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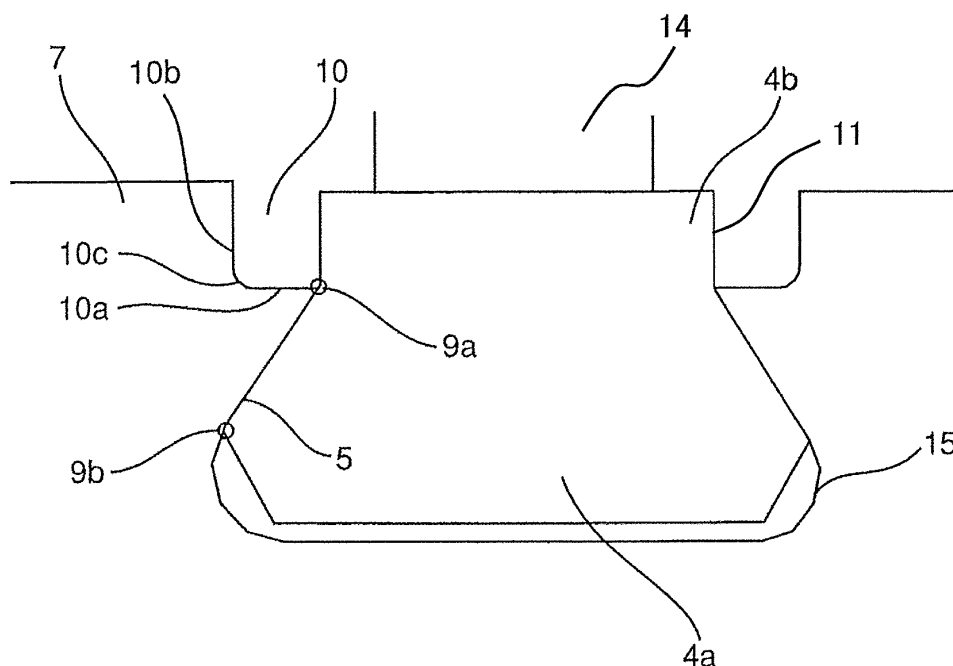
(54) **Compressor**

(57) A compressor is provided that can avoid fretting damage to improve fatigue strength reliability.

The present invention is characterized in that a portion on the circumferential outside and radial outside of a radial outside contact end portion 9a with a dovetail portion 4a is removed from a wheel 7. Specifically, the wheel 7 is formed with a groove portion 10 in an area

that is located on the circumferential outside of the radial outside contact end portion 9a of a blade securing portion 15 with the dovetail portion 4a and that includes a radial outside of the contact end portion 9a. Rigidity on the wheel side of the contact end portion 9a between the dovetail portion 4a and the wheel 7 is reduced to reduce the occurrence of stress, thereby avoiding the lowering of fatigue life reliability resulting from fretting.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a blade-implanting structure for a compressor that is a constituent element of a gas turbine.

2. Description of the Related Art

[0002] Gas turbines generally have a compressor to compress and deliver air to a combustor. The compressor is internally provided with a compressor rotor rotating around a central axis of a gas turbine. In the compressor, an implanting portion of a rotor blade is fixedly fitted into a circumferential groove portion provided on a rotor wheel. Incidentally, a conventional technique relating to the rotor blade securing structure is described in e.g. JP-63-273000-A.

SUMMARY OF THE INVENTION

[0003] While the gas turbine operates, the rotor blade of the gas turbine compressor is subjected to centrifugal force caused by its own weight and to a large pressure load on its high-pressure side. In addition, vibration stress acts on the dovetail portion of the blade due to the exciting force caused by irregular pressure variations that occur during start-up. As a result, fatigue damage may result.

[0004] Conventionally, the surface on which the dovetail portion of the blade receives load wholly bears such load. However, high stress occurs at a contact end portion between the blade-load-receiving surface and the wheel-load-receiving surface of a wheel. Since such a contact end portion suffers fretting damage resulting from abrasion in addition to high stress, reliability in fatigue strength is likely to lower.

[0005] In view of the above, it is desirable to apply to an actual machine a blade-groove structure capable of providing higher reliability.

[0006] It is an object of the present invention to provide a compressor that can reduce stress occurring at a contact end portion between a blade and a wheel to suppress lowering of fatigue strength reliability resulting from fretting.

[0007] To achieve the above object, the compressor according to the present invention is **characterized in that** a portion on the circumferential outside and radial outside of a contact end portion with a blade is removed from a wheel.

[0008] More specifically, the compressor includes a rotor blade secured to an outer circumferential side of a wheel and a stator blade secured to an inner circumferential side of a casing incorporating the wheel. The rotor blade includes a blade portion, a platform portion joined to a root side of the blade portion and having planes par-

allel to a centrifugal-force load direction of the blade portion, and a dovetail portion which merges with the platform portion, is located radially inward of the platform portion and is increased in width outwardly from the parallel planes of the platform portion. The dovetail portion is fixedly inserted into a blade securing groove formed on the outer circumferential side of the wheel. In addition, the wheel is formed with a groove portion or a hollow portion in an area that is located on a circumferential outside of a radial outside contact end portion of the blade securing groove with the dovetail portion and that includes a radial outside of the radial outside contact end portion.

[0009] With the blade groove structure described above, rigidity of the wheel side at a position close to the contact end portion between the wheel and the blade is reduced to reduce the occurrence of stress. Thus, the lowering of fatigue life reliability resulting from fretting can be avoided.

[0010] The present invention can provide the compressor that can reduce stress occurring at the contact end portion between the wheel and the blade to suppress the lowering of fatigue strength reliability resulting from fretting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a cross-sectional diagram viewed from an axial direction that shows structural details of an implanting portion of a rotor blade of a compressor according to a first embodiment of the present invention.

Fig. 2 is a cross-sectional diagram that shows a configurational example of a typical gas turbine.

Fig. 3 is a cross-sectional diagram viewed from an axial direction that shows a typical fitting structure between a rotor blade and a wheel as a comparative example.

Fig. 4 illustrates a stress distribution occurring in a structure of the comparative example.

Fig. 5A is a graph showing the results of mock-up fatigue tests of the first embodiment and the comparative example by simulating the loads of an actual machine.

Fig. 5B illustrates the comparative example.

Fig. 5C illustrates the first embodiment of the present invention.

Fig. 6 illustrates a second embodiment of the present invention.

Fig. 7 illustrates a third embodiment of the present invention.

Fig. 8 illustrates a fourth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Preferred embodiments of the present invention will hereinafter be described with reference to the drawings.

[0013] Fig. 2 is a configurational cross-sectional view of a gas turbine. A gas turbine is mainly composed of a compressor 1, a combustor 2 and a turbine 3. The compressor 1 adiabatically compresses, as working fluid, air sucked from the atmosphere. The combustor 2 mixes fuel with the compressed air delivered from the compressor 1 and burns the mixture to produce high temperature and high pressure air.

[0014] The turbine 3 generates rotational power when the combustion gas introduced from the combustor 2 expands. The exhaust gas from the turbine 3 is discharged into the atmosphere. The compressor 1 includes a rotor blade 1b secured to an outer circumferential side of a wheel 7 (shown in fig. 3 described later), a casing 1a incorporating the wheel 7, and a stator blade 1c secured to an inner circumferential side of the casing 1a.

[0015] Fig. 3 illustrates a blade-groove structure of a common compressor as a comparative example. This fig. 3 is an enlarged diagram that shows an installation state of the rotor blade 1b shown in fig. 2. The rotor blade 1b includes a blade portion 14, a platform portion 4b joined to a root side (lower side in Fig. 3) of the blade portion 14, and a dovetail portion 4a fixedly inserted into a blade securing groove 15 formed on the outer circumferential side (upper side in Fig. 3) of the wheel 7. In the structure in Fig. 3, a groove portion or a hollow portion described later is not formed in the wheel 7. Then, a blade-load-receiving surface 5 of the dovetail portion 4a wholly bears centrifugal force caused by its own weight of the blade portion 14 and a load relating to exciting force caused by irregular pressure variations that occur during the start-up. However, as seen from a distribution 6 of the stress corresponding to the blade-load-receiving surface shown in Fig. 4, high stress occurs at a radial outside contact end portion 9a between the blade-load-receiving surface 5 and a wheel load receiving surface 8 of the wheel 7. Since such a contact end portion 9a suffers fretting damage resulting from abrasion in addition to high stress, reliability in fatigue strength is likely to lower.

[0016] To eliminate such disadvantages, the present invention is devised such that a wheel 7 is formed with a groove portion or a hollow portion formed in an area that is located on a circumferential outside (a widthwise outside of a platform portion 4b) of a radial outside contact end portion 9a of a blade securing groove 15 with a dovetail portion 4a and that includes a radial outside of the contact end portion 9a. The specific examples thereof are described below.

[Embodiment 1]

[0017] Fig. 1 illustrates a blade groove structure of a

compressor that exhibits the most characteristic feature of the present invention, as a first embodiment of the present invention. As shown in the figure, a root portion of a rotor blade is formed to have a platform portion 4b having planes 11 (circumferential end faces) parallel to a centrifugal-force load direction of the blade (an upward direction in Fig. 1) and a dovetail portion 4a flaring radially inward of the wheel (toward a lower side in Fig. 1) from the platform portion 4b and outwardly from the parallel planes 11 (in a left-right direction in Fig. 1). In a fitting portion between a wheel 7 and the dovetail portion 4a of the blade, a groove portion 10 is provided in an area that is located on the circumferential outside (the outside of left-right direction in Fig. 1) of a radial outside contact end portion 9a of the wheel 7 with the dovetail portion 4a (the blade) and that includes the radial outside (the upper side in Fig. 1) of the contact end portion 9a. The groove portion 10 includes a first straight-line part 10a extending toward the circumferential outside from the contact end portion 9a, a second straight-line part 10b extending toward the radial outside from the straight-line part 10a, and a curve part 10c connecting these straight-line parts together. Incidentally, it is desirable that the groove portion 10 be formed in an area including the circumferential inside (the inside of left-right direction in Fig. 1) of a radial inside contact end portion 9b with the dovetail portion 4a. With this structure, since the rigidity of the contact end of the wheel is lowered, the stress at the contact end portion 9a can be reduced.

[0018] Fig. 5A is a graph showing the results of mock-up fatigue tests simulating centrifugal force occurring at the blade groove portion of each of the structures of the present embodiment (Fig. 5C) and a comparative example (Fig. 5B). Test results are made dimensionless using the results of the structure of the comparative example. The present results show that the use of the structure of the present embodiment improves a fatigue life about six times that of the shape of the comparative example.

[Embodiment 2]

[0019] A second embodiment of the present invention is shown in Fig. 6. The second embodiment is **characterized in that** a portion extending from a radial outside contact end portion 9a to the outer circumference of a wheel 7 is removed from the wheel 7 so as to gradually increase a circumferential distance from a circumferential end face 11 of a platform portion 4b of a rotor blade as it goes toward the radial outside of the wheel (upward in Fig. 6) from the contact end portion 9a with a dovetail portion 4a of a rotor blade, thereby providing a groove portion 10 in the wheel 7. This can suppress the lowering of strength at a position close to the contact surface of the wheel with the blade compared with that of the first embodiment.

[Embodiment 3]

[0020] A third embodiment of the present invention is shown in Fig. 7. A groove portion 12 of a wheel 7 is provided that is formed by a straight line parallel to a blade load-receiving surface 5 and straight lines extending from both respective ends thereof toward the radial outside of the wheel. This can make a wheel-side opening portion small or eliminate it, thereby making it possible to reduce an influence on the flow of turbine working fluid.

[Embodiment 4]

[0021] A fourth embodiment of the present invention is described in Fig. 8. A hollow portion 13 of a wheel 7 is formed in an area that is located on a radial outside of a contact surface between the wheel and a dovetail portion 4a of a rotor blade. For example, a circular or elliptical hole as shown in Fig. 8 is provided as the hollow portion 13. Thus, similarly to the third embodiment, stress at a contact end portion 9a can be reduced and an influence on a turbine working fluid can be suppressed.

[0022] In the embodiments described above, it is believed that the deformation of the contact end portion 9a of the wheel can achieve a reduction in stress. It is desirable, therefore, that the groove and the hollow portion (the hole) be located radially above the contact surface. However, it is necessary to appropriately set the size and position of the groove portion or the hollow portion taking into consideration the load conditions of an actual machine, the strength of material to be applied and the like.

[0023] Methods of increasing the fatigue strength of the area having reduced rigidity include application of compressive residual stress by shot peening or water jet peening and surface modification by friction stir.

[0024] Features, components and specific details of the structures of the above-described embodiments may be exchanged or combined to form further embodiments optimized for the respective application. As far as those modifications are apparent for an expert skilled in the art they shall be disclosed implicitly by the above description without specifying explicitly every possible combination.

Claims**1.** A compressor comprising:

a rotor blade (1b) secured to an outer circumferential side of a wheel (7); and
a stator blade (1c) secured to an inner circumferential side of a casing incorporating the wheel (7);
wherein the rotor blade (1b) includes:

a blade portion (14);
a platform portion (4b) joined to a root side of the blade portion (14) and having planes

(11) parallel to a centrifugal-force load direction of the blade portion (14); and
a dovetail portion (4a) which merges with the platform portion (4b), is located radially inward of the platform portion (4b) and is increased in width outwardly from the parallel planes of the platform portion (4b), the dovetail portion (4a) being fixedly inserted into a blade securing groove (15) formed on the outer circumferential side of the wheel (7), and

wherein the wheel (7) is formed with a groove portion (10) or a hollow portion (13) in an area that is located on a circumferential outside of a radial outside contact end portion of the blade securing groove (15) with the dovetail portion (4a) and that includes a radial outside of the radial outside contact end portion (9a).

- 2.** The compressor according to claim 1, wherein the wheel (7) is formed with the groove portion (10) or the hollow portion (13) in an area including a circumferential inside of a radial inside contact end portion of the blade securing groove (15) with the dovetail portion (4a).
- 3.** The compressor according to claim 1 or 2, wherein the groove portion (10) is formed by a first straight-line part extending circumferentially outward from the radial outside contact end portion (9a), a second straight-line part extending radially outward, and a curved part connecting the first and second straight-line parts together.
- 4.** The compressor according to claim 1 or 2, wherein the groove portion (10) is formed such that a distance from the parallel plane of the platform portion (4b) is gradually increased as the groove portion (10) goes toward the radial outside from the radial outside contact end portion (9a).
- 5.** The compressor according to at least one of claims 1 to 4, wherein the groove portion (10) or the hollow portion (13) is subjected to compressive residual stress by shot peening.
- 6.** The compressor according to at least one of claims 1 to 4, wherein the groove portion (10) or the hollow portion (13) has a surface subjected to surface modification by friction stir.

FIG. 1

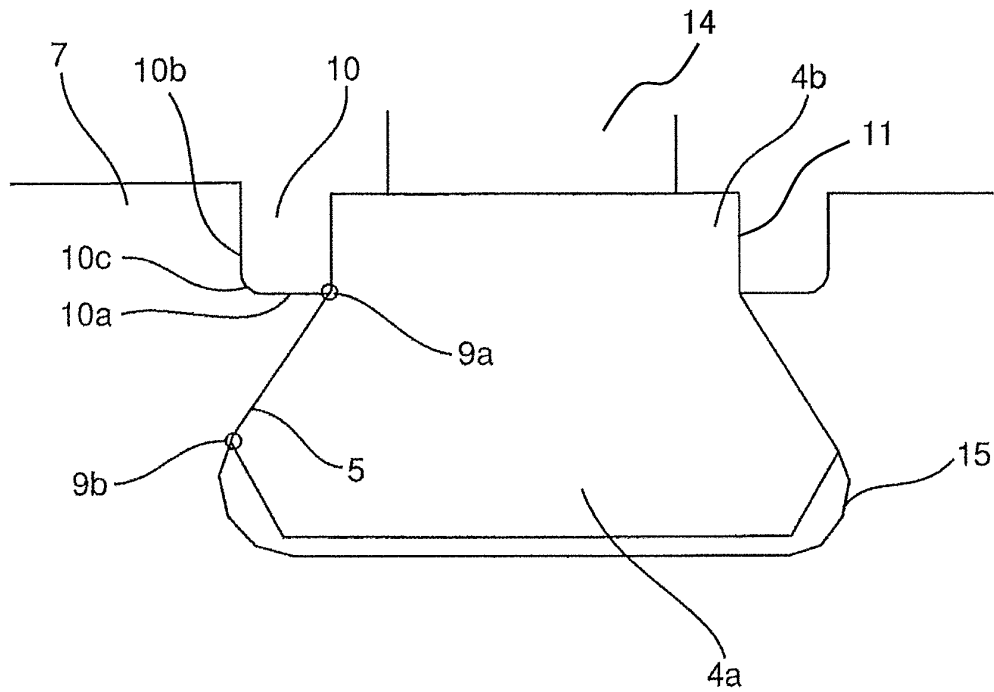


FIG. 2

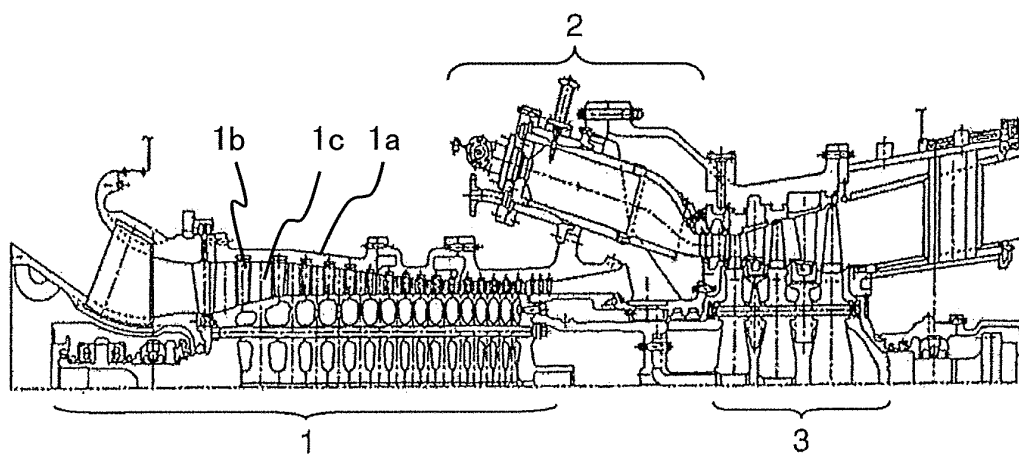


FIG. 3

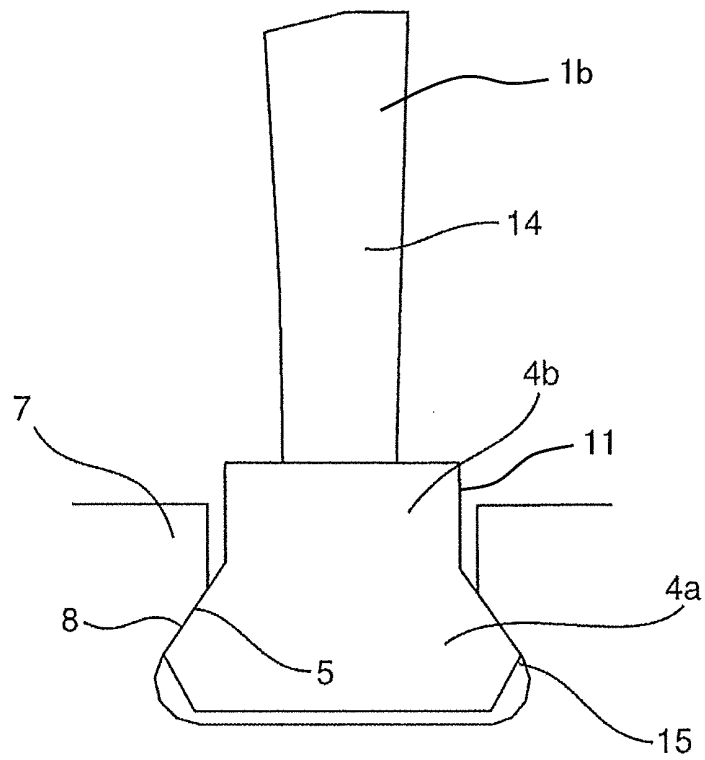


FIG. 4

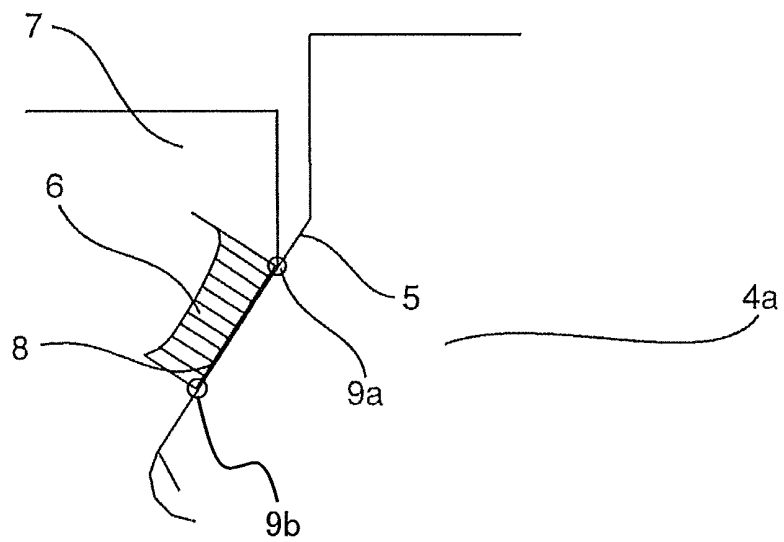


FIG. 5A

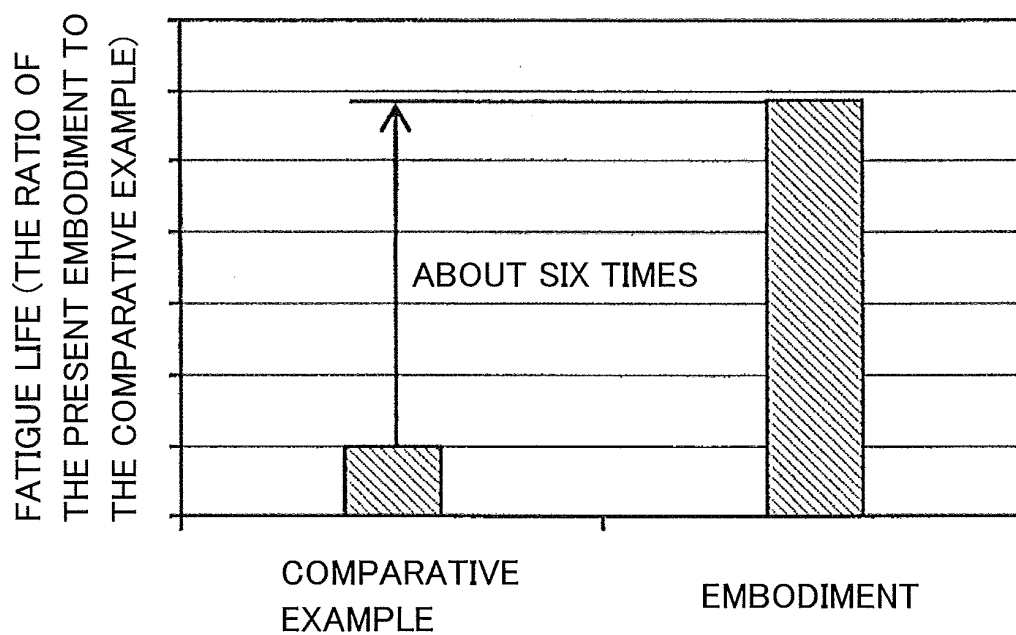
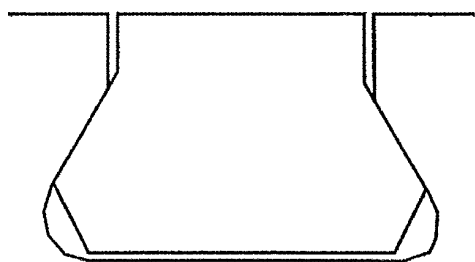
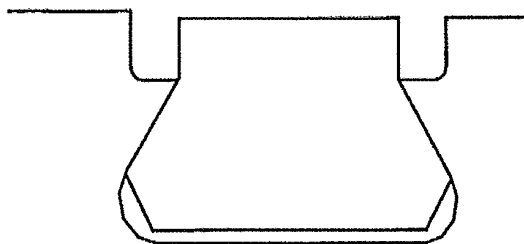


FIG. 5B



COMPARATIVE EXAMPLE

FIG. 5C



EMBODIMENT

FIG. 6

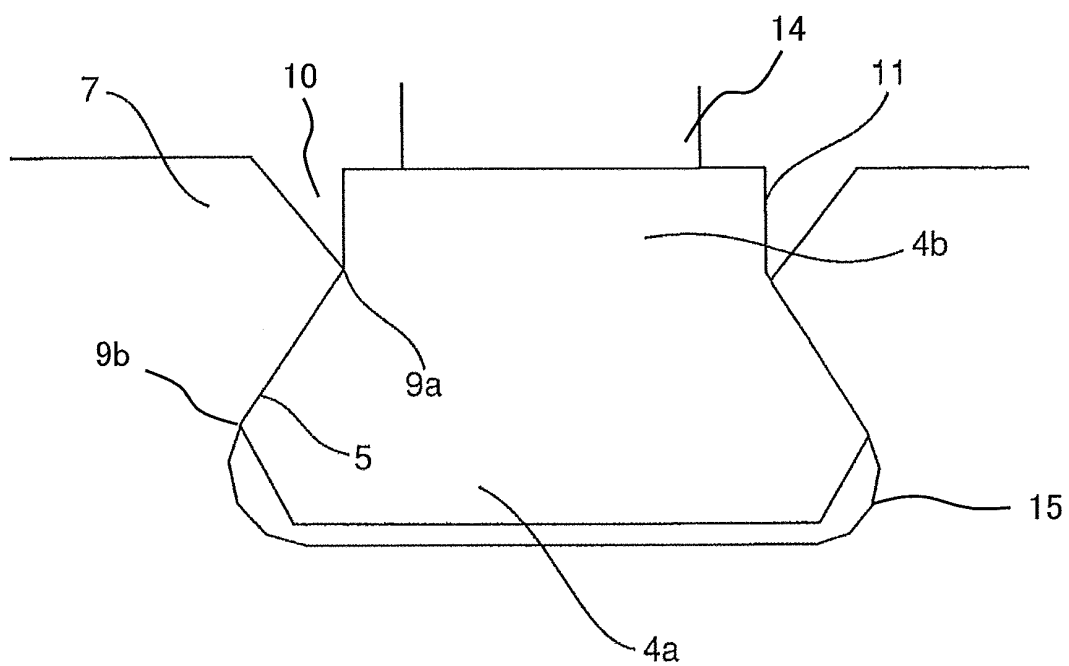


FIG. 7

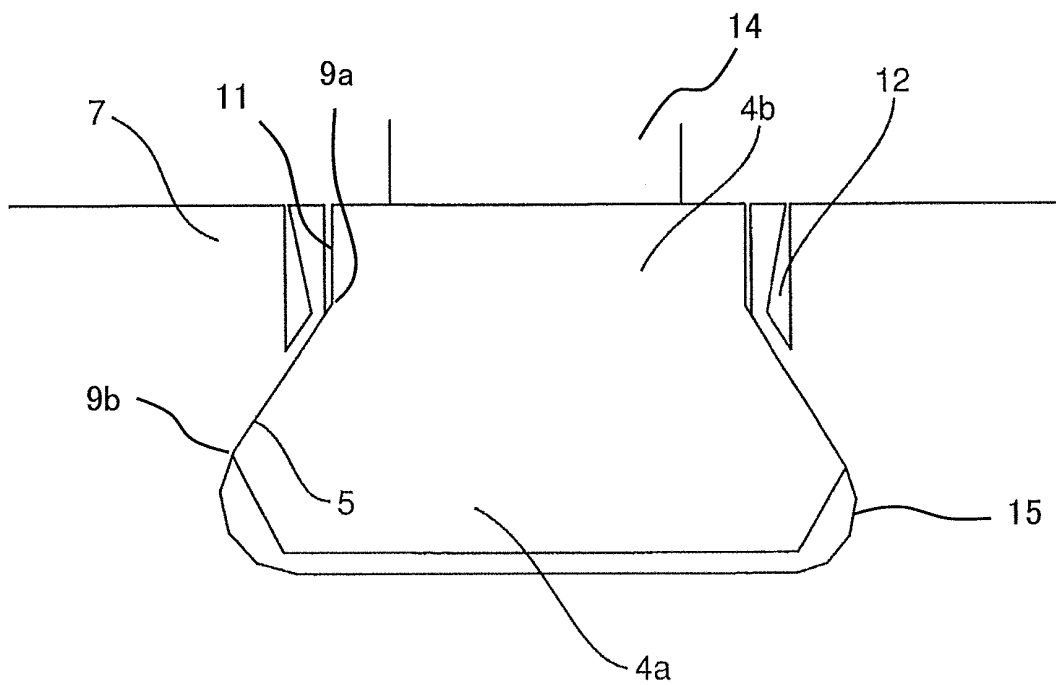
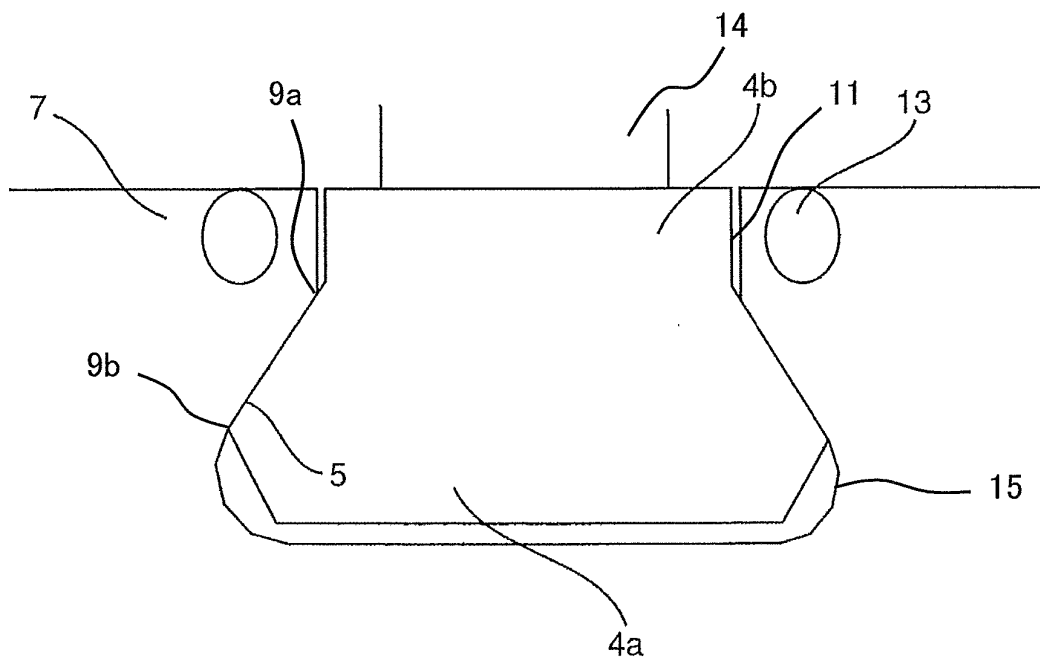


FIG. 8





EUROPEAN SEARCH REPORT

Application Number
EP 13 16 9807

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CH 430 754 A (GOERLITZER MASCHINENBAU VEB [DE]) 28 February 1967 (1967-02-28) * figures *	1-6	ADD. F01D5/30
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 August 2013	Examiner Raspo, Fabrice
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 13 16 9807

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