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MODULE FOR AN AIRCRAFT TURBINE ENGINE

Abstract

A module having a longitudinal axis, a hydraulic actuator, and a pump for supplying the hydraulic actuator with fluid, the pump can include axial pistons intended to be movable to rotate about the longitudinal axis and configured to transfer the fluid to the hydraulic actuator, a connecting plate connected to the axial pistons and engaging with an annular main plate centered on the longitudinal axis intended to be rotated about the longitudinal axis and tilted relative to the longitudinal axis, the connecting plate being arranged between the main plate and the axial pistons, the axial pistons being movable to rotate in a direction parallel to the longitudinal axis, the tilting of the main plate resulting in the movement of the axial pistons in the direction.

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Background/Summary

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to the field of modules for aircraft turbine engines. The invention relates more particularly to the modules comprising a hub movable in rotation and variable pitch vanes carried by the hub, such as the fan or propeller modules.

TECHNICAL BACKGROUND

[0002] An aircraft turbine engine generally comprises a module extending around a longitudinal axis and having a hub movable in rotation around the longitudinal axis and on which vanes are mounted. The module is typically connected to a gas generator. The gas generator comprises, for example, from upstream to downstream, a low-pressure compressor, a high-pressure compressor, a combustion chamber, a high-pressure turbine, a low-pressure turbine and a gas exhaust nozzle. The rotor of the high-pressure compressor is connected to the rotor of the high-pressure turbine by a high-pressure shaft and the rotor of the low-pressure compressor is connected to the rotor of the low-pressure turbine by a low-pressure shaft. The low-pressure shaft is also connected to a drive shaft of the hub of the module to drive it in rotation.

[0003] The module is, for example, a fan or a propeller. In the case of a fan, the vanes are surrounded by an external casing attached to a nacelle of the aircraft. In the case of a propeller, the fan vanes are mounted outside the nacelle and are therefore not surrounded by an external casing.

[0004] In order to optimize the operation of the module and ensure its operability according to the phases of flight of the aircraft, in particular by maintaining a sufficient pumping margin, it is known to modify the orientation of the vanes during the flight of the aircraft. To this end, the vanes are movable about a pitch axis that extends perpendicular to the longitudinal axis. The vanes are referred to as variable pitch vanes. For example, the variable pitch vanes may occupy a reverse thrust position, wherein they generate counter-thrust to help slow down the aircraft, and a feathered position, wherein, in the event of failure or breakdown, they limit their resistance.

[0005] In order to drive in rotation the vanes about their pitch axes, the module of the turbine engine typically comprises a device for changing the pitch of the vanes. The document FR-A1-3 087 232 describes a turbine engine comprising a fan module with a movable hub that may move about a longitudinal axis and on which variable pitch vanes are mounted. The module comprises a vane pitch change device comprising a hydraulic actuator connected to the vanes and a supply pump for supplying fluid to the hydraulic actuator. According to this document, the pump is secured in rotation to the hub.

[0006] To operate the pump and regulate its flow rate, the module also comprises an electric motor secured in rotation to the pump.

[0007] This configuration is not entirely satisfactory. As the electric motor is rotating and the energy source supplying the motor is in a stationary frame of reference, it is necessary to provide for a transfer of energy from a stationary frame of reference towards a rotating frame of reference. To this end, the prior art module also comprises a rotating electrical transformer for supplying electrical energy to the motor from an electrical energy source located in a stationary reference frame of the turbine engine.

[0008] However, the module of the turbine engine has an overall dimension that makes it difficult to add an electrical transformer. Adding a transformer means increasing the size of the module. The

weight and the cost of the transformer are also significant.
[0009] There is therefore a need to provide a turbine engine module for an aircraft, comprising a hub carrying variable pitch vanes, which is compact, lightweight and inexpensive.

SUMMARY OF THE INVENTION

[0010] To this end, the invention proposes a module for an aircraft turbine engine, the module comprising a longitudinal axis and comprising: [0011] a hub centered on the longitudinal axis and configured to be movable in rotation about the longitudinal axis, [0012] vanes carried by the hub, each of the vanes being movable about a pitch axis extending radially with respect to the longitudinal axis, [0013] a device for changing the pitch of the vanes about their pitch axes, the device comprising:
a hydraulic actuator configured to be movable in rotation about the longitudinal axis and configured to drive the vanes about their pitch axes,
a supply pump for supplying fluid to the hydraulic actuator comprising axial pistons configured to be movable in rotation about the longitudinal axis and configured to transfer the fluid to the hydraulic actuator, a connecting plate connected to the axial pistons and cooperating with an annular main plate centered on the longitudinal axis, the main plate being configured to be stationary in rotation about the longitudinal axis and is tiltable relative to the longitudinal axis, the connecting plate being arranged between the main plate and the axial pistons, the axial pistons being able to move in translation in a direction parallel to the longitudinal axis, the tilting of the main plate causing the axial pistons to move in this direction, and
an auxiliary actuator connected to the connecting plate and configured to drive in rotation the connecting plate about the longitudinal axis.
[0014] According to the invention, the module comprises a pump with axial pistons connected to a connecting plate and driven in translation by a main plate.
[0015] The stroke of the pistons varies according to the tilting of the main plate, allowing the pump flow rate to be varied. Depending on the pump flow rate, the hydraulic actuator may vary the pitch of the vanes to the desired angle.
[0016] As the pump has a variable flow rate, there is no longer any need for a rotating electric motor to regulate the flow rate of the pump. This allows to eliminate the need for a rotating electrical transformer to supply the motor with electrical energy.
[0017] The module according to the invention is therefore more compact, lighter and consumes less energy.
[0018] Also, according to the invention, the main plate is stationary in rotation. This allows to simplify the configuration of the pump and of the module.
[0019] In addition, according to the invention, the axial pistons rotate. This allows to eliminate the need for a rotating hydraulic transfer to transfer fluid between the pump and the hydraulic actuator, thereby limiting the fluid leaks.
[0020] The invention may comprise one or more of the following characteristics, taken alone or in combination with each other: [0021] the pump comprises a shroud mounted around the main plate and the connecting plate and configured to be stationary in rotation about the longitudinal axis, [0022] the main plate is tiltable through an angle of tilting α of between −45° and 45°, an angle α of 0° corresponding to a position of the main plate wherein it is perpendicular to the longitudinal axis, [0023] the device further comprises an actuator connected to the main plate and configured to tilt the main plate relative to the longitudinal axis, [0024] the connecting plate is configured to be able to move in rotation about the longitudinal axis and is in flat abutment on the main plate, [0025] the axial pistons are connected to the connecting plate by a ball-and-socket joint, [0026] the pump comprises a transmission axle centered on the longitudinal axis, secured in rotation to the connecting plate, and around which the main plate is mounted, [0027] a drive shaft secured in rotation to the hub and configured to drive the transmission axle in rotation about the longitudinal axis, [0028] an electronic control circuit configured to transmit a command to the auxiliary actuator

to drive in rotation the connecting plate about the longitudinal axis, [0029] the auxiliary actuator is connected to the connecting plate by a splined connection or a universal joint connection or an Oldham joint connection or an embedded connection, [0030] the hydraulic actuator is a cylinder secured in rotation to the drive shaft, the hydraulic actuator comprising a case and a rod arranged within the case, and a first and a second chambers connected to the pump defined in the case, the rod or the case being movable in translation and connected to the vanes, [0031] the case or the rod is secured in rotation to the drive shaft.
[0032] The invention also relates to a turbine engine for an aircraft comprising a module according to any of the preceding characteristics.

Description

BRIEF DESCRIPTION OF THE FIGURES
[0033] Further characteristics and advantages will be apparent from the following description of a non-limiting embodiment of the invention with reference to the appended drawings wherein:
[0034] FIG. **1** is a schematic representation of an aircraft turbine engine in axial cross-section;
[0035] FIG. **2** is a schematic representation in axial cross-section of a module according to the invention;
[0036] FIG. **3***a* is a schematic functional representation of a module according to an example of embodiment of the invention;
[0037] FIG. **3***b* is a schematic functional representation of a module according to another embodiment of the invention;
[0038] FIG. **4***a* is a schematic representation of the plate of the pump equipping the module, the plate being in a first position;
[0039] FIG. **4***b* is a schematic representation of the plate of the pump equipping the module, with the plate in a second position;
[0040] FIG. **5** is a schematic representation of a module according to a particular embodiment of the invention;
[0041] FIG. **6** is a schematic representation of a module according to a particular embodiment of the invention.
DETAILED DESCRIPTION OF THE INVENTION
[0042] An aircraft comprises a fuselage and at least two wings extending on either side of the fuselage along the fuselage axis. At least one turbine engine **1** is mounted under each wing. The turbine engine **1** may be a turbojet engine, for example a turbine engine equipped with a ducted fan equipped with variable pitch vanes, referred by the acronym VPF for “Variable Pitch Fan”. Alternatively, the turbine engine **1** may be a turboprop engine, for example a turbine engine equipped with a non-ducted propeller (“USF” for “Unducted Single Fan” or “UDF” for “Unducted Dual Fan”). Of course, the invention is applicable to other types of turbine engine.
[0043] In the present invention, the terms “axial” and “axially” are defined in relation to a longitudinal axis X of the turbine engine **1** or of a module **3** of the turbine engine **1**. The terms “upstream” and “downstream” are defined in relation to the circulation of the gases in the turbine engine **1** and here along the longitudinal axis X (and even from left to right in FIG. **1**). Similarly, the terms “radial” and “radially” are defined in relation to a radial axis Z perpendicular to the longitudinal axis X. The terms “internal”, “inner”, “external” and “outer” are defined in relation to the distance from the longitudinal axis X along the radial axis Z.
[0044] FIG. **1** shows an example of the turbine engine **1**. The turbine engine **1** comprises a gas generator **2** and a module **3** in accordance with the invention.
[0045] The gas generator **2** comprises, from upstream to downstream, a low-pressure compressor **4**, a high-pressure compressor **5**, a combustion chamber **6**, a high-pressure turbine **7** and a low-

pressure turbine **8**. The rotors of the low-pressure compressor **4** and of the low-pressure turbine **8** are mechanically connected by a low-pressure shaft **9** so as to form a low-pressure body. The rotors of the high-pressure compressor **5** and of the high-pressure turbine **7** are mechanically connected by a high-pressure shaft **10** so as to form a high-pressure body. The high-pressure shaft **10** extends radially at least partly outside the low-pressure shaft **9**. The low-pressure shaft **9** and the high-pressure shaft **10** are coaxial. The high-pressure body is guided in rotation about the longitudinal axis X by a first rolling bearing **11** upstream and a second rolling bearing **12** downstream. The first bearing **11** is mounted radially between an inter-compressor casing **13** and an upstream end of the high-pressure shaft **10**. The inter-compressor casing **13** is arranged axially between the low and high pressure compressors **4**, **5**. The second bearing **12** is mounted between an inter-turbine casing **14** and a downstream end of the high-pressure shaft **10**. The inter-turbine casing **14** is arranged axially between the low and high pressure turbines **8**, **7**. The low-pressure body is guided in rotation about the longitudinal axis X via a third rolling bearing **15** and a fourth rolling bearing **16**. The fourth bearing **16** is a double bearing, for example. The fourth bearing **16** is mounted between an exhaust casing **17** and a downstream end of the low-pressure shaft **9**. The exhaust casing **17** is located downstream of the low-pressure turbine **8**. The third bearing **15** is mounted between an inlet casing **18** and an upstream end of the low-pressure shaft **9**. The inlet casing **18** is located upstream of the low-pressure compressor **4**. More specifically, the inlet casing **18** is arranged axially between the module **3** and the low-pressure compressor **4**.
[0046] In the example shown in FIG. **1**, the module **3** is mounted upstream of the gas generator **2**. Advantageously, according to this example, a stator vane **20** is arranged downstream of the module **3**. The stator vane **20** comprises, for example, vanes **200** mounted on the inlet casing **18**. These vanes **200** are referred to as OGV (Outlet Guide Vanes). The stator vane **20** allows to rectify the flow downstream of the module **3** to optimize the operation of the turbine engine **1**.
[0047] In another embodiment, not shown, the module **3** is mounted downstream of the gas generator **2**.
[0048] In addition, the module **3** according to the invention comprises vanes **30**.
[0049] In the example shown in FIG. **1**, the vanes **30** are surrounded by an external casing **19**.
[0050] A nacelle (not shown) is attached to the external casing **19**. In this example, the module **3** is a fan module.
[0051] In another example not shown, the module **3** is a propeller module. The vanes **30** are not surrounded by an external casing and the vanes **30** are, in this example, arranged around the nacelle.
[0052] With reference to FIG. **2**, the module **3** according to the invention also comprises a hub **43**. The hub **43** is annular and centered on the longitudinal axis X. It comprises an internal space **310**. The hub **43** is secured to a cone centered on the longitudinal axis X. The cone is arranged upstream of the hub **43**. The cone forms an air inlet nozzle for the turbine engine **1**. The hub **43** is for example connected to the cone by an attachment arm **43***a* extending radially with respect to the longitudinal axis X. The attachment arm **43***a* is connected to the cone and to the hub **43** by an assembly of screws and nuts **43***b*, for example. The hub **43** comprises inner housings evenly distributed around the longitudinal axis X.
[0053] The vanes **30** are carried by the hub **43** and are evenly distributed on the hub **43**. They extend radially from the hub **43**. The vanes **30** are driven in rotation about the longitudinal axis X. Each vane **30** comprises a root **41** and a blade **40** extending radially outwards from the root **41**.
[0054] The root **41** comprises, for example, a tenon mounted in a sleeve. The root **41** is pivotally mounted along a pitch axis C in the inner housing of the hub **43**. Advantageously, a root **41** is mounted per inner housing. The sleeve is centered on the pitch axis C and is housed in the inner housing of the hub **43**.
[0055] The pitch axis C is parallel to the radial axis Z and therefore extends radially with respect to the longitudinal axis X. The root **41**, via the sleeve in particular, is pivotally mounted in the hub **43**

by means of two guide bearings **44** mounted in each inner housing and superimposed along the radial axis Z. These bearings **44** are preferably, but not exclusively, ball bearings.

[0056] The hub **43** is movable in rotation about the longitudinal axis X. To drive the hub **43** in rotation about the longitudinal axis X and hence the vanes **30**, the module **3** comprises a drive shaft **32**. The drive shaft **32** is arranged at least partly in the internal space **310**. It is centered on the longitudinal axis X. The drive shaft **32** is guided in rotation in the internal space **310** by a first guide bearing **32***a* and a second guide bearing **32***b*. The first guide bearing **32***a* is a rolling bearing, for example. The second guide bearing **32***b* is a rolling bearing, for example. The first guide bearing **32***a* is arranged downstream of the second guide bearing **32***b*. The first guide bearing **32***a* comprises balls **320***a* arranged between an external ring **321***a* and an internal ring **322***a*. The second guide bearing **32***b* comprises rollers **320***b* arranged, for example, between the external ring **321***a* and the internal ring **322***a*. The internal ring **322***a* is secured to the drive shaft **32** and the external ring **321***a* is carried by a bearing support **34**. The first and second guide bearings **32***a*, **32***b* may share the same external and internal rings or be formed by separate rings. The bearing support **34** is stationary. It extends radially between an end flange **34***a* connected to the inlet casing **18** and a base **34***b* which cooperates with the external ring **321***a*.

[0057] The drive shaft **32** comprises an upstream end to which a trunnion **53** is attached. The trunnion **53** extends radially outwards. The trunnion **53** is connected, for example, by a first flange **52** to the hub **43** to drive it in rotation about the longitudinal axis X.

[0058] The drive shaft **32** is driven in rotation by the low-pressure shaft **9**, for example. In order to reduce the speed of rotation of the drive shaft **32** relative to the low-pressure shaft **9**, the module **3** advantageously comprises a mechanical speed reducer **33** connecting the low-pressure shaft **9** to the drive shaft **32**.

[0059] Referring to FIG. **1**, the speed reducer **33** is arranged in a lubrication enclosure **35**. The lubrication enclosure **35** is for example arranged axially between the third bearing **15** and the second guide bearing **32***b*, inside the inlet casing **18**.

[0060] The speed reducer **33** is, for example, a speed reducer **33** with a planetary or epicyclic gear train. The speed reducer **33** comprises an inner planetary gear, also referred by sun gear configured to cooperate with the low-pressure shaft **9**, an outer ring gear secured in rotation to the drive shaft **32** or connected to a stationary structure of the turbine engine **1** such as the inlet casing **18** and a planet carrier stationary in rotation, for example secured to the inlet casing **18** or secured in rotation to the drive shaft **32**. The speed reducer **33** also comprises planet gears that mesh with the sun gear and the outer ring gear.

[0061] Each vane **30** is movable in rotation about the pitch axis C. To this end, according to the invention, the module **3** comprises a device **45** for changing the pitch of the vanes **30** about their pitch axes C. Advantageously, the device **45** is at least partly arranged in the internal space **310** of the hub **43**. This allows to facilitate the maintenance of the device **45** as it is easily accessible. The device **45** is arranged upstream of the speed reducer **33**. The device **45** comprises a hydraulic actuator **46** movable in rotation about the longitudinal axis X and configured to drive the vanes **30** about their pitch axes C. The hydraulic actuator **46** is, for example, a hydraulic cylinder. For example, it is arranged in the internal space **310**. The hydraulic actuator **46** is secured in rotation to the drive shaft **32**. The drive shaft **32** has, for example, a shell **50** which extends radially inwards from the drive shaft **32** and is connected to the hydraulic actuator **46**.

[0062] The hydraulic actuator **46** comprises a case **48** and a rod **49**. The case **48** is cylindrical, centered on the longitudinal axis X. This configuration allows to limit the overall dimension required by the hydraulic actuator **46** in the hub **43**, both axially and radially. The case **48** extends radially around the rod **49**.

[0063] The rod **49** extends axially between a first end **49***a* and a second end **49***b*.

[0064] The hydraulic actuator **46** also comprises a first chamber **46***a* and a second chamber **46***b*.

[0065] The first and second chambers **46***a*, **46***b* are defined inside the case **48** and are axially delimited by an annular wall **46***c* arranged in the case **48**. The annular wall **46***c*, for example, is secured to the second end **49***b* of the rod **49**.

[0066] In a first example shown in FIG. **3***a*, the rod **49** may be moved in translation in the case **48**. The rod **49** moves in translation along the longitudinal axis X in the case **48**. In this example, the case **48** is secured to the drive shaft **32**. The shell **50** is connected to the case **48**.

[0067] According to another example shown in FIG. **3***b*, the case **48** may be moved in translation along the longitudinal axis X. In this example, the rod **49** is secured in rotation to the drive shaft **32**. The shell **50** is connected to the rod **49**.

[0068] The rod **49** or the case **48** moves in translation under the effect of the pressure of a fluid circulating in each chamber **46***a*, **46***b*.

[0069] The device **45** advantageously comprises a connection mechanism **47** connecting the vanes **30** to the hydraulic actuator **46** and in particular to the rod **49** or to the case **48** of the hydraulic actuator **46**. The connection mechanism **47** allows to transform the translational movement of the hydraulic actuator **46** into a rotational movement of the vanes **30**. The connection mechanism **47** comprises an annular part **47***a*, a connecting rod **47***b* and an eccentric **47***c*. The annular part **47***a* is removably attached to the rod **49** as shown in FIG. **3***a* and, for example, to the second end **49***b* or to the case **48** as shown in FIG. **3***b*. The annular part **47***a* is also detachably connected to the connecting rod **47***b*. The connecting rod **47***b* cooperates with the eccentric **47***c* which is secured to the vane **30** and in particular connected to the root **41**. The annular part **47***a* thus allows the hydraulic actuator **46** to be dismantled for maintenance operations, for example, without affecting the vanes **30**, which remain attached to the connecting rods **47***b* by means of the eccentric **47***c*.

[0070] In order to drive the rod **49** or the case **48** in translation so as to drive the vanes **30** about their pitch axes C via the connection mechanism **47**, the device **45** according to the invention also comprises a pump **54** for supplying fluid to the hydraulic actuator **46**. The pump **54** is located upstream of the reducer **33**, for example. The pump **54** is arranged inside the drive shaft **32**.

[0071] The pump **54** is a reversible hydraulic pump with variable displacement and axial pistons.

[0072] The pump **54** is connected to the first and second chambers **46***a*, **46***b* of the hydraulic actuator **46**.

[0073] Referring to FIGS. **3***a* and **3***b*, the pump **54** comprises a transmission axle **54***a* around which a main plate **54***e* is mounted. The transmission axle **54***a* is centered on the longitudinal axis X and is driven in rotation by the drive shaft **32** by means of an accessory gearbox (AGB), for example.

[0074] Advantageously, the pump **54** also comprises a shroud **54***b* mounted around the main plate **54***e*. The shroud **54***b* is for example annular and centered on the longitudinal axis X. The shroud **54***b* is stationary in rotation with respect to the longitudinal axis X. It is connected to a stationary portion of the module **3** or of the turbine engine **1**, such as the inlet casing **18**.

[0075] According to the invention, the pump **54** comprises axial pistons **54***c* configured to transfer the fluid to the hydraulic actuator **46**. The axial pistons **54***c* are cylindrical or substantially cylindrical and have an axis of revolution parallel to the longitudinal axis X. The pump **54** comprises at least two axial pistons **54***c* which are advantageously evenly distributed around the longitudinal axis X. The axial pistons **54***c* are secured in rotation to the transmission axle **54***a*.

[0076] According to the invention, the axial pistons **54***c* may move in translation in a direction D parallel to the longitudinal axis X. Advantageously, the axial pistons **54***c* may move in translation in two opposite directions along the direction D, for example from upstream to downstream and from downstream to upstream. More particularly, each axial piston **54***c* may move in translation in a reception chamber **54***d* for receiving fluid, formed, for example, in a barrel **54***f* opposite the main plate **54***e*. There are as many reception chambers **54***d* as there are axial pistons **54***c*. According to another example not shown, each reception chamber **54***d* is arranged in a separate barrel, i.e. there are as many barrels as there are reception chambers **54***d*. Each reception chamber **54***d* is secured in rotation to the transmission axle **54***a*. For example, they are secured in rotation to the hydraulic actuator **46**, in particular to the case **48**.

[0077] The main plate **54***e* is annular and centered on the longitudinal axis X. In particular, it extends in a radial plane with respect to the longitudinal axis X and therefore with respect to the transmission axle **54***a*. The main plate **54***e* is stationary in rotation about the longitudinal axis X. It is therefore not driven in rotation by the transmission axle **54***a*.

[0078] According to the invention, the main plate **54***e* may be tilted with respect to the longitudinal axis X. The main plate **54***e* is therefore mounted so that it may rotate about an axis of rotation Y which is perpendicular to the longitudinal axis X and the radial axis Z. The main plate **54***e* is for example connected to the transmission axle **54***a* by a pivot connection Y′ having an axis parallel to the axis of rotation Y.

[0079] Advantageously, the main plate **54***e* may be tilted at an angle of tilting α of between −45° and 45°, it being understood that the angle α of 0° corresponds to a position of the main plate **54***e* wherein it is perpendicular to the longitudinal axis X.

[0080] Advantageously, the device **45** also comprises an actuator **55** connected to the main plate **54***e*. The actuator **55** is configured to tilt the main plate **54***e* relative to the longitudinal axis X. The actuator **55** is, for example, electric, such as an electric cylinder, or hydraulic, such as a hydraulic cylinder. The actuator **55** is secured to the main plate **54***e* and is therefore stationary in rotation about the longitudinal axis X. For example, it is connected to the main plate **54***e* by a ball-and-socket joint. This configuration makes it easier for the actuator **55** to tilt the main plate **54***e* without complicating the configuration of the module **3**. The actuator **55** may also be connected to a casing of the module **3** or of the turbine engine **1** by a ball-and-socket joint.

[0081] According to the invention, the pump **54** comprises a connecting plate **54***g* connected to the axial pistons **54***c* and arranged between the main plate **54***e* and the axial pistons **54***c*. The connecting plate **54***g* is mounted around the transmission axle **54***a*. The connecting plate **54***g* and the main plate **54***e* are coaxial. Advantageously, the main plate **54***e* has an external diameter greater than the external diameter of the connecting plate **54***g*. The main plate **54***e* cooperates with the connecting plate **54***g*. Advantageously, the connecting plate **54***g* is secured in rotation to the main plate **54***e* about the axis of rotation Y. The connecting plate **54***g* may thus be tilted in correlation with the main plate **54***e*. The connecting plate **54***g* is preferably tiltable at an angle identical to the angle of tilting a of the main plate **54***e*. The connecting plate **54***g*, for example, is in flat abutment on the main plate **54***e*. Preferably, the connecting plate **54***g* is movable in rotation about the longitudinal axis X. It is secured in rotation to the transmission axle **54***a*.

[0082] The axial pistons **54***c* are connected to the connecting plate **54***g* by a ball-and-socket joint **54***h*.

[0083] As the axial pistons **54***c* are connected to the connecting plate **54***g*, the tilting of the main plate **54***e* causes the tilting of the connecting plate **54***g* and a displacement of the axial pistons **54***c* in the direction D. The travel of the axial pistons **54***c* in the reception chambers **54***d* is then variable according to the tilting of the main plate **54***e*. This allows to regulate the flow rate of the pump **54**. Advantageously, as shown in FIG. **4***a*, when the angle of tilting α of the main plate **54***e* is between 0° and 45°, the pump **54** is in discharge mode, whereas when the angle of tilting α of the main plate **54***e* is between −45° and 0°, as shown in FIG. **4***b*, the pump **54** is in intake mode.

[0084] According to a preferred embodiment of the invention illustrated in FIG. **5**, the device **45** also comprises an auxiliary actuator **56** connected to the connecting plate **54***g* advantageously by means of a spline connection such as short splines with rounded teeth or a universal joint connection or an Oldham joint connection or an embedded connection.

[0085] The auxiliary actuator **56** is configured to drive in rotation the connecting plate **54***g*. The auxiliary actuator **56** is, for example, an electric motor comprising a rotor connected to the connecting plate **54***g* and a stator arranged coaxially around the rotor. For example, the rotor is centered on the longitudinal axis X and the stator is connected to a stationary structure of the turbine engine **1** or of the module **3**.

[0086] An auxiliary actuator **56** of this type allows the connecting plate **54***g* to be driven in rotation about the longitudinal axis X when the drive shaft **32** is not active. Typically, during the maintenance phases of the turbine engine **1**, the drive shaft **32** is stationary in rotation and therefore does not drive the connecting plate **54***g* in rotation about the longitudinal axis X via the drive shaft **54***a* of the pump **54**. During these phases, the connecting plate **54***g* is driven in rotation by the auxiliary actuator **56**. The auxiliary actuator **56** is, for example, coupled to the pump **54** by means of gears coupled by dog clutches, allowing the auxiliary actuator **56** to drive the connecting plate **54***g* only when the drive shaft **32** is not being driven in rotation.

[0087] The splined, universal joint, Oldham joint or embedded connection are the preferred connections as they are compatible with the angle of tilting of the connecting plate **54***g*.

[0088] With reference to FIG. **6**, advantageously, in order to control and regulate the speed of the actuator **55** and possibly the auxiliary actuator **56**, the module **3** also comprises a control case **57** and an electronic control circuit **58**. The control case **57** is supplied with electrical energy by an electrical energy source **59** located in the turbine engine **1**, for example. The electronic control circuit **58** is located in the turbine engine **1**, for example. The electronic control circuit **58** is, for example, a digital computer such as a FADEC (Full Authority Digital Electronic Computer).

[0089] Advantageously, the module **3** comprises a sensor **60**. The sensor **60** allows to measure an information **11** which is transmitted to the electronic control circuit **58**. The information **11** is, for example, the position of the case **48** or of the rod **49** of the hydraulic actuator **46**. The sensor **60** is, for example, an LVDT (Linear Variable Differential Transformer) type linear sensor. The sensor **60** is configured to measure the position of the rod **49** or of the case **48** of the hydraulic actuator **46**. For example, it is located in the hydraulic actuator **46**. In another example not shown, the sensor **60** is a position sensor. It is used to measure the position of the vanes **30**.

[0090] The sensor **60** supplies the information **11** to the electronic control circuit **58**. The electronic control circuit **58** will then supply a command to the control case **57** which will determine the position of the actuator **55** and if necessary, control the rotation of the auxiliary actuator **56** in order to regulate the flow rate of the pump **54** via the tilting of the auxiliary plate **54***g* and modify the position of the rod **49** or of the case **48** of the hydraulic actuator **46** according to the desired pitch setting of the vanes **30**.

[0091] The electronic control circuit **58** also or alternatively receives a signal S**1** on the flight conditions of the aircraft and/or the state of the turbine engine **1**. The signal S**1** is also or alternatively taken into account to supply the command O**1** to control case **57**.

[0092] The pump **54** is fluidically connected to a hydraulic circuit C. The hydraulic supply circuit C comprises, for example, a first circuit C**1** connecting at least one of the reception chambers **54***d* of the pump **54** to the first chamber **46***a* of the hydraulic actuator **46** and a second circuit C**2** connecting the second chamber **46***b* of the hydraulic actuator **46** to at least one of the reception chambers **54***d* of the pump **54**.

[0093] The hydraulic supply circuit C is a closed circuit. It is independent of a hydraulic lubrication circuit for the turbine engine **1** configured, for example, to lubricate the reducer **33**. The fluid in the hydraulic supply circuit C supplying the hydraulic actuator **46** is, for example, a hydraulic fluid. The liquid is, for example, pressurized oil or a phosphate ester such as Skydrol. The fluid is thus a fluid circulating in a closed circuit in the hydraulic supply circuit C and is independent of the lubrication circuit of the turbine engine **1**. The fluid may therefore be different from the oil used in the lubrication circuit of the turbine engine **1**. The fluid may therefore have a lower freezing point or viscosity characteristics that are better suited to the conditions of the turbine engine **1**, particularly when the operating temperatures of the turbine engine **1** are low. For example, the fluid in the hydraulic supply circuit C has a freezing point of between −70° C. and −50° C., in particular between −65° C. and −60° C. The fluid pressure in the hydraulic supply circuit C is advantageously greater than 100 bar, preferably greater than 200 bar and even more preferably between 250 bar and 350 bar. As the hydraulic supply circuit C is closed, it is not aerated and it is therefore possible to implement high pressures in the hydraulic circuit. This allows to reduce the overall dimensions of the hydraulic actuator **46**.

[0094] With reference to FIG. **6**, the hydraulic circuit C advantageously comprises, for example, a hydraulic accumulator **61** to compensate for variations in the volume of the fluid due to its compressibility and expansion. The hydraulic accumulator **61** is in fluid communication with the pump **54**. The hydraulic accumulator **61** may be integrated with the pump **54**. The hydraulic accumulator **61** is secured in rotation to the hydraulic actuator **46** and may therefore be movable in rotation about the longitudinal axis X.

[0095] As the axial pistons **54***c* and the hydraulic accumulator **61** may rotate relative to the longitudinal axis X, the invention allows to dispense with a rotating hydraulic transfer device.

[0096] Thanks to the invention, the tilting of the main plate **54***e* drives the axial pistons **54***c* in translation. This allows to vary the stroke of the axial pistons **54***c* and therefore the flow rate of the pump **54**. The volume in the first and second chambers **46***a*, **46***b* of the hydraulic actuator **46** varies, which causes the rod **49** or the case **48** of the hydraulic actuator **46** to move in translation, resulting in the vanes **30** being driven in rotation about their pitch axes C.

[0097] Thanks to the invention, there is no need for additional members such as a rotating electric transformer associated with an electric motor allowing to vary the flow rate of the pump **54**, or a rotating oil transfer allowing to transfer oil between the pump **54** and the hydraulic actuator **46**, which also reduces oil leaks and the need for additional recovery pumps. In addition, the power consumption is low because there is no electric motor in operation when the aircraft is in flight, the pump **54** being driven by the drive shaft **32**.

[0098] Also, as the pump **54** is advantageously reversible, there is no need for a flow rate reversal valve or a controlled circuit during the flight phases of the aircraft.

Claims

1. A module for an aircraft turbine engine, the module having a longitudinal axis and comprising: a hub centered on the longitudinal axis and configured to be movable in rotation about the longitudinal axis; vanes carried by the hub, each of the vanes being movable about a pitch axis extending radially with respect to the longitudinal axis; and a device for changing the pitch of the vanes about their pitch axes, the device comprising: a hydraulic actuator configured to be movable in rotation about the longitudinal axis and configured to drive the vanes about their pitch axes; and a supply pump for supplying fluid to the hydraulic actuator, the supply pump comprising: axial pistons configured to be movable in rotation about the longitudinal axis and configured to transfer the fluid to the hydraulic actuator; a connecting plate connected to the axial pistons and cooperating with an annular main plate centered on the longitudinal axis, the main plate being configured to be stationary in rotation about the longitudinal axis and tiltable relative to the longitudinal axis, the connecting plate being arranged between the main plate and the axial pistons; wherein the axial pistons are able to move in translation in a direction parallel to the longitudinal axis, and wherein the tilting of the main plate causes the axial pistons to move in the direction parallel to the longitudinal axis; and an auxiliary actuator connected to the connecting plate and configured to drive in rotation the connecting plate about the longitudinal axis.

2. The module according to claim 1, wherein the pump comprises a shroud mounted around the main plate and the connecting plate and configured to be stationary in rotation about the longitudinal axis.

3. The module according to claim 1, wherein the main plate is tiltable through an angle of tilting between −45° and 45°, and wherein an angle of tilting of 0° corresponds to a position of the main plate wherein the main plate is perpendicular to the longitudinal axis.

4. The module according to claim 1, wherein the device further comprises an actuator connected to the main plate and configured to tilt the main plate relative to the longitudinal axis.

5. The module according to claim 1, wherein the connecting plate is configured to be able to move

in rotation about the longitudinal axis and is in flat abutment on the main plate.
6. The module according to claim 1, wherein the axial pistons are connected to the connecting plate by a ball-and-socket joint.
7. The module according to claim 1, wherein the pump comprises a transmission axle centered on the longitudinal axis, secured in rotation to the connecting plate, and around which the main plate is mounted.
8. The module according to claim 7, further comprising a drive shaft secured in rotation to the hub and configured to drive the transmission axle in rotation about the longitudinal axis.
9. The module according to claim 1, further comprising an electronic control circuit configured to transmit a command to the auxiliary actuator to drive in rotation the connecting plate about the longitudinal axis.
10. The module according to claim 1, wherein the auxiliary actuator is connected to the connecting plate by a splined connection, a universal joint connection, an Oldham joint connection, or an embedded connection.
11. The module according to claim 8, wherein the hydraulic actuator is a cylinder secured in rotation with the drive shaft, wherein the hydraulic actuator comprising comprises: a case and a rod arranged within the case; and first and second chambers connected to the pump defined in the case, wherein the rod or the case are movable in translation and connected to the vanes.
12. The module according to claim 11, wherein the rod or the case is secured in rotation to the drive shaft.
13. A turbine engine for an aircraft comprising a module according to claim 1.