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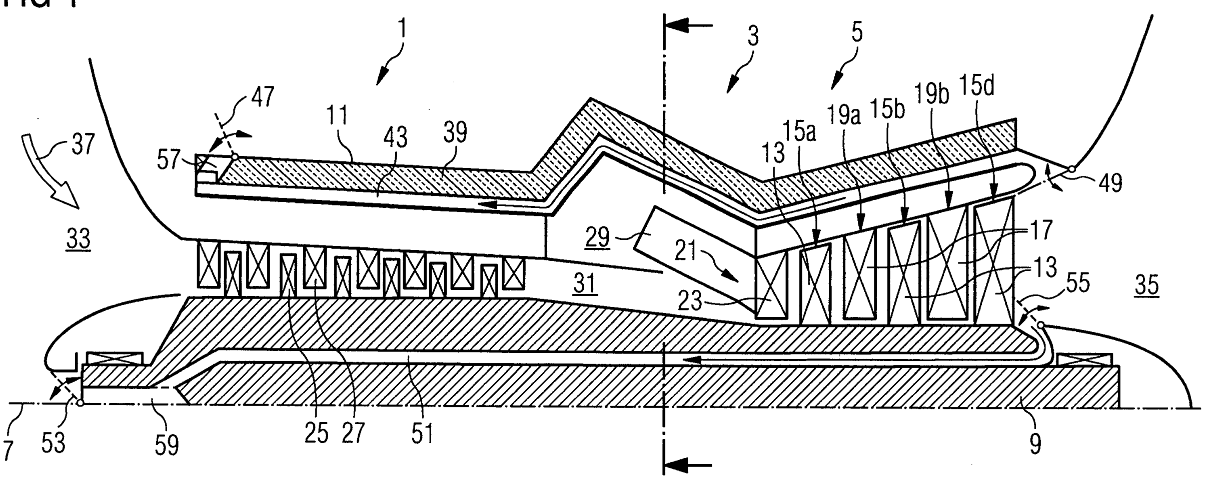
(54) **Turbine engine and method of operating the same**

(57) A turbine engine with a casing (11) and a rotor (9) extending through the casing (11) is provided. The casing (11) and/or the rotor (9) are/is equipped with fluid channels (43, 51). Moreover, at least one fluid introduction device (49, 55) is present which is designed and arranged such as to introduce a fluid into the fluid channels (43, 51) for flowing there through during a transient engine condition.

FIG 1



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Description

[0001] The present invention relates to a turbine engine, in particular to a gas turbine engine, comprising casing and a rotor extending through the casing and a method of operating such an engine.

[0002] The rotors of medium and large scale gas turbine engines require rotation after being in service for a considerable period of time in order to cool them to a point at which they will not adopt a permanent bend under the influence of gravity if stopped. The cooling of a gas turbine rotor may take several hours and during this period it is usual that the casing will also cool asymmetrically. This may cause contact problems between the rotor and the casing during the deceleration of the rotor damaging seals and, in extreme circumstances, generating enough asymmetric heating to bend and damage the rotor, if no counter measures are taken. The usual solution to this problem is to increase rotor-stator clearances. However, increased clearances also mean more leakage and an associated loss of efficiency in turbine operation.

[0003] For a considerable period of time the thermal transients in the rotor and the casing may make restarting the gas turbine impossible without causing damage and thus adversely impact the availability of the machine for service. This period tends to be a performance parameter of the machine associated with customer dissatisfaction and clearly requires energy for both rotation and maintenance of lubrication oil flows to the baring. Casing transients may be reduced by thinner insulation, but of course, this reduces the efficiency of the engine as the amount of heat which is lost through the casing will increase.

[0004] It is therefore an objective of the present invention to provide a turbine engine, which may in particular be a gas turbine engine, and a method of operating the same by which it becomes possible to reduce the above mentioned deficiencies. The objective is solved by a turbine engine, as claimed in claim 1, and by a method of operating a turbine engine, as claimed in claim 16. The depending claims define further developments of the invention.

[0005] An inventive turbine engine, which particularly may be a gas turbine engine, comprises a casing and a rotor extending through the casing. The casing and/or the rotor are/is equipped with fluid channels, e.g. gas channels. At least one fluid introduction device, e.g. a gas introduction device, is present which is designed and arranged such as to introduce fluid, e.g. gas, into the fluid channels for flowing there through during a transient engine condition, as e.g. start-up, shut-down, load changes, etc. In other words, the current invention proposes a means to deal with both casing and rotor transients by forced cooling/warming of the casing and/or the rotor which is activated when the engine is e.g. decelerated thereby obviating the disadvantages of current mitigation measures as mentioned above which are present during operation. This means, i.e. the fluid channels and the fluid introduction device, is located and designed such that the fluid introduced into the fluid channels reduces temperature differences around the periphery and between internal and external parts of casing and rotor. In the following, the term gas is used to represent all kinds of fluids.

[0006] Since a major factor in the speed of cooling the rotor is the long path from the bulk of the material concentrated near the axis and the flow path which is further isolated to reduce the in-service temperature of the rotor, the same approach as taken for the casing can be applied to the rotor, namely to open cooling channels at low turbine exhaust temperatures which are disposed close to the bulk of the rotor material. The same arguments as for the casing apply to normalisation of temperature differentials between the core and the periphery of the rotor, thus leading to similar operability improvements.

[0007] In an advantageous implementation of the inventive turbine engine, the gas channels which are sealed when the engine is in normal operation, i.e. operating not in a transient engine condition, act as convective cooling channels next to the structure of the engine when open. In this implementation the sealed gas channels form a thermal insulation of the casing. By forming these channels with small dimensions in the direction of gravity, vertical natural convection flows are suppressed when the channel ends are sealed and they act much like a gas blanket insulation. Additional turbulence generating features within the channels which are advantageous during the cooling operation, may serve to restrict any longitudinal natural convection when the ends are sealed. Further, if the surfaces of the channels are formed with a reflective layer they can act as radiation shields, further increasing the isolating effect when no fluid is flowing through them.

[0008] A turbine engine usually comprises an exhaust duct which is at least partially delimited by the casing and the rotor. In this case, the introduction device may be implemented as a flow redirector which is designed and arranged such as to redirect a fraction of the exhaust gas flowing through the exhaust duct into the gas channels during a transient engine condition. When the rotor is still being rotated to prevent damage after shut-down, this induces a flow of air through the gas channels. Since the air becomes partially heated by the residual energy extracted from the rotor redirecting the flow, e.g. by valves, from the turbine exhaust duct into the gas channels, at short times after shut-down, will firstly tend to cool the casing, but owing to the preheating of the "coolant" by the rotor over time, over longer periods it will stabilise the casing and the rotor towards equivalent temperatures thus reducing differential temperatures of casing and rotor which would give rise to relative movement and damage. Furthermore, by disposing the gas channels appropriately, asymmetric temperatures of the casing which would also give rise to damage can be avoided.

[0009] The valves which are located between the exhaust duct and the gas channels in the rotor and/or between the exhaust duct and the gas channels in the casing and which form the flow redirectors, may, e.g. be implemented by temperature-activated valves like bimetallic strips in the wall of the casing and/or in the wall of the rotor facing the exhaust duct. With such temperature-activated valves, the valves would be closed as long as a certain temperature value of the exhaust flow is exceeded. Such valves would react automatically to the operating temperature of the engine (which drops very sharply on shut-down) thus would automatically respond to the need for such cooling and thereby eliminate any control signal issues.

[0010] Since the rotor is drastically slower in barring mode than in operation, the centrifugally-activated valves could be used to open the rotor channels instead of the temperature-activated valves. As with the thermally-activated valves, the opening of the valve operates automatically when needed. Either type of valve on the rotor could be designed so as to take up an aerodynamic form which, when open pumps additional coolant gas through the channels. Like the valves on the rotor the valves on the casing could also be designed to take up an aerodynamic form when open.

[0011] For both casing and rotor, the fact that the fluid introduced into the channels is extracted from the filtered air supplied to the machine itself should ensure that the system is no more sensitive to blockage than any other mission-critical cooling flow path in the engine. Indeed, since the casing and the rotor flow passages are likely to be significantly larger than blading cooling passages, the reliability impact of this risk should be very small and more than offset by the reduced risk of power outage to the barring mode during current long cooling periods.

[0012] As an alternative to taking the temperature equalising fluid from the exhaust duct, implementations of introducing the fluid by fans would also be possible. Although schemes of casing cooling by fans are known, no such scheme is known to be used for reducing temperature transients in transient operation modes of the turbine engine. Although it is in principle possible to provide the equalising fluid by fans it is beneficial to use the air flowing through the exhaust duct, as mentioned above. This would be beneficial over providing the fluid by fans in that a failure of fan (or its control signal or its power supply), which could result in damage if the clearances and seals in the machine were set to rely on symmetric and/or rapid cooling, does not need to be taken into account. By using the flow induced by the rotor, the only possible failure element involved is the valves sealing or unsealing the insulation channels which can be engineered for much higher reliability than fans. It should be noted that if the rotor stops before thermal stabilisation is achieved, damage is inevitable with rotor induced flow as well as with fan induced flow. Since the proposed invention reduces the time during which the rotor has to be barred, risk exposure is reduced here as well. Additionally less energy would be consumed by the barring motor.

[0013] Instead of valves at the exits of the gas channels it would be possible that the gas channels in the rotor include an exit section which is u-bent with the curved part of the "u" showing radially outwards with respect to the rotational axis. Thus centrifugal forces lead to a density barrier within the u-bent section closing the exit of the gas channel.

[0014] The gas channels in the housing could include an exit section which is located at the bottom dead centre of the housing and extends below the lowest point of the channels. As the warm gas tends to ascend the exit section would be closed without the need of a valve.

[0015] In an inventive method of operating a turbine engine with a casing and a rotor extending through the casing and/or the rotor being equipped with gas channels, the temperatures of the casing and the rotor are equalised when the turbine engine is in a transient engine condition by introducing a thermally equalising gas into the gas channels in the casing and/or the gas channels in the rotor. By performing the inventive method during the shut-down phase and keeping casing and rotor in thermal synchronisation, the system will permit much shorter delays between shut-down and restart. It may be even possible that a "live restart" can take place before the rotor has decelerated to the barring speed or the engine has progressed a very long way down its cooling cycle. This would be a major shift in operability and availability for service, avoiding the need to waste fuel whilst sat idling in those applications where frequent fluctuations down to zero demand output are common. Even the expected reduction in barring time represents a significant improvement in engine availability and consumes less energy running the motor.

[0016] The method could also be designed to operate during the early start-up phase of the engine thus increasing the rate at which the engine can be accelerated after a restart. This is also clearly a further advantage for the customer and thus the competitiveness of the engine technology. The inventive method would bring both more rapid stabilisation of operating temperatures (which closes down clearances and increases efficiency) as well as controlling thermal growth overshoot allowing the fundamental clearances themselves to be set tighter with a continuous efficiency advantage in operation.

[0017] The thermally equalising gas may be the exhaust gas of the turbine engine which is redirected into the gas channels. By the expression exhaust gas the gas flowing through the exhaust duct is meant, even if no exhaust gas in the strict sense is produced during shut down mode as no combustion takes place in this mode. The exhaust gas is then unreacted air taken in into the turbine engine by the compressor. To redirect the exhaust gas into the gas channels during a transient engine condition valves could be used, as described above.

[0018] Further features, properties and advantages will become clear by the following description of an embodiment of the invention in conjunction with the accompanying drawings.

[0019] Figure 1 schematically shows an inventive gas turbine engine in a longitudinal section.

[0020] Figure 2 shows the engine of Figure 1 in a section perpendicular to the section shown in Figure 1.

[0021] Figure 3 schematically shows an alternative embodiment of the inventive gas turbine engine in a longitudinal section.

[0022] Figure 4 schematically shows a detail of Figure 3.

[0023] Figure 5 schematically shows another detail of Figure 3.

[0024] Figure 1 shows, as an embodiment of the invention, a gas turbine engine in a sectional view. A section of the engine along the line AA in Figure 1 is depicted in Figure 2.

[0025] The engine comprises a compressor section 1, a combustor section 3 and a turbine section 5 which are arranged adjacent to each other in a longitudinal axis of the engine. The engine further comprises a rotor 9 which is rotatable about a rotational axis 7 and which coincides with the longitudinal axis of the engine. A casing 11 surrounds the compressor section 1, the combustor section 3 and the turbine section 5.

[0026] In the turbine section 5, a number of turbine blades 13 fixed to the rotor 9 to rotate together with the rotor 9 are present. The turbine blades 13 are grouped to a number of blade rings. In the present embodiment, three blade rings 15a, 15b, 15d are present. Between each blade ring 15a, 15b, 15d turbine vanes 17, which are grouped to vane rings 19a, 19b are fixed to the casing 11 of the engine so as to be stationary with respect to the rotating rotor 9. At the entrance 21 of the turbine section 5 a ring of guide vanes 23 is fixed to the casing 11. Like the vanes 17, the guide vanes 23 are fixed to the casing 11 so as to be stationary with respect to the rotating rotor 9.

[0027] Similar to the turbine section 5, the compressor section 1 comprises a number of compressor blades 25 fixed to and rotating with the rotor 9 and a number of compressor vanes 27 fixed to the casing 11 so as to be stationary with respect to the rotating rotor 9. The compressor blades 25 and the compressor vanes 27 are grouped so as to form blade rings and vane rings, respectively.

[0028] The combustor section 3 comprises one or more combustion chambers 29 and at least one burner (not shown) fixed to each combustion chamber 29. The combustion chamber 29 is, on one side, in flow connection with the compressor through the compressor outlet 31 and, on the other side, in flow connection with the turbine section 5 through the turbine entrance 21.

[0029] The turbine engine further comprises an air intake section 33 leading to the compressor section 1 and an exhaust duct 35 following on the turbine section 5 for blowing out exhaust gases.

[0030] During operation of the gas turbine engine, air is taken in through the air inlet 33 into the compressor section 1. There the air is compressed and fed through the compressor outlet 31 to a combustor section 3. The temperature of the air 37 taken in increases during compression. After leaving the compressor outlet 31, at least part of the compressed air is fed to the burners where it is mixed with a fuel, for example gas or fuel oil, to produce a fuel air mixture. This mixture is then burned in the combustion chamber 29 and the exhaust gas formed by the combustion is led to the turbine entrance 21.

[0031] While being led through the turbine section, the exhaust gas expands and cools, thereby transferring momentum to the turbine blades 13 which results in the rotation of the rotor 9. The vanes 17 and 23 serve to optimise the impact of the exhaust gas on the turbine blades 13.

[0032] The casing 11 of the gas turbine engine comprises a casing insulation 39 with a number of longitudinal ripples 41, creating gas channels 43 between itself and an inner wall 45 provided by the outer surface of the casing 11. These ripples 41 can be conventionally formed or machined into the insulation 39 before assembly. Provided that adjacent sections of the insulation are assembled so that the gas channels 43 line up, there is no necessity for the insulation to be in a single longitudinal piece. Another alternative would be to machine or cast the gas channels 43 into the surface of the casing 11 before the insulation 39 is fixed thereto. A third alternative would be to have two layers of insulation, the first one formed of narrow strips with gaps between them next to the inner wall 45 covered by a continuous layer thus forming the gas channels 43 and the casing insulation 39. The gas channels 43 extend over the whole longitudinal dimension of the casing 11 so as to form continuous flow path from one end of the casing to the other. At both ends of the casing 11 one or more valves 47, 49 are present which allow for opening and sealingly closing the gas channels 43. When the valves 47, 49 are closed, the gas channels 43 are sealed so as to form a closed gas volume within the gas channels 43.

[0033] With the valves 47, 49 open, these channels form convective cooling channels next to the structure of the engine. When closed, the channels 43 are formed with small dimensions in the direction of gravity, so that vertical natural convection flows are suppressed within the sealed gas channels 43. It would also be possible to form turbulators, i.e. turbulence generating elements, in the gas channels 43 which would provide further resistance to the channel convection currents and enhance heat transfer when the gas channels are sealed and the machine is in normal operation mode. If the surfaces of the gas channels 43 are provided with a reflective layer, it would be possible to offset heat transfer loss due to thinner insulation at the location of a gas channel 43 since the gas channel 43 would act as a radiation shield.

[0034] Like the casing 11, the rotor 9 is provided with longitudinal gas channels 51, at least where the rotor 9 is surrounded by the compressor section 1, the combustor section 3 and the turbine section 5 of the engine. These gas channels 51 could be bored into a forging of a solid rotor or drilled into the discs of a bolted rotor. Alternatively, the central bores of a rotor 9 composed of disks could be formed in such a way as to leave channels between the discs and a centre-bolt or flow sleeve mounted axi-symmetrically down the centre of the rotor. The latter approach may be advantageous with respect to rotor stress levels.

[0035] At both ends of the gas channels 51 extending through the rotor 9 valves 53, 55 are located which allow for sealingly closing the channels 51. When sealed, the gas channels 51 in the rotor 9 would act as gas blankets in the same manner as the gas channels 43 of the casing 11. To achieve the gas blanket effect, the dimensions of the gas channels 51 in the rotor 9 are small enough in the direction of gravity so as to suppress vertical natural convection. Like in the gas channels 43 of the casing 11, additional turbulence generating features and/or reflecting layers could be present in the gas channels 51 of the rotor 9.

[0036] The valves 47, 49, 53, 55, are self-acting based on centrifugal or thermal principles. While the valves 47, 49 at the casing are temperature driven the valves 53, 55 at the rotor 9 are driven by the centrifugal force acting on them when the rotor 9 is rotating.

[0037] The valves 47, 47 at the casing are implemented as bimetallic elements which are exposed to the gases flowing through the turbine exhaust duct 35 and to the gas inside the gas channels. When the engine is shut down the operating temperature of the engine drops very sharply. As a consequence, the temperature of the gases in the exhaust duct 35 and in the gas channels 43 decreases and the bimetallic elements open due to the decrease of the temperature. With the valves 47, 49 open, the gas flowing through the exhaust duct 35 is partly introduced into the gas channels 43 and flows there through. In order to assist leading the gases into the gas channel 43, the bimetallic elements are designed such as to take up an aerodynamic form when open. Note, that after shut-down, the gases flowing through the exhaust duct are no longer the exhaust gases of the combustion but only air which is heated by the residual heat in the engine.

[0038] The bimetallic elements can easily be implemented such that they are open after fuel shut-down and closed before fuel shut-down.

[0039] The centrifugally activated valves 53, 55 of the rotor 9 are implemented such that they close when the rotation speed of the rotor 9 is above a given level and open when the rotational speed of the rotor 9 is below this given level. Thus, upon a deceleration of the machine these valves will open due to the decrease of rotation speed of the rotor 9. The valves 55 disposed in the exhaust duct 35 of the engine will thus open and lead gas from the exhaust duct partially into the gas channels 51. To enhance the ability to pump gas into the gas channels 51 of the rotor 9, the valves 55 have, in the present embodiment, an aerodynamic form when open.

[0040] Leading the exhaust gas through the gas channels 43, 51 at short times after shut-down, will at first tend to cool the casing, but owing to the preheating by the contact with the rotor over time, over longer periods the exhaust gas led through the gas channels 43, 51 will stabilise the casing 11 and the rotor 9 towards equivalent temperatures. As a consequence, differtial temperatures of the casing 11 and the rotor 9 which could give rise to relative movement and damage can be reduced. Furthermore, by disposing the gas channels 43 appropriately, asymmetric temperature distributions of the casing 11 which could also give rise to damage can be avoided.

[0041] All gas channels 43 in the casing 11 lead to a common exit section 57 which is open towards the outside of the casing 11 and leads the gas flowing through the gas channels 43 to the environment. A temperature driven valve 47 is located at the exit of the exit section 57. In contrast to the exit section 57 shown in Figures 1 and 2, the exit section could also be placed at the bottom dead centre of the engine, and extend below the lowest point of the gas channels 43. By this implementation it may be possible to eliminate the need for any closure at the exit section (apart from the need for a filter to prevent the ingression of foreign bodies) and thus the valve 47. Closing of the gas channels at the outlet end would then be achieved by a density barrier caused by warm gas ascending in the exit section. As eliminating the need for a valve 47 allows the elimination of a movable part, the reliability of the construction can be increased.

[0042] Although a valve 53 is present at an exit section 59 of the gas channels 51 in the rotor 9 this valve 53 can be eliminated by giving the exit section 59 a suitable form. For example, if the exit section would be "U-bent" with the arcuate part of the "U" showing radially outwards, the centrifugal force imposed by the rotor 9 before shut-down would provide a density barrier to the flow of the gases within the gas channels 51. Thus in a usual operation mode, the exit section 59 would be sealed without the need for a valve. The density barrier decreases when the rotation of the rotor 9 slows down after shut-down. The gases pumped into the gas channels 51 through the now open valves 55 in the exhaust duct 35 are then strong enough to overcome any remaining density barrier so that a continuous flow through the gas channel 51 becomes possible. Like in the case of the casing's exit section 57 a filter at the exit section 59 would be useful to prevent the ingression of foreign bodies.

[0043] The admission of moving air from the exhaust duct 35 into the gas channels 43 of the casing 11 and the gas channels 51 of the rotor is driven by the motion of the rotor during deceleration after shut-down. Thus, an additional drive for admitting gas into the gas channels 43, 51 is not necessary. However, it would also be possible to implement the invention with inlet openings open towards the environment and with fans or other pumping means to supply air for equalising the temperatures of the rotor and the casing. However, this would obviously sacrifice some of the reliability advantages which can be gained when the rotor itself is used for driving the admittance of the gas to the gas channels as the additional pumping means could, in principle, be the source of system failures.

[0044] Admitting gas into the gas channels 43, 51 can, in addition to shut-down, also be used during the early start-up phase of the engine. In this case, the already hot exhaust gases would be led into the gas channels 43, 51 in order to bring the casing 11 and the rotor 9 more rapidly to their operation temperatures. This could increase the rate at which the engine can be accelerated after a restart.

[0045] As described above, the present invention proposes means to deal with both casing and rotor transients by forced cooling and heating which is only activated when the engine is in a transition mode of operation, in particular during start up and shut down, thereby reducing the time which is needed to accelerate or decelerate the engine.

[0046] An alternative embodiment of the inventive gas turbine engine is shown in Fig. 3 in a longitudinal section. All features of the alternative embodiment which correspond to features of the gas turbine engine shown in Fig. 1 are designated with the same reference numerals as in Fig. 1 and will not be described again. The gas turbine engine according to the alternative embodiment differs from the gas turbine engine shown in Fig. 1 in the location of the gas redirector valves 149, 155. They are located in the plenum chamber 130 of the gas turbine engine rather than in the exhaust duct (not shown in Fig. 3).

[0047] The valves 149, one of which is schematically shown in detail in Fig. 4, are temperature activated valves located at the inner wall 45 of the casing 11. When open, the valves 149 allow air from the plenum chamber 130 to enter the gas channels 43 of the casing 11.

[0048] The valves 149 comprise a seat 150 and a disk 151 which can be brought into contact the seat 150 by a temperature driven actuator 152 to form a seal. The temperature driven actuator 152 is chosen such that it is only strong enough to open the valve 149 when the pressure in the plenum chamber 130 is below a certain pressure level. In operation of the gas turbine engine, the pressure level in the plenum chamber 130 is so high that the temperature driven actuator 152 can not open the valve 149. However, when the gas turbine engine runs at low speed so that the compression in the compressor is low the pressure level in the plenum chamber 130 is low enough so that the actuator 152 can open the valve 149, and hence compressed air from the plenum chamber 130 can enter the gas channel 43.

[0049] The valves 155, one of which is schematically shown in detail in Fig. 5, are located in the rotor 9. When open, the valves 155 allow air from the plenum chamber 130 to enter the gas channels 51 of the rotor 9.

[0050] The valves 155 comprise a seat 156 and a disk 157 which can be brought into contact the seat 156 by centrifugal force of the rotating rotor 9 to form a seal. Pretensioned resilient elements, e.g. springs 158, tend to remove the disc 157 from the seat 156 with a predetermined spring force. Although tension springs are shown in Fig. 5 suitably located pressure springs could be used as well. The spring force is chosen such that the valve can, together with the force provided by the pressure in the plenum chamber 130, withstand a certain level of centrifugal force acting on the disc 157 so as to keep the valve 155 open. This level of centrifugal force corresponds to a certain rotational speed of the rotor 9.

[0051] In operation of the gas turbine engine, the rotational speed of the rotor 9 is so high that the disc 157 is pressed into the seat 156 against the spring force and the force provided by the pressure level in the plenum chamber 130. However, when the gas turbine engine runs at low speed so that the centrifugal force acting on the disc 157 is low the spring force and the force provided by the pressure level in the plenum chamber 130 are high enough to open the valve 155, and hence compressed air from the plenum chamber 130 can enter the gas channel 51.

[0052] Although resilient elements are used to actuate the valves 155 in the rotor 9 temperature activated valves could be used as well. In this case, the temperature driven actuator would replace the resilient element. The temperature driven actuator would be chosen such that it is only strong enough to overcome, together with the force provided by the pressure level in the plenum chamber 130, the centrifugal force up to a certain rotational speed of the rotor 9. Hence, the valve 155 would be closed when the rotor 9 runs at high speed and would open when the rotor 9 runs at low speed, i.e. the centrifugal force acting on the disc 157 is low.

[0053] It should be mentioned that the invention does not necessarily require that both the rotor and the casing are simultaneously cooled or heated. For example, if the casing cools down faster than the rotor when the rotor decelerates it may be useful to cool the rotor and to heat or isolate the casing in order to equalise their temperatures during a cooling down cycle.

Claims

1. A turbine engine comprising a casing (11) and a rotor (9) extending through the casing (11), wherein the casing (11) and/or the rotor (9) are/is equipped with fluid channels (43, 51) and wherein at least one fluid introduction device (49, 55, 149, 155) is present which is designed and arranged such as to introduce a fluid into the fluid channels (43, 51) for flowing there through during a transient engine condition.

2. The turbine engine, as claimed in claim 1, in which the fluid channels (43, 51) and the fluid introduction device (49, 55, 149, 155) are located and designed such that the fluid introduced into the fluid channels (43, 51) reduces temperature differences around the periphery and between internal and external parts of casing (11) and rotor (9).

3. The turbine engine, as claimed in claim 1 or 2, in which the fluid channels (43, 51) are sealed when the engine is not operating in a transient engine condition.

4. The turbine engine, as claimed in claim 1, claim 2 or claim 3, in which an exhaust duct (35) is at least partially delimited by the casing (11) and the rotor (9) and in which the introduction device is implemented as a flow redirector (49, 55) which is designed and arranged such as to redirect a fraction of the exhaust gas flowing through the exhaust duct (35) into the fluid channels (43, 51) during a transient engine condition.

5. The turbine engine, as claimed in claim 4, wherein valves (49, 55) are located between the exhaust duct (35) and the fluid channels (51) in the rotor (9) and/or between the exhaust duct (35) and the fluid channels in the casing (11) as flow redirectors.

6. The turbine engine, as claimed in claim 5, in which the valves are implemented by temperature-activated valves (49) in the wall of the casing (11) and/or in the wall of the rotor (9) which face the exhaust duct.

7. The turbine engine, as claimed in claim 5 or claim 6, in which the valves (55) in the wall of the rotor (9) are implemented as centrifugally activated valves.

8. The turbine engine as claimed in any of the claims 5 to 7, in which the valves (49, 55) are designed such as to have an aerodynamic form enhancing the flow through the fluid channels (43, 51) when open.

9. The turbine engine, as claimed in claim 1 or 2, in which an external fluid source is present providing a fluid which can be introduced into the fluid channels (43, 51) by the fluid introduction device.

10. The turbine engine, as claimed in claim 1 or 2, in which the introduction device is implemented as a flow redirector (149, 155) which is arranged in the plenum chamber (130) of the gas turbine engine.

11. The turbine engine, as claimed in any of the preceding claims, in which the fluid channels (43, 55) have small dimensions in the direction of gravity.

12. The turbine engine as claimed in any of the preceding claims, in which turbulence generating elements are present within the fluid channels (43, 51).

13. The turbine engine as claimed in any of the preceding claims, in which the fluid channels (43, 51) are provided with a reflective layer.

14. The turbine engine as claimed in any of the preceding claims, in which the fluid channels (51) in the rotor (9) include an exit section (59) which is U-bent with the curved part of the U showing radial outwards.

15. The turbine engine as claimed in any of the preceding claims, in which the fluid channels (43) in the housing include an exit section (57) which is located at the bottom dead centre of the casing (11) and extends below the lowest point of the fluid channels (43).

16. A method of operating a turbine engine comprising a casing (11) and a rotor (9) extending through the casing (11) the casing (11) and/or the rotor (9) are/is being equipped with fluid channels (43, 51), in which the temperatures of the casing (11) and the rotor (9) are equalised when the turbine engine is in a transient engine condition by introducing a thermally equalising fluid into the fluid channels (43) in the casing (11) and/or the fluid channels (51) in the rotor (9).

17. The method as claimed in claim 16, in which exhaust gas of the turbine engine is redirected into the fluid channels (43, 51) as the thermally equalising fluid.

18. The method as claimed in claim 17, in which valves (49, 55) are used to redirect the gas into the fluid channels (43, 51) during a transient engine condition.

19. The method as claimed in claim 16, in which a fluid from an external source is introduced into the fluid channels as the thermally equalising fluid.

20. The method as claimed in claim 16, in which compressed air is redirected from the plenum chamber (130) of the gas turbine engine into the fluid channels (43, 51) as the thermally equalising fluid.

FIG 1

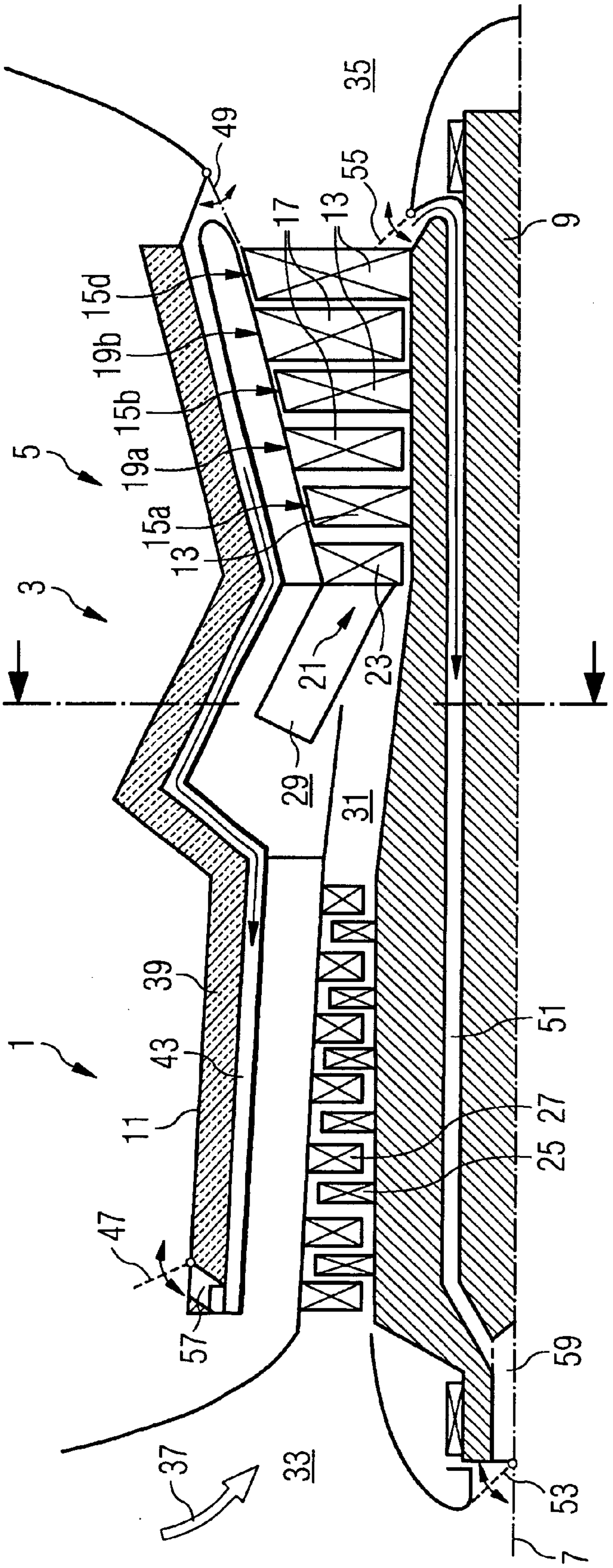
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FIG 2

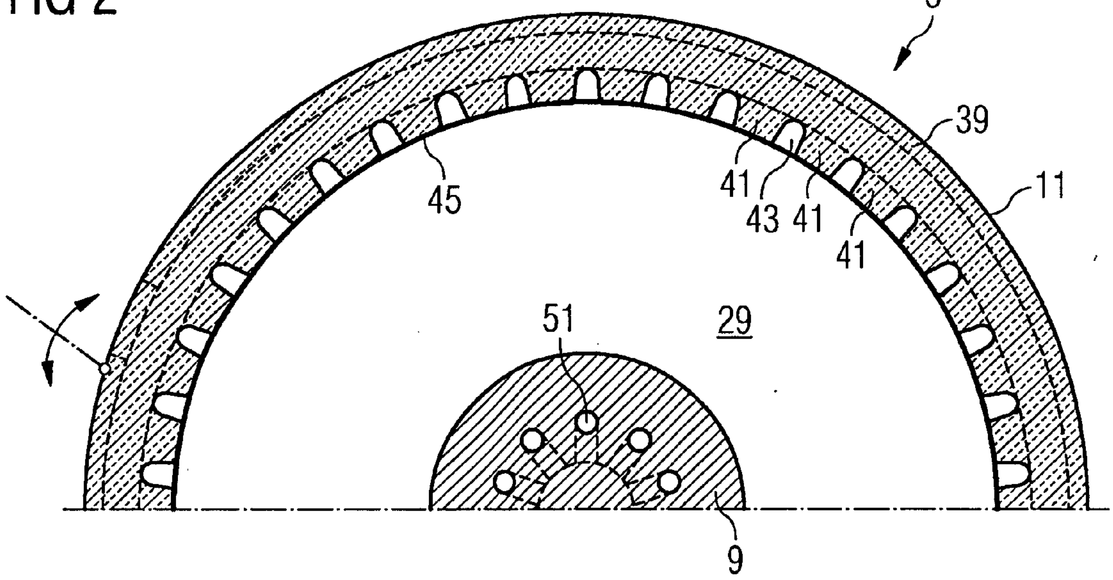
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FIG 3

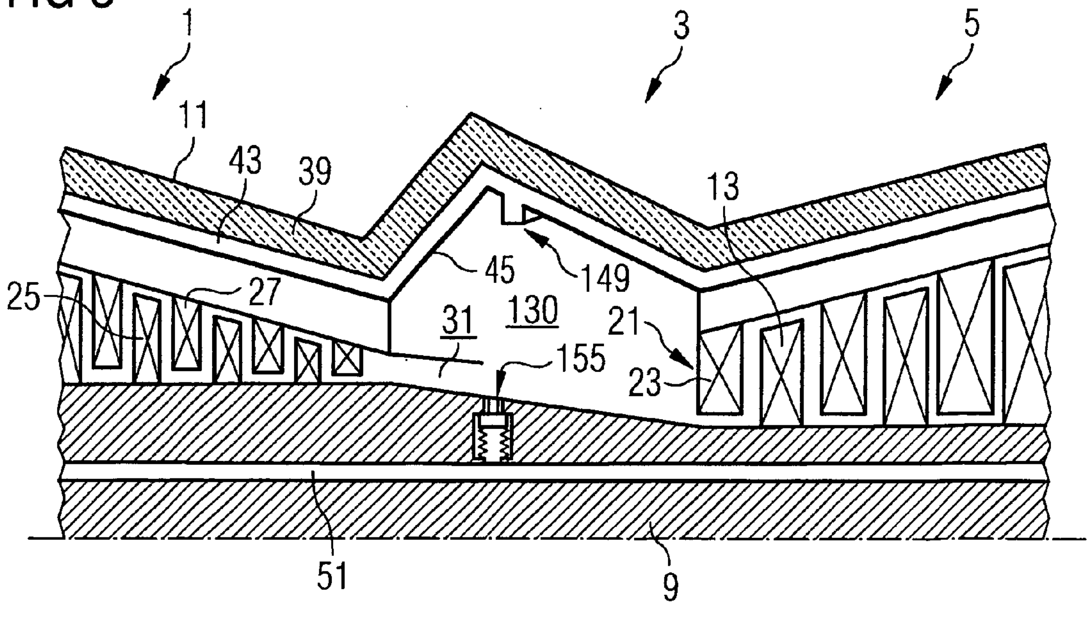
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FIG 4

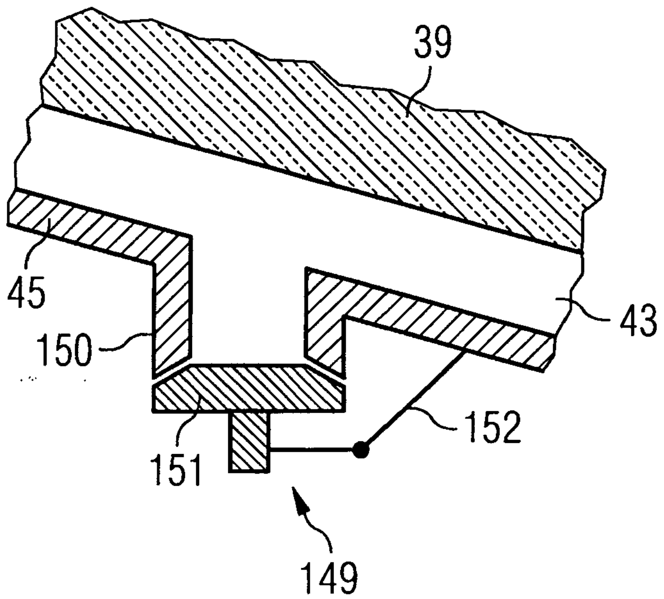
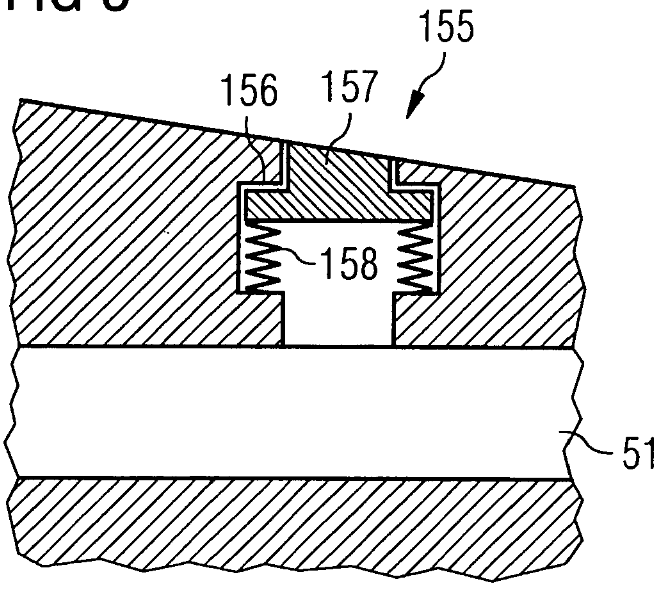


FIG 5



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EUROPEAN SEARCH REPORT

Application Number
EP 06 01 8487

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 February 2007	CHATZIAPOSTOLOU, A

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