



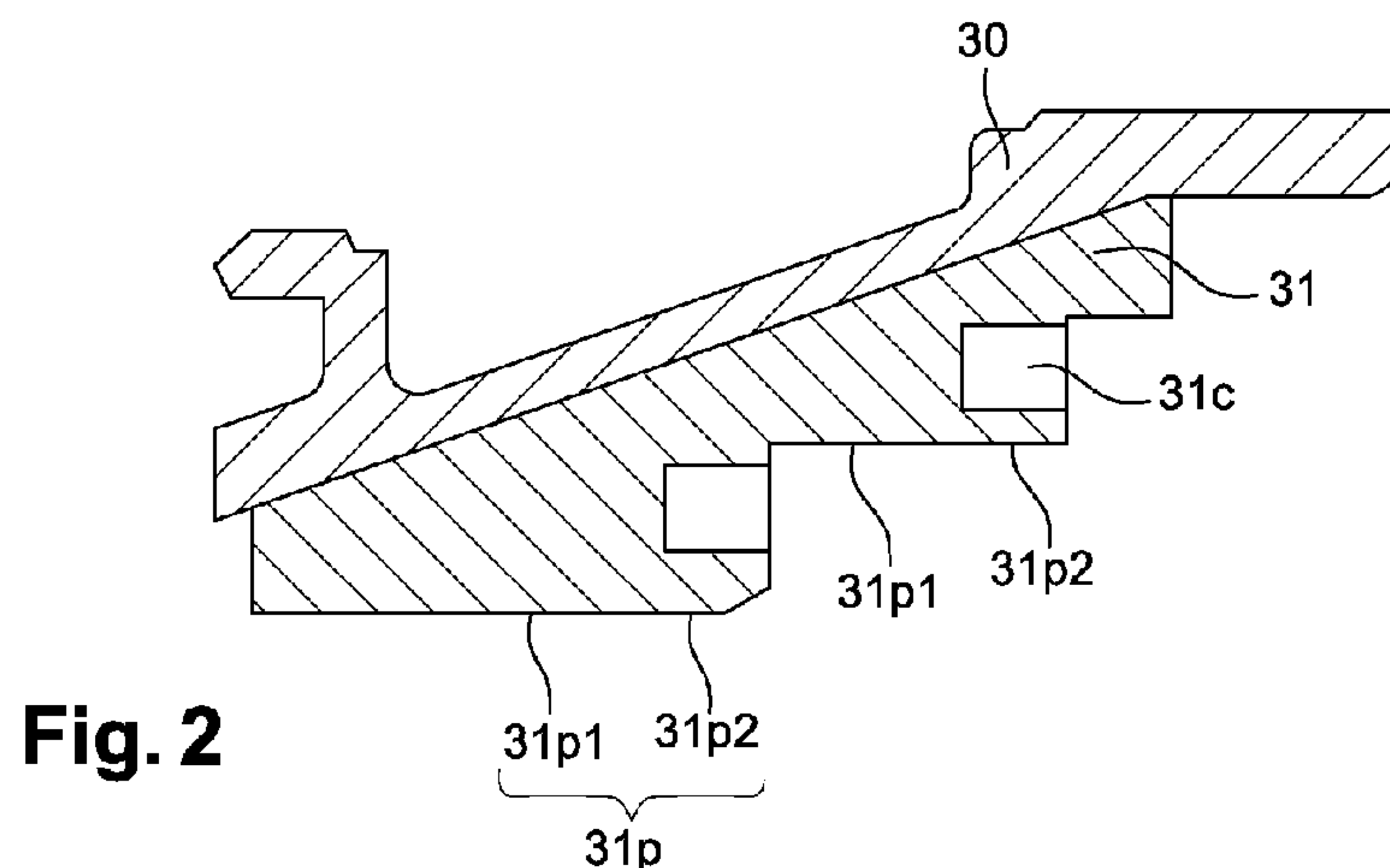
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(54) Titre : TURBINE DE MOTEUR A TURBINE A GAZ COMPRENANT UN ELEMENT DE JOINT D'ETANCHEITE A LABYRINTHE
(54) Title: TURBINE OF A GAS TURBINE ENGINE COMPRISING A LABYRINTH SEAL ELEMENT



(57) **Abrégé/Abstract:**

The invention relates to a turbine of a gas turbine engine. Said turbine includes a stator sealing ring element (31) arranged so as to form a labyrinth sealing joint in combination with at least one wiper, rotatable about the axis of the sealing ring. The element (31) includes an abradable material layer with a surface portion (31p) engageable with said movable wiper. Said turbine is characterized in that the abradable material layer on said surface portion (31p) axially includes a first area (31p1) having a first wiper penetration resistance, said first area (31p1) corresponding to the axial position of the wiper during nominal operation of the turbine, and a second area (31p2) adjacent to the first area (31p1) and having lower wiper penetration resistance than the first area. Said second area (31p2) is located downstream from the first area (31p1) and corresponds to the axial position that the wiper takes when a flame goes out in the combustion chamber of the engine.

ABSTRACT

The invention relates to a turbine of a gas turbine engine. Said turbine includes a stator sealing ring element (31) arranged so as to form a labyrinth sealing joint in combination with at least one wiper, rotatable about the axis of the sealing ring. The element (31) includes an abradable material layer with a surface portion (31p) engageable with said movable wiper. Said turbine is characterized in that the abradable material layer on said surface portion (31p) axially includes a first area (31p1) having a first wiper penetration resistance, said first area (31p1) corresponding to the axial position of the wiper during nominal operation of the turbine, and a second area (31p2) adjacent to the first area (31p1) and having lower wiper penetration resistance than the first area. Said second area (31p2) is located downstream from the first area (31p1) and corresponds to the axial position that the wiper takes when a flame goes out in the combustion chamber of the engine.

TURBINE OF A GAS TURBINE ENGINE COMPRISING A LABYRINTH SEAL ELEMENT

Field of the invention

5 The present invention relates to the field of gas turbine engines and more particularly to the field of stator seal elements used in the labyrinth seal between the moving and stationary parts of a turbine.

Prior art

10 A gas turbine engine comprises, at the level of the turbine for example, seals between the outer radial ends of the rotor blades and the stator surface swept by the outer radial ends of the moving stage; it is a matter of preventing a portion of the driving gas not working by bypassing the turbine stage. Labyrinth seals are used for this purpose. These seals comprise a seal element integral with the rotor, formed from one or more strips, called
15 wipers, arranged radially and transversely relative to the rotation axis of the machine. They also comprise a complementary stator element, facing the strips. This element has a surface portion that interacts with the strips to provide clearance that is as small as possible. Several strips in parallel cause a succession of pressure losses of the gas stream flowing round the turbine stage, providing the desired sealing.

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These labyrinth seals are used in several places of the engine, for example also between the turbine shaft and the base of the stator stage, formed from stator vanes, between two successive moving stages of a turbine.

25 Depending on their operating conditions, gas turbine engines are subject to differential variations in expansion between in particular the elements of the stator and those of the rotor. If these differences in variation are not kept under control they may affect the clearances between the moving parts and the stationary parts. Thus, for an engine for propulsion of an aircraft undergoing flame extinction in the combustion chamber in flight
30 for any reason, the whole turbine cools down because high-temperature gases are no longer passing through it. However, the casing may be cooled more quickly than the turbine rotor, which has an effect on the clearances. Now, for optimum efficiency, the

clearances of the labyrinth seals are designed to be as small as possible in operation. In such a situation there is a consequent risk of blocking of the rotor owing to the more or less close contact of the wipers with the abradable material.

5 The characteristics of the labyrinth seal are determined and adjusted to allow a variation of clearance and possible slight contact during the different phases of flight, in normal operation, but when the dimensional variations are large, resulting from an incident of this kind, the labyrinth seal can no longer fulfil its role. As the rotor is prevented from turning, restarting of the engine by autorotation of the LP or HP body or else by being
10 driven by an auxiliary engine may not proceed satisfactorily.

To prevent rotor lock-up in the case of such extinction of the combustion chamber, it would be conceivable to increase the clearance between the wipers and the abradable material. However, this solution is not economically viable owing to the drop in engine
15 performance that it would cause.

The present applicant therefore pursued the aim of developing a solution that would make it possible to cope with the situation of untimely extinction of the combustion chamber without reducing the performance of the engine in normal operation.

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Description of the invention

This aim is achieved according to the invention with a turbine of a gas turbine engine, comprising a stator sealing ring element arranged to form a labyrinth seal in conjunction with at least one wiper rotatable around the axis of the sealing ring, said element
25 comprising a layer of abradable material with a sealing surface portion able to interact with said moving wiper.

In the turbine according to the invention, the layer of abradable material on said surface portion comprises, axially, a first zone with a first resistance to penetration of a wiper, said first zone corresponding to the axial position of the wiper in nominal operation of the
30 turbine, and a second zone adjacent to the first zone with reduced resistance to penetration of a wiper relative to the first zone, said second zone being located

downstream relative to the first zone and corresponding to the axial position that the wiper assumes when flame extinction occurs in the combustion chamber of the engine.

The abradable material is a material that is worn or deformed in contact with the rotating
5 wiper, preferably the latter. It may be a honeycomb material.

The sealing ring element may be a sealing ring sector or a whole ring.

The invention results from the observation that in flight, when the engine is no longer
10 driven by the engine gases, it goes into autorotation and is subjected to the pressure of the relative wind. Moreover, in flight and when the engine is no longer driven, the differences in axial and radial expansion between the casing and the rotor may cause blocking of the rotor. This blocking may moreover be promoted by the slight downstream displacement of the various bodies, LP and HP, resulting from the aforementioned pressure of the
15 relative wind. The invention takes advantage of this displacement to reserve two zones on the surface portion opposite the wiper. The first zone corresponds to the axial position of the wiper in normal operation of the machine; the clearance between the wiper and the abradable material is in this case that of optimum operation of the machine. The second zone is located downstream relative to the first and corresponds to the axial position that
20 the wiper assumes when flame extinction occurs in the combustion chamber. As the clearance will then decrease until it is negative, it is important to reduce the frictional forces between the two parts moving relative to one another. This reduces or even eliminates the risks of rotor lock-up resulting from this contact.

25 Thus, said at least one moving wiper is able to move between two axial positions, a first position corresponding to normal (nominal) operation of the turbine, and a second position, downstream of the first position, corresponding to the axial position that the wiper assumes when flame extinction occurs in the combustion chamber. The layer of abradable material is configured to comprise, axially, said first zone, on which the wiper
30 will be positioned when it is in its first axial position, and said second zone, on which the wiper will be positioned when it is in its second axial position.

Said second zone may comprise at least one cavity. The presence of this cavity leads to reduced resistance to penetration of the wiper relative to the first zone. Said at least one cavity may be arranged in the thickness of the layer of abradable material and/or open onto the outside (axially and/or radially) of the layer of abradable material.

5

According to a first embodiment, said surface portion of the turbine stator sealing element has, relative to the axis (A) of the engine, a constant radius along the two zones, and in said second zone adjacent to the first, the thickness of the abradable layer is reduced. This zone with reduced thickness gives way to the lock-up pressure and releases the wipers
10 from the frictional forces. Rotor lock-up is avoided.

According to a particular embodiment, the thickness of the abradable layer in the second zone is reduced to 50-95% of the thickness of the abradable layer in the first zone. Advantageously, the zone with reduced thickness is filled with a material with resistance
15 lower than that of the abradable material.

According to another embodiment, the surface portion is cylindrical along the first zone and truncated along the second zone.

20 The invention finds a first application in which the element is arranged to form a labyrinth seal at the outer radial end of the rotor blades of a turbine, in particular axial.

The invention finds another application in which the element is arranged to form a labyrinth seal at the inner radial end of the stator blades of a turbine.

25

In one embodiment, the turbine comprises a rotor and a stator, the rotor comprising a plurality of radial blades provided at their radially outer end with a rotor sealing element with at least one wiper in the form of a radial strip, oriented radially outwards (it may be perpendicular to the axis or inclined relative to said axis, for example upstream) relative
30 to the rotation axis (A) of the rotor, the stator forming the cylindrical envelope within which the rotor blades are set in motion, the stator comprising, opposite said strip, a stator sealing element made of an abradable material and forming a labyrinth seal with the rotor sealing element. Said stator sealing element forms a sealing ring, said first zone

corresponding to nominal operation of the turbine and said second zone corresponding to operation in the phase of re-ignition after extinction of the engine's combustion chamber.

5 In one embodiment, the turbine comprises a stage formed from stator fins, said fins comprising, on the side of the axis (A) of the turbine, a sealing element interacting with at least one rotatable wiper to form a labyrinth seal. In the sealing element, said first zone corresponds to nominal operation of the turbine and said second zone corresponds to operation in the phase of re-ignition after extinction of the combustion chamber.

10 The invention also relates to a gas turbine engine comprising a turbine described above. It also relates to a turbine aero-engine comprising a gas turbine engine of this kind.

Brief description of the figures

15 The invention will be better understood, and other aims, details, features and advantages thereof will become clearer on reading the detailed explanatory description given hereunder, of embodiments of the invention given as examples, purely illustrative and non-limiting, referring to the appended schematic drawings.

In these drawings:

20 Fig. 1 is a schematic representation, in partial axial section, of an example of turbine of a gas turbine engine to which the invention applies;

Fig. 2 shows a detail from Fig. 1 relating to a stator sealing element to which the invention applies;

Fig. 3 shows a detail from Fig. 1 relating to another stator sealing element to which the invention applies;

25 Fig. 4 shows another embodiment of the invention.

Description of embodiments of the invention

Fig. 1 shows the LP turbine of a gas turbine engine. The structure of this turbine is known per se.

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This turbine 1 in this case has four stages. In this example, the rotor 20 of the turbine is formed from four turbine disks 21 bolted together. Each disk 21 carries rotor blades 21a

on its rim. At their outer radial end the blades have a root 21t, which is provided with radial strips 21l, facing the stator 30. In the example in the figure, each root 21t supports two radial strips forming the wipers of labyrinth seals. Opposite the wipers, the stator comprises sealing elements 31, which, as is known per se, form labyrinth seals with the wipers on the roots. According to this example, the two labyrinth seals are at two different radii relative to the axis (A) of the machine.

There are also labyrinth seals on the inner radial end of the wheels of interstage stator blades 22. The stator sealing element 22s is for example a ring in two halves. The wipers 20l are carried by the lateral extensions of the turbine disks 21 joining the latter by bolting.

The invention will now be described with reference to Figs. 2 to 6. Fig. 2 shows a detail of one of the stator sealing elements 31. This element 31 is an annular sector; in this example it comprises two surface portions 31p, each arranged to interact with a wiper 21l of the root 21t of the blade of the stage under consideration. Each surface portion 31p comprises a first zone 31p1 and a second zone 31p2. The first zone 31p1 is upstream of the zone 31p2 and interacts with a wiper 21l of the root 21t. This first zone 31p1 corresponds to the axial position of the wiper 21l in normal operation of the machine. The clearance between the wiper 21l and the abradable layer of the sealing element 31 is controlled. In normal operation of the gas turbine engine, the labyrinth seal is not subject to any appreciable deterioration, the temperature differences are controlled, and the differences in expansion between the moving parts and the stator parts do not affect the surface of the abradable material.

25

In the second zone 31p2, located downstream of the first zone, the abradable layer is of reduced thickness. A cavity 31c is made in the material to weaken it. On an existing sealing element the reduction may consist of machining into the thickness of the layer covering the sealing element; this zone corresponds to the axial position of the wiper during extreme operation of the engine in which the combustion chamber is extinguished in flight; the rotor is liable to be gripped by the stator element. In fact, when the combustion chamber is extinguished for an undesirable reason, the engine gases no longer pass through the rotors and the latter are subjected to the pressure of the air coming into

the engine. In this situation, the rotors undergo a downstream axial displacement. Owing to the differential cooling between the rotor and the stator, if the stator is cooled rapidly and contracts, the ends of the wipers penetrate into the material, which is weakened by the cavity 31c. No risk of blocking of the rotor is then to be feared from the solution of
5 the invention as appropriate materials are used.

The solution in Fig. 4 relates to a variant. The sealing element 31' has, on the surface portion 31'p opposite the wipers, two zones 31'p1 and 31'p2. The solution consisted of bevelling the second zone of the surface portion affected by the seal.

10

Fig. 3 shows application of the invention to the seal between the inner radial end 22s of the interstage stator disk. On this element, cavities 22c have been machined in the abradable material so as to create, on the second zone, a low resistance to penetration by the corresponding wiper 20l.

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Fig. 5 is a variant embodiment of the concept in Fig. 3, in which the cavities 22c, rather than being located at the outer periphery of the sealing element, are located at the inner periphery of this element and open out radially inwards.

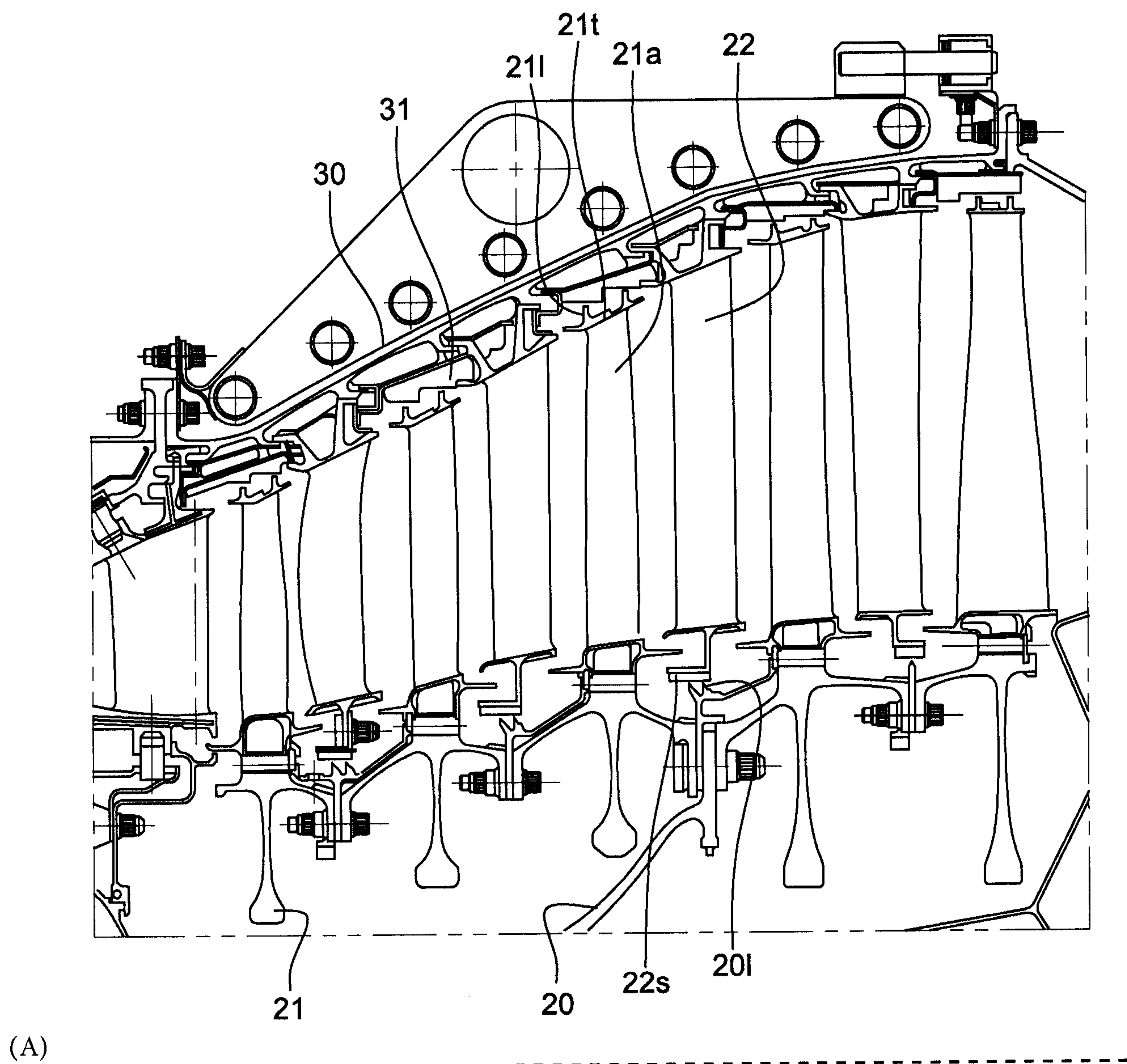
20 Fig. 6 is a variant embodiment of the concept in Fig. 2, in which the cavities 31c, rather than opening out axially downstream, in this case open out radially inwards.

CLAIMS

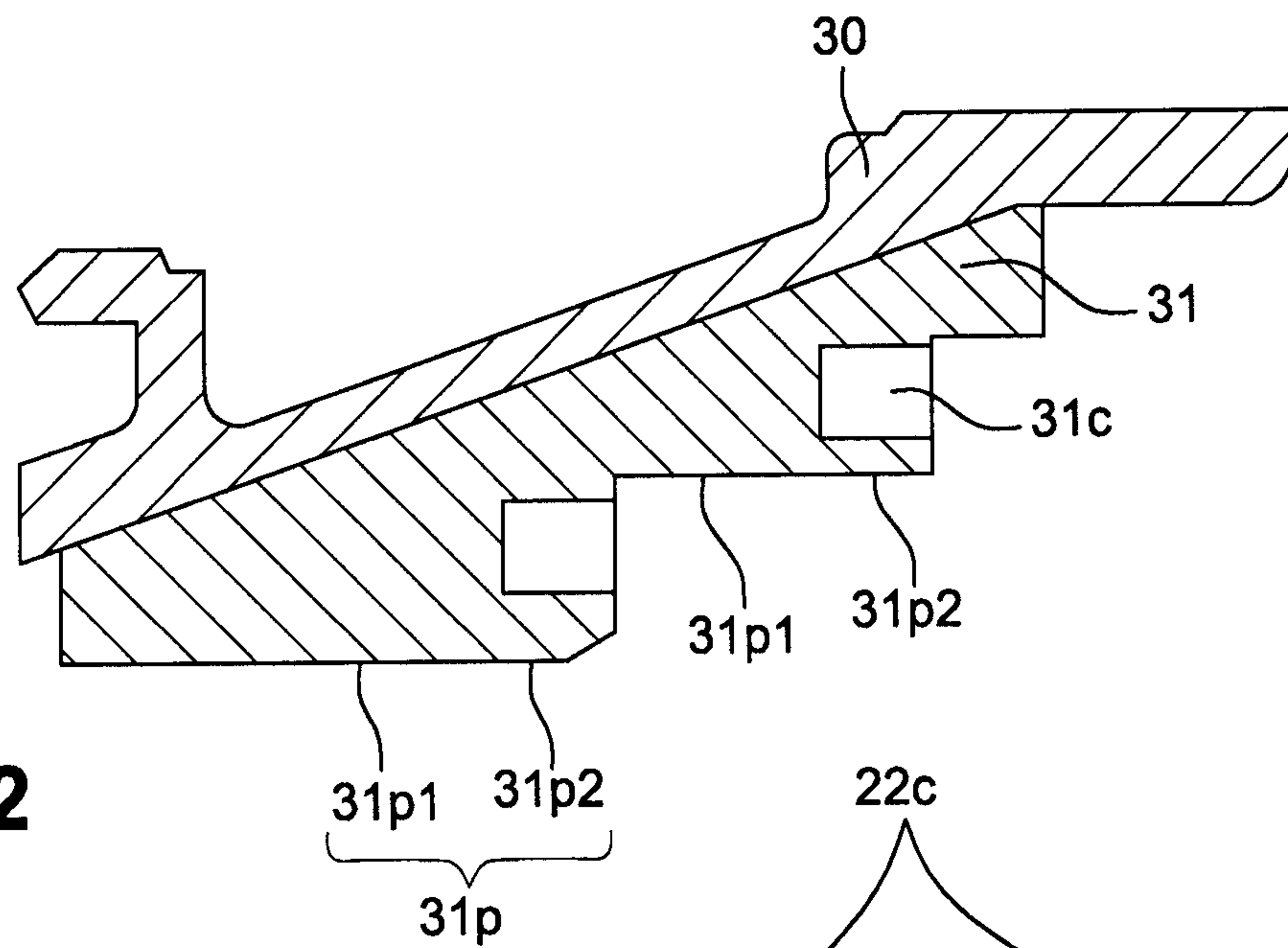
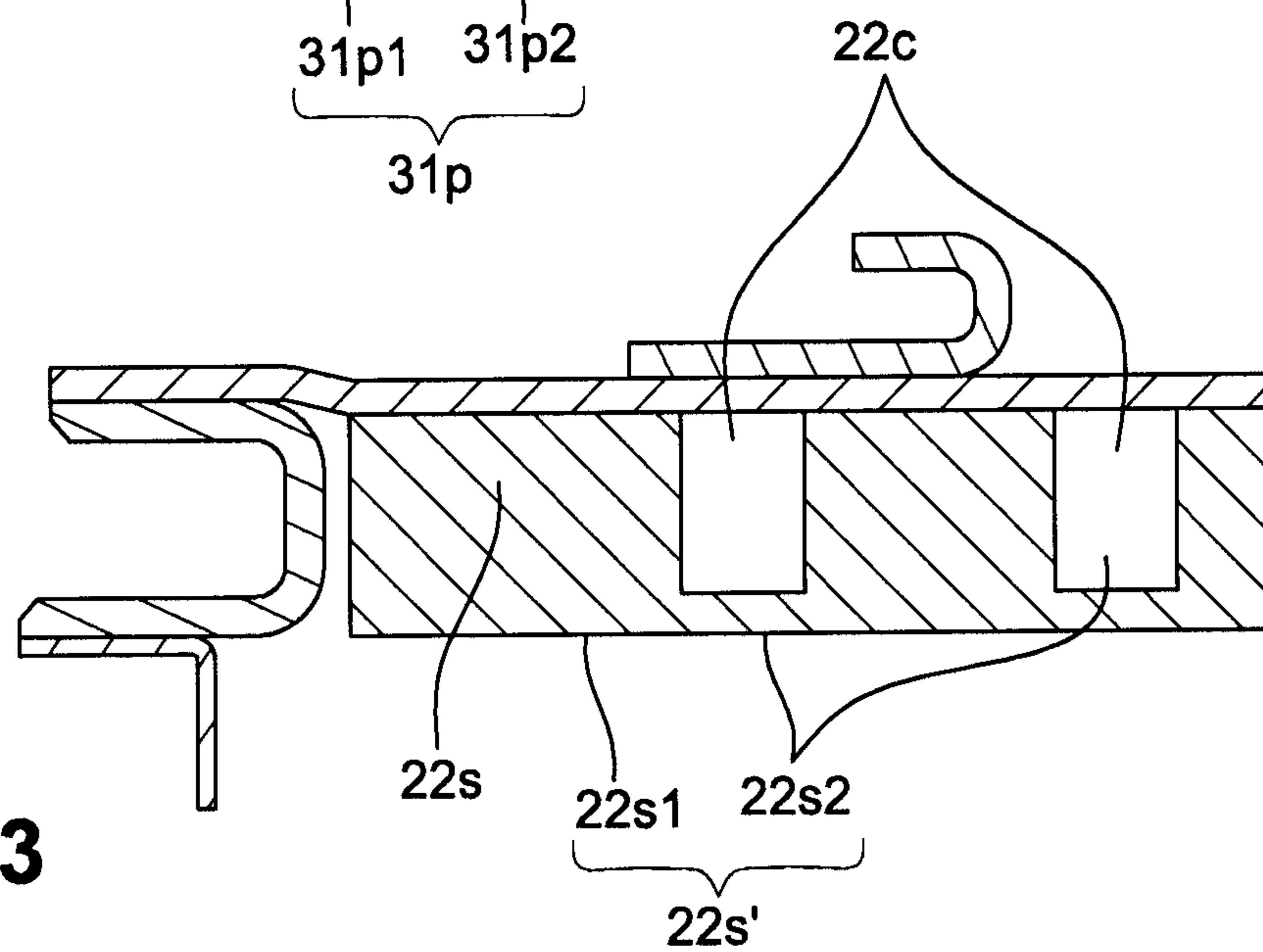
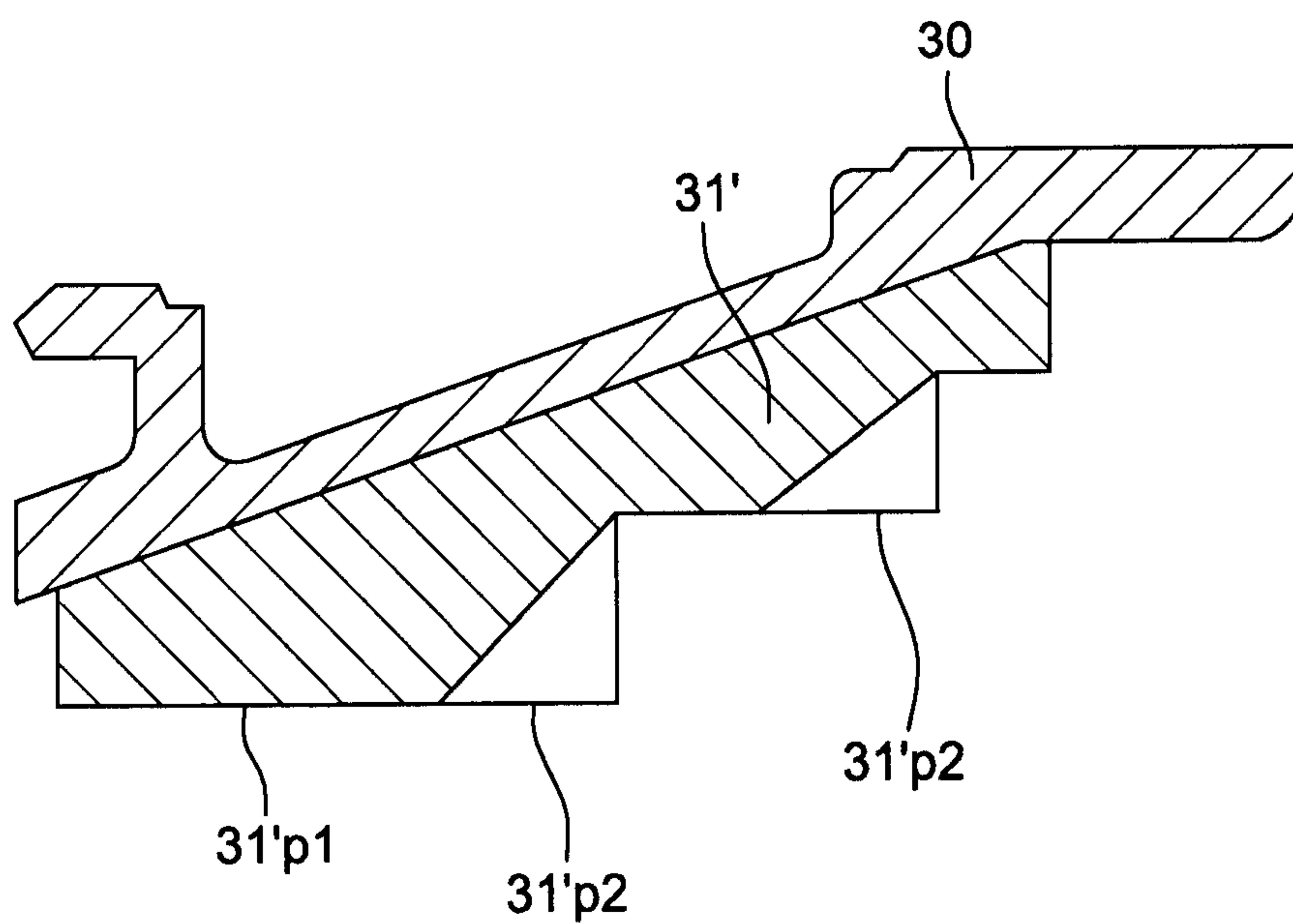
1. Turbine (1) of a gas turbine engine, comprising a stator sealing ring element (31, 31', 22s) arranged to form a labyrinth seal in conjunction with at least one wiper (21l, 20l) rotatable around the axis (A) of the sealing ring, said element (31, 31', 22s) comprising a layer of abradable material with a sealing surface portion (31p, 31'p, 22s') capable of interacting with said moving wiper (21l, 20l), characterized in that the layer of abradable material on said surface portion (31p, 31'p, 22s') comprises axially a first zone (31p1, 31'p1, 22s1) with a first resistance to penetration of a wiper (20l, 21l), said first zone (31p1, 31'p1, 22s1) corresponding to the axial position of the wiper (21l, 20l) in nominal operation of the turbine, and a second zone (31p2, 31'p2, 22s2) adjacent to the first zone (31p1, 31'p1, 22s1) with a reduced resistance to penetration of a wiper relative to the first zone, said second zone (31p2, 31'p2, 22s2) being located downstream relative to the first zone (31p1, 31'p1, 22s1) and corresponding to the axial position that the wiper (21l, 20l) assumes when flame extinction occurs in the combustion chamber of the engine.
2. Turbine (1) according to claim 1, characterized in that said second zone (31p2, 31'p2, 22s2) comprises at least one cavity (31c, 31'p2, 22c).
3. Turbine (1) according to claim 1 or 2, characterized in that the radius of said surface portion (31p, 31'p, 22s') is constant along the two zones, and in that in said second zone (31p2, 31'p2, 22s2), adjacent to the first (31p1, 31'p1, 22s1), the thickness of the abradable layer is reduced relative to the first zone.
4. Turbine (1) according to one of claims 1 to 3, characterized in that the thickness of the abradable layer in the second zone (31p2, 31'p2, 22s2) is reduced to 50-95% of the thickness in the first zone.
5. Turbine (1) according to claim 4, characterized in that the zone with reduced thickness is filled with a material of lower resistance.
6. Turbine (1) according to claim 1, characterized in that the surface portion is cylindrical along the first zone and truncated along the second zone.

7. Turbine (1) according to one of the preceding claims, characterized in that the stator sealing ring element (31, 31', 22s) is arranged to form a labyrinth seal at the outer radial end of the rotor blades (21a) of the turbine.
- 5 8. Turbine (1) according to one of claims 1 to 6, characterized in that the stator sealing ring element (31, 31', 22s) is arranged to form a labyrinth seal at the inner radial end of the stator blades (22) of the turbine.
- 10 9. Turbine (1) according to claim 1, comprising a rotor and a stator, said rotor comprising a plurality of radial blades (21a) provided at their radially outer end with a rotor sealing element with at least one wiper (21l) in the form of a radial strip, oriented radially outwards relative to the rotation axis (A) of the rotor, said stator (30) forming the cylindrical envelope within which the rotor blades are set in motion, the stator comprising, opposite said strip, a stator sealing ring element (31) made of an abradable material and forming a labyrinth seal with the rotor sealing element (21l), the turbine being characterized in that said stator sealing element is
15 formed by sealing elements according to one of claims 1 to 7, said first zone (31p1, 31'p1) corresponding to nominal operation of the turbine and said second zone (31p2, 31p2) corresponding to operation in the phase of re-ignition after extinction of the engine's combustion chamber.
- 20 10. Turbine (1) according to claim 1, comprising a stage formed from stator fins (22), said fins comprising, on the side of the axis (A) of the turbine, a sealing element (22s) interacting with at least one rotatable wiper (20l) to form a labyrinth seal, characterized in that the sealing element is formed from sealing sectors according to one of claims 1 to 6 and 8, said first zone (22s1) corresponding to nominal operation of the turbine and said second zone (22s2) corresponding to operation in
25 the phase of re-ignition after extinction of the engine's combustion chamber.
11. Gas turbine engine, characterized in that it comprises a turbine (1) according to one of claims 1 to 10.
12. Turbine aero-engine, characterized in that it comprises a gas turbine engine according to claim 11.

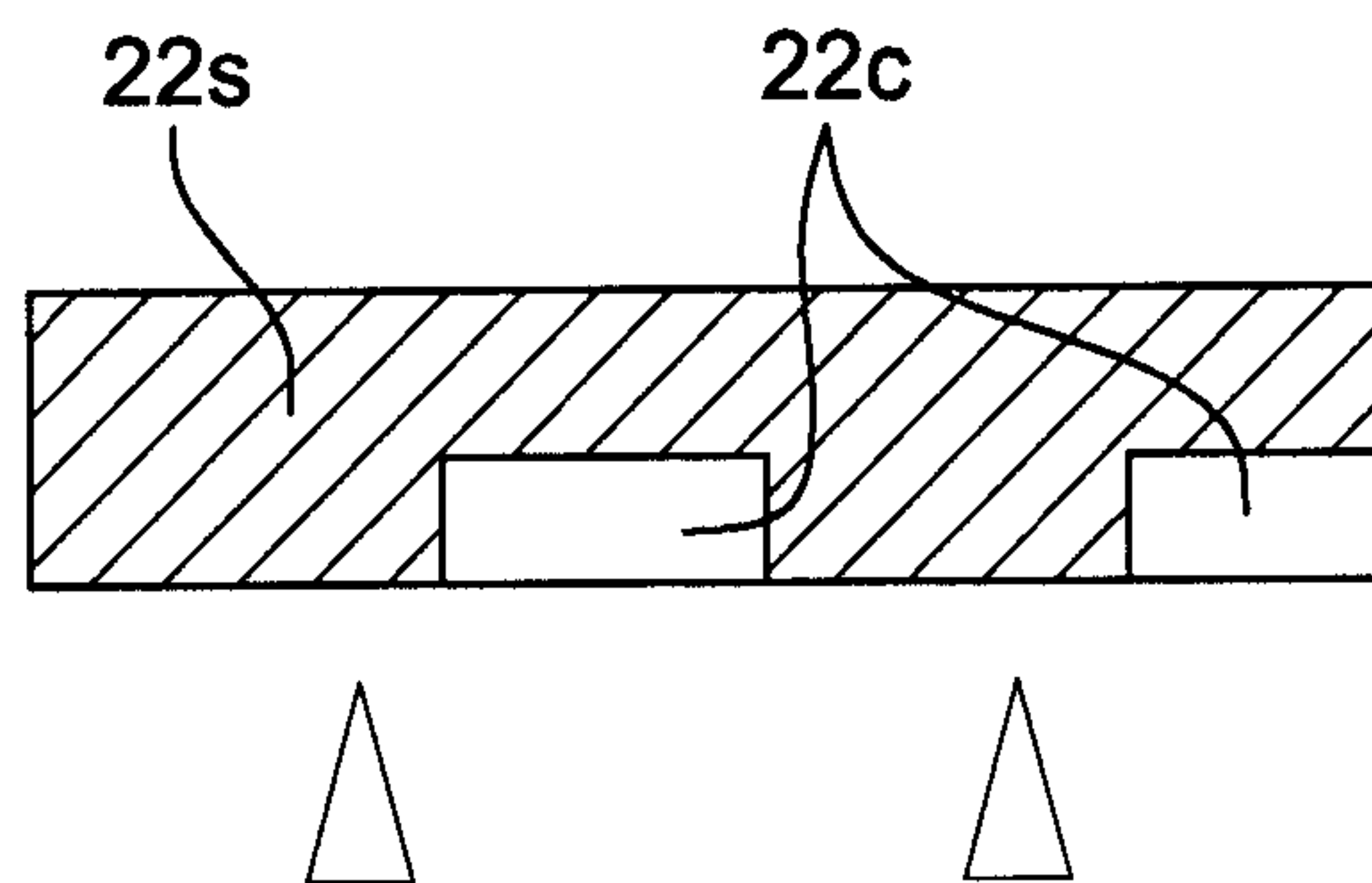
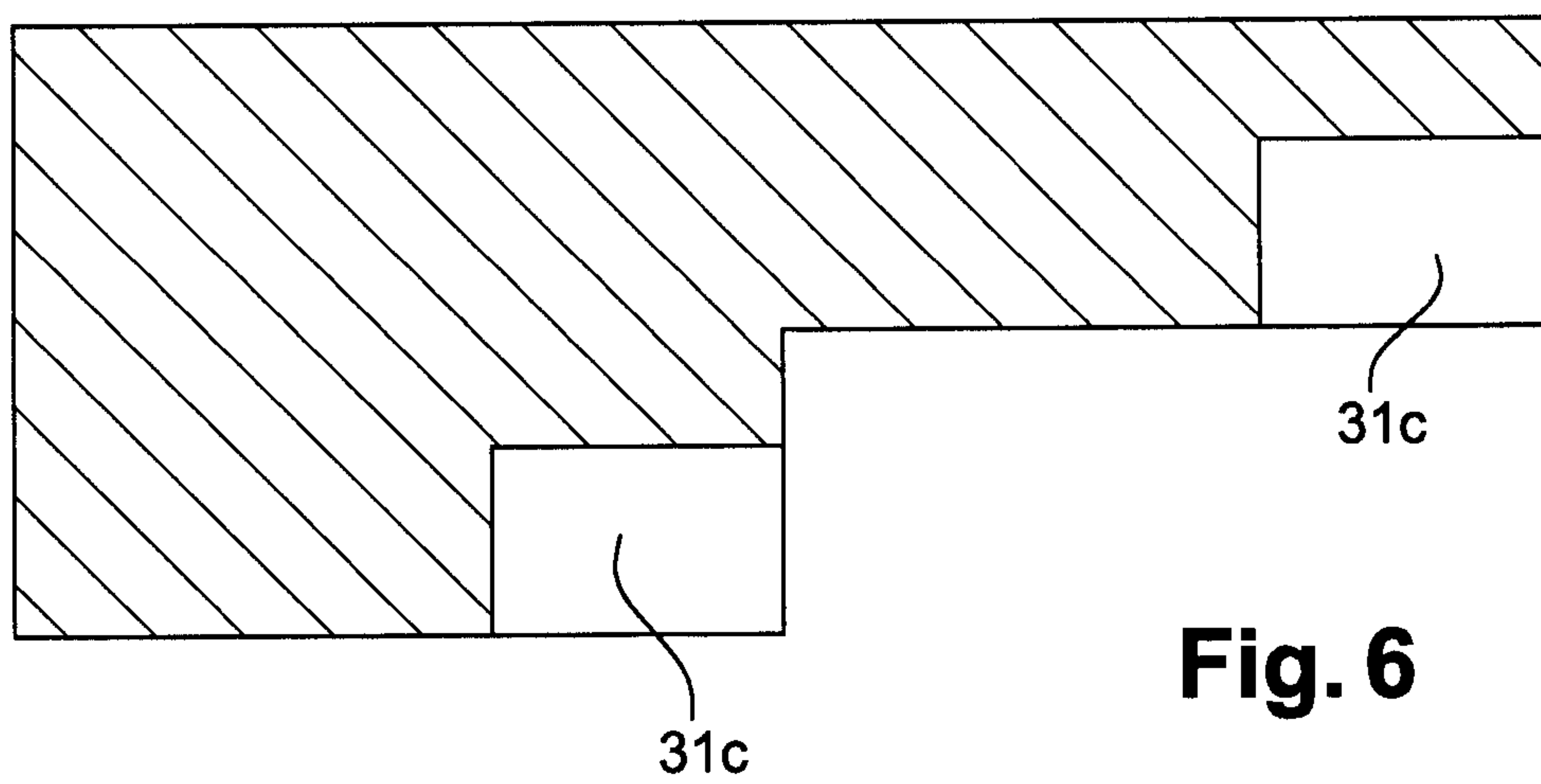
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**Fig. 1**

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**Fig. 2****Fig. 3****Fig. 4**

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**Fig. 5****Fig. 6**

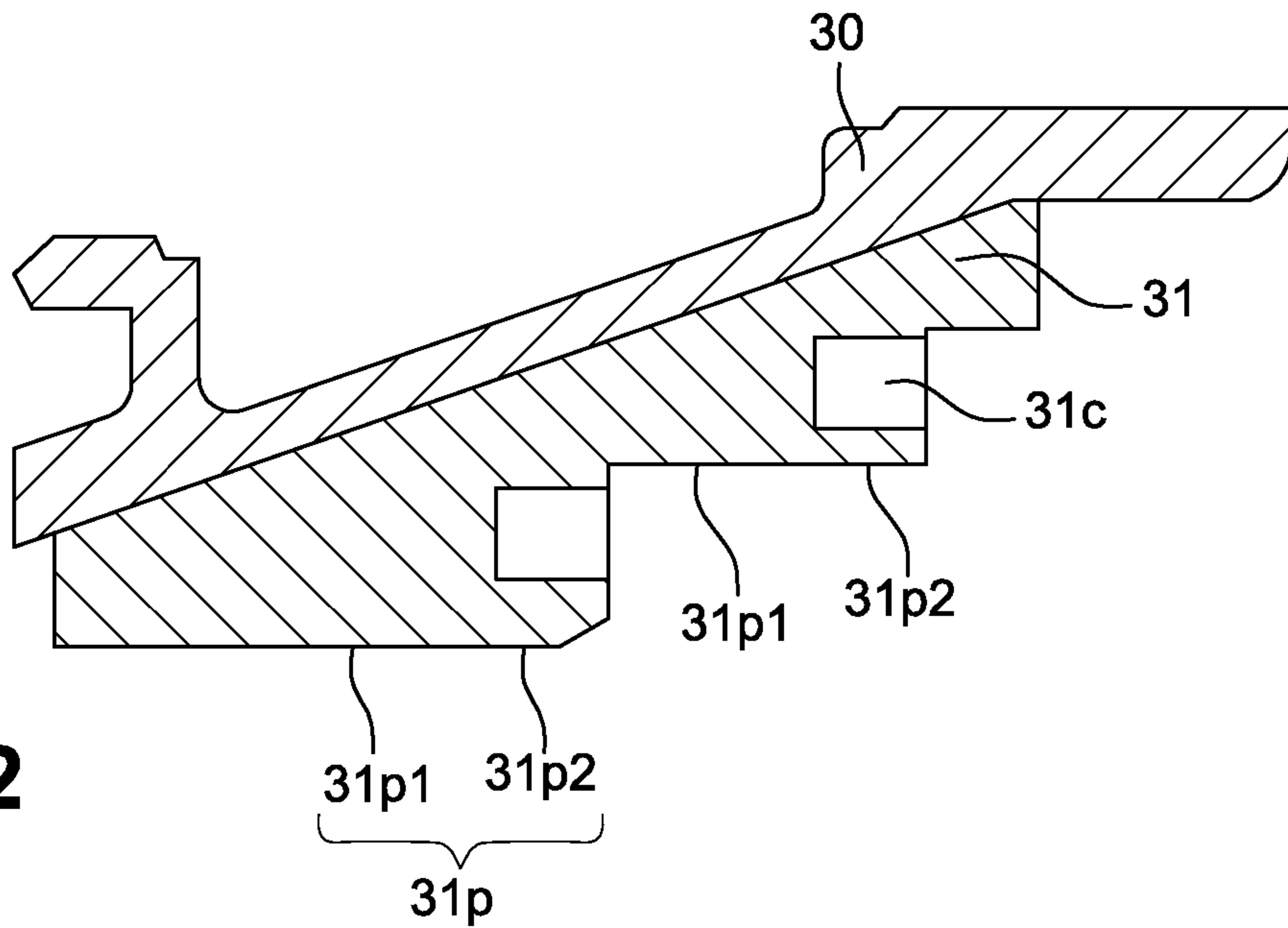


Fig. 2