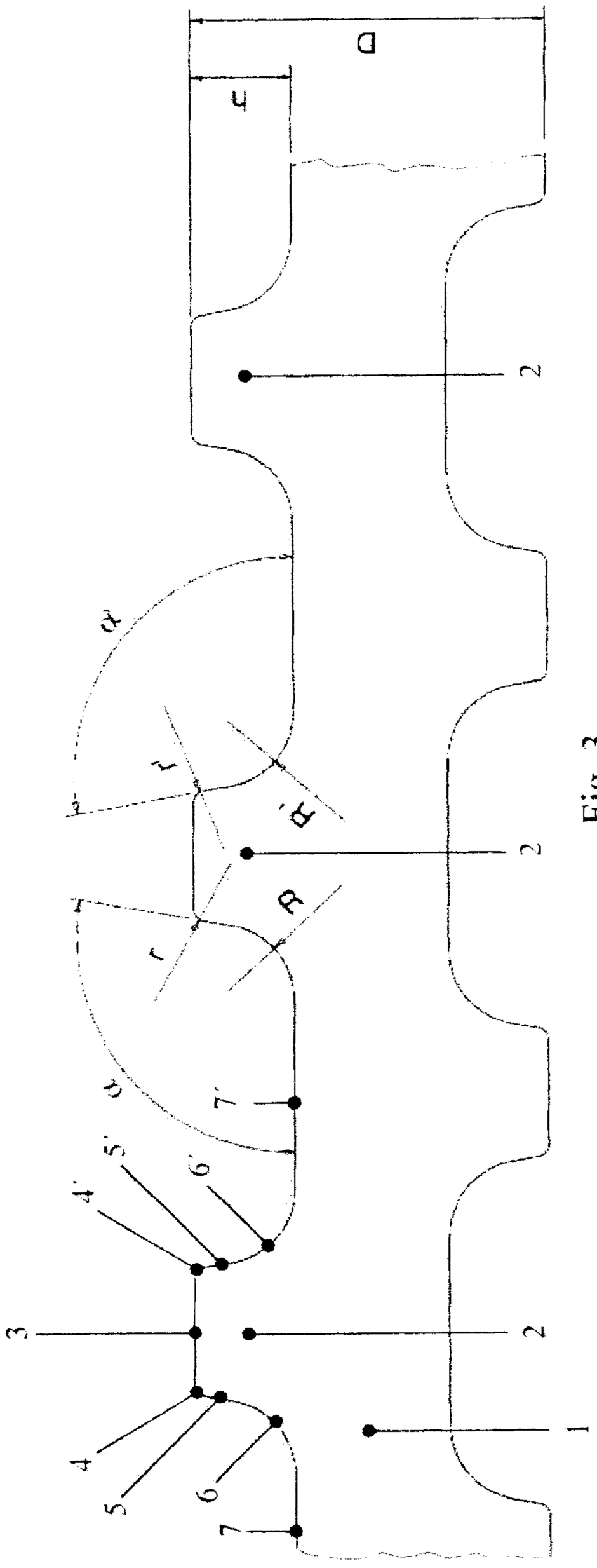


Fig. 3

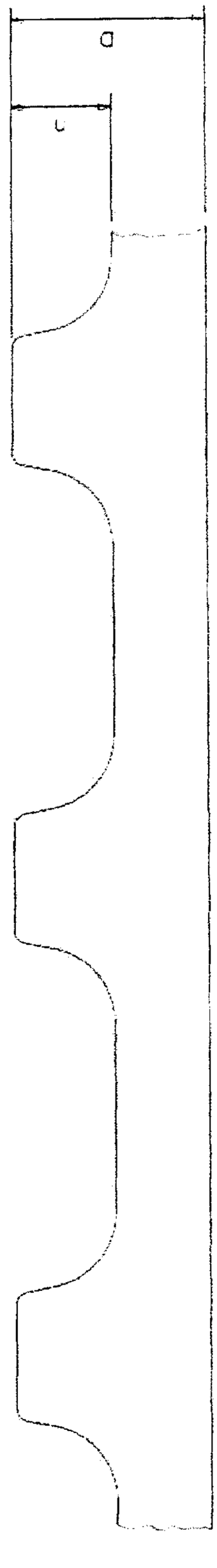
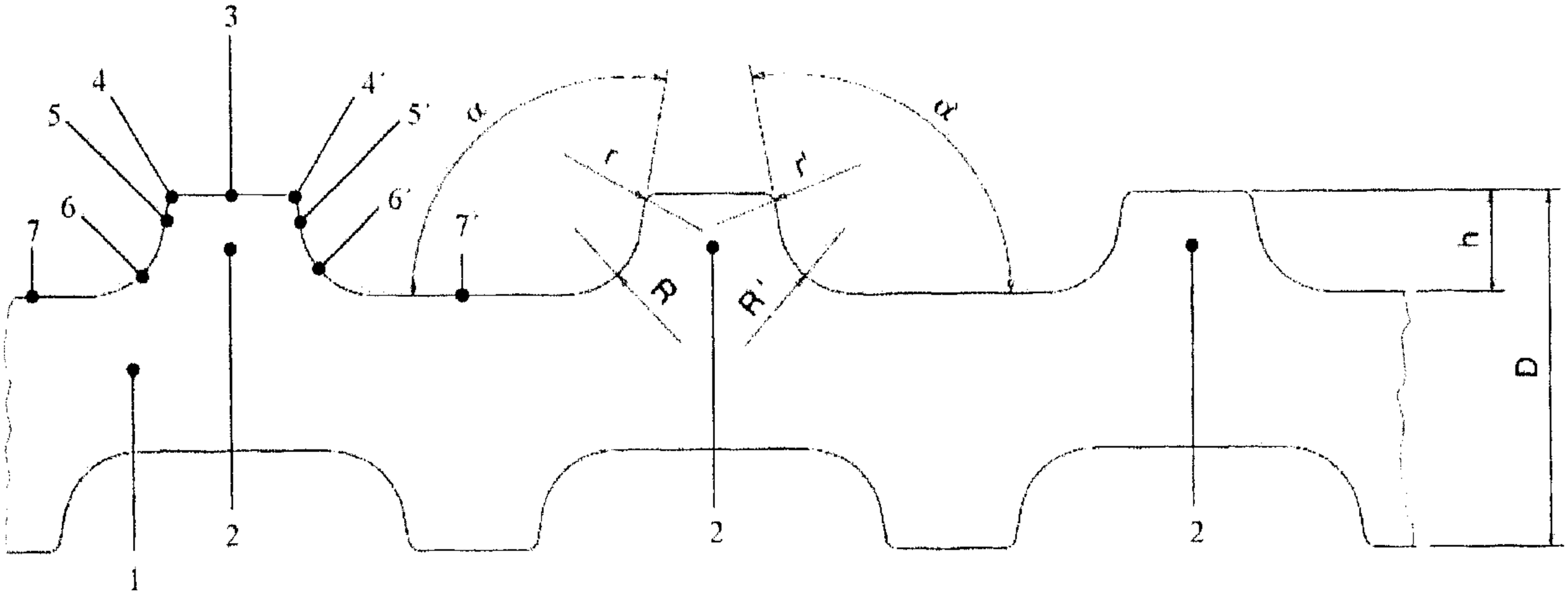


Fig. 4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