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GB 1295003 A **FR 002913064 A1**

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INT CL **F01D**
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(54) Title of the Invention: **Rotor disc sealing flange sector**
Abstract Title: **Turbomachine rotor disc sealing flange sector**

(57) A sealing flange 9 for a turbomachine rotor disc 1, eg a compressor or turbine rotor disc of an aircraft turbojet or turboprop engine, comprises several flange sectors 12 each having a radially outer part 13, to bear against the roots 4 of the blades 5 to ensure sealing between the blades 5, and a radially inner part 14. The radially inner part has a radially outer, weight-reducing, groove 27 and a radially inner groove 28 which receives an annular sealing strip 10. To prevent the sealing strip 10 being installed wrongly into the outer groove 27 at least one fool-proofing protuberance 35 projects from the bottom of the groove 27. The protuberance may have a circumferential thickness of between 0.5mm and 2mm.

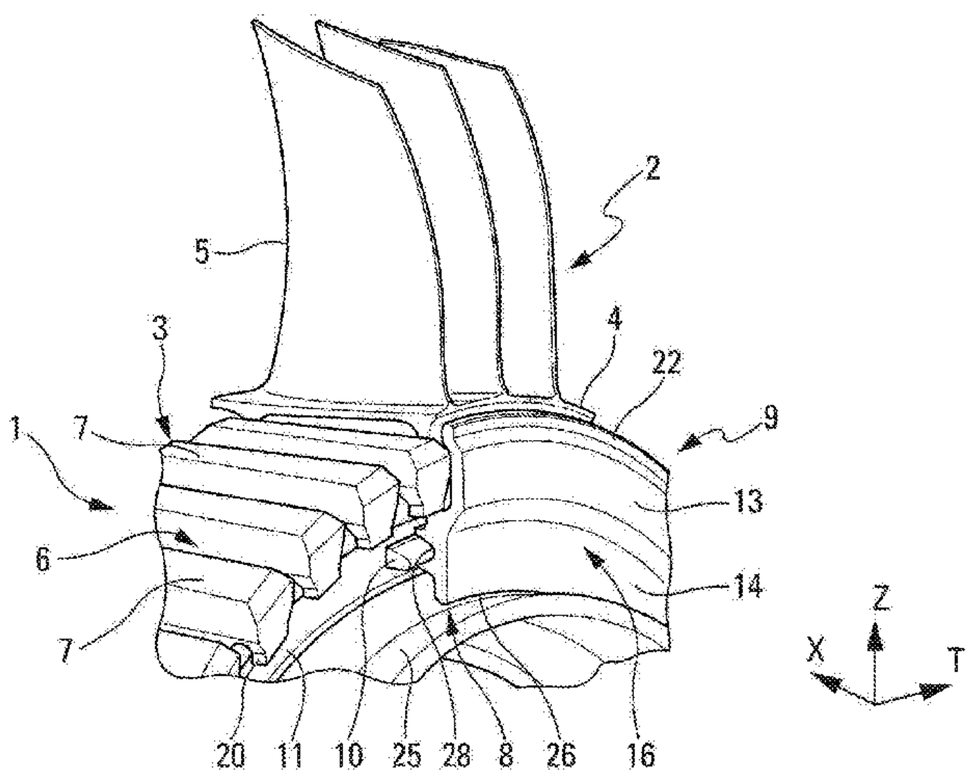

Fig. 1

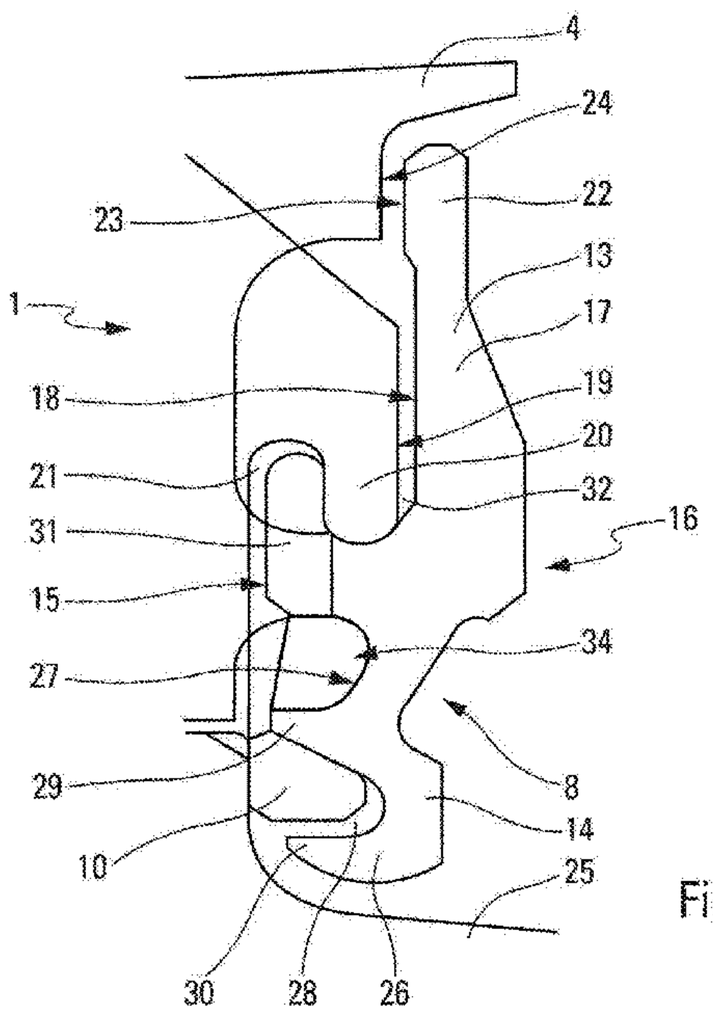

Fig. 3

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[Fig.1]

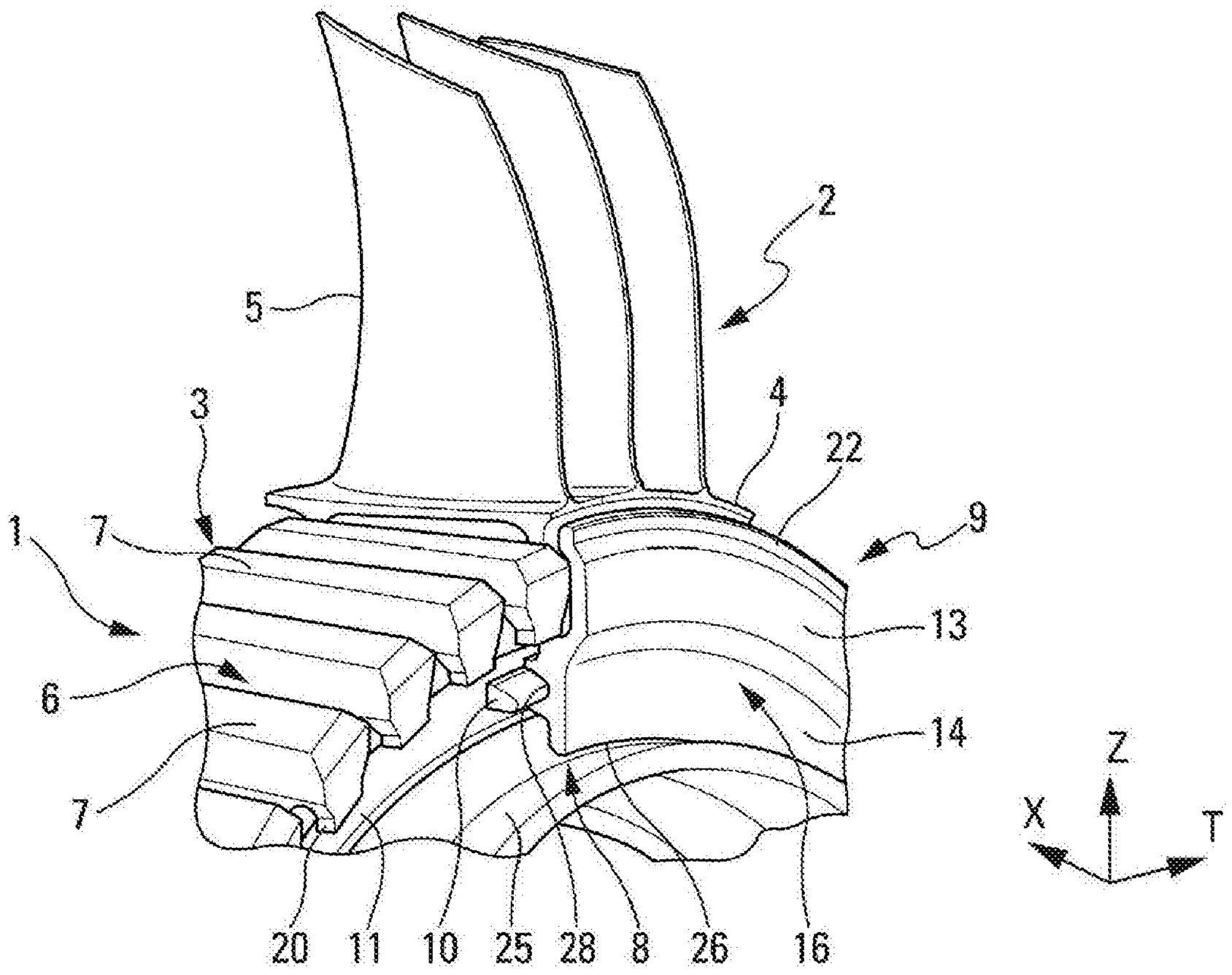

Fig. 1

[Fig.2]

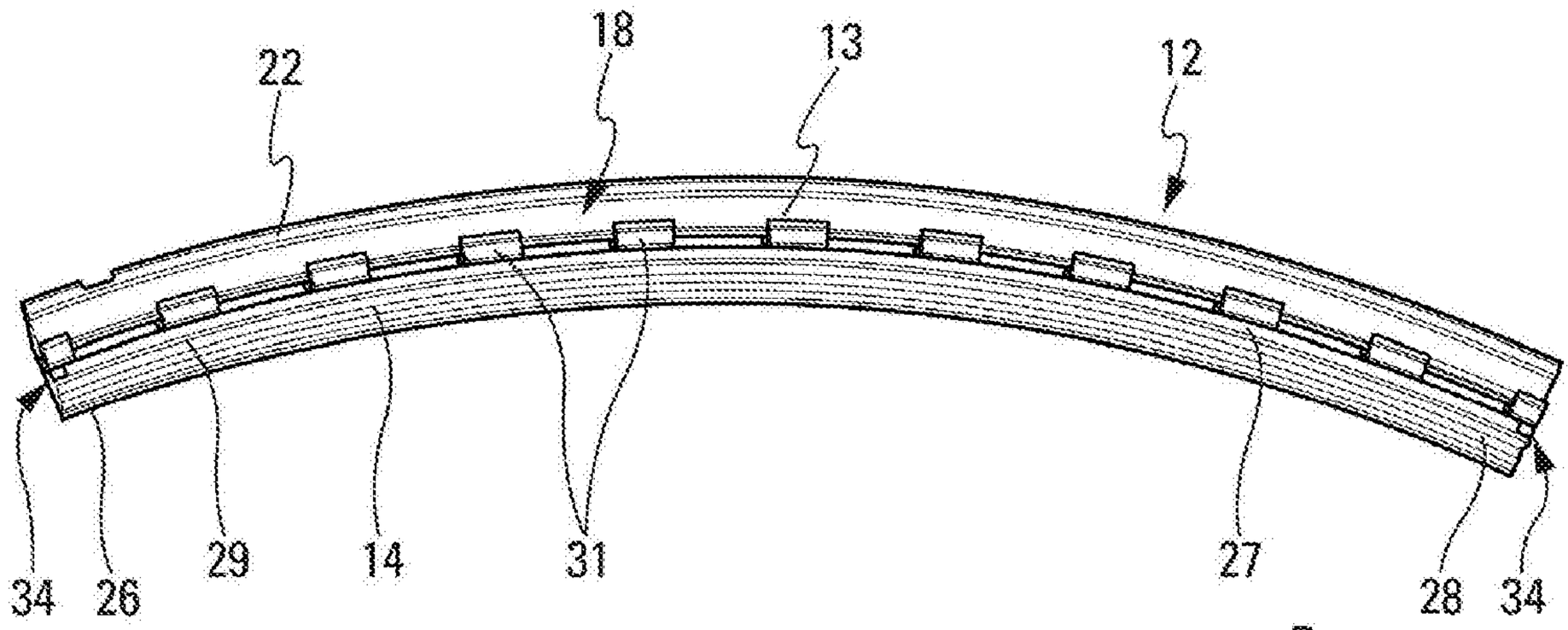

Fig. 2

[Fig.3]

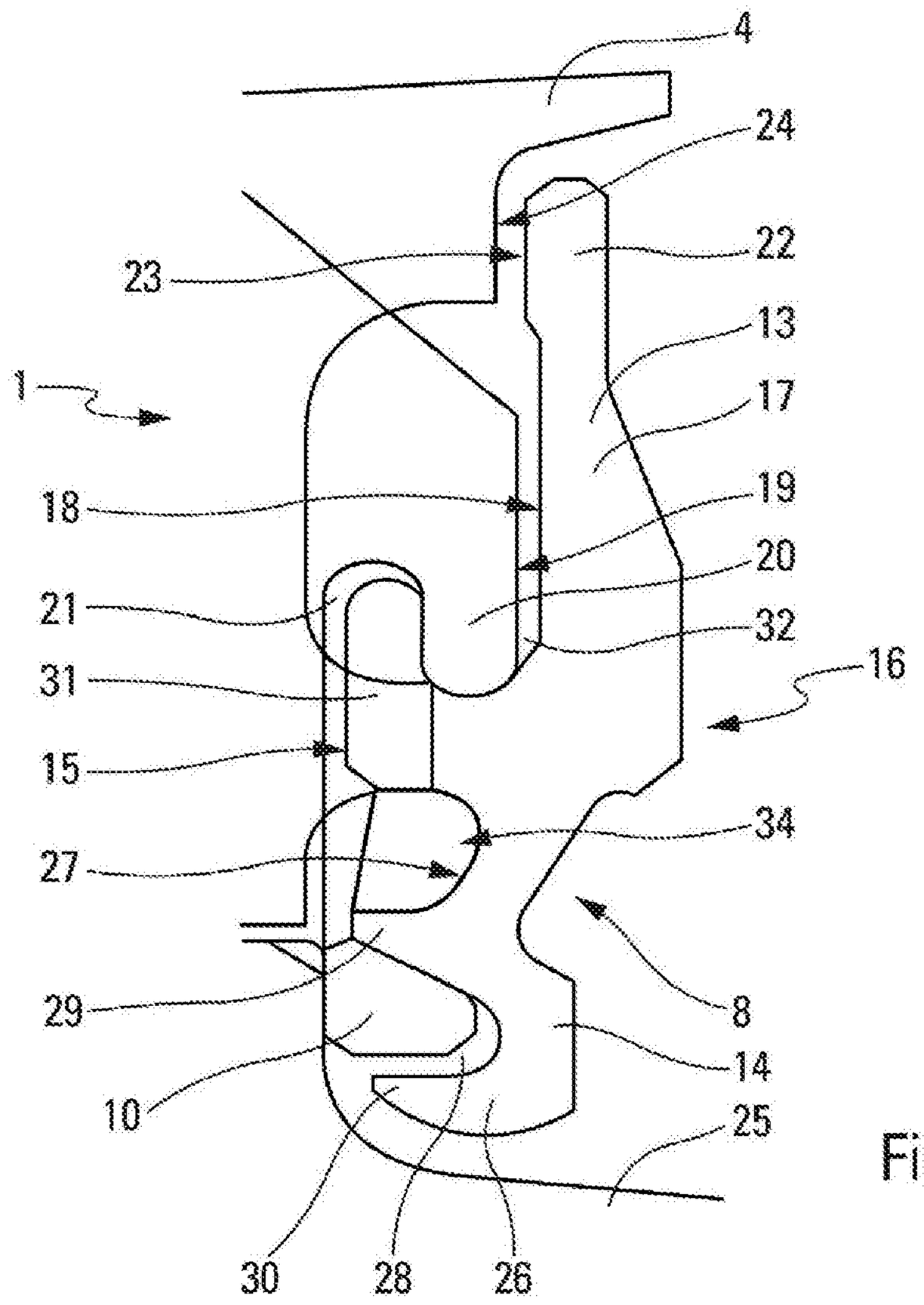

Fig. 3

[Fig.4]

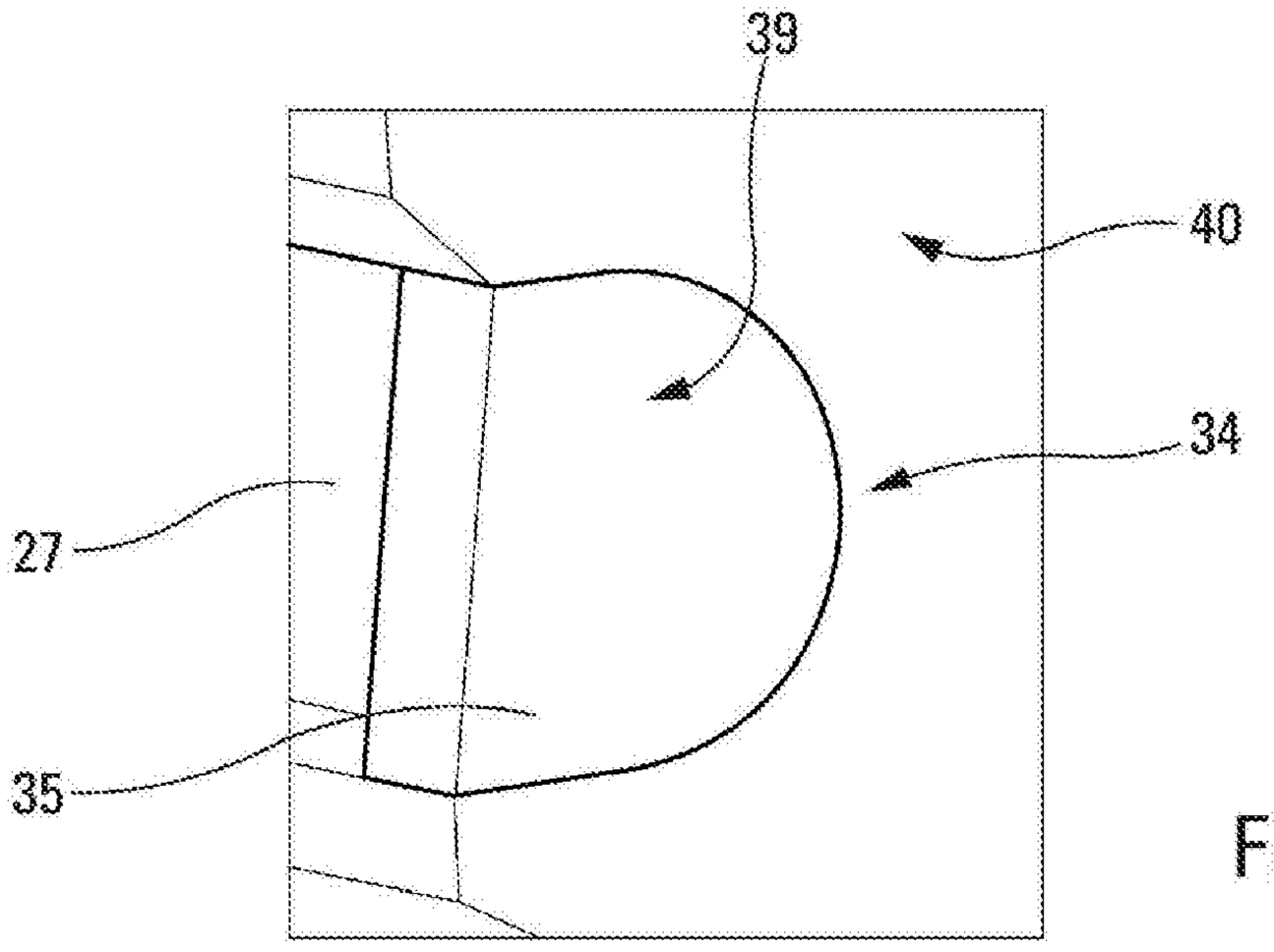

Fig. 4

DESCRIPTION

TITLE: ROTOR DISC SEALING FLANGE SECTOR

Technical field of the invention

The present invention concerns the field of aeronautical turbomachines. It is aimed more particularly at a sealing flange sector for a turbomachine rotor disc. It also concerns an annular flange equipped with such a sealing flange sector, a rotor disc comprising such a flange and a turbomachine comprising such a rotor disc.

Background

The prior art comprises patent documents US-A1- 2014/193265, EP-A2-1 895 103, EP-A1-1 498 579 and WO-A1-2011/092439.

In general, some turbomachine rotor discs with blades, such as compressor or turbine discs, are equipped with a sealing system to prevent air flow leakage at the blade roots. In particular, the rotor discs, centered on a longitudinal axis of the turbomachine, comprise a plurality of cavities evenly distributed over their periphery. The cavities each have a main direction parallel to the axis of the turbomachine and the blade roots are each housed in a cavity. This arrangement is known as the "axial attachment" or "pinned attachment". The clearance required for mounting between the blade roots and the disc cavities, together with the axial forces of the aerodynamic flow passing through the compressor or turbine on the blades which exerted over the blades, allow unwanted airflow to pass on either side of the root of the blades. These leaks lead to airflow recirculation, resulting in significant losses in turbine or compressor performance and flow rate. The sealing system is designed to compensate for these leaks and air flow recirculation.

An example of a sealing system, known from FR-B1-2913064, comprises several circumferentially juxtaposed flange sectors. Each flange sector comprises a radially outer part and a radially inner part. Each flange sector is movable by centrifugal effect between a rest position in which its radially inner part bears against a hub of the disc and an operating position in which its radially outer part is applied to the disc (more precisely the blading) to prevent leakage of pressurized air flows towards the axis of the disc and upstream thereof. In addition, the radially inner part of the flange comprises a first annular groove arranged radially outside a second annular groove. An annular sealing strip is intended to be mounted in the second groove and to bear against a downstream face of the rotor disc hub. This annular sealing strip makes it possible, on the one hand, to keep the annular flange or several flange sectors cold and, on the other hand, to clamp the

flange radially during operation under the effect of centrifugal force and to tilt them around disc hooks, thus ensuring complete sealing.

When the sealing system is mounted by an operator, the sealing strip is first mounted on one face of the rotor disc, followed by the individual sealing flange sectors by sliding and making the annular strip fit into the second groove of each flange sector. Finally, the blades are mounted on the rotor disc with their roots in the cavities. However, the geometry of both the first and second grooves is essentially identical and their configuration, especially sufficiently close to each other at the radially inner groove, make that the operator can inadvertently fit the annular strip without obstacle into the first groove, which is not intended for this purpose. Such a mounting error leads to a leakage of the flange sectors. This is due to the fact that the annular strip, which is now mounted in the first groove, is located at the bottom of the cavities with a radial gap between the annular strip and the bottom of the cavities. The air flow can thus flow through this radial space, towards the disc axis and upstream of the rotor disc, passing again under the blade roots. An area with fins can be located on either side of the rotor disc, these fins cooperating with a layer of abradable material. Leakage of the air flow can lead to an increase in the temperature of this fins area and irreversible plastic deformation of the fins, which can lead to cracks or crevices in the fins due to the strong penetration of the fins into the abradable material opposite them.

The present invention has in particular the objective of providing a simple and effective solution for mounting an annular strip cooperating with at least one flange sector at the right place and for the flange sector to be able to ensure its sealing function.

Summary of the invention

This objective is achieved in accordance with the invention by means of a sealing flange sector for a turbomachine rotor disc which carries blades, the annular flange sector comprising a radially outer part which is intended to be applied at least partly on the blades in order to ensure sealing between the blades and a radially inner part intended to bear against an annular strip mounted on one face of the rotor disc, the radially inner part comprising a first groove arranged radially outside a second groove, the first groove comprising at least one foolproofing element.

Thus, this solution allows to achieve the above-mentioned objective. In particular, this foolproofing element in the first groove prevents the operator from inserting an organ of the turbomachine, such as an annular strip of a sealing system in this first groove which is not intended to receive it and consequently the risks of leakage of aerodynamic flow through the flange are limited. In other words, the operator will not be able to insert the annular strip in the first groove because of this foolproofing element. This solution guarantees the mounting of the flange sectors on the disc and is easy to implement.

The flange sector also comprises one or more of the following features, taken alone or in combination:

- the first groove comprises two opposite ends along a circumferential direction of elongation of the first groove, a foolproofing element being arranged at at least one of the two circumferential ends of the first groove;

- a foolproofing element is arranged respectively at each end of the first groove;

- each foolproofing element is constituted by a protuberance projecting from a bottom of the first groove;

- the protuberance is integrally formed with the flange sector;

- the radially outer part comprises a peripheral lip intended to come against at least one blade root;

- the flange sector comprises a plurality of lugs arranged radially between the radially inner part and radially outer part, each lug extending radially outwardly;

- the first groove and the second groove are arranged on an upstream face of the flange sector;

- the first and second grooves are radially separated by an annular projection extending axially from the upstream face of the flange sector;

- the flange sector is made of a metallic material or a metallic alloy.

The invention also relates to an annular flange comprising a plurality of flange sectors having any of the foregoing characteristics.

The invention also relates to a turbomachine rotor disc carrying blades and equipped with an annular flange having any of the above-mentioned characteristics and with an annular sealing strip installed in the second groove of each flange sector.

The invention further relates to a turbomachine comprising a rotor disc having any of the above-mentioned characteristics.

The invention further relates to a method of installing a sealing system on a rotor disc having any of the above-mentioned characteristics, the sealing system comprising an annular sealing strip and an annular sealing flange and the method comprising the following steps:

- installing the annular sealing strip on the face of the rotor disc,

- installing the sealing flange sectors forming the annular flange,

- positioning the annular strip in the second groove of the flange,

- installing the blades on the rotor disc by inserting their roots into cavities of the rotor disc.

Brief description of the figures

The invention shall be better understood, and other purposes, details, characteristics and advantages of the invention shall appear more clearly on reading the

following detailed explanatory description of embodiments of the invention given as purely illustrative and non-limitative examples, with reference to the attached schematic drawings in which:

[Fig. 1] Figure 1 is a partial schematic and perspective view of a sealing system mounted on a turbomachine rotor disc according to the invention;

[Fig. 2] Figure 2 is a schematic and side view of an example of a sealing flange sector to form an annular flange according to the invention;

[Fig. 3] Figure 3 is a detailed and axial sectional view of an example of a flange sector equipped with a foolproofing element and mounted on a rotor disc according to the invention; and

[Fig. 4] Figure 4 shows an example of a foolproofing element arranged in a sealing flange sector according to the invention.

Detailed description of the invention

Figure 1 partially illustrates a turbomachine rotor disc 1, for example a compressor or turbine rotor disc. The turbomachine may be an aircraft turbojet or turboprop engine. The rotor disc 1 is centered on a longitudinal axis X of the turbomachine and several blades 2 each extend along a radial axis Z from the periphery 3 of the rotor disc 1. The blades 2 are evenly distributed around the periphery of the rotor disc. Each blade 2 comprises a root 4 and a vane 5 which extends along a radial axis from the root 4. Each blade 4 is bathed in an aerodynamic flow passing through the turbomachine.

The rotor disc 1 comprises a plurality of cavities 6 which each extend substantially along the longitudinal axis X and which are evenly distributed around the periphery 3 of the rotor disc 1. Alternatively, the cavities may be arranged in a direction having a non-zero angle to the longitudinal axis (pinning angle).

The cavities 6 are each intended to receive one blade root 4. The cavities 6 are each circumferentially bounded by two teeth 7 as shown in Fig. 1. The roots 4 each have a shape corresponding to that of a cavity 6, such as a fir tree or dovetail shape.

With reference to Figures 1 and 2, at least one sealing system 8 is mounted on the rotor disc so as to prevent aerodynamic flow to circulate upstream of the rotor disc. The sealing system 8 comprises an annular sealing flange 9 and an annular sealing strip 10. The annular strip 10, as will be seen in the following description, is mounted on the annular flange 9 in such a way as to prevent the passage of air under the annular flange.

The annular flange 9 is mounted against one face 11 of the rotor disc 1, which extends along the radial axis Z, so that the blades 2 carried by the rotor disc 1, in particular the roots 4 in the cavities 6, are axially fixed. The annular flange 9 also makes it possible, by means of the annular strip, to prevent the aerodynamic flow from flowing into the cavities 6 and under the blade roots 4 by forming a sealing barrier.

The face 11 can be either an upstream or a downstream face of the rotor disc depending on the stage on which the annular flange 9 is mounted.

In fact, each turbine (like each compressor) comprises one or more stages. In the case of a plurality of stages, these are arranged successively along the longitudinal axis X. Each stage comprises a movable wheel with blades forming a rotor and a fixed wheel forming a stator. The blades of this stator are referred to as distributor blades. Each movable wheel is arranged upstream of a distributor wheel. In the case of a compressor, the stator blades are referred to as rectifier and each of these is respectively downstream of one movable wheel as well. Each movable wheel comprises a rotor disc as shown in Figure 1.

Alternatively, annular flanges can be mounted upstream and downstream of the rotor disc.

In the present invention, and in general, the terms "upstream" and "downstream" are defined in relation to the flow of gases in the turbomachine which is substantially parallel to the longitudinal axis X. The terms "axial" and "axially" are defined in relation to the longitudinal axis. A transverse axis T shown in Figure 1 is also perpendicular to the longitudinal and radial axes.

In this example of embodiment where the flange is located on the downstream face of the disc, the annular flange 9 comprises several flange sectors 12 such as the one shown in Figure 2. Each flange sector 12 extends in a circumferential direction around an axial direction A. This axial direction A is centered on the longitudinal axis X of the rotor disc and the turbomachine in the installed condition.

Each flange sector comprises a radially outer part 13 and a radially inner part 14 which each extend respectively in a radial direction R. The terms "inner", "outer", "radial" and "radially" are defined with respect to the radial direction R perpendicular to the axial direction A and with respect to the distance from the axial direction A. Similarly, in the situation where the flange is installed on the turbomachine disc, the radial direction R is parallel to the radial axis Z.

Each flange sector 12 also comprises an upstream face 15 and a downstream face 16 which are opposite in the axial direction (and along the longitudinal axis X in the case of installation on the rotor disc).

With reference to figures 2 and 3, the radially outer part 13 is intended to be applied to the blade roots to ensure sealing. In particular, the radially outer part 13 comprises a first wall 17 having a first surface 18 which is defined in a plane which is substantially perpendicular to the axial direction A. The first surface 18 faces at least one (substantially flat) bearing surface 19 of a hook 20. The latter is carried by each tooth 7 of the rotor disc. In other words, there is a plurality of hooks 20 which are distributed around

the longitudinal axis. The hooks 20 extend radially towards the longitudinal axis (i.e. inwards). The hooks are spaced axially from the face of the disc forming an annular groove 21.

The radially outer part 13 also comprises a peripheral lip 22 which extends radially from the first wall 17 of the flange sector 12. The peripheral lip 22 has a second surface 23 which is intended to bear against at least one root 4 of blade 2, and in particular against a bearing surface 24 of each blade root. The second surface 23 is defined in a plane substantially parallel to that of the first surface 18 of the first wall 17 of the flange sector 12. The first and second surfaces are located on the side of the upstream face 15 of the flange sector 12. In particular, as can be seen in Figure 3, the second surface 23 is upstream of the first surface 18, allowing contact between the second surface 23 and the bearing surface 24.

With reference to Figures 2 and 3, the radially inner part 14 comprises a peripheral edge 26 formed at the radially inner end of the flange sector and facing a hub 25 of the rotor disc. The radially inner part comprises a first groove 27 intended to be arranged opposite the rotor disc face 11. In other words, the first groove 27 is arranged on the upstream face 15 of the flange sector 12. The first groove is elongated in a circumferential direction. This first groove 27 reduces the weight of the flange sector 12 to improve the performance of the compressor or turbine and the service life of the turbine (or compressor).

The radially inner part 14 is supplemented by a second groove 28 designed to be arranged also opposite the face 11 of the rotor disc. In other words, the first groove 28 is arranged on the upstream side 15 of the flange sector 12. The second groove also extends in a circumferential direction. The first groove 27 is arranged radially outside the second groove 28.

In particular, the second groove 28 is intended to receive at least part of the annular sealing strip 10 (or ring). The annular strip 10 is split radially. More specifically, the annular strip prevents the aerodynamic flow from rising to the disc cavities 6. In this example of embodiment, this one has a trapezoidal cross-section. However, the annular strip 10 can have an approximately triangular cross-section.

The first and second grooves 27, 28 each extend circumferentially over the entire surface of the flange sector. Each first and second groove has a U-shaped axial section with a bottom and two substantially axial branches extending from the bottom. Likewise, each first groove and second groove extends between a first end and a second opposite end in the circumferential direction of elongation.

As can be seen in Figures 1 and 3, the first and second grooves are radially separated by an annular projection 29 extending axially from the upstream face 15 of the

flange sector. The annular projection 29 also extends over the entire surface of the flange sector in the circumferential direction. The peripheral edge 26 furthermore comprises a pin 30 which makes it possible to form one of the branches of the U of the second groove 28.

Each flange sector 12 in this example also comprises a plurality of lugs 31 (or flange hook) which are evenly distributed on the upstream face 15 of the flange sector in a circumferential direction. These lugs 31 project from the upstream face and extend radially outwardly. They are intended to cooperate with the hooks 20 of the rotor disc carried by the teeth so as to form an axial and radial retention of the flange sector in relation to the rotor disc. In particular, the lugs 31 have shapes and dimensions substantially complementary to the annular groove 21 in which they are intended to be housed. In this example, the lugs 31 are arranged radially between the radially outer part 13 and the radially inner part 14. The lugs 31 are spaced axially from the upstream face so as to form a third groove 32 in which the hooks 20 are received.

As can be seen in Figures 2, 3 and 4, the first groove 27 comprises at least one foolproofing element 34 so as to prevent the mounting of the annular strip 10 in it.

In this example, one foolproofing element 34 is arranged at each circumferential end of the first groove.

Advantageously, but not restrictively, at least one foolproofing element 34 consists of a protuberance 35 projecting from the bottom of the first groove 27. In this example, the protuberance 35 is integrally formed with the flange 9, 12. This configuration is simple to implement because it is sufficient to interrupt the machining operation of the first groove at the desired position for the foolproofing element. When the protuberances 35 are located at the ends of the first groove 27, it is sufficient to stop the machining operation earlier. Such a solution only has a very small impact on the mass of the flange. On the other hand, this solution is simple since it is applied during the machining of the flange.

Another advantage is that each protuberance 35 has a small thickness so that the flange mass can be checked. For example, each protuberance 35 has a thickness (in the circumferential direction) of between 0.5 and 2 mm.

Each protuberance has a height less than or equal to that of the first groove 27 substantially in the axial direction A. This guarantees the sealing of the flange.

As can be seen in figure 4, the protuberance has a face 39 which is flush with a side face 40 of the flange sector.

Each flange sector is made of a metallic material or a metal alloy. Advantageously, the metal material or metal alloy comprises a base of nickel, chromium, iron and/or molybdenum.

We will now describe an example of a method for mounting a sealing system 8 on a rotor disc 1 as described above. The sealing system comprises an annular sealing

flange 9 and also an annular sealing strip 10. In this mounting method, the operator first installs the annular sealing strip on the face 11 of the rotor disc. The flange sectors 12 are then placed on the rotor disc to form the flange 9. It is of course possible for the flange 9 to be formed in one piece to form a closed ring.

In this step, the lugs 31 of each sector 12 are slid into the annular groove 21 formed by the hooks 20 of the rotor disc. Each hook 20 is also housed in the third groove 32 of the flange sector.

In the same way, during this step, the annular strip 10 is positioned at a desired height in the radial direction so that it can be inserted into the second groove 28. The operator cannot make a mistake in the choice of groove since the first groove 27 comprises at least one foolproofing element to prevent the insertion of the strip 10. Finally, the blades 2 are mounted on the disc by inserting the blade roots into the cavities.

As the rotor disc rotates, the flange sectors 12 move radially outwards under centrifugal force so that the peripheral lip 22 of each flange sector 12 is in contact with the blade root 4. The free ends of the hooks 20 may abut against the bottom of the third groove 32 and/or the free ends of the tabs 31 may abut against the bottom of the annular groove 21. The second surface 23 of the peripheral lip also comes into contact with the contact surface 24 of the blade root by tilting around a point of contact with the disc hooks 20. This enables axial and radial locking of the annular flange 9 and also of the blade. The complete sealing of the system (rotor disc - annular strip - annular flange - blade) is thus ensured.

When the rotor disc is stationary, the flange 9 is no longer subject to centrifugal force and is held by the annular strip 10 (due to the inherent rigidity of the annular strip 10) on the rotor disc 1.

CLAIMS

1. A sealing flange sector (12) for a turbomachine rotor disc (1) which carries blades (2), the flange sector (12) comprising a radially outer part (13) which is intended to be applied at least partly on the blades (2) to ensure sealing between the blades, and a radially inner part (14) intended to bear against an annular strip (10) mounted on a face (11) of the rotor disc, the radially inner part (14) comprising a first groove (27) disposed radially outside a second groove (28), characterized in that the first groove (27) comprises at least one k foolproofing eying element (34).

2. The flange sector (12) according to the preceding claim, characterized in that the first groove (17) comprises two opposite ends along a circumferential direction of elongation of the first groove, a foolproofing element (34) being arranged at at least one of the two circumferential ends of the first groove (27).

3. The flange sector (12) according to any one of the preceding claims, characterized in that each foolproofing element (34) is constituted by a protuberance (35) projecting from a bottom of the first groove (27).

4. The flange sector (12) according to the preceding claim, characterized in that the protuberance (35) is integrally formed with the flange sector (12).

5. The flange sector (12) according to any one of the preceding claims, characterized in that the radially outer part (13) comprises a peripheral lip (22) intended to come against a blade root (4).

6. The flange sector (12) according to any one of the preceding claims, characterized in that it comprises a plurality of lugs (31) arranged radially between the radially inner part (14) and the radially outer part (13), each lug (31) extending radially outwardly.

7. The flange sector (12) according to any one of the preceding claims, characterized in that the first groove (27) and the second groove (28) are arranged on an upstream face (15) of the flange sector (12).

8. The flange sector (12) according to the preceding claim, characterized in that the first and second grooves (27, 28) are radially separated by an annular projection (29) extending axially from the upstream face (15) of the flange sector.

9. An annular flange (9) characterized in that it comprises a plurality of flange sectors (12) according to any one of the preceding claims.

10. Turbomachine rotor disc (1) carrying blades (2) and equipped with an annular flange (9) according to the preceding claim and with an annular sealing strip (10) installed in the second groove (28) of each flange sector (12).

11. Turbomachine comprising a rotor disc (1) according to the preceding claim.

Intellectual Property Office

Application No:	GB2000602.9	**Examiner:**	John Twin
Claims searched:	1 to 11	**Date of search:**	12 May 2020

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	FR2913064 A1 (SNECMA)
A	-	GB1295003 A (Rolls-Royce) - note foolproofing protuberances 37

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F01D

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
F01D	0005/30	01/01/2006