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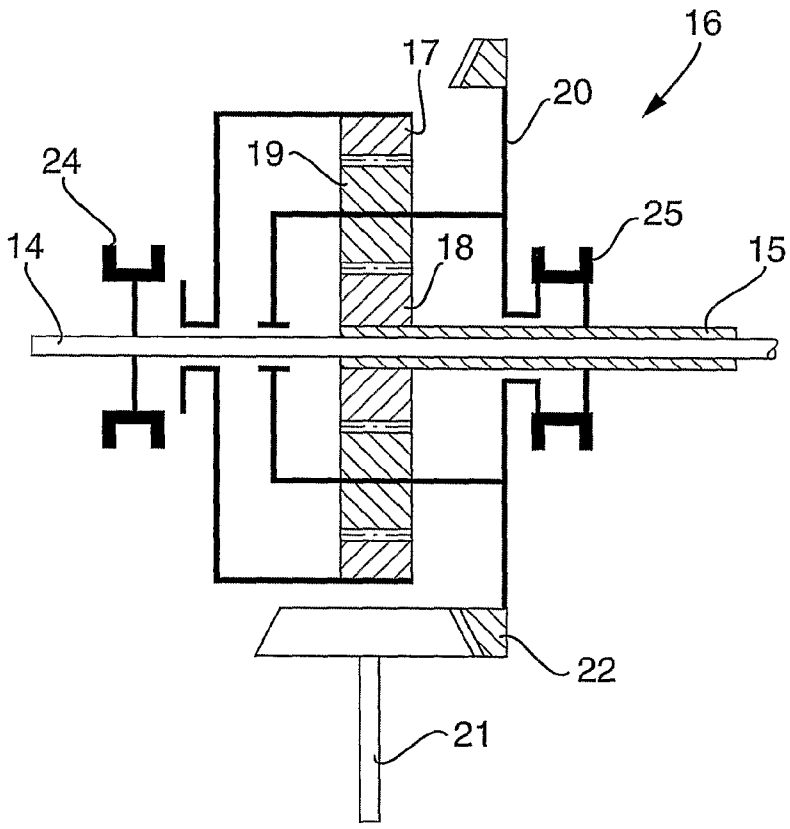
(54) Title: A DEVICE FOR AND A METHOD OF STARTING A GAS TURBINE ENGINE



(57) Abstract: A device for starting a gas turbine engine, said gas turbine engine comprising a low pressure compressor and a high pressure compressor, wherein said device comprises: a start motor (23); a differential gear (16); a first shaft (21) driven by said start motor and defining a power input shaft to said differential gear (16); a first power output shaft (14) drivingly connecting said differential gear (16) with the low pressure compressor; a second power output shaft (15) drivingly connecting said differential gear (16) with the high pressure compressor; said first and second power output shafts (14, 15) being drivingly connected with said power input shaft (21) through said differential gear (16). The device comprises a means (24) for temporary disconnection of one of the first and second power output shafts (14, 15) from the power input shaft (21).

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A device for and a method of starting a gas turbine engine

TECHNICAL FIELD

The present invention relates to a device for starting a gas turbine engine, said gas turbine engine comprising a low pressure compressor and a high pressure compressor, wherein said device comprises: a start motor; a differential gear; a first shaft driven by said start motor and defining a power input shaft to said differential gear; a first power output shaft drivingly connecting said differential gear with the low pressure compressor; a second power output shaft drivingly connecting said differential gear with the high pressure compressor; said first and second power output shafts being drivingly connected with said power input shaft through said differential gear.

The invention also relates to a gas turbine provided with such a device, an aeroplane equipped with such a gas turbine, and a method of starting a gas turbine by means of such a device.

In the following text "drivingly connected" is referred to as either a direct connection or a connection through any further component, such as a gear transmission or the like. Drivingly connected components may or may not have coinciding rotational axes. On the other hand "rotationally interconnected" will indicate that two components are directly interconnected and will rotate with the same rotational speed, preferably with coinciding rotational axes.

BACKGROUND OF THE INVENTION

A portion of the power provided by aircraft turbo engines is used for powering the ancillary services both of the turbo engines themselves and of the aeroplane for which they provide propulsion.

According to prior art, it is conceivable to equip an aeroplane provided with a gas turbine engine with an accessory gearbox through which power is taken from the high pressure and low pressure compressors in order to drive ancillary machines such as generators, oil or fuel hydraulic pumps.

At the present time, this power is mainly extracted on the shaft of the high pressure stage, the HP-shaft, of the twin-spool engine mechanically in order to drive the input shaft of an accessory casing or gear box. However, there is also suggested to extract power from both the low pressure stage and the high pressure stage. This is mainly because the need of electric power to be used for the operation of such ancillary machines will most probably increase in the future. Therefore, it will be necessary to retrieve more power from the turbine engines. The high pressure rotor shaft that, by tradition, has been the shaft from which said power is retrieved, will not be able to deliver all of said power alone, due to the fact that a large mechanical power extraction has a negative effect on the operation of the high pressure spool as it is likely to cause pumping of the compressor, in particular when the engine is running at low speed.

Accordingly, the manufacturers of aeroplane engines are considering to use also the low pressure rotor shaft, the LP-shaft, for the purpose of transferring power to the accessory gearbox.

However, upon start of the engine, the power is transferred in an opposite direction, from a start motor through the accessory gearbox and further to the engine itself, i.e. to the compressor or compressors.

When a plurality of compressors are drivingly connected to the accessory gearbox, suitably through a differential gear, the power needed for the start up procedure will be rather high.

THE OBJECT OF THE INVENTION

It is an object of the present invention to present a device and method by means of which the power needed for start up of a gas turbine engine as previously defined may be kept at a moderate level and which, accordingly, does not require the use of an excessively large start motor.

It is also an object of the invention to provide a device which is uncomplicated as to its design, manufacture and maintenance, reliable, robust and economically feasible, but still able to fulfil the main objective of the invention.

SUMMARY OF THE INVENTION

The object of the invention is achieved by means of the initially defined device, characterised in that it comprises a means for temporary disconnection of one of the first and second power output shafts from the power input shaft.

Preferably, the device also comprises a means for temporary power-transmitting connection of the power input shaft to the power output shaft not provided with said disconnection means, said connection means being arranged to present a power-transmitting connection between the power input shaft and said power output shaft upon action of the disconnection means. This feature may be important in order to achieve the required power transmission when, for example, the differential gear comprises a planetary gear and one of the first and second power output shafts is temporarily disconnected from the gearwheel or planet carrier to which it is normally connected.

According to a preferred embodiment, said disconnection means and said connection means are arranged so as to execute their disconnection and connection functions simultaneously. However, preferably, the disconnection means is activated before the activation of the connection means.

According to a preferred embodiment, said disconnecting means comprises a freewheel mechanism.

According to an alternative embodiment said disconnecting means comprises a tooth clutch mechanism.

According to one embodiment, said power-transmitting connection means comprises a free-wheel mechanism.

According to a further embodiment, said power-transmitting connection means comprises a tooth clutch mechanism.

According to a preferred embodiment, said differential gear comprises a planetary gear comprising: a first gearwheel and a second gearwheel; at least one planetary wheel; wherein each of the gearwheels is in engagement with at least one of said at least one planetary wheel; and a planet carrier carrying said at least one planetary wheel.

It is further preferred that the power-transmitting connection means comprise a tooth clutch mechanism by means of which the internal motion of the wheels of the planetary gear is blocked and the planetary gear will rotate as a solid unit. Internal blocking may be achieved by means rotational interconnection of two of said planet carrier and said first and second gearwheels. Preferably, one of said rotationally interconnected gearwheels, or planet carrier and gearwheel is a gearwheel or planet carrier that is disconnected from one of said power output shafts to which it, during inactivation of said disconnection means, is directly and drivingly connected.

Preferably, said means for temporary disconnection is arranged for disconnection of the first power output shaft. Since the first power output shaft is arranged to drivingly connect the low pressure compressor with the power input shaft through the differential gear, a consequence of the activation of the disconnection means will be a more rapid start up of the high pressure compressor, since the power of the start motor may then be concentrated thereupon. With regard to further engine start

parameters, initial start up of the high pressure compressor is preferred in front of initial start up the low pressure compressor.

According to the invention, it is preferred that the device comprises means for synchronising the temporary disconnecting one of said power output shafts through said disconnecting means and the temporary connecting of the power input shaft to the other power output shaft by means of said power-transmitting connection means during a start procedure. Such means may include a control unit that delivers control signals to motors or the like that implement the activation of said disconnecting and connecting respectively. The synchronising may also be a direct consequence of the design of the means for temporary disconnection and connection respectively. For example, said means may be mechanically interconnected, such that a movement of one thereof during its activation, will result in a corresponding activating movement of the other thereof.

According to a preferred embodiment, the first power output shaft is the low pressure rotor shaft of a turbojet or turbofan engine. The differential gear may be arranged in alignment with said rotor, in an internal arrangement in the engine. However, a gear, e.g. a step down or step up gear, might as well be provided in the transmission line between the differential gear and the low pressure rotor. Accordingly, the differential gear may, as an alternative, be arranged out of line with regard to said rotor shaft, for example outside a hood or casing that surrounds the combustion air channels extending from the compressors to the combustion chamber.

Preferably, the second power output shaft is a high pressure rotor shaft of a turbojet or turbofan engine. The differential gear may be arranged in alignment with said rotor, in an internal arrangement in the engine. However, a gear, e.g. a step down or step up gear, might as well be provided in the transmission line between the differential gear and the high pressure rotor. Accordingly, the differential gear may, as an alternative, be arranged out of line with regard to said rotor shaft, for example outside a hood or casing that surrounds the combustion air channels extending from the compressors to the combustion chamber.

According to one embodiment, preferably in which the planetary gear is in alignment with said rotor shafts, both gearwheels of the planetary gear are coaxial with said first and second power output shafts.

Preferably, the power input shaft is drivingly connected with an accessory gearbox, through which power retrieved from the first and second power output shafts is further distributed during engine operation.

The invention also relates to a gas turbine engine that comprises a device according to the invention. Preferably, said gas turbine engine is a multiple spool turbojet or turbofan engine for the propulsion of an aeroplane.

The invention also relates to an aeroplane, that comprises a gas turbine engine according to the invention.

The invention also relates to a method of starting a gas turbine engine by means of a device according to the invention, characterised in that, during start of the engine, power is delivered to one of said power output shafts through the power input shaft, while the other of said power output shafts is temporarily disconnected from the power input shaft.

Preferably, the first power output shaft is disconnected during said start of the engine. Thereby, power can be concentrated to the upstart of the high pressure compressor, which is the one primarily to be accelerated during start up.

Preferably, when a start procedure is ended or at the end thereof, the disconnected power output shaft is reconnected to the power input shaft, and power is retrieved in an opposite direction, from the engine to said power input shaft through said power output shafts. When the temporarily disconnected power output shaft is to be re-connected, through an inactivation of said disconnecting means, said inactivation is preceded by an inactivation of said connecting means. Thereby, the differential gear

will operate as such a one, distributing power from the high pressure compressor and the low pressure compressor to the accessory gearbox.

Further features and advantages of the present invention will be presented in the annexed claims and in the following, detailed description of preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of a first embodiment of a gas turbine engine provided with a device according to the invention,

Fig. 2a is a schematic representation of a first embodiment of a device according to the invention, during engine operation,

Fig. 2b is another representation of the first embodiment, during engine start up,

Fig. 2c shows a side view of the planetary gear of fig. 2a and 2b.

Fig. 3a is a schematic representation of a second embodiment of a device according to the invention, during engine operation,

Fig. 3b is another representation of the second embodiment, during engine start up,

Fig. 4a is a schematic representation of a third embodiment of a device according to the invention, during engine operation,

Fig. 4b is another representation of the third embodiment, during engine start up,

Fig. 5a is a schematic representation of a fourth embodiment of a device according to the invention, during engine operation,

Fig. 5b is another representation of the fourth embodiment, during engine start up.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is an oversight view of a gas turbine engine 1 according to the invention provided with a device 2 according to the invention. The gas turbine engine 1 shown in fig. 1 is of conventional construction and comprises, in axial flow series, an air intake 3, low pressure compressor 4, high pressure compressor 5, combustion equipment 6, high pressure turbine 7, low pressure turbine 8 and an exhaust outlet 9. During operation, the high pressure compressor is driven by the high pressure turbine via a first hollow shaft 10. Similarly, the low pressure compressor is driven by the low pressure turbine via a second hollow shaft 11 which is coaxially disposed within the first hollow shaft 10.

The gas turbine 1 operates in the conventional manner whereby air drawn in through the air intake 3 is compressed by the low pressure compressor before passing into the high pressure compressor where it is compressed further. The compressed air then flows into the combustion equipment 6 where it is mixed with fuel and the mixture combusted. The resultant hot combustion products then expand through the high and low pressure turbines 7, 8 before being exhausted to the atmosphere through the exhaust nozzle 9.

The device 2 of the invention comprises a differential gear that has as its main task to transfer power from the low pressure compressor rotor 4 and the high pressure compressor rotor 5 of the engine 1 to an accessory gearbox 12 during engine operation, said accessory gearbox 12 being located on the outside of the engine 1. There may also be provided a transfer gearbox 13 through which power is transferred to the accessory gearbox 12. Typically, different ancillary machines, such as generators and oil or fuel hydraulic pumps, are driven through the accessory gearbox 12. However, during start up of the engine 1, the power transfer direction is reversed, whereby power is transferred from a start motor 23 through the accessory gearbox 12 to the rotor of at least one of said compressors 4, 5, preferably to the high pressure compressor 5. Once, by definition, the engine 1 has been started and power may be

retrieved from the coaxial compressor shafts 10, 11, the device according to the invention is set in an operation mode by which power is transferred from the compressor shafts to the accessory gearbox 12 through said device 2.

Figs. 2a-2c show an example of a device 2 according to a first embodiment of the invention. The device will be described outgoing from how it is supposed to operate during start up of the gas turbine engine 1.

The low pressure compressor shaft 11 forms a first power output shaft 14 of the device, while the high pressure compressor shaft 10 forms a second power output shaft 15 of the device 2. The device 2 further comprises a differential gear 16 formed by a planetary gear comprising a first gearwheel 17 and a second gearwheel 18, both of which are coaxial with said first and second power output shafts 14, 15, and a plurality of planetary wheels 19. The device also comprises a planet carrier 20 connected to a power input shaft 21 through a bevel gear assembly 22. The power input shaft 21 is, in its turn, connected with the accessory gearbox 12 via the transfer gearbox 13.

During start up of the gas turbine engine, the power input shaft 21 defines a shaft through which power is transmitted to the differential gear. The first power output shaft 14 defines a shaft by means of which power might be transmitted from the differential gear 16 to the low pressure compressor 4 for the rotation thereof. The second power output shaft 15 defines a shaft by means of which power may be transmitted from the differential gear 16 to the high pressure compressor 5 for the rotation thereof.

In this specific embodiment, the first gearwheel 17 is a ring wheel provided with cogs on the inner periphery thereof and in meshing engagement with the planetary wheels 19 through said cogged inner periphery, said planetary wheels being arranged radially inside the first gearwheel 17. The first power output shaft 14 is drivingly connected, in this case even rotationally interconnected, with said ring wheel 17. The second gearwheel 18 is provided with cogs on its outer periphery and is in meshing

engagement with the planetary wheels 19 through said cogged outer periphery, said second gearwheel 18 defining a sun wheel arranged radially inside the planetary wheels 19. The second power output shaft 15 is drivingly connected, in this case even rotationally interconnected, with the second gearwheel 18. During operation when power is transferred from the compressors 4, 5 to the accessory gearbox via the differential gear and said shafts 14, 15, 21, an elevated torque may be transferred from the first power output shaft 14 to the power input shaft 21 via the planetary gear 16, in relation to the torque transferred from the second power output shaft 15. However, it should be noted that the inventive device is not delimited to such a differential gear design and to the suggested connections between shafts and gearwheels and planet carrier 20. For example, the power input shaft 21 may as well be drivingly connected, even rotationally interconnected, to any one of the gear wheels 17, 18, while the output shafts may be drivingly connected, even rotationally interconnected, to a respective one of the remaining gearwheels 17, 18 or the planet carrier 20.

Reference will now be made to figs. 2-5. As already mentioned, during a start up sequence, power is to be transferred in a direction from a start motor or starter/generator 23 connected with the accessory gearbox 12, and through the latter and the inventive device to any of the compressors 4, 5 of the gas turbine engine 1. Preferably, power is only to be transferred to the high pressure compressor 5 during start up. Accordingly, the connection between low pressure compressor 4 and the power input shaft 21 has to be disrupted, though only temporarily. Accordingly, the device 2 comprises a means 24 for temporary disconnection of the first power output shaft 14 from the power input shaft 21. Preferably, said means is arranged to disconnect the first power output shaft 14 from the one of the gearwheels 17, 18 or planet carrier 20 to which it is connected. The embodiments shown in figs. 2-5 all comprise a device that presents a basic concept regarding the design of the planetary gear 16 and its connection between gearwheels 17, 18 and the first and second power output shafts 14, 15. In other words, the power input shaft 21 is drivingly connected to the planet carrier 20, the first power output shaft 14 is drivingly connected to the first gearwheel 17, and the second power output shaft 15 is drivingly connected to

the second gearwheel 18. However, the basic principle described with reference to figs. 2-5 might as well be implemented on alternative solutions.

In order to guarantee that the power is transferred from the input shaft 21 to the second power output shaft 15 during start up, upon disconnection of the first power output shaft from the first gearwheel 17, the device comprises a means 25 for temporary power-transmitting connection of the power input shaft 21 to the second power output shaft 15, said connection means 25 being arranged to provide a power-transmitting connection between the power input shaft 21 and the second power output shaft 15 upon action of the disconnection means 24. In absence of the connection means 25, and upon disconnection of the first power output shaft 14 the planetary gear 16 would just go freewheeling, without any requested power transmission. Said disconnection means 24 and said connection means 25 are arranged so as to execute their disconnection and connection functions simultaneously during start up and reversed power transfer direction. However, preferably, the disconnection means 24 is activated before the activation of the connection means 25.

Figs. 2a and 2b show an embodiment of the inventive device during operation and during start up respectively. The disconnection means 24 comprises a tooth clutch mechanism, known per se. Also the connection means 25 comprises a tooth clutch mechanism known per se. In fig. 2a the disconnection means 24 as well as the connection means 25 are inactivated. The second power output shaft 15 is then in power-transmitting connection with the power input shaft through the planetary gear 16 as described earlier. In fig. 2b the disconnection means 24 and connection means 25 are activated. The connection means 25 are arranged so as to connect the second power output shaft 15 with the planet carrier upon its activation.

Fig. 2c is a cross-section showing a possible design of the planetary gear shown in figs. 2a and 2b.

Figs. 3a and 3b show an alternative embodiment differing from the one of figs. 2a and 2b in that the disconnection means 24 comprises a freewheel mechanism, known per se, and in that also the connection means 25 comprises such a freewheel mechanism. The freewheel mechanism of the disconnection means 24 does not permit the first gearwheel 17 to rotate at lower speed than the first power output shaft 14 in a first power transfer direction, from the first power output shaft 14 to the first gearwheel 17. However, in an opposite second direction, in which the power transfer direction is reversed, it permits the first gearwheel 17 to rotate at higher rotational speed than the first power output shaft 14. In other words, it transfers power in said first direction from first power output shaft 14 to first gearwheel 17, but not in the opposite direction. Accordingly, a free wheeling effect will be produced during start up. This is shown in figs. 3a and 3b. The connection means 25 for temporary by pass connection of the second power output shaft 15 with the power input shaft 21 is of similar construction. During continuous operation, as shown in fig. 3a, it permits the second power output shaft to rotate at higher speed than the planet carrier 20. No power is thereby transferred directly through said connection means 25 to the planet carrier 20, but through the planetary gear as described previously for the preceding embodiments. However, during start up, when the power transfer direction is reversed, as shown in fig. 3b, the connection means 25 is activated, whereby it does not permit the second power output shaft 15 to rotate at lower rotational speed than the planet carrier 20.

Fig. 4a and 4b show yet another embodiment of the device according to the invention equipped with said disconnection means and connection means. However, in this embodiment said disconnection and connection means and are integrated in a two-way tooth clutch mechanism 26, which in a first operation mode shown in fig. 4a connects the first power output shaft 14 to the first gearwheel 17 and disconnects the first gearwheel 17 from the planet carrier 20. Thereby, the first operation mode in fig. 4a will work in the same way as in figs. 2a and 2b. The tooth clutch mechanism 26 is moveable in a direction corresponding to the axial direction of said power input shafts 14, 15, and by displacement thereof in a first axial direction the position according to fig. 4b is achieved. In the latter position the tooth

clutch mechanism 26 disconnects the first power output shaft 14 from the first gearwheel 17 and connects the first gearwheel 17 with the planet carrier 20. This will block internal motion in the planetary gear 16, and it will rotate as a solid unit thereby establishing a driving connection between the power input shaft 21 and the second power output shaft 15 to provide a start up mode.

Figs. 5a and 5b show an embodiment in which the two-way tooth clutch mechanism 26 of figs. 4a and 4b is provided by means of a two-way clutch mechanism 27 which might be somewhat more compact than the mechanism of figs. 4a and 4b. The two-way clutch mechanism 27 is permanently connected with the first gearwheel 17. During continuous operation, as shown in fig. 5a, said clutch mechanism is displaced in an axial direction to a position in which it is in meshing and power transferring engagement with the first power output shaft, thereby permitting power transfer as described for previous embodiments. In said first position there is no direct connection between said clutch mechanism 27 and the planet carrier 20. However, during start up, said clutch mechanism 27 is axially displaced into a second position in which it is not in power-transferring engagement with the first power output shaft 14 but with the planet carrier 20. By connecting the first gearwheel 17 with the planet carrier 20, the effect will be that power will be permitted to be transferred from the planet carrier 20 to the second power output shaft 15, which is shown in fig. 5b.

In the above text, the principles of different embodiments of the device according to the invention have been discussed. In the following, a suggested starting sequence is described.

First it should be stated that, during engine start up, the low pressure rotor 11 will be accelerated thanks to the flow of combustion gases that leaves the high pressure turbine 7 and accelerates the low pressure turbine 8.

When the engine, i.e. the high pressure rotor shaft 10, as well as the high pressure compressor 5 to which it is connected, has reached a predetermined rotational speed,

the low pressure rotor 11 may be reconnected in many different ways. When a freewheel mechanism is used as the disconnection means 24, re-connection may be performed by initial inactivation of the start motor 23, resulting in a decrease of the speed of the power input shaft 21, which in its turn will result in a freewheeling of the freewheel mechanism 25 and in a decrease of the rotational speed of the ring wheel 17. After a while the rotational speed of the ring wheel 17 is at the same level as the rotational speed of the low pressure shaft 11, i.e. the first power output shaft 14, and, accordingly, the freewheel mechanism 24 will stop freewheeling, and power can be transferred from the low pressure shaft 11 through the differential gear 16 to the accessory gearbox 12.

When tooth clutch mechanisms are used, like in figs 2a and 2b, the torque from the start motor 23 is lowered such that the tooth clutch mechanism does not transfer any torque and may be disconnected. Then, the start motor is inactivated, whereby the rotational speed of the accessory gearbox 12 and the power input shaft 21 is lowered. This, in its turn, results in a decrease of the rotational speed of the ring wheel 17, and, eventually, the ring wheel 17 will rotate with the same speed as the low pressure shaft 11, or first output shaft 14. Then the tooth clutch mechanism 24 may be reconnected.

Another possible solution is when the clutch 24 is a sliding disc clutch that is applied when the start motor has been turned off (inactivated). The disc clutch will then slide together with the ring wheel 17 and the low pressure rotor shaft 11 (or first output shaft 14), such that they will get the same rotational speed, i.e. get rotationally interconnected.

It should be understood that the above description of preferred embodiments has been made in order exemplify the invention, and that alternative solutions will be obvious for a person skilled in the art, however without departing from the scope of the invention as defined in the appended claims supported by the description and the drawings.

The power input shaft, the first power output shaft and the second power output shaft are also drivingly connected to further components, more precisely to the start motor, the low pressure compressor and the high pressure compressor respectively, and there may be further gears provided between any of said shafts and said further components. Thereby, it should be understood that the rotational speed of any of said shafts may differ from the one of the further component to which said shaft is connected. In other words "drivingly connected" means that a power can be transferred through said connection, but that there may be further components in the drive chain between the driving and the driven components. Accordingly, driving and driven components that are drivingly connected may have different rotational speeds.

PATENT CLAIMS

1. A device for starting a gas turbine engine, said gas turbine engine comprising a low pressure compressor and a high pressure compressor, wherein said device comprises:

a start motor (23);

a differential gear (16);

a power input shaft (21) driven by said start motor and defining a power input shaft (21) to said differential gear (16);

a first power output shaft (14) drivingly connecting said differential gear (16) with the low pressure compressor (4);

a second power output shaft (15) drivingly connecting said differential gear (16) with the high pressure compressor (5);

said first and second power output shafts (14, 15) being drivingly connected with said power input shaft (21) through said differential gear (16),

characterised in that it comprises a means (24; 26, 27) for temporary disconnection of one of the first and second power output shafts (14, 15) from the power input shaft (21).

2. A device according to claim 1, **characterised in** that it comprises a means (25; 26; 27) for temporary power-transmitting connection of the power input shaft (21) to the power output shaft (15) not provided with said disconnection means, said connection means (25; 26; 27) being arranged to present a power-transmitting connection between the power input shaft and said power output shaft upon action of the disconnection means (24; 26; 27).

3. A device according to claim 2, **characterised in** that said disconnection means (24; 26; 27) and said connection means (25; 26; 27) are arranged so as to execute their disconnection and connection functions simultaneously.

4. A device according to any one of claims 1-3, **characterised in** that said disconnection means (24) comprises a freewheel mechanism.

5. A device according to any one of claims 1-3, **characterised in** that said disconnection means (24) comprises a tooth clutch mechanism.

6. A device according to any one of claims 1-5, **characterised in** that said power-transmitting connection means (25) comprises a free-wheel mechanism.

7. A device according to any one of claims 1-5, **characterised in** that said power-transmitting connection means (25) comprises a tooth clutch mechanism.

8. A device according to any one of claims 1-7, characterised in that said differential gear (16) comprises a planetary gear comprising:
-a first gearwheel (17) and a second gearwheel (18),
-at least one planetary wheel (19),
-wherein each of the gearwheels (17, 18) is in engagement with at least one of said at least one planetary wheel (19),
-a planet carrier (20) carrying said at least one planetary wheel (19).

9. A device according to claim 8, **characterised in** that the power-transmitting connection means (26) comprises a tooth clutch mechanism by means of which the internal motion of the wheels (17, 18, 19) of the planetary gear (19) is blocked and the planetary gear will rotate as a solid unit.

10. A device according to claim 8 or 9, **characterised in** that the power-transmitting connection means comprises a tooth clutch mechanism by means of which two of said planet carrier and said first and second gearwheels (17, 18) are rotationally interconnected.

11. A device according to any one of claims 1-10, **characterised in** that said means (24) for temporary disconnection is arranged for disconnection of the first power output shaft (14).

12. A device according to any one of claims 1-11, **characterised in** that it comprises means for synchronising the temporary disconnecting one (14) of said power output shafts through said disconnection means (24) and the temporary connecting of the power input shaft (21) to the other power output shaft(15) by means of said power-transmitting connection means (25) during a start procedure.

13. A device according to any one of claims 1-12, **characterised in** that the first power output shaft (14) is a low pressure rotor shaft (11) of a turbojet or turbofan engine.

14. A device according to any one of claims 1-13, **characterised in** that the second power output shaft (15) is a high pressure rotor shaft (10) of a turbojet or turbofan engine.

15. A device according to any one of claims 1-14, **characterised in** that the power input shaft (21) is drivingly connected with an accessory gearbox (12), through which power retrieved from the first and second power output shafts (14, 15) is further distributed during engine operation.

16. A gas turbine engine, **characterised in** that it comprises a device (2) according to any one of claims 1-15.

17. A gas turbine engine according to claim 16, **characterised in** that it is a multiple spool turbojet or turbofan engine for the propulsion of an aeroplane.

18. An aeroplane, **characterised in** that it comprises a gas turbine engine (1) according to claim 17 or 18.

19. A method of starting a gas turbine engine by means of a device according to any one of claims 1-18, **characterised in** that, during start of the engine, power is delivered to one (15) of said power output shafts (14, 15) through the power input

shaft (21), while the other (14) of said power output shafts (14, 15) is temporarily disconnected from the power input shaft (21).

20. A method according to claim 19, **characterised in** that the first power output shaft (14) is disconnected during said start of the engine.

21. A method according to claim 19 or 20, **characterised in** that, when a start procedure is ended, the disconnected power output shaft (14) is reconnected to the power input shaft (21), and power is retrieved in an opposite direction, from the engine to said power input shaft (21) through said power output shafts (14, 15).

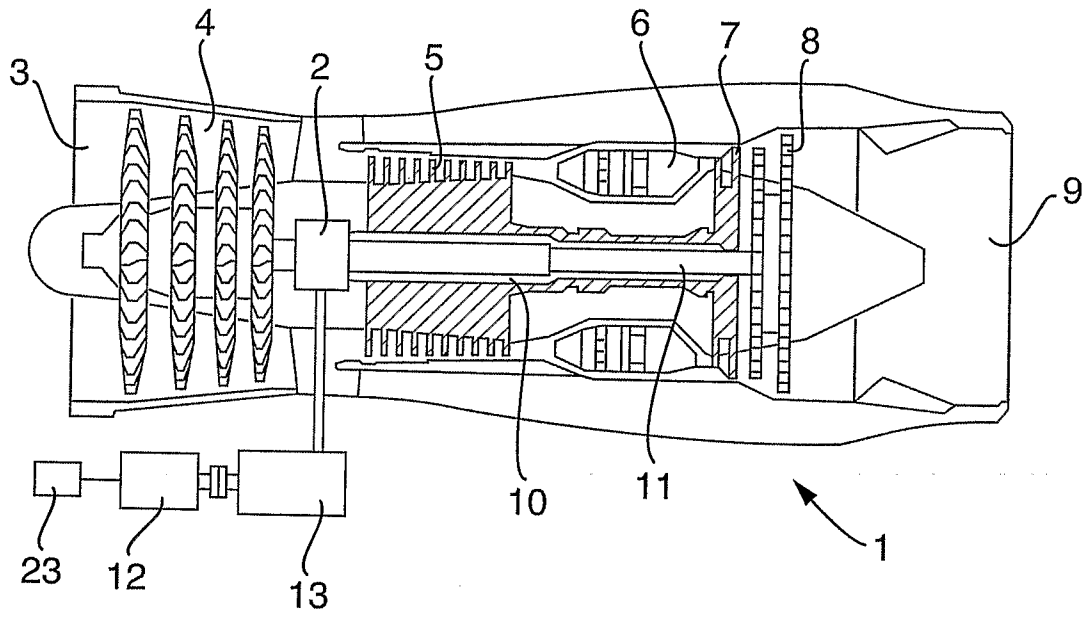

Fig 1

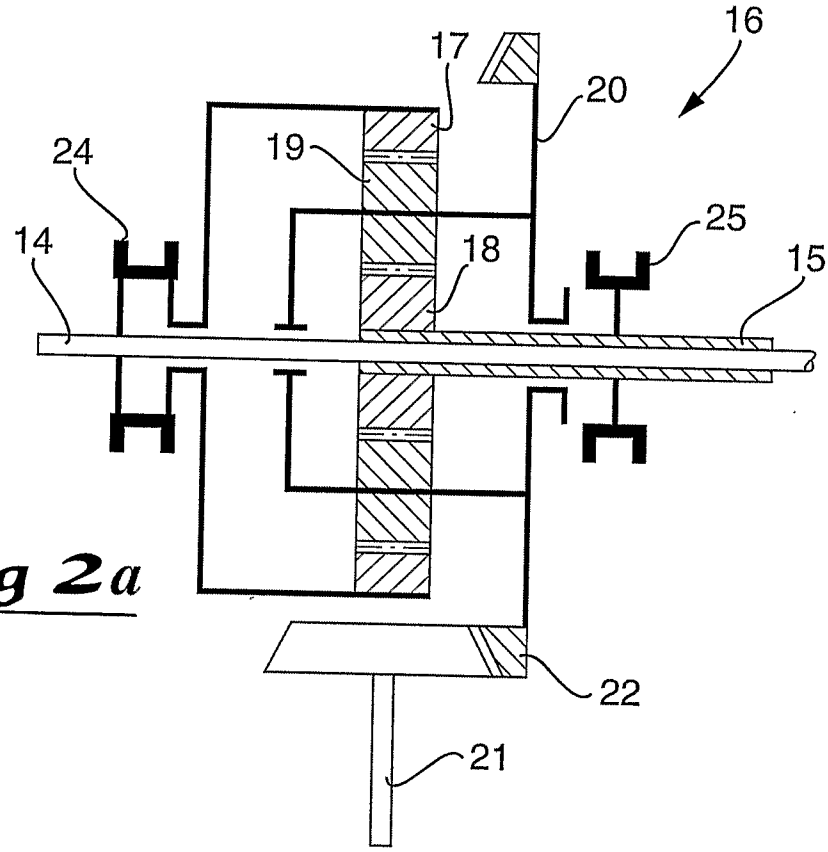

Fig 2a

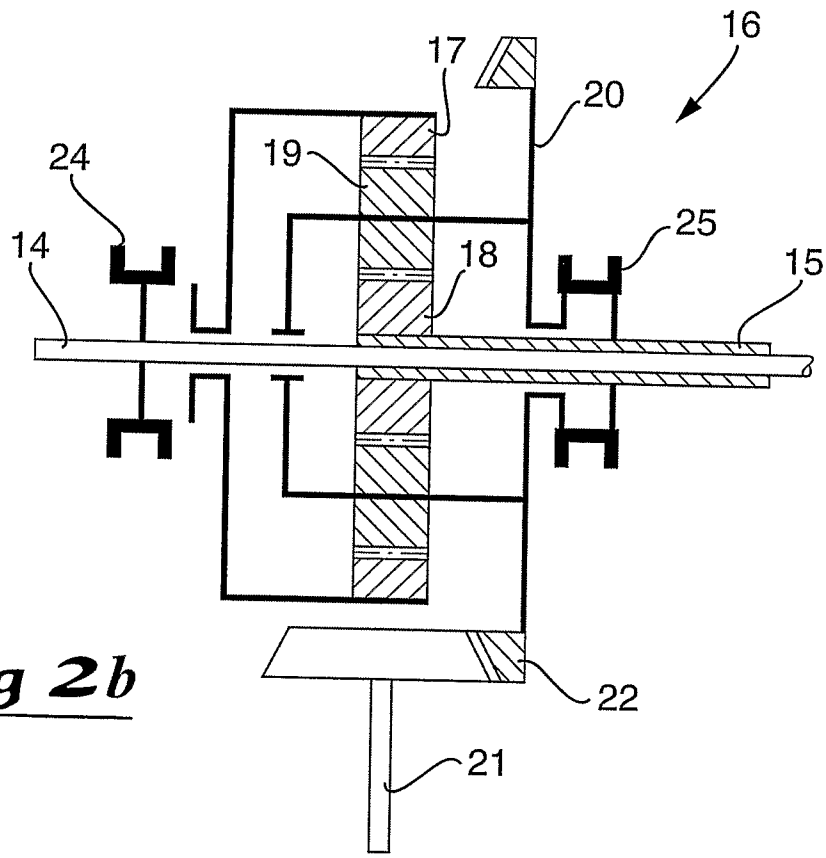

Fig 2b

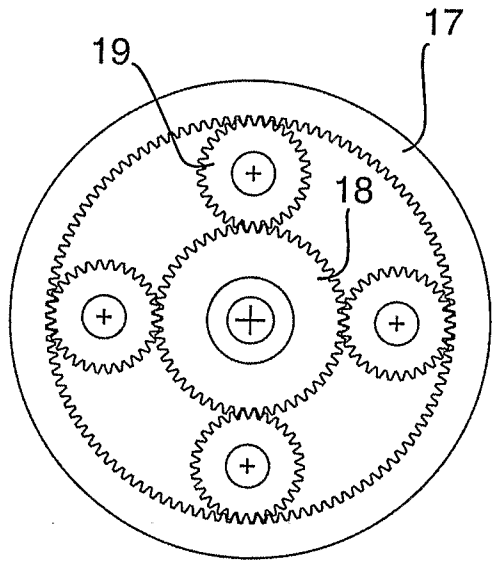

Fig 2c

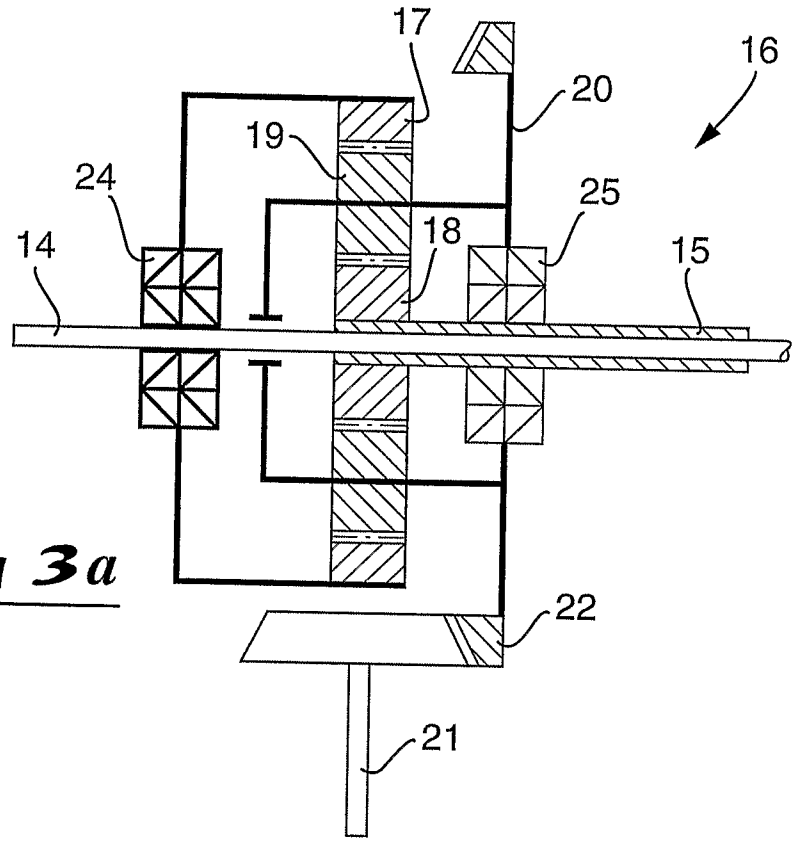

Fig 3a

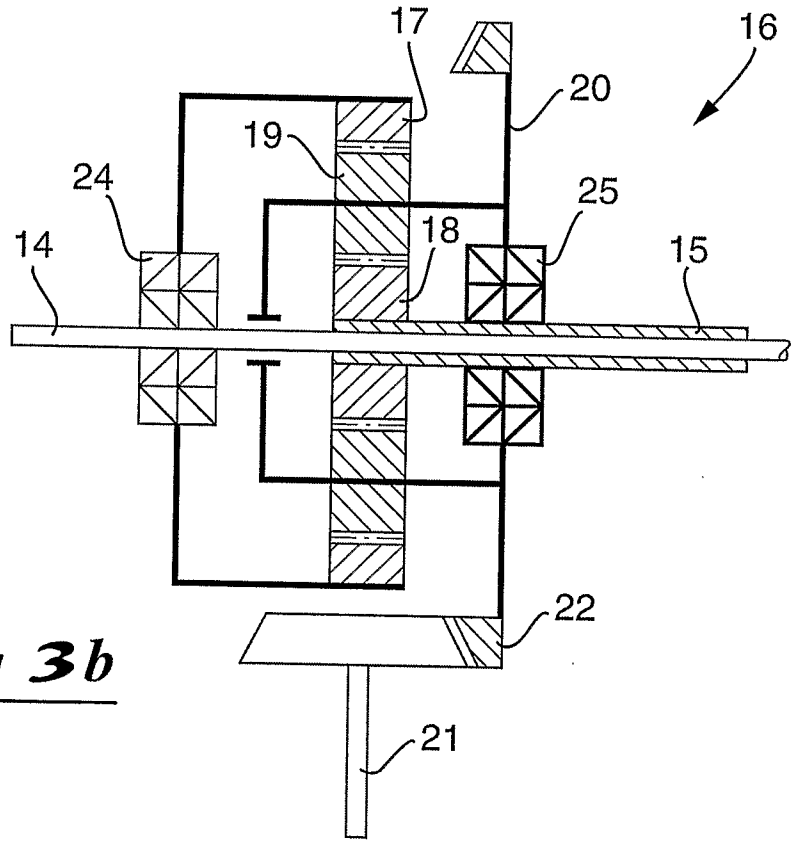

Fig 3b

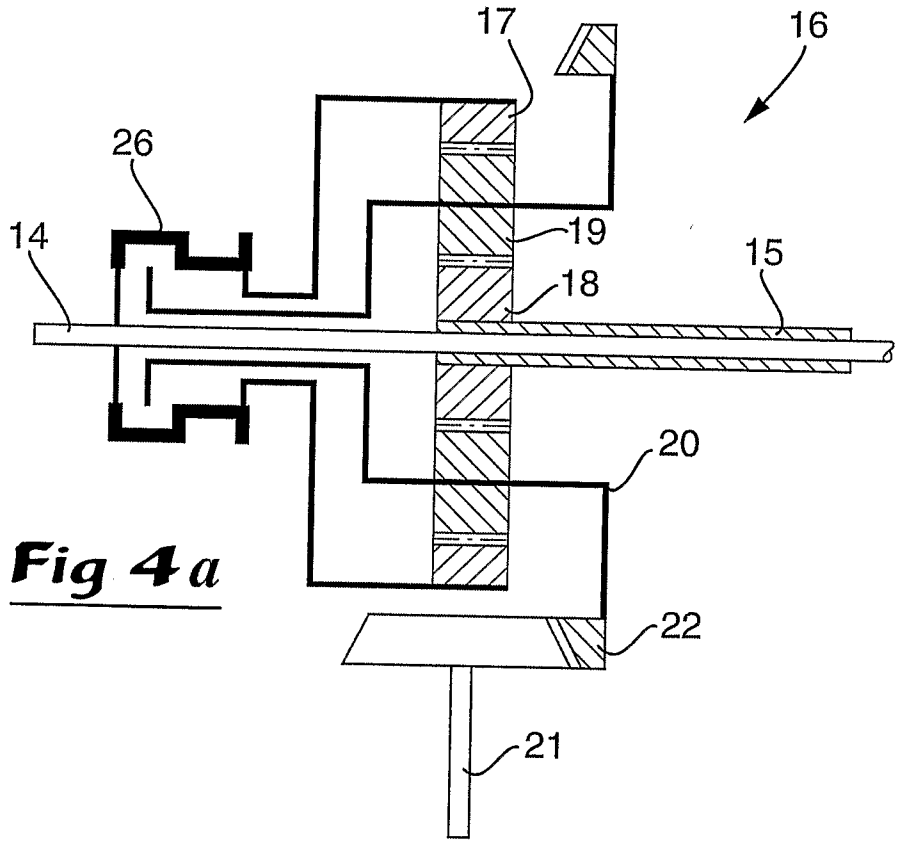

Fig 4a

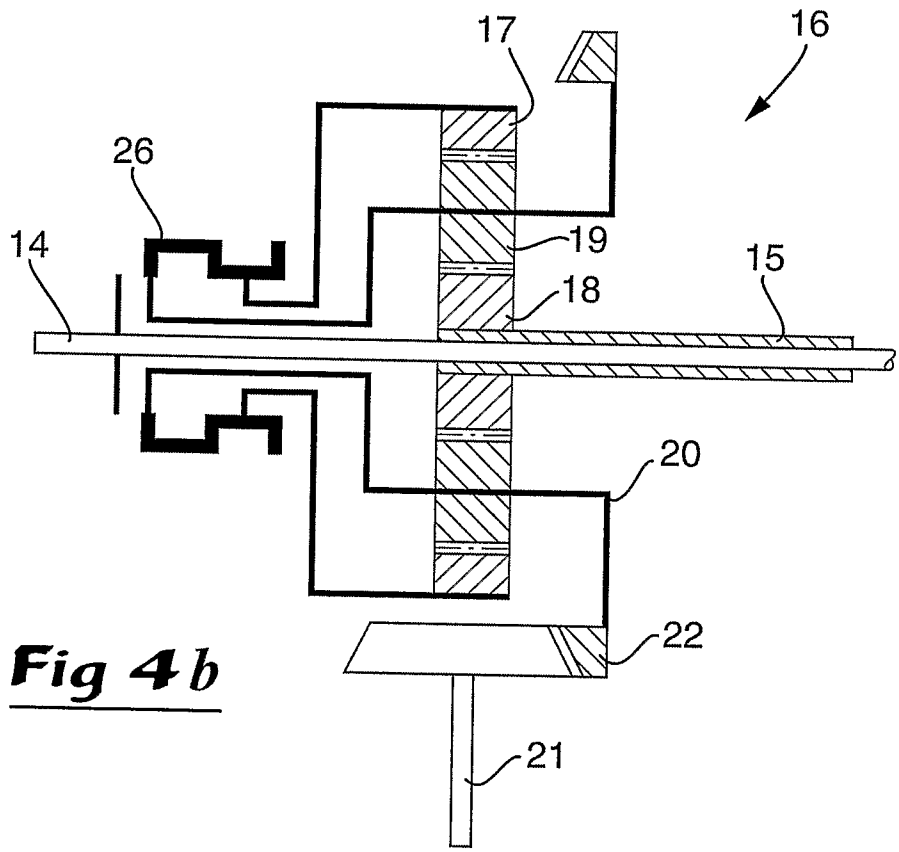

Fig 4b

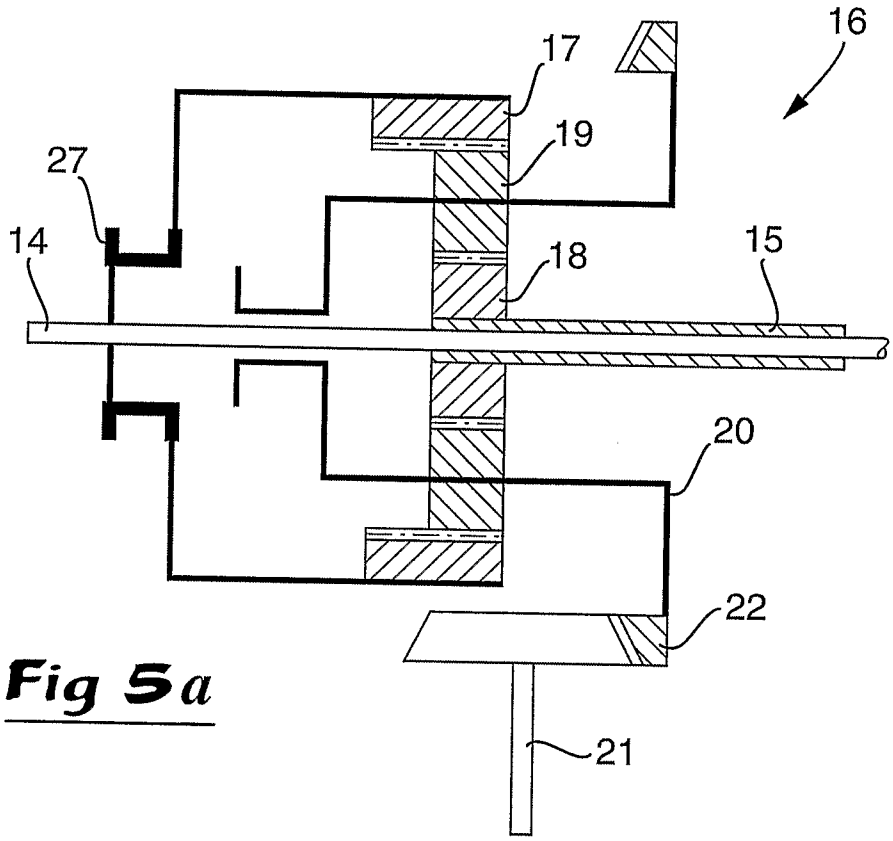

Fig 5a

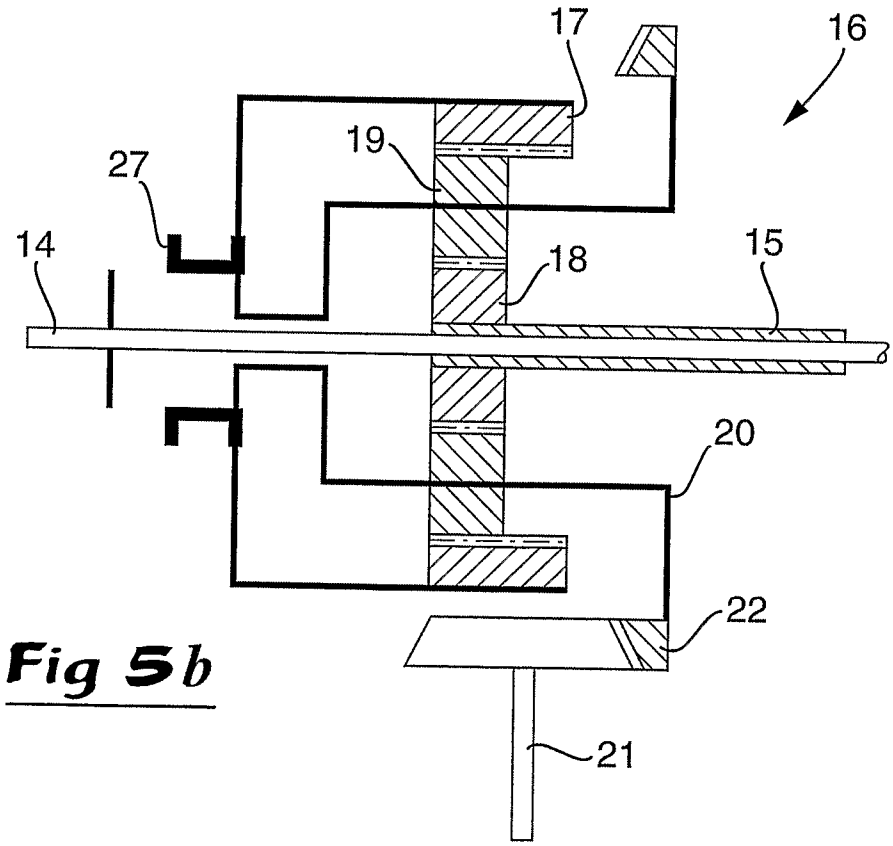

Fig 5b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2006/001165

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1519018 A1 (ROLLS ROYCE PLC), 30 March 2005 (30.03.2005), abstract ---	1-21
A	EP 0087302 A1 (A/S KONGSBERG VÄPENFABRIKK), 31 August 1983 (31.08.1983), abstract ---	1-21
A	GB 817591 A (C.A. PARSONS & COMPANY LIMITED), 6 August 1959 (06.08.1959), page 1, line 67 - page 2, line 65 ---	1-21
A	FR 1206492 A (BMW TRIEBWERKBAU), 10 February 1960 (10.02.1960), page 2 --- --------	1-21

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 May 2007	16 -05- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per-Olof Warnbo / JA A Telephone No. +46 8 782 25 00

International patent classification (IPC)

F02C 7/268 (2006.01)
F02C 3/107 (2006.01)
F02C 7/36 (2006.01)

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Cited literature, if any, will be enclosed in paper form.

EP	1519018	A1	30/03/2005	GB	0321952	D	00/00/0000
EP	0087302	A1	31/08/1983	JP	58185942	A	29/10/1983
GB	817591	A	06/08/1959	NONE			
FR	1206492	A	10/02/1960	DE	1049159	B	22/01/1959