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(54) **Method and apparatus for sensing integrity degradation in turbine engine components**

Verfahren und Vorrichtung zum Nachweis von Schäden an Turbinentriebwerkskomponenten

Méthode et appareil pour la détection des dommages aux composants de moteur à turbine

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EP 1 746 262 B1

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Description

FIELD OF USE

[0001] This invention relates to a method and apparatus for sensing integrity degradation in turbine engine components.

BACKGROUND OF THE INVENTION

[0002] Presently, existing methods to detect and/or measure integrity degradation in blades and vanes of turbine engines do not effectively gauge the extent of or potential formation of integrity degradation, that is, a crack, without manually and/or visually inspecting the blades and vanes. One present method for detecting integrity degradation in a blade is limited to helicopters and their respective blades. Such methods concerning integrity degradation detection and their related apparatus, which all pertain to helicopter blades, are described in United States Patent Nos. 3,985,318; 4,026,660; 4,106,332; 4,345,237; 4,524,620; and, 4,727,251.

[0003] However, one skilled in the art of turbine engines recognizes that helicopter blades are very long and slender as compared to typical aircraft blades and are subject to severe stress from flexing, bending, twisting, etc, which are different than stress experienced by turbine engine blades and vanes. Thus, the information contained in the aforementioned patents is useful for what is taught, but such information is not readily adaptable to the challenges and obstacles experienced when attempting to detect the extent of or potential formation of integrity degradation of turbine engine blades and vanes without manually and/or visually inspecting the turbine engine blades and vanes.

[0004] Consequently, there exists a need for a method and apparatus for detecting integrity degradation in turbine engine blades and vanes without manually and/or visually inspecting the blades and vanes.

[0005] Prior art detection methods are disclosed in US-3795147, US-3691820 and GB-2376744.

SUMMARY OF THE INVENTION

[0006] According to the present invention, there is provided a method as claimed in claim 1 and an apparatus as claimed in claim 4.

[0007] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a representation of a cross-sectional view of a turbine engine compartment indicating a potential disposition of the sensor signal collection device with respect to the oxygen detection sensor;

FIG. 2 is a representation of a cross-sectional view of a turbine engine blade tip fitted with an oxygen detection sensor exposed to a series of hollow cavities within the blade;

FIG. 3 is a representation of a cross-sectional view of a turbine engine blade fitted with several oxygen detection sensors in a root section that are exposed to a series of hollow cavities within the blade;

FIG. 4 is a representation of a section A-A of FIG. 3 depicting an alternative embodiment where oxygen detection sensors are disposed within each cavity formed by internal ribs of the turbine engine blade; and

FIG. 5 is a representation of another alternative embodiment of FIG. 3 where oxygen detection sensors are disposed within channels formed within the cavity in the root section of the turbine engine blade.

[0009] Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0010] The method(s) and apparatus for detecting integrity degradation in a turbine engine component described herein utilize an oxygen sensor, disposed within a hollow cavity containing a first fluid within the turbine engine component and a sensor signal collection device. The combination of the oxygen detection sensor and sensor signal collection device provides at a minimum the following functions:

(a) the detection of a fluid at some minimum concentration foreign to the fluid originally sealed within the turbine engine component after manufacture;
(b) a self-powered attribute such that the oxygen detection sensor does not require wire connections or slip rings;
(c) a self-test attribute that verifies the oxygen detection sensor is operational whether or not the turbine engine is in service; and
(d) wireless signal transmission attributes for both the oxygen detection sensor and the sensor signal collection device.

[0011] Referring now to FIG. 1, a representative turbine engine compartment housing a turbine engine and various turbine engine components for purposes of describing the methods and apparatus of the present invention is shown. A turbine engine component is shown which may comprise a blade, a vane or any other turbine

engine component that may experience integrity degradation. For purposes of the present application, integrity degradation generally means any degradation experienced by the structure of a turbine engine component that may allow the introduction of, in part or in whole, oxygen into a hollow cavity of the turbine engine component and force the evacuation of a first fluid from the hollow cavity, even if the first fluid constitutes a vacuum.

[0012] Referring generally now to FIGS. 2-5, a turbine engine blade 10 may comprise one or more hollow cavities 12, for example, multiple hollow cavities or a single hollow cavity divided by one or more internal integral geometry and the like, having one or more first channels 14 that expose a first fluid sealed within cavities 12 to one or more oxygen detection sensors 16. When blade 10 experiences integrity degradation, the first fluid evacuates and oxygen fills the void within cavities 12 created by the absence of the first fluid. At that time, oxygen detection sensor 16 detects the presence of the oxygen within cavities 12. The presence of the oxygen may be detected once an amount of oxygen sufficient to be detected by oxygen detection sensor 16 enters cavities 12. Oxygen detection sensor 16 is disposed within cavities 12 and the fluid(s) contained or introduced therein. Oxygen detection sensor 16 then transmits a signal to a sensor signal collection device 18 which processes the signal and transmits the data to another device or an interested party capable of receiving such data.

[0013] Oxygen detection sensor 16 may comprise a power source (not shown), means for self-testing (not shown) and means for wirelessly transmitting a signal (not shown). The power source may constitute a galvanic power source, for example, a galvanic battery commonly used for hearing aid devices. The means for self-testing may comprise a self-test electronic mechanism capable of registering, for example, chronologically, when oxygen was ever detected whether or not the sensor 16, or even the turbine engine, was in use at the time. The means for wirelessly transmitting a signal may comprise any wireless technology capable of sending a signal containing the data collected by the sensor 16 to another device or interested party capable of receiving such data. In the alternative, sensor 16 may comprise a galvanic sensor or a zirconium based sensor, each further comprising means for self-testing and means for wirelessly transmitting a signal. As known to one of ordinary skill in the art, galvanic sensors generate electrical energy translated from chemical energy derived from a chemical reaction ignited by the presence of a sufficient amount of oxygen. The electrical energy generated is sufficient to self power the galvanic sensor, generate signals and transmit data. And, as known to one of ordinary skill in the art, zirconium sensors generally require a continuous power source capable of generating about 2 watts of power. The continuous power supply may comprise triggered electrical induction, harvested microwave energy, or harvested laser light from a transmitter mounted on a static structure within the turbine engine housing.

[0014] Sensor signal collection device 18 comprises a means for receiving signals from second fluid detection sensor 16 and a means for transmitting a signal which notifies an interested party that the turbine engine component is experiencing integrity degradation. Means for receiving signals from oxygen detection sensor 16 may comprise a receiver (not shown) coupled to a signal processor (not shown), if necessary, to process the signal into a desired format for communicating the data from oxygen detection sensor 16. Means for transmitting a signal of device 18 may comprise any transmission technology capable of sending data to another device or interested party capable of receiving such data. Preferably, sensor signal collection device 18 is mounted to a stationary object, part and the like within the turbine engine housing or turbine engine itself.

[0015] The first fluid may comprise any fluid free of oxygen. And, the first fluid may comprise a noble gas such as argon. Once oxygen detection sensor 16 detects the presence of oxygen within cavities 12, sensor 16 transmits a signal to a sensor signal collection device 18 disposed proximate to blade 10 and in communication with sensor 16.

[0016] It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible to modification of form, size, arrangement of parts, and details of operation. The invention rather is intended to encompass all such modifications which are within its scope as defined by the claims.

Claims

1. A method for detecting integrity degradation of a turbine engine component (10), comprising:

   detecting oxygen in a hollow cavity (12) of a turbine engine component using an oxygen detection sensor (16) disposed within said cavity (12);
   wirelessly transmitting a signal confirming detection of oxygen from said sensor (16) to a sensor signal collection device (18) comprising means for receiving and processing a signal from said sensor;
   processing said signal within said sensor signal collection device (18);
   transmitting the processed signal from said sensor signal collection device (18) to provide notification that said turbine engine component (10) has experienced integrity degradation; and
   self-testing the oxygen detection sensor (16) to verify whether the oxygen detection sensor (16) is operational.

2. The method of claim 1, wherein said detection of oxygen comprises evacuating a noble gas within

said cavity (12) through the introduction of an amount of oxygen.

3. The method of claim 2, wherein said noble gas is argon.

4. An apparatus for the detection of integrity degradation in a turbine engine component (10), comprising:

an oxygen detection sensor (16) disposed within a hollow cavity (12) of a turbine engine component; and
a sensor signal collection device (18) in communication with said oxygen detection sensor (16) and disposed proximate to said turbine engine component, wherein said sensor signal collection device (18) comprises means for receiving and processing signals confirming detection of oxygen from said oxygen detection sensor (16) and means for transmitting a processed signal which provides notification that said turbine engine component (10) has experienced integrity degradation and wherein said oxygen detection sensor (16) comprises means for wirelessly transmitting a signal to said sensor collection device (18) and any one of the following:

a power source and means for self-testing;
a galvanic sensor comprising means for self-testing; and
a zirconium based sensor comprising means for self-testing.

5. The apparatus of claim 4, wherein said turbine engine component is a blade or a vane.

Patentansprüche

1. Verfahren zum Erfassen einer Integritätsverschlechterung einer Turbinentriebwerkskomponente (10), das Folgendes umfasst:

Erfassen von Sauerstoff in einem Hohlraum (12) einer Turbinentriebwerkskomponente unter Verwendung eines Sauerstofferfassungssensors (16), der im Inneren des Hohlraums (12) angeordnet ist;
drahtloses Übermitteln eines Signals, das die Erfassung von Sauerstoff durch den Sensor (16) bestätigt, an eine Sensorsignalerfassungssammeleinrichtung (18), die Mittel zum Empfangen und Verarbeiten eines Signals vom Sensor umfasst;
Verarbeiten des Signals innerhalb der Sensorsignalerfassungssammeleinrichtung (18);
Übermitteln des verarbeiteten Signals von der Sensorsignalsammeleinrichtung (18), um zu melden, dass die Turbinentriebwerkskomponente (10) eine Integritätsverschlechterung erfahren hat; und
Selbsttesten des Sauerstofferfassungssensors (16), um zu prüfen, ob der Sauerstofferfassungssensor (16) funktionsfähig ist.

2. Verfahren nach Anspruch 1, wobei die Erfassung von Sauerstoff eine Entleerung eines Edelgases im Inneren des Hohlraums (12) durch die Einleitung einer Sauerstoffmenge umfasst.

3. Verfahren nach Anspruch 2, wobei das Edelgas Argon ist.

4. Vorrichtung zur Erfassung einer Integritätsverschlechterung in einer Turbinentriebwerkskomponente (10), die Folgendes umfasst:

einen Sauerstofferfassungssensor (16), der im Inneren eines Hohlraums (12) einer Turbinentriebwerkskomponente angeordnet ist; und
eine Sensorsignalerfassungssammeleinrichtung (18), die in Kommunikation mit dem Sauerstofferfassungssensor (16) und in der Nähe der Turbinentriebwerkskomponente angeordnet ist, wobei die Sensorsignalerfassungssammeleinrichtung (18) Mittel zum Empfangen und Verarbeiten von Signalen vom Sauerstofferfassungssensor (16), die eine Erfassung von Sauerstoff bestätigen, und Mittel zum Übermitteln eines verarbeiteten Signals umfasst, die melden, dass die Turbinentriebwerkskomponente (10) eine Integritätsverschlechterung erfahren hat, und wobei der Sauerstofferfassungssensor (16) Mittel zu einem drahtlosen Übermitteln eines Signals an die Sensorsignalerfassungssammeleinrichtung (18) und eines von Folgenden umfasst:
eine Energiequelle und Mittel zum Selbsttesten;
einen galvanischen Sensor, der Mittel zum Selbsttesten umfasst; und
einen Sensor auf Zirkonbasis, der Mittel zum Selbsttesten umfasst.

5. Vorrichtung nach Anspruch 4, wobei die Turbinentriebwerkskomponente eine Schaufel oder ein Flügel ist.

Revendications

1. Procédé de détection de la dégradation de l'intégrité d'un composant de moteur à turbine (10), comprenant :

la détection de l'oxygène dans une cavité creuse (12) d'un composant de moteur à turbine en uti-

lisant un capteur de détection d'oxygène (16) agencé dans ladite cavité (12) ;
la transmission sans fil d'un signal confirmant la détection de l'oxygène dudit capteur (16) à un dispositif de collecte de signal de capteur (18) comprenant des moyens de réception et de traitement d'un signal dudit capteur ;
le traitement dudit signal dans ledit dispositif de collecte de signal de capteur (18) ;
la transmission du signal traité dudit dispositif de collecte de signal de capteur (18) pour fournir une notification que ledit composant de moteur à turbine (10) a subi une dégradation de l'intégrité ; et
l'autotest du capteur de détection d'oxygène (16) pour vérifier si le capteur de détection d'oxygène (16) est opérationnel.

2. Procédé selon la revendication 1, dans lequel ladite détection d'oxygène comprend l'évacuation d'un gaz rare dans ladite cavité (12) par l'introduction d'une quantité d'oxygène.

3. Procédé selon la revendication 2, dans lequel ledit gaz rare est de l'argon.

4. Appareil pour la détection de la dégradation de l'intégrité dans un composant de moteur à turbine (10), comprenant :

un capteur de détection d'oxygène (16) agencé dans une cavité creuse (12) d'un composant de moteur à turbine ; et
un dispositif de collecte de signal de capteur (18) en communication avec ledit capteur de détection d'oxygène (16) et agencé à proximité dudit composant de moteur à turbine, dans lequel ledit dispositif de collecte de signal de capteur (18) comprend des moyens de réception et de traitement de signaux confirmant la détection d'oxygène par ledit capteur de détection d'oxygène (16) et des moyens de transmission d'un signal traité qui fournit une notification que ledit composant de moteur à turbine (10) a subi une dégradation de l'intégrité et dans lequel ledit capteur de détection d'oxygène (16) comprend des moyens pour la transmission sans fil d'un signal audit dispositif de collecte de capteur (18) et l'un quelconque des éléments suivants :

une source d'alimentation et des moyens d'autotest ;
un capteur galvanique comprenant des moyens d'autotest ; et
un capteur à base de zirconium comprenant des moyens d'autotest.

5. Appareil selon la revendication 4, dans lequel ledit composant de moteur à turbine est une ailette ou une aube.

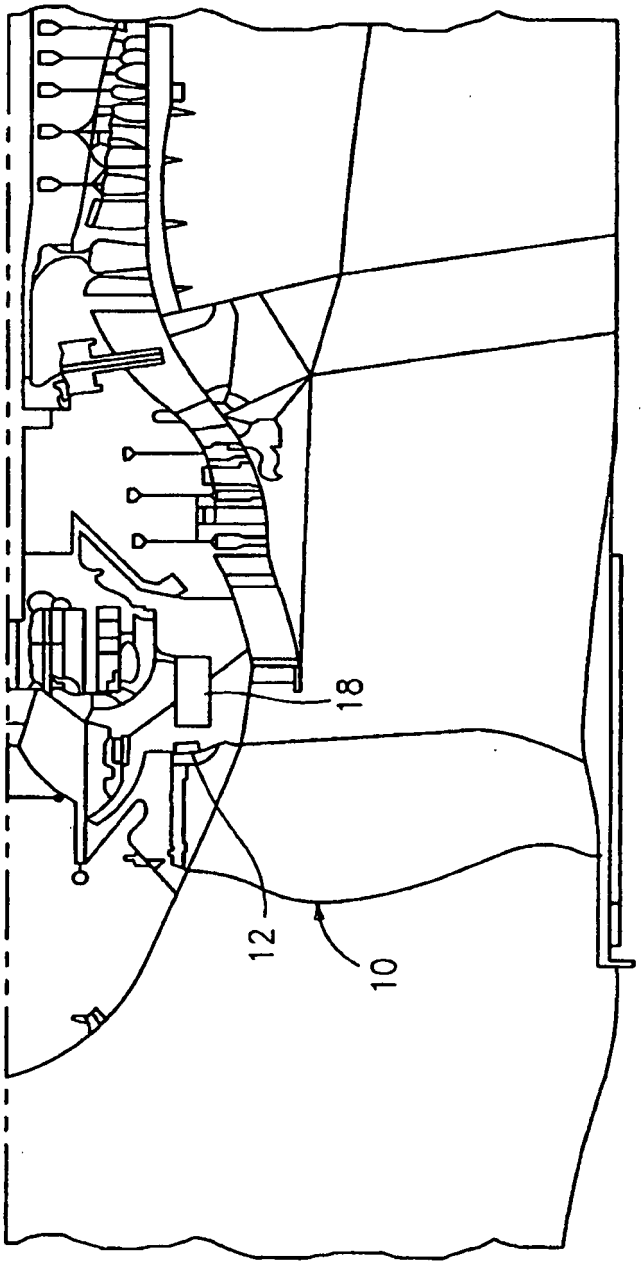

FIG. 1

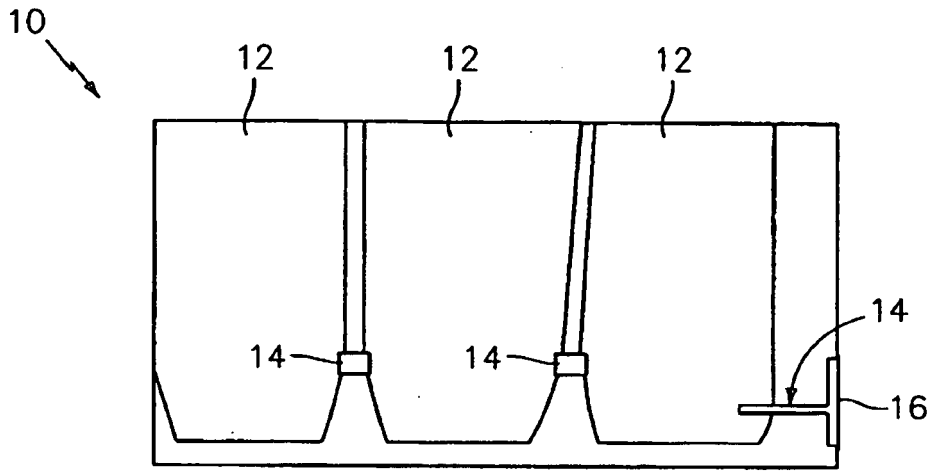

FIG. 2

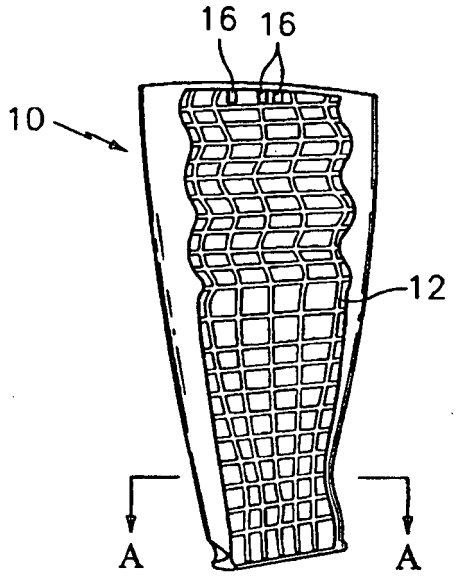

FIG. 3

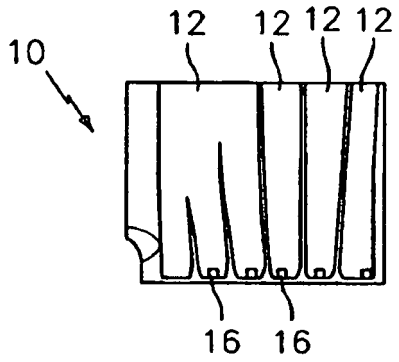

FIG. 4

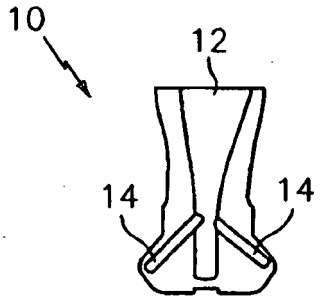

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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