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(54) **DEVICE FOR CONTROLLING THE PITCH OF FAN BLADES OF A TURBOPROP**

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(57) **ABSTRACT**

The invention relates to a device for controlling the pitch of fan blades of a turboprop. The device includes at least at least one set of adjustable pitch fan blades secured to rotate with a rotary ring centered on a longitudinal axis and mechanically connected to a turbine rotor. Each blade of the set is coupled for pitch-adjustment purposes with a synchronization ring centered on the longitudinal axis, the synchronization ring being suitable for pivoting about the longitudinal axis relative to the rotary ring under drive from actuators carried by the rotary ring and each having a respective axis extending in a direction that is substantially tangential to the synchronization ring.

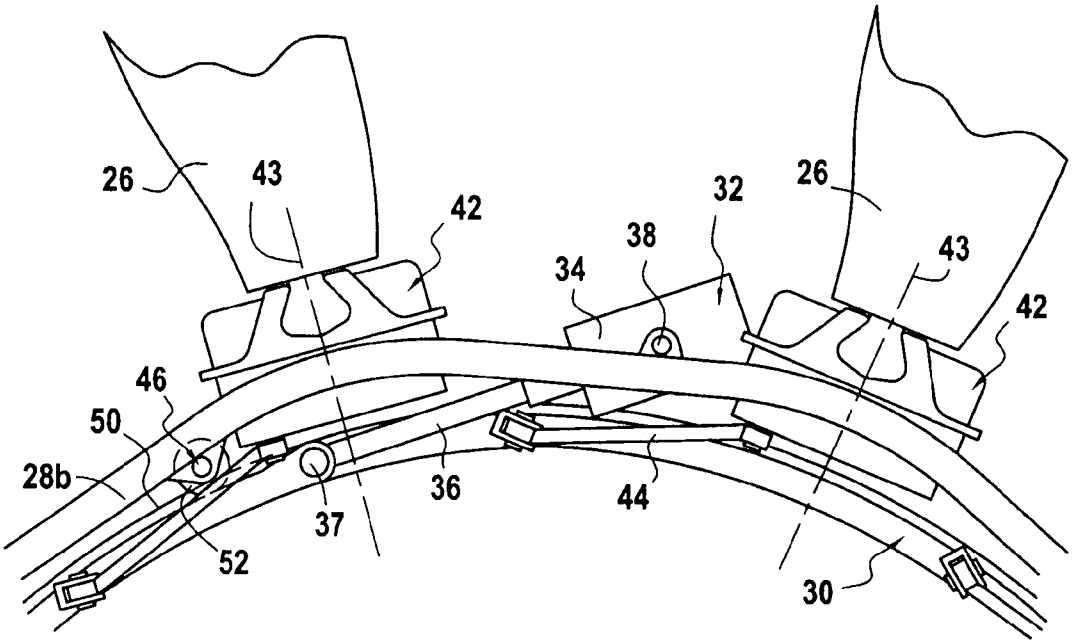
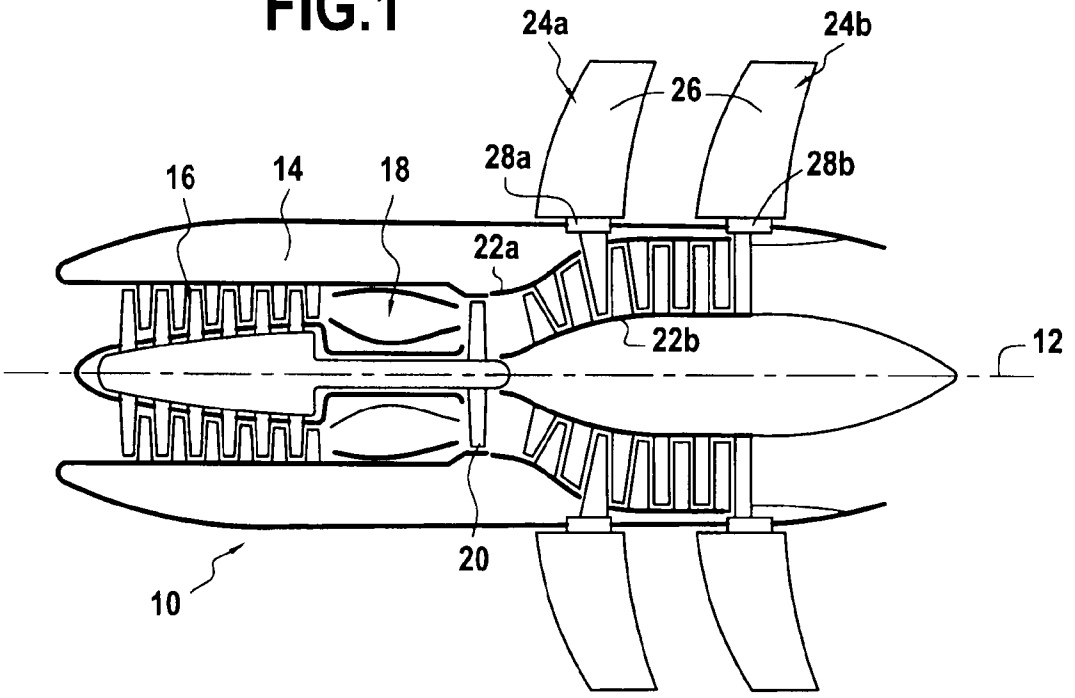


FIG.1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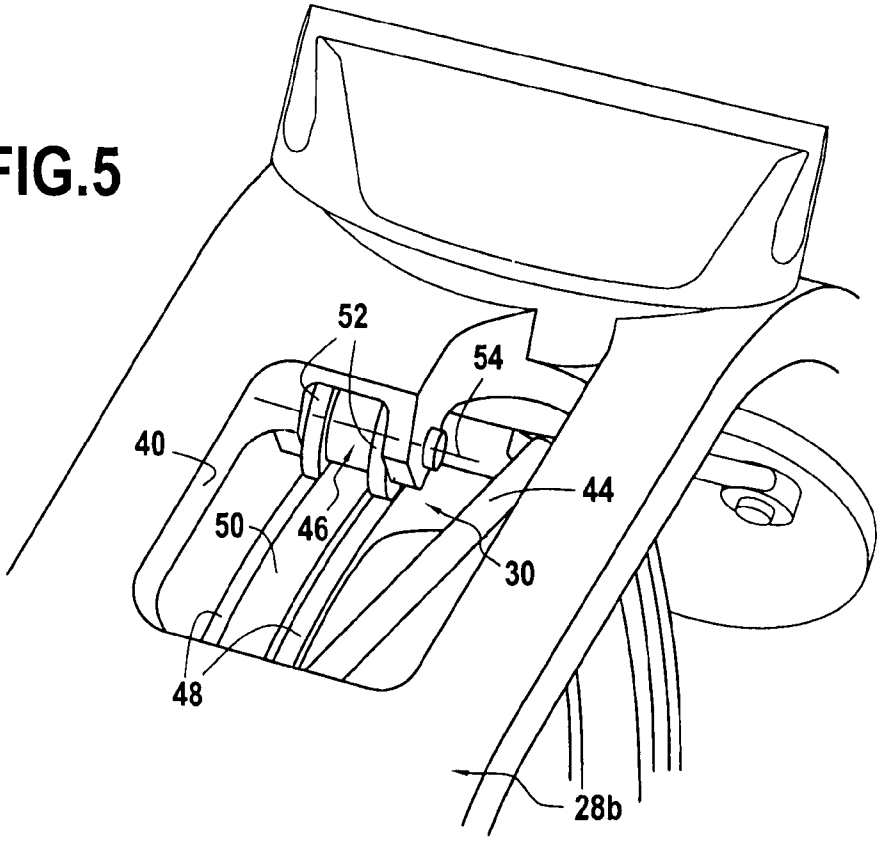
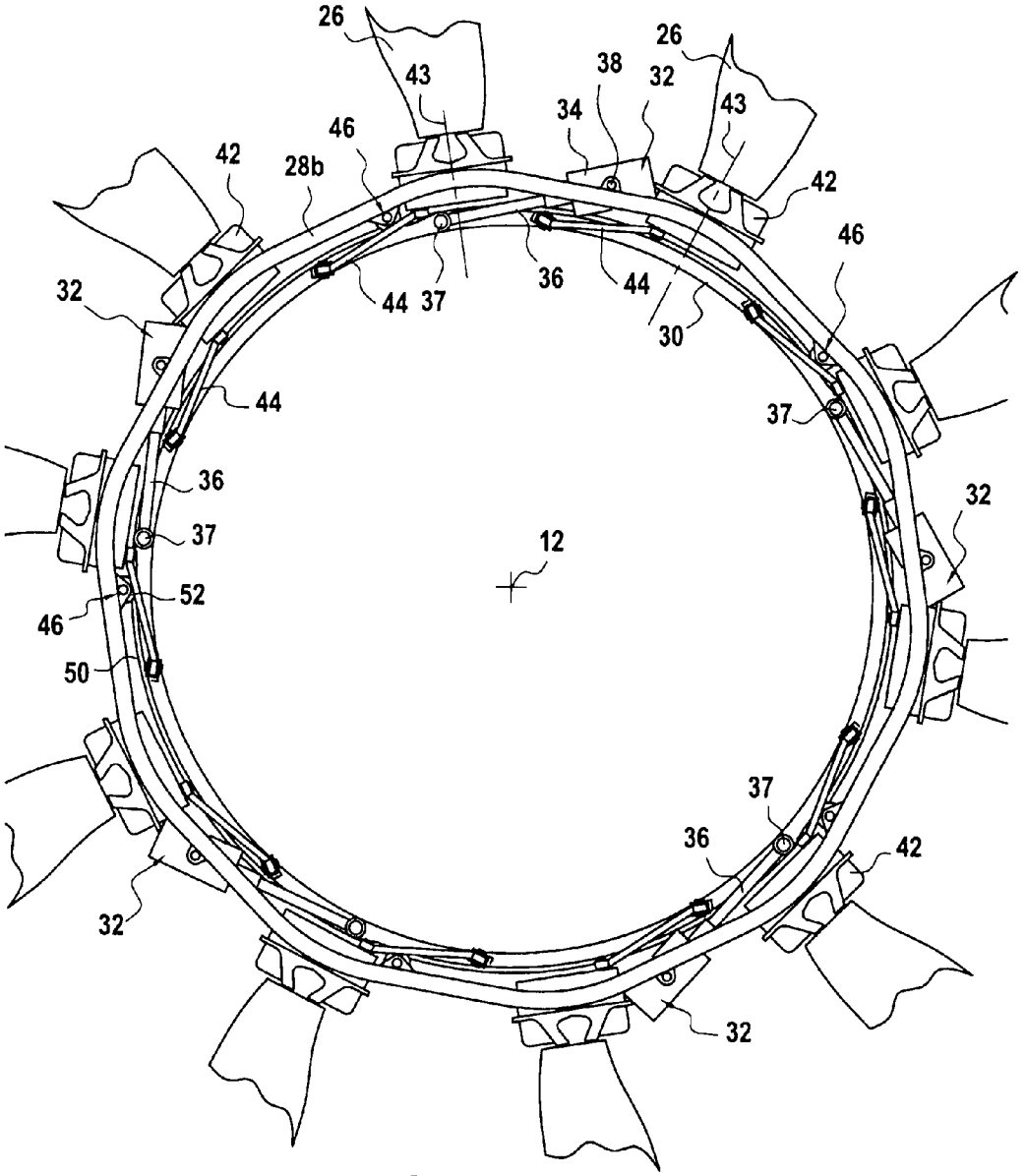
24b
26
28a
28b
16
14
18
22a
22b
12
20
10

FIG.5


52
54
40
44
50
46
30
48
28b


26
43
46
42
28b
32
44
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36
34
38
32
26
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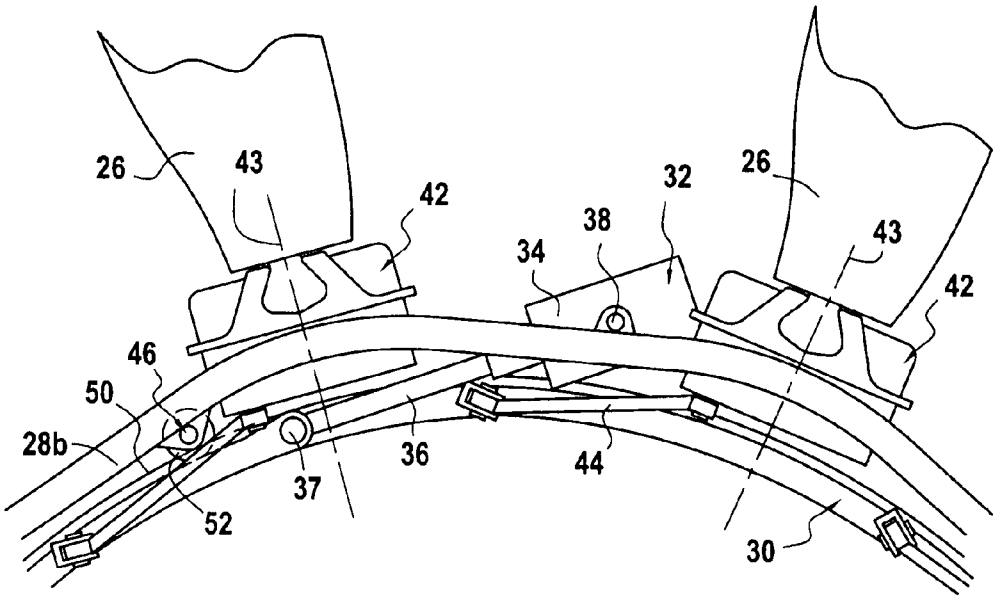
44
30
37
32
12
52
46
50
37
36
42
32
32

FIG.2

FIG.3


26
43
42
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38
34
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46
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28b
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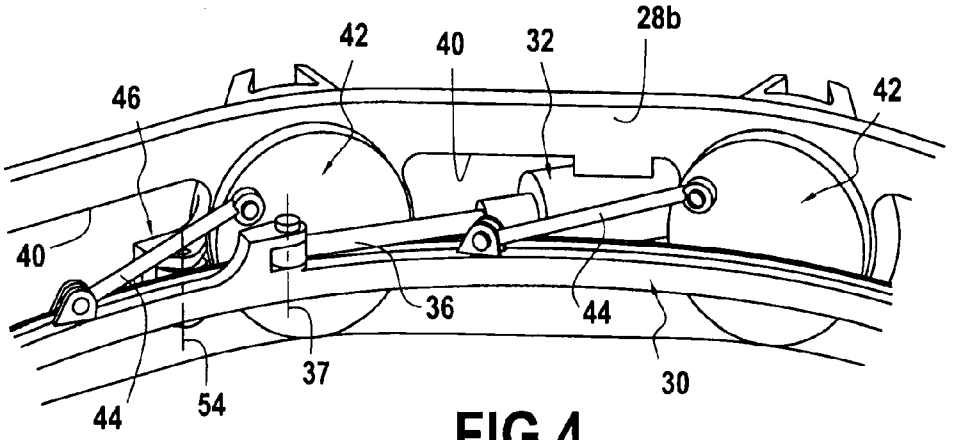
42
40
32
28b
46
42
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36
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44
54

FIG.4

DEVICE FOR CONTROLLING THE PITCH OF FAN BLADES OF A TURBOPROP

BACKGROUND OF THE INVENTION

[0001] The present invention relates to the general field of turboprops having at least one set of fan blades that are adjustable in pitch. The invention relates more particularly to controlling the pitch of fan blades of an airplane turboprop having two propellers.

[0002] In known manner, an airplane turboprop having two propellers comprises a turbine with two contrarotating rotors each driving a non-ducted set of fan blades. For example, reference can be made to document GB 2 129 502 which describes various embodiments of such a turboprop.

[0003] In that type of turboprop, the pitch of the fan blades in each set constitutes one of the parameters that enables the thrust of the turboprop to be controlled (this can also be referred to as adjusting the orientation of the blades). Various devices already exist for adjusting the pitch of fan blades in a given set. For example, one known system consists in using an actuator that is arranged axially in the inside space formed at the center of the turbine. Mechanical connections transmit the movement of the actuator rod radially to the adjustable pitch blades.

[0004] That type of control device requires mechanical connections that are complex to provide, bulky, heavy, and expensive. In addition, since the forces that need to be transmitted are large, it is necessary to use an actuator that is operated at high pressure. Unfortunately, an actuation pressure that is too high is particularly harmful to the lifetime of the actuator. In addition, the mechanical connections of that type of control device are not easily accessible from inside the casing, and that complicates maintenance operations.

[0005] Another control device is known from document EP 1 921 325. It consists in using an annular actuator coupled to the set of fan blades in order to adjust their pitch. Although satisfactory, such a mechanism is not particularly well suited to actuating the fan blades of the set that is located further downstream relative to the turboprop. The space available for said downstream set is small, which makes it necessary to have recourse to a device for controlling the pitch of the fan blades that is of small size radially.

OBJECT AND SUMMARY OF THE INVENTION

[0006] The present invention thus has a main object of mitigating such drawbacks by proposing a device for controlling the pitch of fan blades, which device is radially compact, light in weight, and simple in design.

[0007] This object is achieved by a device for controlling the pitch of fan blades of a turboprop having at least one set of adjustable pitch fan blades, said set being constrained to rotate with a rotary ring centered on a longitudinal axis and being mechanically connected to a turbine rotor, wherein each blade of the set is coupled, for pitch-adjustment purposes, to a synchronization ring centered on the longitudinal axis, said synchronization ring being suitable for pivoting about the longitudinal axis relative to the rotary ring under drive from actuators that are carried by the rotary ring and that have respective axes extending in a direction that is substantially tangential to the synchronization ring.

[0008] The control device of the invention presents the advantage of constituting an independent module that is easily mounted on the turboprop turbine in an already assembled configuration. It also presents small size in a radial direction and can therefore easily be located under the set of blades that is situated further downstream relative to the turboprop. The weight of the control device is also small. Finally, the device is placed outside the turbine and is therefore easily accessible for maintenance operations without it being necessary to begin by dismantling the turbine.

[0009] In an advantageous disposition, the control device further comprises means for providing longitudinal and radial guidance to the synchronization ring relative to the rotary ring. Under such circumstances, the control device may comprise a plurality of wheel means carried by the rotary ring and co-operating with running tracks formed on the synchronization ring. More precisely, the outside surface of the synchronization ring may have two parallel running tracks extending in a circumferential direction and separated by a projecting rib, the wheel means each comprising two wheels rotatable about respective axes parallel to the longitudinal axis and each co-operating with a running track.

[0010] In another advantageous disposition, each actuator comprises a cylindrical tube fastened to the rotary ring and having a rigid rod slidably mounted therein and extending in a direction that is substantially tangential to the synchronization ring and having its free end fastened to the synchronization ring.

[0011] In yet another advantageous disposition, each blade is mounted on the rotary ring by means of a support suitable for pivoting about a radial axis and connected to the synchronization ring via a drive controlling rod.

[0012] Each actuator of the control device may be fastened to the rotary ring by means of lugs having respective axes that coincide and that are parallel to the longitudinal axis.

[0013] The rotary ring may present a polygonal shape and is provided with openings in which the actuators are mounted.

[0014] The set of the control device may comprise ten fan blades, the synchronization ring being suitable for pivoting under drive from five actuators.

[0015] The invention also provides a two-propeller turboprop comprising a turbine having two contrarotating rotors and two sets of adjustable-pitch fan blades constrained to rotate with two rotary rings connected to respective ones of the rotors, the pitch of the fan blades of at least one of the sets being controlled by a device as defined above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Other characteristics and advantages of the present invention appear from the following description given with reference to the accompanying drawings that show an embodiment having no limiting character. In the figures:

[0017] FIG. **1** is a diagrammatic longitudinal section view of a two-propeller turboprop;

[0018] FIG. **2** is a face view of a control device in accordance with invention for controlling the pitch of fan blades;

[0019] FIG. **3** is an enlargement of a portion of FIG. **2**;

[0020] FIG. **4** is a fragmentary view of the FIG. **2** control device seen from an angle that is different from that of FIGS. **2** and **3**; and

[0021] FIG. **5** shows the longitudinal and radial guidance of the synchronization ring for the FIG. **2** control device.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0022] FIG. **1** is a highly diagrammatic view showing an embodiment of an airplane turboprop of the type having two propellers.

[0023] Such a turbojet is itself known and is therefore not described in detail. The turboprop **10** comprises in particular a longitudinal axis **12** and an annular nacelle **14** disposed coaxially around the longitudinal axis. The turboprop **10** also comprises, from upstream to downstream: a compressor **16**; a combustion chamber **18**; and a turbine **20** having two contrarotating rotors **22***a* and **22***b*, these various elements all being disposed coaxially about the longitudinal axis **12** of the turboprop.

[0024] The turboprop **10** also comprises an upstream set **24***a* and a downstream set **24***b* of fan blades **26** of adjustable pitch. The fan blades **26** in each set **24***a*, **24***b* are, more precisely, mounted on a respective rotary ring **28***a*, **28***b* in the form of an annular platform centered on the longitudinal axis **12** of the turboprop. The fan blades in each set are regularly spaced apart circumferentially and they extend radially from the surface of the respective rotary ring **28***a*, **28***b*. Each rotor **22***a*, **22***b* of the turbine **20** carries and drives in rotation one of the rotary rings **28***a*, **28***b* having one of the sets **24***a*, **24***b* of adjustable pitch fan blades mounted thereon.

[0025] In order to adjust the thrust of the turboprop, it is known to use a control device to modify the pitch of the blades (it is also possible to speak of adjusting the orientation of the blades).

[0026] The invention relates mainly to such a control device for controlling the pitch of the blades in the set(s).

[0027] The control device described below with reference to FIGS. **2** to **5** applies more particularly to controlling the pitch of the fan blades **26** of the downstream set **24***b* of the turboprop shown in FIG. **1**. Naturally, this control device could also be applied to the upstream set **24***a* of the same turboprop.

[0028] With reference to FIGS. **2** and **3**, the control device of the invention comprises a synchronization ring **30** that is centered on the longitudinal axis **12** of the turboprop and that is disposed coaxially inside the rotary ring **28***b*, which presents, in known manner, a polygonal shape.

[0029] The synchronization ring **30** may pivot relative to the rotary ring **28***b* about the longitudinal axis **12** of the turboprop. This rotary movement in one direction or the other is controlled by actuating actuators **32** that are carried by the rotary ring and that have respective axes extending in a direction that is substantially tangential to the synchronization ring.

[0030] More precisely, the actuators **32** (which may be hydraulic or electrical) are regularly distributed circumferentially. Each of them comprises a cylindrical tube **34** constituting the cylinder of the actuator, the tube being fastened to the rotary ring **28***b*. A rigid rod **36** extends in a direction that is substantially tangential to the synchronization ring and is suitable for sliding inside the cylinder **34** of the actuator. The free end of the rod is mounted on the synchronization ring so as to pivot about an axis **37** that is substantially parallel to the longitudinal axis **12** of the turboprop. As a result, when the rod slides inside the actuator cylinder, it causes the synchronization ring to pivot relative to the rotary ring **28** about the longitudinal axis **12**.

[0031] As shown in FIG. **3**, the cylinder **34** of each actuator **32** is fastened to the rotary ring **28***b* by means of lugs **38** presenting axes that coincide and that are parallel to the longitudinal axis **12** of the turboprop. These lugs **38** are disposed in register with openings **40** (FIG. **4**) formed in each side of the polygon forming the rotary ring **28***b* so as to reduce its weight. Preferably, the lugs of the actuators are located towards the middles of the actuator cylinders so as to take up centripetal forces better.

[0032] Furthermore, each blade **26** of the set **24***b* is pivotally mounted on the rotary ring **28***b* by means of a support **42** suitable for pivoting about a radial axis **43**. More particularly, the root of each blade is mounted on the support **42** by means for example of a dovetail-shaped fastener. The support **42** is pivotally mounted about a radial axis **43** on the rotary ring between two adjacent openings **40**, e.g. by means of a ball bearing (not shown).

[0033] Finally, each pivotal support **42** of a blade is connected to the synchronization ring **30** via a driver connecting rod **44** hinged at both ends (FIG. **4**). As a result, pivoting the synchronization ring about the longitudinal axis **12** of the turboprop causes the support **42** to turn about the corresponding radial axis **43**, thereby changing the pitch of the blade mounted on said support.

[0034] The operation of the control device of the invention stems clearly from the above description. The actuators **32** are actuated simultaneously, e.g. under the control of the turboprop's electronic control system (not shown in the figures). Under the effect of this control, the rods **36** of the actuators slide inside the cylinders of the actuator so as to cause the synchronization ring **30** to pivot relative to the rotary ring **28***b* about the longitudinal axis **12** of the turboprop. Since the synchronization ring is connected to the blade support **42** by the driver connecting rods, pivoting the ring causes said support to pivot about the radial axes, thereby causing the pitch of all of the blades **26** to be changed simultaneously.

[0035] According to an advantageous characteristic of the invention, the control device also includes means for providing longitudinal and radial guidance of the synchronization ring **30** relative to the rotary ring **28***b*.

[0036] As shown in particular in FIG. **5**, these guide means may be constituted by wheel pairs **46** carried by the rotary ring **28***b* and co-operating with running tracks **48** formed on the synchronization ring **30**.

[0037] More precisely, the outside surface of the synchronization ring **30** has two running tracks **48** that are parallel and that extend in a circumferential direction. These running tracks are also separated by a projecting rib **50**. Furthermore, the wheel pairs **46** of the rotary ring comprise individual wheels **52** on common axes of rotation **54** that are parallel to the longitudinal axis of the turboprop, each individual wheel co-operating with a respective one of the running tracks.

[0038] By running along the tracks **48**, the individual wheels **52** making up each wheel pair **46** thus serve to provide the synchronization ring **30** with radial guidance relative to the rotary ring **28***b*. The longitudinal guidance of the ring is provided by the presence of the rib **50** that is positioned between the two wheels making up each pair.

[0039] Finally, FIG. **2** shows an example of a turboprop configuration in which the set of blades on which the control device of the invention is located has ten fan blades **26**. In such a configuration, five actuators **32** that are regularly distributed around the plurality axis **12** of the turboprop can serve to cause the synchronization ring **30** to pivot (the ring then being in the form of a decagon). Furthermore, these actuators **32** can be positioned between two adjacent fan blades **26** and they can alternate with five wheel pairs **46** for providing the synchronization ring with longitudinal and radial guidance (these wheel pairs being likewise regularly distributed circumferentially). Naturally, other configura-

tions could be envisaged depending on the number of fan blades to be controlled in pitch.

[0040] Furthermore, the invention is described above in association with a turboprop having a contrarotating turbine connected directly to the propellers. Naturally, the invention also applies to two-propeller turboprops in which the propellers are driven by planetary gearing.

What is claimed is:

1. A device for controlling the pitch of fan blades of a turboprop having at least one set of adjustable pitch fan blades, said set being constrained to rotate with a rotary ring centered on a longitudinal axis and being mechanically connected to a turbine rotor, wherein each blade of the set is coupled, for pitch-adjustment purposes, to a synchronization ring centered on the longitudinal axis, said synchronization ring being suitable for pivoting about the longitudinal axis relative to the rotary ring under drive from actuators, each comprising a cylindrical tube fastened to the rotary ring and having a rigid rod suitable for sliding therein, the rod extending in a direction that is substantially tangential to the synchronization ring and having its free end fastened to the synchronization ring.

2. A device according to claim **1**, further including means for providing longitudinal and radial guidance to the synchronization ring relative to the rotary ring.

3. A device according claim **2**, having a plurality of wheel means carried by the rotary ring and co-operating with running tracks formed on the synchronization ring so as to provide it with longitudinal and radial guidance relative to the rotary ring.

4. A device according claim **3**, wherein the outside surface of the synchronization ring has two parallel running tracks extending in a circumferential direction and separated by a projecting rib, the wheel means each comprising two wheels rotatable about respective axes parallel to the longitudinal axis and each co-operating with a running track.

5. A device according claim **1**, wherein each blade is mounted on the rotary ring by means of a support suitable for pivoting about a radial axis and connected to the synchronization ring via a drive controlling rod.

6. A device according claim **1**, wherein each actuator is fastened to the rotary ring by means of lugs having respective axes that coincide and that are parallel to the longitudinal axis.

7. A device according claim **1**, wherein the rotary ring presents a polygonal shape and is provided with openings in which the actuators are mounted.

8. A device according claim **1**, wherein the set has ten fan blades, the synchronization ring being suitable for pivoting under drive from five actuators.

9. A two-propeller turboprop comprising a turbine having two contrarotating rotors and two sets of adjustable-pitch fan blades constrained to rotate with two rotary rings connected to respective ones of the rotors, the pitch of the fan blades of at least one of the sets being controlled by a device according to claim **1**.

* * * * *