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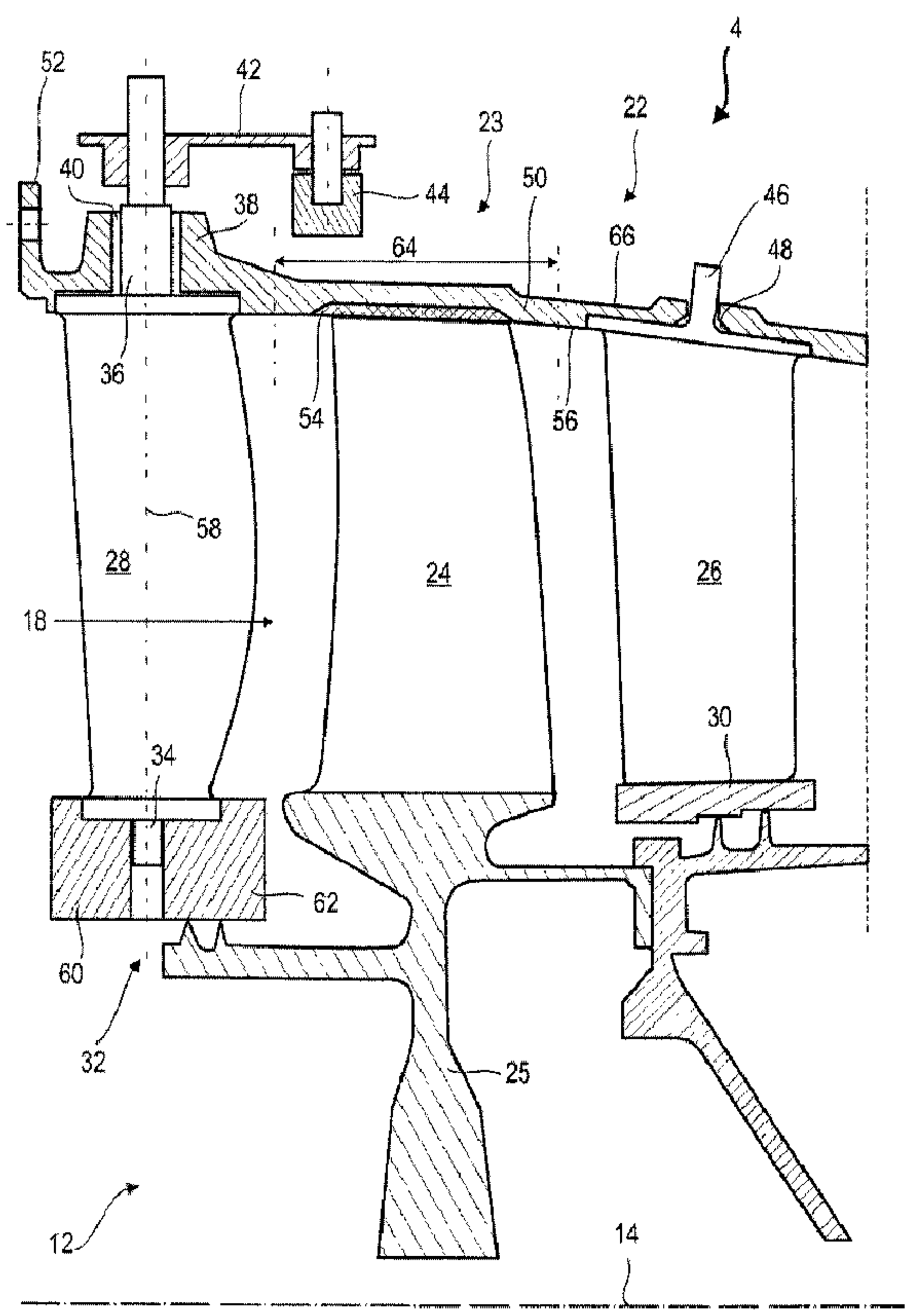
(54) Titre : STATOR DOTE D'AUBES AJUSTABLES DESTINE AU COMPRESSEUR D'UNE TURBINE AXIALE
(54) Title: STATOR WITH ADJUSTABLE VANES FOR THE COMPRESSOR OF AN AXIAL TURBINE ENGINE



(57) Abrégé/Abstract:
An assembly for the stator of a compressor of an axial-flow turbine engine, such as a low-pressure compressor of the turbojet engine, also known as a booster,includes: a first annular array of first vanes of the stator extending radially in the axial flow; and a

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(57) Abrégé(suite)/Abstract(continued):
second annular row of second vanes of the stator, with controlled orientation, also known as variable-pitch vanes or VSV. In addition, the assembly includes an external monobloc shroud on which the first vanes and the second vanes are mounted in a pivoting manner.

Abstract

An assembly for the stator of a compressor of an axial-flow turbine engine, such as a low-pressure compressor of the turbojet engine, also known as a booster,includes: a first annular array of first vanes of the stator extending radially in the axial flow; and a second annular row of second vanes of the stator, with controlled orientation, also known as variable-pitch vanes or VSV. In addition, the assembly includes an external monobloc shroud on which the first vanes and the second vanes are mounted in a pivoting manner.

Description

STATOR WITH ADJUSTABLE VANES FOR THE COMPRESSOR OF AN AXIAL TURBINE ENGINE

Technical field

The disclosure pertains to the field of stators with vanes of controlled orientation for an axial turbine engine. The disclosure also relates to the assembly process of a stator with adjustable vanes. The disclosure also relates to an axial turbine engine, especially a turbojet engine of an aeroplane or a turboprop engine of an aircraft.

Background

At present, several rows of orientable vanes may outfit a stator housing of a compressor of a turbojet engine. Such vanes can pivot during the operation of the engine. Their cambered blades tilt in relation to the primary flow passing through them, making it possible to adapt their action depending on the engine conditions and the flight conditions. The operating range is thus extended, and the efficiency is optimized.

The performance of the compressor is based on the precision of angular positioning of the vanes with respect to the housing, as well as the positioning of the vanes relative to each other. The precision of relative positioning of the vanes is understood both within their row but also in regard to the other rows. In particular, the efficiency requires the vanes to form a blading which best conforms to a predefined geometry.

Document US 2014/0182292 A1 discloses a dual-flow turbofan. The turbofan comprises a low-pressure compressor provided with several rows of vanes, one row of vanes of the stator having a variable geometry. The different rows of vanes of the stator are supported by dedicated external shrouds; these various external shrouds are fixed one after the other by means of radial annular flanges. This configuration enables a mounting when a monobloc bladed disk is present. In fact, the compressor is assembled by alternately securing the rows of rotor vanes and the rows of stator vanes. Each of these rows forms a ring which is brought axially against its support and which radially overlaps the row of vanes downstream from it. Now, this architecture is particularly bulky. Furthermore, the efficiency of such a turbine engine is limited.

Summary

Technical problem

The disclosure aims to solve at least one of the problems posed by the prior art. More precisely, the disclosure aims to improve the efficiency of a turbine engine with a stator having a controllable geometry. The disclosure also aims to help provide a compact, tough, light, economical and reliable solution.

Technical solution

The subject of the disclosure is an assembly for the stator of an axial-flow turbine engine, in particular for the stator of a compressor of an axial-flow turbine engine the assembly comprising: a first annular row of first vanes of the stator extending radially in the axial flow; and a second annular row of second vanes of the stator, with controlled orientation, extending radially in the axial flow; remarkable in that it further comprises an external monobloc shroud on which the first vanes and the second vanes are mounted.

According to an embodiment of the disclosure, the second row of vanes is disposed upstream from the first row of vanes.

According to an embodiment of the disclosure, the external shroud has a fixation flange at its upstream end, optionally in the area of the second row of vanes, and optionally a fixation flange at its downstream end.

According to an embodiment of the disclosure, the external shroud comprises a first annular row of orifices at which the first vanes are mounted, and a second annular row of orifices at which the second vanes are mounted.

According to an embodiment of the disclosure, the external shroud comprises an annular wall of the same material, and which extends optionally from the first vanes to the second vanes.

According to an embodiment of the disclosure, in the area of and/or between the first vanes and the second vanes, the external shroud comprises an axial portion free of the annular flange, said portion optionally comprising a generally tubular or substantially truncated outer surface.

According to an embodiment of the disclosure, the external shroud comprises an annular segment of constant thickness, or whose thickness varies by at most 30%, or at most 15%; said annular segment being disposed between the first vanes and the second vanes.

According to an embodiment of the disclosure, the annular segment extends axially over the majority of the space between the first vanes and the second vanes.

According to an embodiment of the disclosure, the assembly comprises a second internal shroud mounted at the internal ends of the second vanes, said second internal shroud having a continuity of circular material.

According to an embodiment of the disclosure, the second internal shroud is axially split up into elements, each one having a continuity of circular material.

According to an embodiment of the disclosure, the assembly comprises a rotor with a third annular row of third vanes disposed between the first vanes and the second vanes.

According to an embodiment of the disclosure, the assembly comprises a synchronization ring disposed around the external shroud.

According to an embodiment of the disclosure, the ring is disposed axially between the first vanes and the second vanes.

According to an embodiment of the disclosure, the external shroud comprises an inner surface of annular shape whose diameter decreases downstream, in particular along at least one row of vanes or each row of vanes.

According to an embodiment of the disclosure, the assembly further comprises a fourth annular row of fourth vanes, said fourth vanes being mounted on the exterior monobloc shroud.

According to an embodiment of the disclosure, the diameter of the internal surface decreases in a monotonous or continuous manner.

According to an embodiment of the disclosure, the external shroud has a continuity of circumferential material, and this optionally for its entire axial length.

According to an embodiment of the disclosure, the external shroud has a continuity of material axially along the first vanes and the second vanes.

According to an embodiment of the disclosure, the external shroud is at least monobloc from the first row of orifices to the second row of orifices.

According to an embodiment of the disclosure, the second vanes are mounted movable in rotation in the orifices of the second row of orifices.

According to an embodiment of the disclosure, the orifices of the second row are configured to enable a guiding in rotation of the second vanes, and/or they are higher radially than the orifices of the first row of orifices.

According to an embodiment of the disclosure, the orientation of the second vanes may vary with respect to the first vanes and/or with respect to the external shroud.

According to an embodiment of the disclosure, the orientation of the second vanes may vary by at least 10° or 20° or 30°.

According to an embodiment of the disclosure, the first vanes and/or the fourth vanes have a fixed orientation, and/or each comprise an internal shroud.

According to an embodiment of the disclosure, the fourth vanes are disposed downstream from the first vanes.

According to an embodiment of the disclosure, the second shroud comprises means of guidance in rotation, especially of the orifices, cooperating with the second vanes.

The disclosure likewise concerns a turbine engine having a stator with an assembly, remarkable in that the assembly is according to to the disclosure.

According to an embodiment of the disclosure, the turbine engine comprises a compressor, the second row of vanes forming the row of vanes upstream from said compressor.

According to an embodiment of the disclosure, the turbine engine comprises a housing having an annular vein traversed by the axial flow of the turbine engine, and an axial face, the external shroud being mounted on said axial face, optionally around said annular vein.

The disclosure aims to help improve the efficiency of the turbine engine. For this, it helps allow a greater precision of positioning of the vanes of at least two annular rows of vanes. The operation of the turbine engine may be improved in a broader operating range. The solution proposed by the disclosure also obeys the constraints of the assembly process, and preserves the simplicity of certain operations.

Brief description of the drawings

Figure 1 represents an axial turbine engine according to the disclosure.
Figure 2 is a diagram of a portion of the compressor of the turbine engine according to the disclosure.

Description of the embodiments

In the following description, the terms internal and external refer to a positioning with respect to the axis of rotation of an axial turbine engine. The axial direction corresponds to the direction along the axis of rotation of the turbine engine. The radial direction is perpendicular to the axis of rotation. Upstream and downstream refer to the principal direction of flow of the flow in the turbine engine.

Each vane, whether rotor or stator, has a leading edge, a trailing edge, an intrados surface and an extrados surface, said surfaces joining the leading edge to the trailing edge, like the chords of the vane. In the following description, one may refer to a median chord.

Figure 1 shows in a simplified manner an axial turbine engine. In this particular instance, it is a dual-flow turbojet engine. The turbojet engine 2 comprises a first compression level, known as the low-pressure compressor 4, a second compression level, known as the high-pressure compressor 6, a combustion chamber 8 and one or more levels of turbines 10. In operation, the mechanical power of the turbine 10 transmitted via the central shaft to the rotor 12 places in motion the two compressors 4 and 6. The latter comprise several rows of vanes of the rotor associated with rows of vanes of the stator. The rotation of the rotor about its axis of rotation 14 thus allows the generating of an air flow and the progressive compressing of the latter up to the entrance into the combustion chamber 8. A transmission 15 with an epicycloid reducing gear may be mounted in the rotor 12.

An entry fan 16 is coupled to the rotor 12 and generates an air flow which is divided into a primary flow 18 passing through the various levels mentioned above of the turbine engine, and a secondary flow 20 passing through an annular conduit (partially shown), generating a thrust which can be used to propel an aeroplane.

Figure 2 is a cross sectional view of a portion of the compressor of an axial turbine engine like that of figure 1. The compressor may be a low-pressure compressor 4.

The compressor comprises a stator 22 with an external monobloc shroud 23. It is of a single material. It describes a closed loop. It has a continuity of circular material and/or a circular homogeneity. It may be monobloc for its entire length. It may comprise a portion made of a single material. The external shroud 23 is fitted about the axis of rotation 14 and surrounds the rotor 12.

The rotor 12 may comprise several rows of rotor vanes 24, such as two or three or more rotor rows, a single row of rotor vanes 24 being visible here. These rotor vanes 24, also called third vanes 24, describe an annular row, called the third row. Despite the rotation of the rotor 12, the inclination in space of the chords of the rotor vanes 24 remains unchanged with respect to the axis of rotation 14. The third vanes 24 may form a monobloc disk; that is, they are indissociable from their support apron 25. Such an arrangement is also known as a “blisk”.

The compressor 4 comprises several straighteners, such as at least two, or at least three or lest four straighteners. Each straightener comprises an annular row of stator vanes (26; 28). These vanes are stator vanes in the sense that they are mounted on the stator 22 and thus remain in contact with it. The straighteners are associated with the fan 16 or with a row of rotor vanes 24 to straighten their air flows, so as to convert the speed of the flow into static pressure.

The stator vanes (26; 28) extend substantially radially from the external shroud 23 to the interior. The stator vanes (26; 28) comprise first stator vanes 26 of fixed orientation which form a first annular row, and second stator vanes 28 of controlled orientation which form a second annular row. The stator vanes may likewise comprise a fourth row of fourth vanes (not shown), and optionally a fifth row of fifth vanes (not shown). These other rows of vanes may be placed downstream from the first vanes 26, which are themselves downstream from the second vanes 28. Each of these rows are axially spaced apart from each other. For example, the first vanes 26 may be separated axially from the second vanes 28 by the annular row of the third vanes 24.

The second vanes 28 are also called variable-pitch vanes, or also VSV for "variable stator vane". Their particularity is that the inclination of their chords may vary with respect to the axis of rotation 14 of the compressor 4, and this during the operation of the turbine engine. Their intrados and extrados faces may be more or less exposed to the primary flow 18. Their orientation may be controlled during the operation of the turbine engine, for example so as to sweep an angle of at least 30°. The stator of the compressor is mixed. It comprises both vanes of controlled orientation, that are thus modifiable, and vanes of fixed orientation. Of course, a single row of vanes with controlled orientation is shown, although this stator could likewise receive more rows of vanes with controlled orientation.

The second vanes 28 can pivot in relation to the flow 18, so that they cover more or less the fluid vein thanks to their blades. They may intercept moreover the primary flow 18. The circumferential width which they occupy may vary. Their leading edges and their trailing edges may move closer to or further away from the vanes of the same row. Being more or less inclined in relation to the general direction of flow, they deviate the primary flow 18 more or less to modulate the flow straightening produced by them. Thus, the turbine engine and the compressor may follow different efficiency curves during the operation, and this on account of a variable geometry of their blading.

The compressor 4 may comprise internal shrouds (30; 32) suspended at the internal ends of the stator vanes (26; 28), a first internal shroud 30 being secured to the first vanes 26, and a second internal shroud 32 with respect to which the second vanes 28 are hinged. In order to allow the rotation of the latter, they have internal pins 34 engaged in the second internal shroud 32. They likewise have external pins 36 passing through the external shroud 23 in the area of bosses 38. The bosses 38 may comprise second orifices 40 enabling a pivot connection with the external pins 36 to be formed. The pins (34; 36) may form cylindrical rods, and they may be made of the same material as their blade. Bearings (not shown) may be provided around the internal pins

34, as well as between the second orifices 40 and the external pins 36. The latter are prolonged by control rods on which are mounted control levers 42 controlled by a synchronization ring 44 which controls each of the second vanes 28 via their control levers 42. An actuator (not shown) of a control system enables controlling the synchronization ring 44, and thus the orientation of the second vanes 28 in the primary flow 18.

The first vanes 26 are fixed and rigidly joined to the external shroud 23 via their rods 46 which are introduced through orifices 48 describing a row, called the first row of orifices 48. A clamping means (not shown) helps freeze the orientation of the first vanes 26. The orifices (40; 48) may be realized during the same phase on the same machine, so that their respective positions are better mastered, and the installation of their vanes (26; 28) better conforms to the predefined geometry.

The stator 22 comprises an annular wall 50. Optionally, it comprises an upstream fixation flange 52, a downstream fixation flange (not shown), and an annular seal 54 which is applied inside the annular wall 50 and which cooperates in a leak tight manner with the third vanes 24 of the rotor 12. The upstream flange 52 forms the upstream end of the wall 50, and allows a fixation on a housing of the turbine engine, for example the upstream housing or the intermediate housing. The wall 50 can be of the same material. It may extend axially all along the second vanes 28 and the first vanes 26, and optionally all along the fourth vanes. The wall 50 forms a mounting support for the vanes of the stator(26; 28).

According to one option of the disclosure, the internal surface 56 of the external shroud 23 has an internal diameter which decreases downstream and hugs the external ends of the third vanes 24 mounted on the rotor 12. This configuration thus requires placing the third vanes 24 in the external shroud 23 before mounting the second vanes 28 and their internal shroud 32. The contrary would not be technically feasible, since these second vanes 28 would block the entry of the rotor 12 inside the external shroud 23.

In addition, the second vanes 28 are adjustable. They can pivot on themselves thanks to their external pins 36 which are adjusted in the orifices 40. Hence, their mounting is done by a radial introduction, or along their pivot axes 58 which become their axes of introduction.

In order to allow its mounting, the second internal shroud 32 is split up. It is divided axially into an upstream element 60 and a downstream element 62, each of them forming closed loops. At least one or each of these elements (60; 62) is monobloc, that is, it has a continuity of circular material. One of them may be segmented angularly. At least one of them may cooperate in a leak tight manner with the rotor 12, for example with seal teeth. During the assembly process, the downstream element 62 is placed opposite the third vanes 24. Next, the second vanes 28 are introduced, disposing their internal pins 34 axially facing and radially in the area of the downstream element 62. Next, the upstream element 60 is attached axially against the downstream element 62 while maintaining the internal pins 34 in place. The latter are then locked between the elements (60; 62) while forming a pivot connection; that is, a mechanical connection with a single degree of freedom.

The external shroud 23 comprises a homogeneous axial portion 64. This axial portion 64 may be free of the annular flange, and it may have a generally tubular or substantially truncated exterior surface 66. This exterior surface 66 may be axially continuous. The axial portion 64 may extend over the majority of the space separating the first 26 and second vanes 28, and may have a reduction in diameter from the second vanes 28 towards the first vanes 26.

The axial portion 64 may delimit on the wall 50 an annular segment of constant thickness. Optionally, the thickness of the annular segment may vary axially by at most 20%, or at most 10%. This annular segment is disposed between the first vanes 26 and the second vanes 28, and it may extend axially over the majority of the space between the first vanes 26 and the second vanes 28.

Claims

1. A stator assembly of an axial-flow turbine engine, the stator assembly comprising:
   - a first annular row of first vanes projecting radially;
   - a second annular row of second vanes with controlled orientation, said second vanes extending radially;
   - a one-piece outer shroud on which the first vanes and the second vanes are mounted, and forming a one-piece closed loop about the first vanes and the second vanes.
2. The stator assembly according to Claim 1, wherein the second row of second vanes is disposed upstream from the first row of first vanes.
3. The stator assembly according to Claim 1, wherein the one-piece outer shroud has a radial fixation flange at its upstream end, and a radial fixation flange at its downstream end.
4. The stator assembly according to Claim 1, wherein the one-piece outer shroud comprises a first annular row of orifices at which the first vanes are mounted, and a second annular row of orifices at which the second vanes are mounted.
5. The stator assembly according to Claim 1, wherein the one-piece outer shroud comprises an annular wall a material which is integrally molded and which projects from the first vanes to the second vanes.
6. The stator assembly according to Claim 1, wherein between the first vanes and the second vanes, the one-piece outer shroud comprises an axial portion free of outer annular flange, said axial portion comprising a generally tubular or substantially truncated outer surface.
7. The stator assembly according to Claim 1, wherein the one-piece outer shroud comprises an annular segment of constant thickness, or whose thickness varies by at most 30%; said annular segment being disposed between the first vanes and the second vanes.

8. The stator assembly according to Claim 7, wherein the annular segment extends axially over the majority of the space between the first vanes and the second vanes.

9. The stator assembly according to Claim 1, wherein it comprises an inner shroud mounted at the internal ends of the second vanes, said internal inner having a circular continuity of material.

10. The stator assembly according to Claim 9, wherein the inner shroud is axially split up into axial elements, each one having a circular continuity of material.

11. The stator assembly according to Claim 1, wherein it comprises a synchronization ring disposed around the one-piece outer shroud.

12. The stator assembly according to Claim 11, wherein the synchronization ring is disposed axially between the first vanes and the second vanes.

13. The stator assembly according to Claim 1, wherein the one-piece outer shroud comprises an inner surface of annular shape whose diameter decreases downstream, along at least one of the first row and the second row.

14. The stator assembly according to Claim 1, wherein it further comprises a fourth annular row of fourth vanes, said fourth vanes being mounted on the one-piece outer shroud, said fourth vane being fixed downstream the first vanes and the second vanes.

15. A compressor for an axial turbine engine, the compressor comprising a rotor with a one-piece row of rotor blades, and a compressor stator assembly, the compressor stator assembly comprising:

- a first annular row of first vanes;
- a second annular row of second vanes, with variable orientation;
- a one-piece outer shroud on which each of the first vanes and of the second vanes are mounted, said one-piece outer shroud forming a one-piece element along the first annular row of first vanes, the one-

piece row of rotor blades and the second annular row of second vanes.

16. The compressor of claim 15, wherein the rotor includes a first one-piece sealing device axially level with the first annular row of first vanes, and a second one-piece sealing device axially level with the second annular row of second vanes, the second one-piece sealing device including an outer diameter which is greater than an outer diameter of the first one-piece sealing device.

17. The compressor of claim 15, wherein it comprises an inlet vane row formed by the second row of vanes.

18. A turbine engine comprising an axial flow and a stator with an assembly, the assembly comprising:

   - a first annular row of first vanes projecting radially in the axial flow; and
   - a second annular row of variable stator vanes projecting radially in the axial flow;
   - a one-piece outer shroud on which the first vanes and the second vanes are mounted, the one-piece outer shroud including an inner diameter decreasing downstream.

19. The turbine engine according to Claim 18, wherein it comprises a housing having an annular vein traversed by the axial flow of the turbine engine, and an axial face, the one-piece outer shroud being mounted on said axial face.

20. The turbine engine according to Claim 18, wherein it comprises a rotor with a third annular row of third vanes disposed between the first vanes and the second vanes.

FIG. 1

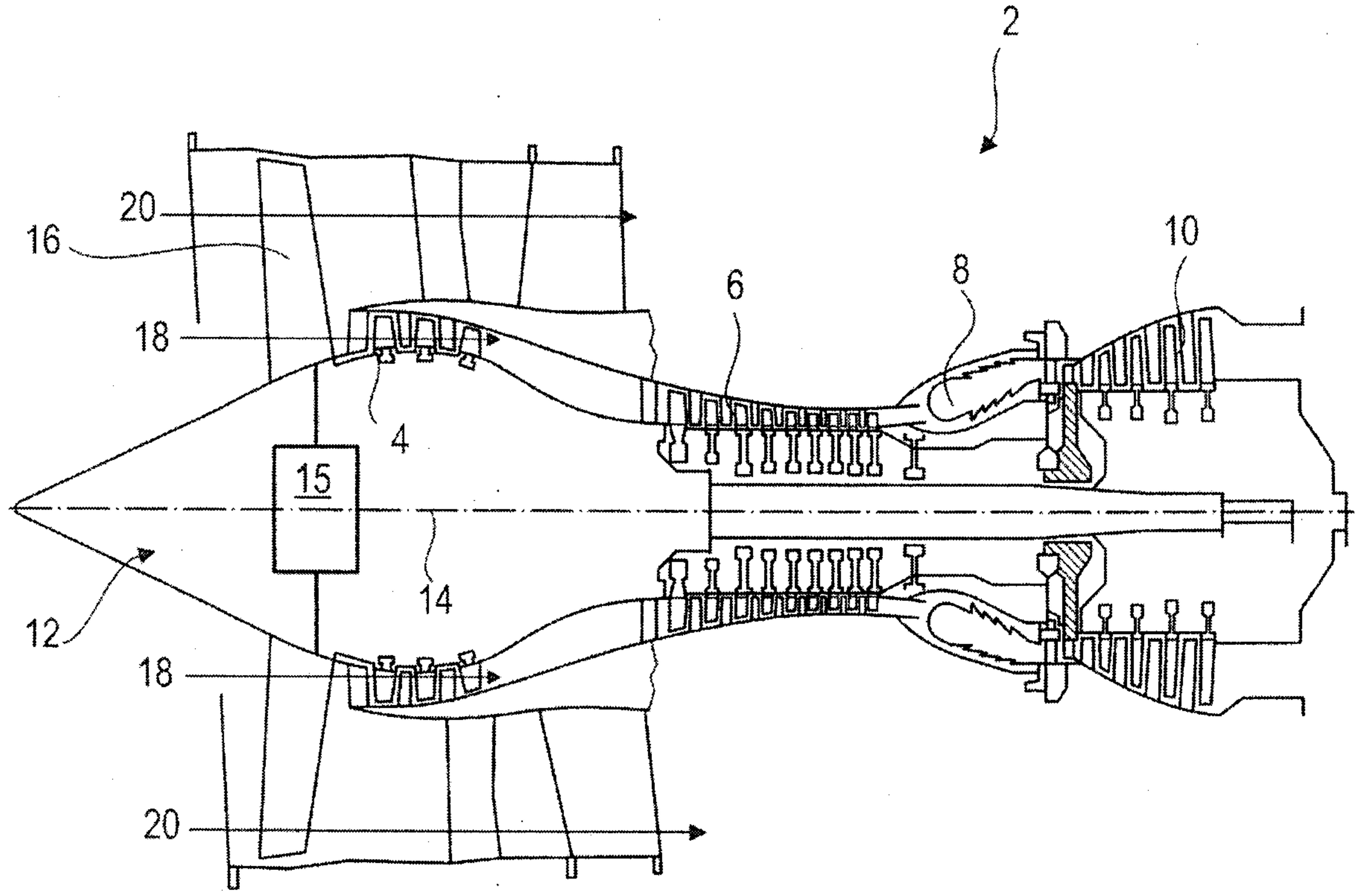
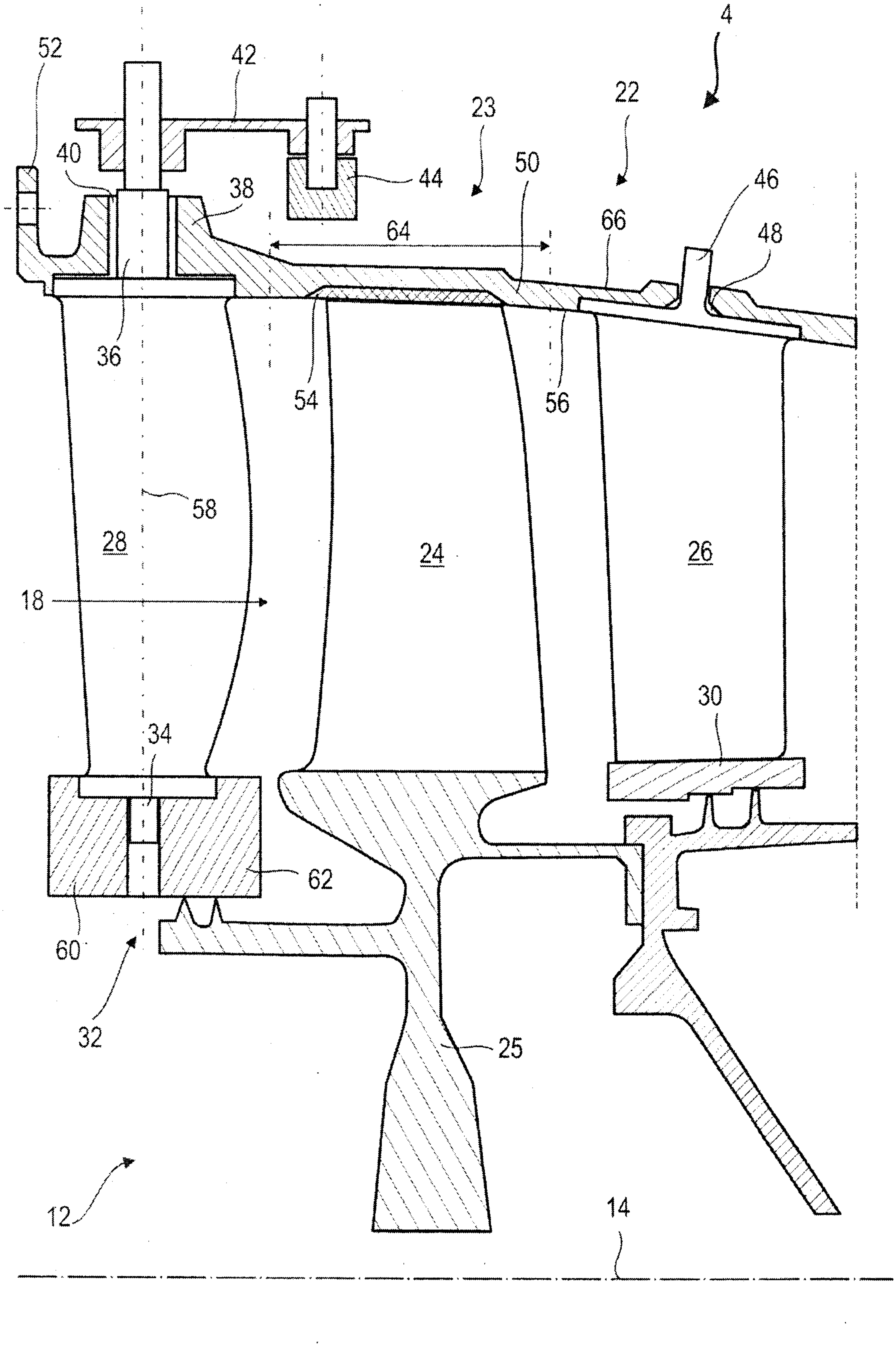


FIG. 2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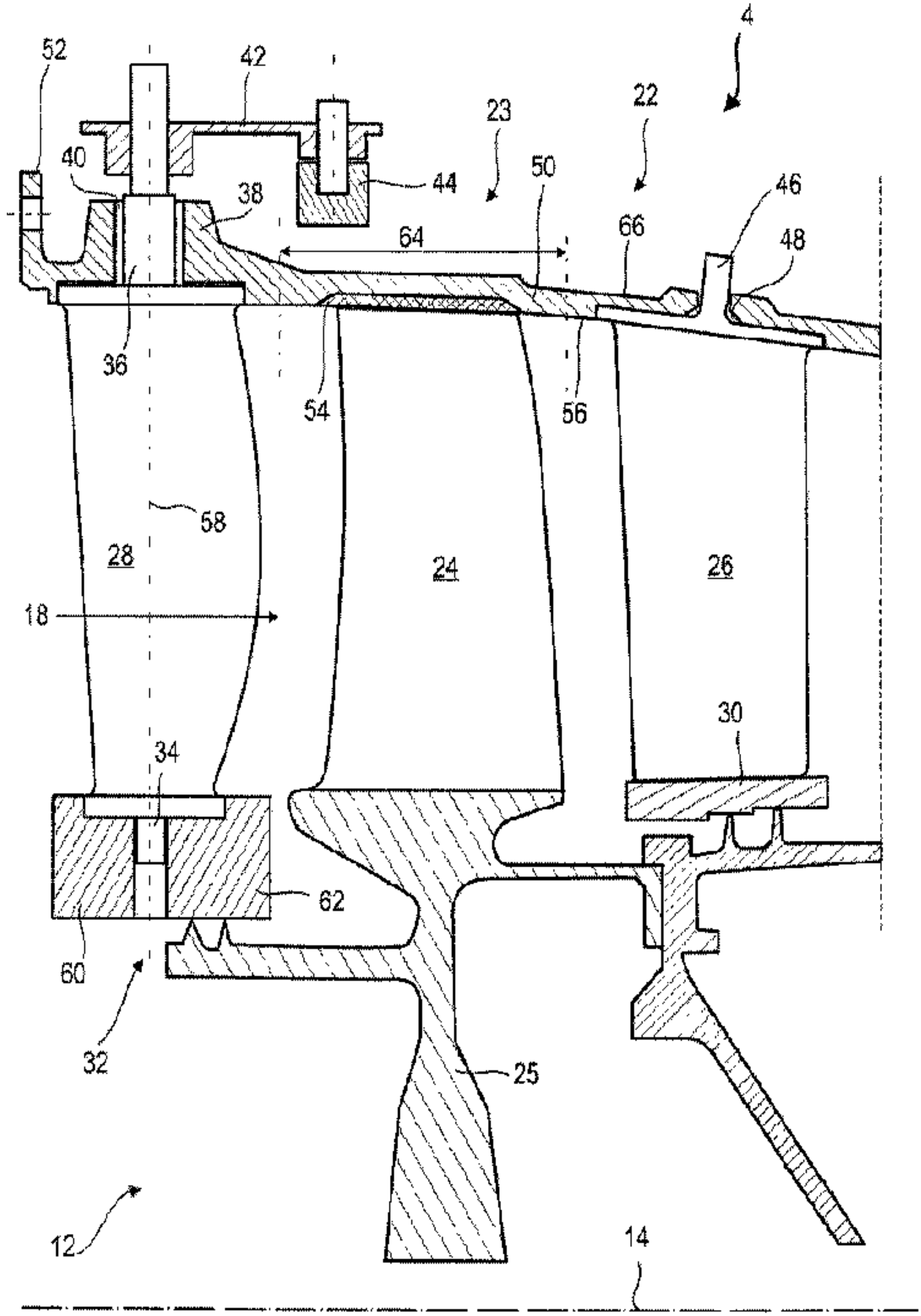

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