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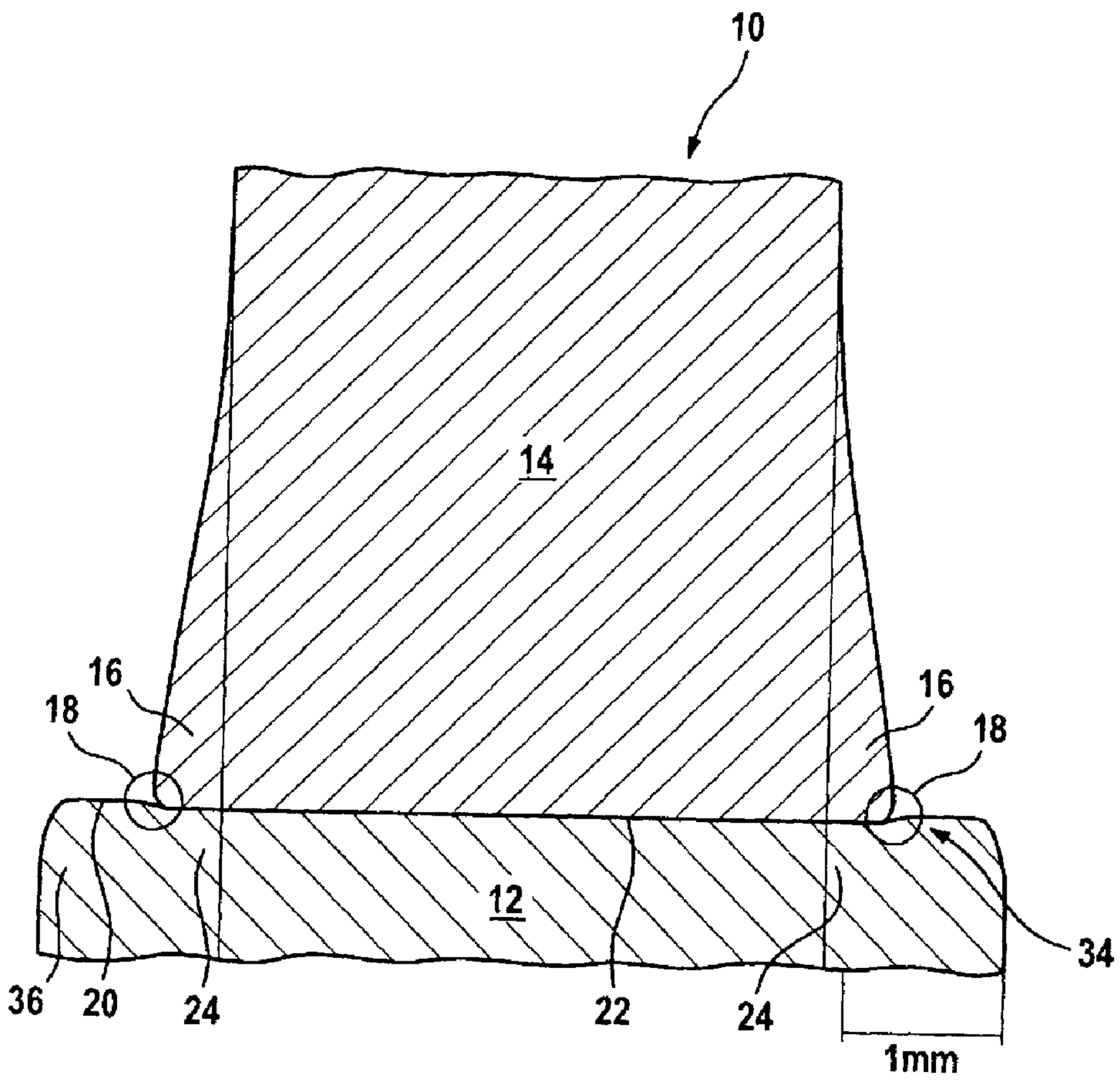
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(54) Titre : PIECE ET PROCEDE POUR RELIER DES ELEMENTS STRUCTURELS METALLIQUES
(54) Title: COMPONENT AND METHOD FOR JOINING METAL ELEMENTS



(57) Abrégé/Abstract:
The invention relates to a component, especially a component of a gas turbine, which consists of at least two metal elements (12, 14), the first element (12) having a first welding surface (20) and the second element (14) having a second welding surface (22),

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(57) Abrégé(suite)/Abstract(continued):
and the elements (12, 24) being joined by inductive HF pressure welding. According to the invention, one of the welding surfaces (20) is configured in such a manner that it has a wider periphery than the other welding surface (22) and that an upset portion (16), produced when the elements (12, 14) are joined, rests almost completely within and especially on a peripheral collar (36) that is formed by the peripheral widening of the one welding surface (20). The invention also relates to a method for joining metal elements (12, 14), especially elements of a gas turbine, the welding surfaces (20, 22) of the elements (12, 14) being joined by inductive HF pressure welding. One of the welding surfaces (20) is configured in such a manner that it has a wider periphery than the other welding surface (22) and that an upset portion (16), produced when the elements (12, 14) are joined, rests almost completely within and especially on a peripheral collar (36) that is formed by the peripheral widening of the one welding surface (20).

ABSTRACT

A component, in particular a component of a gas turbine, composed of at least two metallic structural elements (12, 14), the first structural element (12) having a first joining surface (20), and the second structural element (14) having a second joining surface (22), and the structural elements (12, 14) being joined via their joining surfaces (20, 22) by an inductive high-frequency pressure welding. One of the joining surfaces (20) is shaped to widen peripherally in comparison to the other joining surface (22), and an upsetting deformation (16) produced in a join region (34) in response to the joining of the structural elements (12, 14) rests virtually entirely within and, in particular, on a peripheral collar (36) formed by the peripheral widening of the one joining surface (20). In addition, a method for joining metallic structural elements (12, 14), in particular structural elements of a gas turbine, an inductive high-frequency pressure welding being used to join corresponding joining surfaces (20, 22) of the structural elements (12, 14). One of the joining surfaces (20) is shaped to widen peripherally in comparison to the other joining surface (22). An upsetting deformation (16) produced in a join region (34) in response to the joining of the structural elements (12, 14) rests virtually entirely within and, in particular, on a peripheral collar (36) formed by the peripheral widening of the one joining surface (20).

COMPONENT AND METHOD FOR JOINING METAL ELEMENTS

[0001] The present invention relates to a component, in particular a component of a gas turbine, composed of at least two metallic structural elements **[metal elements]**, the first structural element having a first joining surface and the second structural element having a second joining surface, and the structural elements being joined via their joining surfaces by an inductive high-frequency pressure welding. The present invention also relates to a method for joining metallic structural elements, in particular structural elements of a gas turbine, an inductive high-frequency pressure welding being used to join corresponding joining surfaces of the structural elements.

[0002] Various methods for joining metallic structural elements by inductive high-frequency pressure welding are known from the related art. Thus, for example, the German Patent Application DE 198 58 702 Al describes a method for joining blade parts of a gas turbine, one blade section and at least one further blade part being provided. In this context, corresponding joining surfaces of these elements are essentially mutually aligned while allowing for spacing therebetween; are subsequently welded together by the action of an inductor excited by high-frequency current; and are then driven together with mutual contacting of the joining surfaces thereof. The inductor is excited using a constant frequency which is generally above 0.75 MHz. In addition, the frequency is selected as a function of the geometry of the joining surfaces. When working with inductive high-frequency pressure welding, it is critical to the quality of the join that the two welding partners be heated simultaneously and homogeneously. Moreover, a uniform upsetting deformation of the join region must be ensured in order to obtain a welded connection that is free of defects. However, the disadvantage of the known methods is that it is precisely the last mentioned condition that can only be met with great difficulty or not at all. Thus,

the requisite quality for the resulting components and, in particular, for the joins thereof is not always attainable.

[0003] It is, therefore, an object of the present invention to devise a component of the species, which, on the one hand, will ensure a secure and durable bond between the individual structural elements and, on the other hand, a high quality of the joins among the structural elements.

[0004] It is also an object of the present invention to devise a method of the species for joining metallic structural elements, which, on the one hand, will ensure a secure and durable bonding of structural elements and, on the other hand, a high quality of the joins among the structural elements.

[0005] These objectives are achieved by a component having the features set forth in claim 1, as well as by a method having the features set forth in claim 11.

[0006] It is expressly mentioned for clarification in this case that the inductive high-frequency pressure welding designation does not stipulate a specific frequency range for the method, respectively the component. Rather, frequencies in the low kHz range up to the high MHz range are used, so that the new designation of inductive pressure welding (IPS) may also be introduced.

[0007] Advantageous embodiments of the present invention are described in the respective dependent claims.

[0008] A component according to the present invention, in particular a component of a gas turbine, is composed of at least two metallic structural elements, the first structural element having a first joining surface, and the second structural element having a second joining surface, and the structural elements being joined via their joining surfaces by an inductive high-frequency pressure welding. In this context, one of the joining surfaces is shaped to widen peripherally in comparison to the other joining surface, an upsetting deformation produced in a join region in response to the joining of the structural elements, resting virtually entirely within and, in particular, on a peripheral collar formed by the peripheral widening of the one joining surface. In accordance with the present invention,

the peripheral widening of the one joining surface ensures a uniform upsetting deformation of the join region, so that a defect-free welded connection is obtained. Thus, not only is a secure and durable bond between the individual structural elements ensured, but also a high quality of the resulting components and, in particular, of the joins of these components. As a result of the uniform upsetting deformation, the join region is free of notches, cracks, or of any other defects that affect strength, **[in particular,]** following an optional finish-machining.

[0009] The widening preferably results in a joining surface having a substantially constant width. This makes it possible to adapt the frequency used in the joining process more readily to the process.

[0010] In one advantageous embodiment of the component according to the present invention, a notch in the upsetting deformation that is formed in a region of transition to the joining surface of the peripheral widening, is situated outside of a nominal geometry of the two structural elements, respectively of the joined-together component. This ensures that the notches that form in response to the upsetting deformation are always located outside of the actual component, thereby also avoiding any defects that affect strength. In one advantageous embodiment of the component, the peripheral widening amounts to at least 0.5 mm. In this context, the magnitude of the component widening, respectively **[the size]** of the collar is dependent on the cross section of the structural element, respectively of the joining surface of the structural element. Given a cross-sectional area of approximately 40 mm^2, the peripheral widening is typically 0.5 mm. Given cross-sectional areas in the region of 500 mm^2, the magnitude of the peripheral widening may amount to 1.0 mm or more.

[0011] In another advantageous embodiment of the component according to the present invention, the first joining surface is peripherally widened in a mechanical process by the application of force. Moreover, to effect peripheral widening, an attachment element may be joined to the first structural element, the attachment element having a joining surface that is designed to widen peripherally in comparison to the joining surface of the second structural element. The attachment element is typically welded to the first structural element. It is thus possible for the structural elements to be used not only to produce new components, but also to repair damaged components, while **[at the same time]**

incorporating the advantages of the present invention.

[0012] Another advantageous embodiment of the component according to the present invention provides for at least two different frequencies induced by at least one inductor to be used during the inductive high-frequency pressure welding to heat the joining surfaces of the structural elements. This ensures a uniform and homogenous heating of the different-sized joining surfaces. Moreover, structural elements made of similar or also of different metallic materials may be joined together.

[0013] In one advantageous embodiment of the component according to the present invention, the second structural element is a blade or a part of a blade of a rotor in a gas turbine, and the second structural element is a ring or a disk of the rotor or a blade stump configured at the periphery of the ring or the disk. These components that have been joined together from the mentioned structural elements, are what are commonly referred to as BLINGs ("bladed rings") or BLISKs ("bladed disks") of gas turbine engines.

[0014] A method according to the present invention for joining metallic structural elements, in particular structural elements of a gas turbine, provides that an inductive high-frequency pressure welding be used to join corresponding joining surfaces of the structural elements. In this context, the joining surfaces are pressed together in a sufficiently heated state and held until cooled, one of the joining surfaces being shaped to widen peripherally in comparison to the other joining surface, an upsetting deformation produced in a join region in response to the joining of the structural elements, resting virtually entirely within and, in particular, on a peripheral collar formed by the peripheral widening of the one joining surface. The cast structure produced by the welding is completely removed by pressing out the molten material. This ensures a secure and durable bond between the structural elements. Moreover, a very high quality is attained for the join, respectively for the join region of these components, since a uniform upsetting of the join region is possible. Since the welded connection is free of defects, the join region is free of notches, cracks, or of any other defects, respectively cast structures that affect strength, in particular following an optional finish-machining. Since it is only necessary that one of the joining surfaces be shaped to widen peripherally, the method may be employed both for new parts manufacturing, which requires a relatively substantial over-allowance for the finish machining, as well as for repairs, which do not require an over-allowance.

[0015] Preferably, the widening process will effect a substantially constant width for the joining surface. This makes it possible for the frequency to be more readily adapted to the particular circumstances.

[0016] In another advantageous embodiment of the method according to the present invention, a notch formed in a region of transition to the joining surface of the peripheral widening in response to the upsetting deformation is situated outside of a nominal geometry of the two structural elements, respectively of the component. This ensures, in turn, that, upon completion of the component, the join region is free of potential defects that could affect strength. In the method according to the present invention, the one joining surface widens peripherally by at least 0.5 mm, the magnitude of the peripheral widening conforming to the diameter or the cross-sectional area of the joining surfaces to be joined. Thus, given a cross-sectional area of approximately 40 mm^2, the size of the peripheral collar, respectively **[the magnitude]** of the widening, is approximately 0.5 mm. Given a cross-sectional area of approximately 500 mm^2, the peripheral widening may amount to approximately 1.0 mm or more.

[0017] In other advantageous embodiments of the method according to the present invention, the first joining surface is peripherally widened in a mechanical process by the application of force or by an attachment element that is joined to the first structural element and that has a joining surface which is designed to widen peripherally in comparison to the joining surface of the second structural element. Thus, the method according to the present invention may also be employed for repairing damaged components. Cited as an example in this context is the reconditioning of what are commonly referred to as BLISKs ("bladed disks") and BLINGs ("bladed rings"), which require a partial or complete blade exchange. The attachment element referred to is typically welded to the first structural element. Different types of welding processes, such as keyhole welding or laser welding, may be used, for example. In the described fields of application of the method according to the present invention, the second structural element is a blade or a part of a blade of a rotor in a gas turbine; and the first structural element is a ring or a disk of the rotor or a blade stump configured at the periphery of the ring or the disk.

[0018] Another advantageous embodiment of the method according to the present

invention provides for at least two different frequencies induced by at least one inductor to be used during the inductive high-frequency pressure welding to heat the joining surfaces of the structural elements. This ensures a uniform and homogenous heating of the joining surfaces having different cross-sectional areas. The result is a secure and durable bond between the two structural elements.

[0019] Other advantages and features of the present invention and details pertaining thereto are derived from the following description of two graphically illustrated exemplary embodiments. Specifically,

[0020] FIG. 1 shows a representation of a microsection through a join region of a component according to the present invention in accordance with a first specific embodiment; and

[0021] FIG. 2 shows a schematic representation of a portion of a component according to the present invention in accordance with a second specific embodiment.

[0022] FIG. 1 shows a microsection through a join region 34 of a component 10. It is discernible that component 10 is composed of a first structural element 12 and a second structural element 14 that have been joined together via their joining surfaces 20, 22 by an inductive high-frequency pressure welding. In this context, first joining surface 20 is shaped to widen peripherally in comparison to second joining surface 22 and thereby forms a collar, respectively a peripheral widening 36. It is also discernible that an upsetting deformation 16 produced in a join region 34 in response to the joining of structural elements 12, 14 rests entirely within and, in particular, on a peripheral collar 36 formed by the peripheral widening of first joining surface 20. In this context, in a region of transition to joining surface 20 having the peripheral widening, respectively collar 36, upsetting deformation 16 has a notch 18, notch 18 residing outside of a nominal geometry 24 of the two structural elements 12, 14, respectively of component 10.

[0023] The micrograph clearly shows the form and effect of the widening of the one joining partner, namely of first structural element 12, respectively of first joining surface 20 of first structural element 12. Upsetting deformation 16 resulting from the joining process may be intentionally outwardly directed on the peripheral widening of first joining surface 20, so that notch 18 formed during the joining process is situated outside of nominal

geometry 18 of component 10.

[0024] FIG. 2 shows a schematic representation of first structural element 12 of a component 10 in accordance with a second specific embodiment. It is discernible that first component 12 is constituted of a partial element 30, namely of a blade stump formed on the periphery of a rotor 32, and of an attachment element 28 that is joined thereto. In this context, an attachment element body 26 is designed to be wider than blade stump 30. In addition, attachment element 28 has a joining surface 20 that is designed to widen peripherally in comparison to joining surface 22 of second structural element 14 (not shown in this exemplary embodiment). In this context, attachment element 28 is welded to partial element 30 of first structural element 12.

[0025] When the exemplary embodiments are considered, it becomes apparent that the method according to the present invention, as well as structural elements 12, 14 are suited both for manufacturing, as well as for repairing components 10 of a gas turbine.

PATENT CLAIMS

1. A component, in particular a component of a gas turbine, composed of at least two metallic structural elements **[metal elements]** (12, 14), the first structural element (12) having a first joining surface (20), and the second structural element (14) having a second joining surface (22), and the structural elements (12, 14) being joined via their joining surfaces (20, 22) by an inductive high-frequency pressure welding,
wherein one of the joining surfaces (20) is shaped to widen peripherally in comparison to the other joining surface (22), and an upsetting deformation (16) produced in a join region (34) in response to the joining of the structural elements (12, 14) rests virtually entirely within and, in particular, on a peripheral collar (36) formed by the peripheral widening of the one joining surface (20).

2. The component as recited in claim 1,
wherein, as a result of the peripheral widening, the joining surface has a substantially constant width.

3. The component as recited in claim 1 or 2,
wherein, in a region of transition to joining surface (20) having the peripheral widening, upsetting deformation (16) has a notch (18), and notch (18) resides outside of a nominal geometry (24) of the two structural elements (12, 14), respectively of the component (10).

4. The component as recited in one of the preceding claims,
wherein the peripheral widening amounts to at least 0.5 mm.

5. The component as recited in one of the preceding claims,
wherein the peripheral widening of the first joining surface (20) is produced mechanically by the application of force.

6. The component as recited in one of claims 1 through 4,
wherein, to effect peripheral widening, an attachment element (28) is joined to partial element (30) of the first structural element (12), the attachment element (28) having a joining surface (20) that is designed to widen peripherally in comparison to the joining surface (22) of the second structural element (14).

7. The component as recited in claim 6,
wherein the attachment element (28) is welded to the partial element (30) of the first structural element (12).

8. The component as recited in one of the preceding claims,
wherein at least two different frequencies induced by at least one inductor are used during the inductive high-frequency pressure welding process to heat the joining surfaces (20, 22) of the structural elements (12, 14).

9. The component as recited in one of the preceding claims,
wherein the first and the second structural element (12, 14) are made of different or similar metallic materials.

10. The component as recited in one of the preceding claims,
wherein the second structural element (14) is a blade or a part of a blade of a rotor in a gas turbine, and the first structural element (12) is a ring or a disk (32) of the rotor or a blade stump (30) configured at the periphery of the ring or the disk (32).

11. The component as recited in one of the preceding claims,
wherein the component (10) is a BLING or a BLISK.

12. A method for joining metallic structural elements (12, 14), in particular structural elements of a gas turbine, an inductive high-frequency pressure welding being used to join corresponding joining surfaces (20, 22) of the structural elements (12, 14),
wherein the joining surfaces (20, 22) are pressed together in a sufficiently heated state and held until cooled, one of the joining surfaces (20) being shaped to widen peripherally in comparison to the other joining surface (22), and an upsetting deformation (16) produced in a join region (34) in response to the joining of the structural elements (12, 14) resting virtually entirely within and, in particular, on a peripheral collar (36) formed by the peripheral widening of the one joining surface (20).

13. The method as recited in claim 12,
wherein, as a result of the peripheral widening, a joining surface is produced having a

substantially constant width.

14. The method as recited in claim 12 or 13,
wherein, in a region of transition to the joining surface (20) having the peripheral widening, the upsetting deformation (16) has a notch (18), and the notch (18) is situated outside of a nominal geometry of the two structural elements (12, 14), respectively of the component (10).

15. The method as recited in one of claims 12 through 14,
wherein the peripheral widening amounts to at least 0.5 mm.

16. The method as recited in one of claims 12 through 15,
wherein the peripheral widening of the first joining surface (20) is produced mechanically by the application of force.

17. The method as recited in one of the claims 12 through 15,
wherein, to effect peripheral widening, an attachment element (28) is joined to the partial element (30) of the first structural element (12), the attachment element (28) having a joining surface (20) that is designed to widen peripherally in comparison to the joining surface (22) of the second structural element (14).

18. The method as recited in claim 17,
wherein the attachment element (28) is welded to the partial element (30) of the first structural element (12).

19. The method as recited in one of the preceding claims,
wherein the second structural element (14) is a blade or a part of a blade of a rotor in a gas turbine, and the first structural element (12) is a ring or a disk (32) of the rotor or a blade stump (30) configured at the periphery of the ring or the disk (32).

20. The method as recited in one of claims 12 through 19,
wherein the component (10) is a BLING or a BLISK.

21. The method as recited in one of the preceding claims,

wherein at least two different frequencies induced by at least one inductor are used during the inductive high-frequency pressure welding process to heat the joining surfaces (20, 22) of the structural elements (12, 14).

Fig. 1

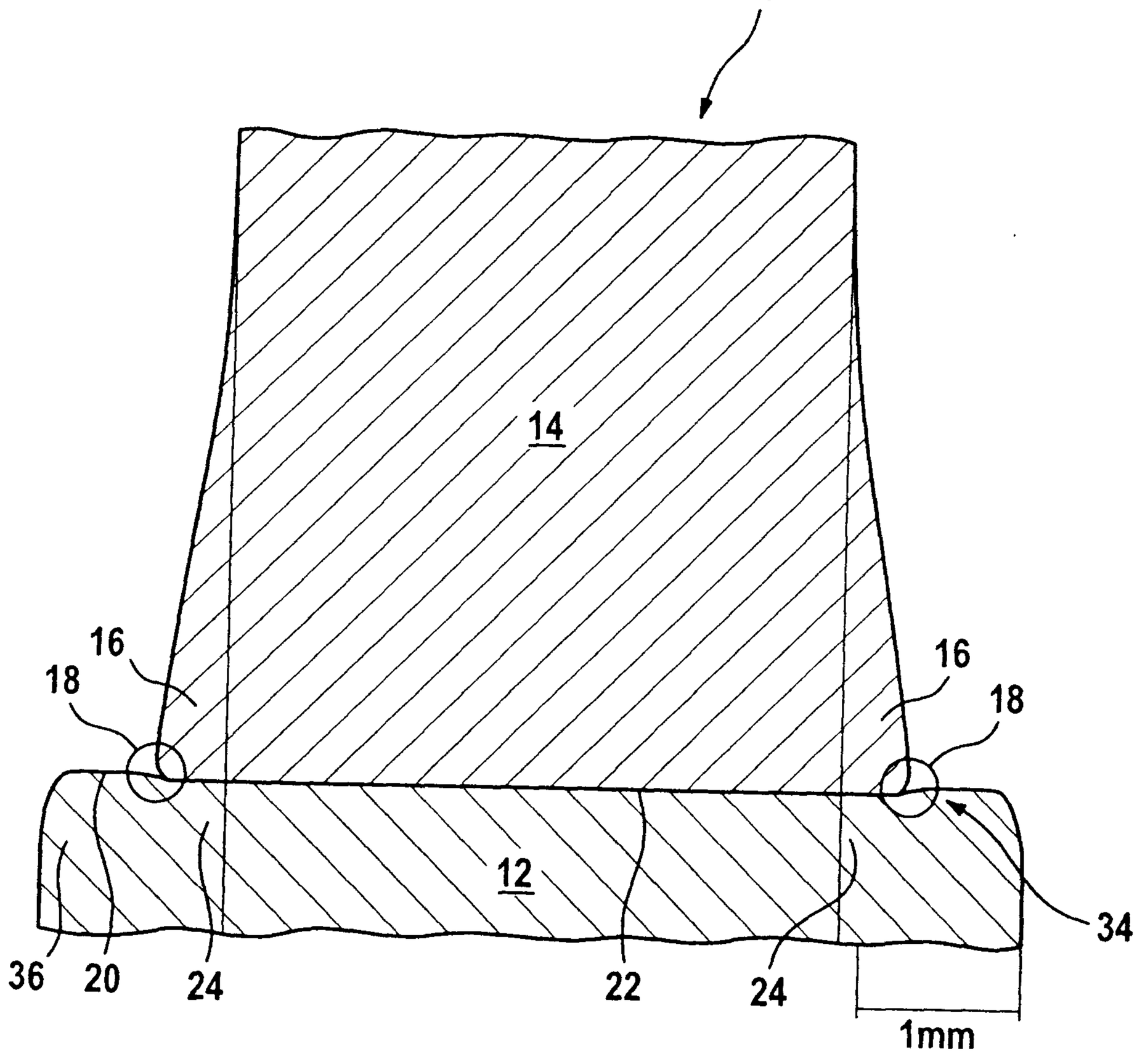
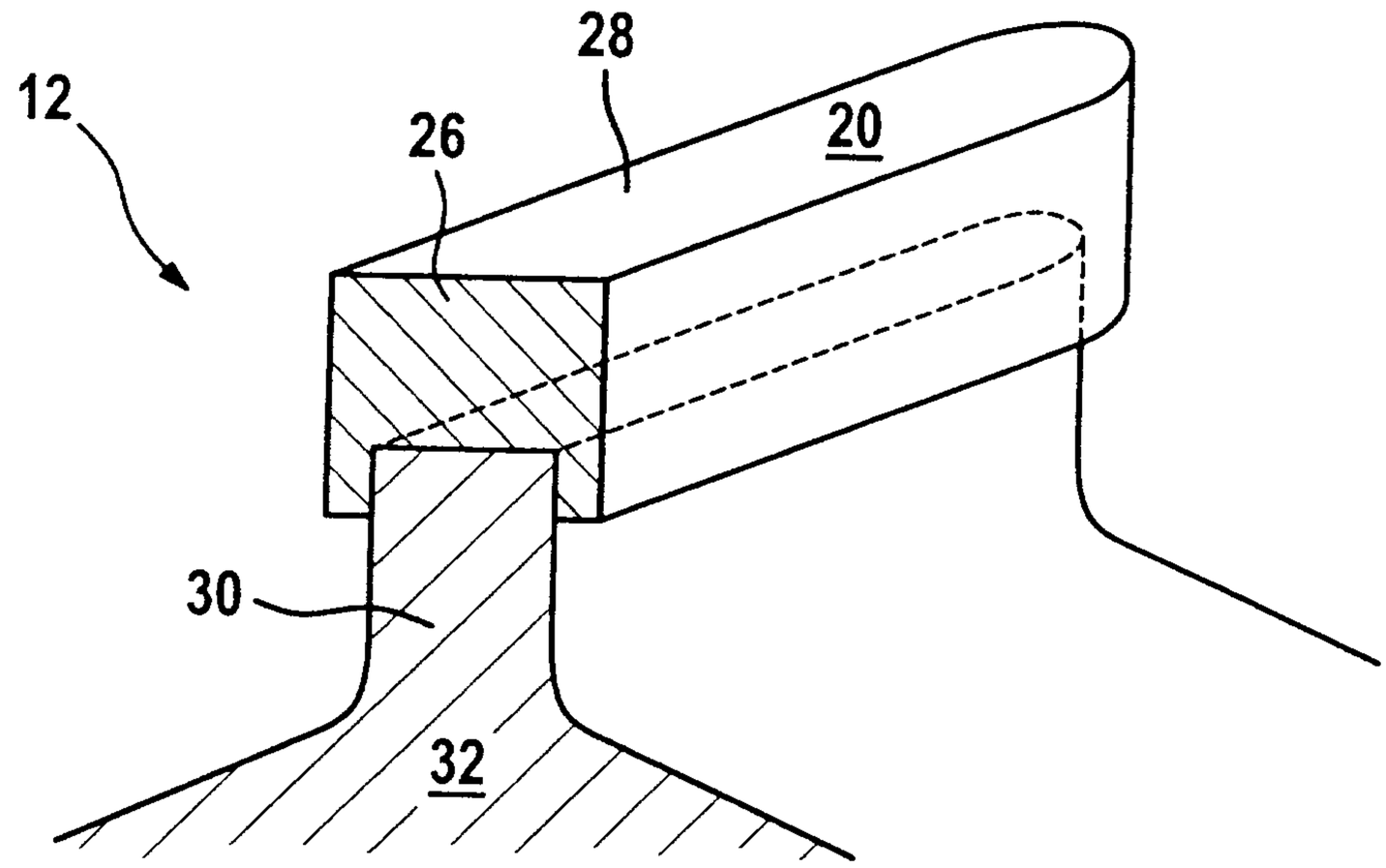
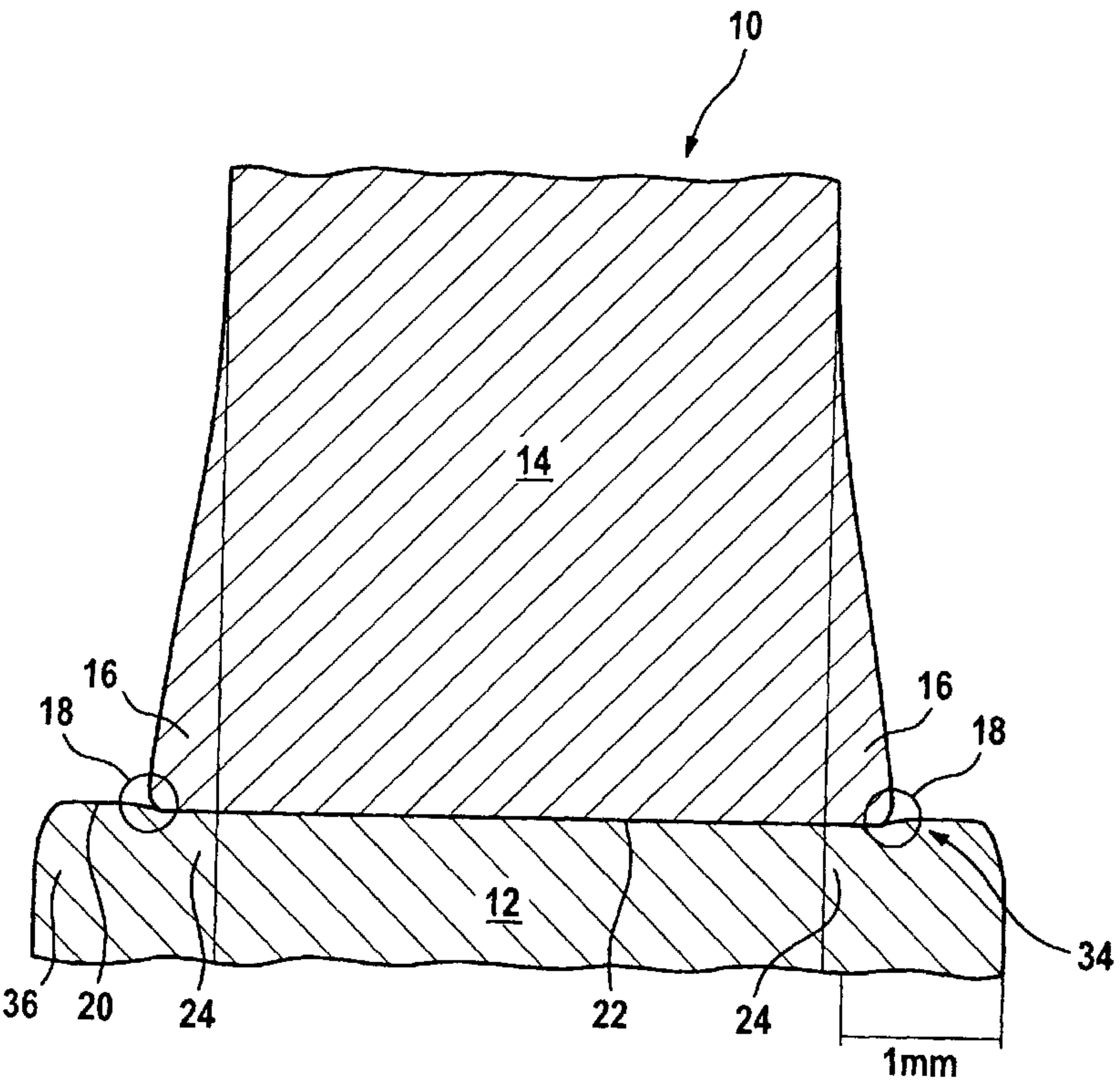


Fig. 2




10
14
16
18
16
18
12
36
20
24
22
24
34
1mm