US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250264375
Kind Code A1
Publication Date August 21, 2025
Inventor(s) Stehlik; Eric G.

FUEL AND OIL LEAK DETECTION SYSTEM

Abstract

A system includes a housing. The system also includes a membrane disposed within the housing and configured to separate the housing into a lower area and an upper area, the membrane formed of a material that dissolves when exposed to a flammable liquid. The system further includes at least one sensor disposed within the lower area of the housing, the sensor configured to detect a presence of a liquid collected in a pool area corresponding to a bottom surface inside the housing.

Inventors: **Stehlik; Eric G. (West Hartford, CT)**

Applicant: **RTX Corporation** (Farmington, CT)

Family ID: **1000007711599**

Appl. No.: **18/583591**

Filed: **February 21, 2024**

Publication Classification

Int. Cl.: **G01M15/02** (20060101)

U.S. Cl.:

CPC **G01M15/02** (20130101);

Background/Summary

TECHNICAL FIELD
[0001] This disclosure relates generally to leak detection systems. More specifically, this disclosure relates to a fuel and oil leak detection system.
BACKGROUND

[0002] While in operation, engines can leak oil or fuel. For an aviation engine, this can lead to a potentially flammable environment. Currently, systems that detect the leakage of flammable liquids while the engine is in operation typically operate by checking liquid consumption levels. This poses a concern for slow leaks, as such leaks can be misconstrued as simply slightly higher consumption while the flammable liquid pools.

SUMMARY

[0003] This disclosure provides a fuel and oil leak detection system.

[0004] In a first embodiment, a system includes a housing. The system also includes a membrane disposed within the housing and configured to separate the housing into a lower area and an upper area, the membrane formed of a material that dissolves when exposed to a flammable liquid. The system further includes at least one sensor disposed within the lower area of the housing, the sensor configured to detect a presence of a liquid collected in a pool area corresponding to a bottom surface inside the housing.

[0005] In a second embodiment, a system includes an aircraft engine and one or more leak detection systems disposed on, in, or adjacent to the aircraft engine. Each of the one or more leak detection systems includes a housing. Each leak detection systems also includes a membrane disposed within the housing and configured to separate the housing into a lower area and an upper area, the membrane formed of a material that dissolves when exposed to a flammable liquid. Each leak detection systems further includes at least one sensor disposed within the lower area of the housing, the sensor configured to detect a presence of a liquid collected in a pool area corresponding to a bottom surface inside the housing.

[0006] Other technical features may be readily apparent to one skilled in the art from the following figures, descriptions, and claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a more complete understanding of this disclosure and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, in which like reference numerals represent like parts:

[0008] FIG. **1** illustrates an example fuel and oil leak detection system for use with an aviation engine according to this disclosure;

[0009] FIGS. **2** and **3** illustrate other embodiments of the system of FIG. **1** according to this disclosure;

[0010] FIG. **4** illustrates the system of FIG. **1** with one or more fire suppression packs according to this disclosure;

[0011] FIGS. **5** and **6** illustrate the system of FIG. **1** with one or more other fire suppression packs according to this disclosure;

[0012] FIG. **7** illustrates the system of FIG. **1** with still other fire suppression packs according to this disclosure; and

[0013] FIGS. **8** through **10** illustrate various mounting options for the system of FIG. **1** according to this disclosure.

DETAILED DESCRIPTION

[0014] FIGS. **1** through **10**, described below, and the various embodiments used to describe the principles of the present disclosure are by way of illustration only and should not be construed in any way to limit the scope of this disclosure. Those skilled in the art will understand that the principles of the present disclosure may be implemented in any type of suitably arranged device or system.

[0015] For simplicity and clarity, some features and components are not explicitly shown in every

figure, including those illustrated in connection with other figures. It will be understood that all features illustrated in the figures may be employed in any of the embodiments described. Omission of a feature or component from a particular figure is for purposes of simplicity and clarity and is not meant to imply that the feature or component cannot be employed in the embodiments described in connection with that figure. It will be understood that embodiments of this disclosure may include any one, more than one, or all of the features described here. Also, embodiments of this disclosure may additionally or alternatively include other features not listed here.

[0016] As discussed above, engines can leak oil or fuel while in operation. For an aviation engine, this can lead to a potentially flammable environment. Currently, systems that detect the leakage of flammable liquids while the engine is in operation typically operate by checking liquid consumption levels. This poses a concern for slow leaks, as such leaks can be misconstrued as simply slightly higher consumption while the flammable liquid pools.

[0017] This disclosure provides a fuel and oil leak detection system for use with an aviation engine. As described in greater detail below, the disclosed leak detection system can detect a leak of a flammable liquid, such as fuel, before the liquid collects in a quantity large enough to become a hazard. Note that while this disclosure is described with respect to aviation vehicle engines, it will be understood that the principles disclosed here are also applicable to other types of devices or environments.

[0018] FIG. **1** illustrates an example fuel and oil leak detection system **100** for use with an aviation engine according to this disclosure. As shown in FIG. **1**, the system **100** is shown in a vertical cross-sectional view, and includes a housing **102**, a membrane **104**, a bracket **106**, and at least one sensor **108**.

[0019] The housing **102** can represent, or be disposed in, a lower portion of an aircraft engine case. In other embodiments, the housing **102** can be a portion of a self-contained leak detection structure that is attached or affixed to (or within) the aircraft engine case. For example, the housing **102** can be attached to one or more fuel or oil lines that form a part of the aircraft engine case. In other embodiments, the housing **102** can be integrated into other structural elements of the aircraft engine. As shown in FIG. **1**, the housing **102** can include a concave upper wall **110** that includes one or more input holes **112** passing through the upper wall **110**. The input holes **112** are positioned at or near the low point of the upper wall **110** (as measured in the vertical direction) and above the membrane **104**. If a liquid (such as fuel, oil, water, or the like) leaks onto the top surface of the upper wall **110**, the liquid will tend to flow towards the input holes **112**, and then down through the input holes **112** into the interior portion of the housing **102**, where the liquid will land on a top surface of the membrane **104**.

[0020] The membrane **104** is a solid planar membrane that extends horizontally and completely across the interior of the housing **102**, thereby dividing the housing **102** into an upper area **114** and a lower area **116**. The membrane **104** is formed of polystyrenc, polypropylene, or another polymer that is soluble in certain petroleum based liquids, such as fuel. In operation, if a non-flammable liquid (such as atmospheric water) leaks into the upper area **114** of the housing **102** through the input holes **112**, the liquid will tend to accumulate on the top surface of the membrane **104**, which is impenetrable to such a liquid. If enough liquid is present on the top surface of the membrane **104**, the liquid will flow out of the housing **102** through one or more exit holes **118** in side walls of the housing **102**.

[0021] However, if a flammable liquid, such as fuel or oil, leaks through the input holes **112** and lands on the top surface of the membrane **104**, the flammable liquid will dissolve a portion of the membrane **104**, resulting in one or more holes formed through the membrane **104**. The flammable liquid passes through the formed hole(s) into the lower area **116** of the housing **102** and collecting in a pool area **120** on a bottom inner surface of the housing **102**. In other words, the membrane **104** is selectively penetrable-impervious to non-flammable liquids and dissolvable by flammable liquids. In some embodiments, the membrane **104** is configured to be easily installed in, or

removed from, the housing **102**. For example, the membrane **104** may be slidably installable along rails disposed on sides of the housing **102**. This is useful because, once the membrane **104** has been penetrated by a flammable liquid, the resulting hole(s) would later allow a non-flammable liquid to pass through. Thus, the membrane **104** may need to be easily replaceable.

[0022] The bracket **106** is provided to hold the sensor **108** in a fixed position within the lower area **116** of the housing **102**. In some embodiments, the bracket **106** is a horizontally oriented plate to which the sensor **108** is attached. In some embodiments, the bracket **106** is porous or otherwise contains openings such that any liquid that passes through the membrane **104** will also pass through the bracket **106**. This allows the liquid to descend all the way to the pool area **120**.

[0023] The sensor **108** can be a liquid detection probe that is capable of detecting the presence of a liquid (such as fuel, oil, water, or the like) that may have collected in the pool area **120** of the housing **102**. As shown in FIG. **1**, the sensor **108** can be installed such that there is a small threshold space **122** between the sensing element of the sensor **108** and the bottom inner surface of the housing **102**. This threshold space **122** allows a predetermined amount of liquid to collect within the pool area **120** before the sensor **108** senses the presence of the liquid. This can be useful in environments in which the presence of a small amount of liquid is acceptable. In some embodiments, the sensing element of the sensor **108** may be in contact with the bottom surface of the housing such that the threshold space **122** is zero. This can be helpful in environments where it is desirable for the sensor **108** to detect any liquid at the bottom of the housing **102**.

[0024] FIG. **2** illustrates another embodiment of the system **100** according to this disclosure. As shown in FIG. **2**, the system **100** includes a power source **202** for powering the sensor **108**. In some embodiments, the power source **202** can be a battery. In other embodiments, the power source **202** can be a Peltier plate that generates a current when the plate is exposed to both hot air surrounding the hot engine and cool air on a lower side of the housing **102**. When opposite sides of a Peltier plate are exposed to a different temperatures with a large differential, a current can be generated in the Peltier plate. This current can then be provided from the power source **202** to the sensor **108** for powering the sensor **108**. In some embodiments, the sensor **108** is coupled to the power source **202** via one or more wires that can be insulated to avoid exposing any flammable liquids to a spark.

[0025] The system **100** can also include a wired or wireless transmitter **204** coupled to the sensor **108**. The transmitter **204** is provided to enable unidirectional or bidirectional communication between the sensor **108** and another device, such as a cockpit controller or monitor, a ground-based monitoring device, an engine computer, or any combination of these. For example, sensor readings indicating the presence of liquid in the pool area **120** can be transmitted from the sensor **108** to the cockpit via the transmitter **204**. In some embodiments, the sensor **108** is coupled to the transmitter **204** via one or more wires that can be insulated to avoid exposing any flammable liquids to a spark.

[0026] In some embodiments, the power source **202**, the transmitter **204**, or both can be located outside of the housing **102**. In such embodiments, one or more wires can extend from the sensor **108** inside the housing **102** to the external power source **202** and/or the transmitter **204**.

[0027] FIG. **3** illustrates another embodiment of the system **100** according to this disclosure. As shown in FIG. **3**, the system **100** is installed in an aircraft nacelle that houses an engine. In this embodiment, the system **100** includes a door **302** disposed on a bottom wall of the housing **102**, such as the bottom of the nacelle. The door **302** is provided to allow access to the interior portion of the housing **102** in order to release and/or inspect any trapped liquid that may have accumulated in the pool area **120** of the housing **102**. The door **302** can also provide access to replace the membrane **104** or any other worn or faulty components within the housing **102**. In some embodiments, the door **302** can be hinged on one side. In some embodiments, the door **302** can be lockable. While FIG. **3** shows a single door **302** at the bottom of the housing **102**, this is merely one example. Other numbers of doors in other locations around the housing **102** are possible and within the scope of this disclosure. Also, while not specifically shown, one or more doors **302** could be included in any of the embodiments described in this disclosure.

[0028] In some embodiments, the system **100** can include one or more fire suppression components to discourage or prevent a fire from igniting within the housing **102**. For example, FIG. **4** illustrates the system **100** with one or more fire suppression packs according to this disclosure. As shown in FIG. **4**, the housing **102** includes two fire suppression packs **402** disposed inside the housing **102** on opposite ends. Each fire suppression pack **402** includes a fire suppression fluid **404** disposed within, and a temperature-sensitive trigger **406**. The trigger **406** could be, for example, a mercury/alcohol/glycerin-based switch. In operation, if something (such as a leaked flammable liquid) ignites inside the housing **102**, the temperature will rise inside the housing, causing the trigger **406** to melt or burst, thereby releasing the fire suppression fluid **404** within the housing **102**.
[0029] As another example, FIGS. **5** and **6** illustrate the system **100** with one or more other fire suppression packs according to this disclosure. As shown in FIG. **5**, the housing **102** includes two fire suppression packs **502** disposed inside the housing on opposite ends. Each fire suppression pack **502** includes a fuse **504** and a fire suppression fluid disposed within the fire suppression pack **502**. In operation, if a fire occurs inside the housing **102**, the fire will ignite the fuse **504**, which will burn until it releases the fire suppression fluid inside the housing **102**, thereby suppressing the fire. In FIG. **6**, the fuse **504** is disposed outside the housing **102**.
[0030] FIG. **7** illustrates the system **100** with still other fire suppression packs according to this disclosure. As shown in FIG. **5**, the housing **102** includes two fire suppression packs **702** disposed at the bottom inner surface of the housing **102**, such as in or near the pool area **120**. In this embodiment, the fire suppression packs **702** comprise a neutralizing fluid surrounded by a sealed membrane, similar to the structure of a dishwasher detergent pod. When the membrane becomes wet or warm, the membrane dissolves, thereby releasing the neutralizing fluid into the pool area **120**, where the neutralizing fluid can neutralize any flammable liquid present in the pool area **120**. The neutralizing discourages or prevents the flammable liquid from igniting.
[0031] FIGS. **8** through **10** illustrates various mounting options for the system **100** according to this disclosure. As shown in FIG. **8**, the system **100** could be self-contained and mountable on the side of an aircraft engine **802**. In some embodiments, multiple units of the system **100** could be installed on or adjacent to an oil or fuel line **804** that forms part of the engine **802**. As shown in FIG. **9**, the system **100** could be installed along a bottom portion of a nacelle **902** that surrounds an aircraft engine **904**. Here also, one or multiple units of the system **100** could be included within the nacelle **902**. As shown in FIG. **10**, the system **100** could be installed within or adjacent to a cabin air duct **1002** of an aircraft nacelle between the cabin **1004** and the gearbox **1006**.
[0032] Although FIGS. **1** through **10** illustrate examples of a fuel and oil leak detection system **100** and related details, various changes may be made to FIGS. **1** through **10**. For example, the housing **102** could be formed in various shapes different from those shown in the figures. Also, the membrane **104** could be made of one or more materials other than polystyrene or polypropylene. In some embodiments, a fire suppression system such as shown in FIGS. **4** through **7** could be activated by the pilot of the aircraft. In addition, various components in the system **100** may be combined, further subdivided, replicated, rearranged, or omitted and additional components may be added according to particular needs.
[0033] As described above, the disclosed embodiments provide multiple advantageous benefits over conventional leak detection systems, including increased speed in detecting leaks and potentially preventing in-flight shutdowns (IFSDs). Other conventional sensing systems may have difficulty differentiating between oil, fuel and water. The disclosed membrane ensures that only petroleum based liquids make it through to the sensor area. This allows for the selection of a relatively simple, low-cost sensor that only needs to screen for a pool of liquid. Additionally, the option of powering the system with a Peltier plate can allows the system to have a long operational life without needing to be recharged, thereby reducing maintenance.
[0034] In some embodiments, various functions described in this patent document are implemented or supported by a computer program that is formed from computer readable program code and that

is embodied in a computer readable medium. The phrase “computer readable program code” includes any type of computer code, including source code, object code, and executable code. The phrase “computer readable medium” includes any type of medium capable of being accessed by a computer, such as read only memory (ROM), random access memory (RAM), a hard disk drive, a compact disc (CD), a digital video disc (DVD), or any other type of memory.

[0035] It may be advantageous to set forth definitions of certain words and phrases used throughout this patent document. The term “couple” and its derivatives refer to any direct or indirect communication between two or more components, whether or not those components are in physical contact with one another. The terms “include” and “comprise,” as well as derivatives thereof, mean inclusion without limitation. The term “or” is inclusive, meaning and/or. The phrase “associated with,” as well as derivatives thereof, may mean to include, be included within, interconnect with, contain, be contained within, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, have a relationship to or with, or the like. The phrase “at least one of,” when used with a list of items, means that different combinations of one or more of the listed items may be used, and only one item in the list may be needed. For example, “at least one of: A, B, and C” includes any of the following combinations: A, B, C, A and B, A and C, B and C, and A and B and C.

[0036] The description in the present disclosure should not be read as implying that any particular element, step, or function is an essential or critical element that must be included in the claim scope. The scope of patented subject matter is defined only by the allowed claims. Moreover, none of the claims invokes 35 U.S.C. § 112(f) with respect to any of the appended claims or claim elements unless the exact words “means for” or “step for” are explicitly used in the particular claim, followed by a participle phrase identifying a function. Use of terms such as (but not limited to) “mechanism,” “module,” “device,” “unit,” “component,” “element,” “member,” “apparatus,” “machine,” “system,” “processor,” or “controller” within a claim is understood and intended to refer to structures known to those skilled in the relevant art, as further modified or enhanced by the features of the claims themselves, and is not intended to invoke 35 U.S.C. § 112(f).

[0037] While this disclosure has described certain embodiments and generally associated methods, alterations and permutations of these embodiments and methods will be apparent to those skilled in the art. Accordingly, the above description of example embodiments does not define or constrain this disclosure. Other changes, substitutions, and alterations are also possible without departing from the spirit and scope of this disclosure, as defined by the following claims.

Claims

1. A system comprising: a housing; a membrane disposed within the housing and configured to separate the housing into a lower area and an upper area, the membrane formed of a material that dissolves when exposed to a flammable liquid; and at least one sensor disposed within the lower area of the housing, the sensor configured to detect a presence of a liquid collected in a pool area corresponding to a bottom surface inside the housing.

2. The system of claim 1, wherein the material comprises polystyrene or polypropylene.

3. The system of claim 1, wherein the housing includes an upper wall that includes one or more input holes passing through the upper wall, the input holes positioned above the membrane.

4. The system of claim 1, wherein the housing includes one or more side walls having one or more exit holes provided to allow non-flammable liquid to exit the housing.

5. The system of claim 1, further comprising a bracket disposed within the housing and configured to hold the sensor in a fixed position within the lower area of the housing.

6. The system of claim 1, wherein the sensor is installed at a location such that a space of a predetermined size exists between a liquid sensing element of the sensor and the bottom surface inside the housing.

7. The system of claim 1, further comprising: a Peltier plate disposed within the housing and configured to power the sensor.
8. The system of claim 1, further comprising: a wired or wireless transmitter coupled to the sensor and configured to enable communication between the sensor and another device.
9. The system of claim 1, further comprising: at least one fire suppression pack disposed within the housing.
10. A system comprising: an aircraft engine; and one or more leak detection systems disposed on, in, or adjacent to the aircraft engine, each of the one or more leak detection systems comprising: a housing; a membrane disposed within the housing and configured to separate the housing into a lower area and an upper area, the membrane formed of a material that dissolves when exposed to a flammable liquid; and at least one sensor disposed within the lower area of the housing, the sensor configured to detect a presence of a liquid collected in a pool area corresponding to a bottom surface inside the housing.
11. The system of claim 10, wherein the material comprises polystyrene or polypropylene.
12. The system of claim 10, wherein the housing includes an upper wall that includes one or more input holes passing through the upper wall, the input holes positioned above the membrane.
13. The system of claim 10, wherein the housing includes one or more side walls having one or more exit holes provided to allow non-flammable liquid to exit the housing.
14. The system of claim 10, further comprising a bracket disposed within the housing and configured to hold the sensor in a fixed position within the lower area of the housing.
15. The system of claim 10, wherein the sensor is installed at a location such that a space of a predetermined size exists between a liquid sensing element of the sensor and the bottom surface inside the housing.
16. The system of claim 10, further comprising: a Peltier plate disposed within the housing and configured to power the sensor.
17. The system of claim 10, further comprising: a wired or wireless transmitter coupled to the sensor and configured to enable communication between the sensor and another device.
18. The system of claim 10, further comprising: at least one fire suppression pack disposed within the housing.
19. The system of claim 10, wherein the aircraft engine and the one or more leak detection systems are disposed within a nacelle.
20. The system of claim 10, wherein the one or more leak detection systems are installed on or adjacent to an oil or fuel line that forms part of the aircraft engine.