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(56) Documents Cited:
GB 2347211 A **GB 2239090 A**
GB 1527965 A **JP 110326042 A**
JP 090115076 A **US 5384467 A**
US 3861458 A **US 20020134138 A1**

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UK CL (Edition X) **G1A**
INT CL[7] **A62C, F01P, F02B, F23N, G01B, G01D, G01J, G01K**
Other:

(54) Abstract Title: **Fire warning system**

(57) A fire warning system, suitable for use in an aircraft engine bay or other installation involving a prime mover or a furnace or boiler for example, in which a plurality of optical sensors 20,20a,20b are arranged to monitor at least two zones a,b, for example on opposite sides of the engine etc. Sensor signals from the zones are compared and in the event of a difference between signals exceeding a predetermined amount a fire warning alarm is energised.

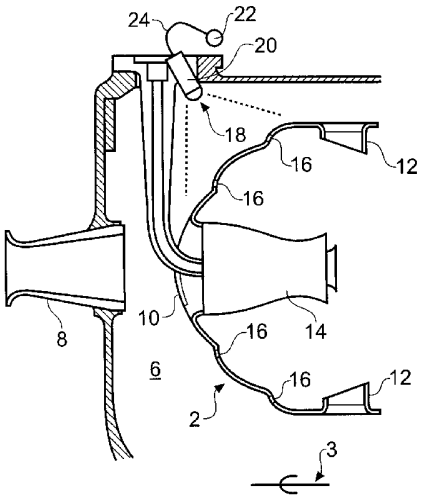

Fig. 1

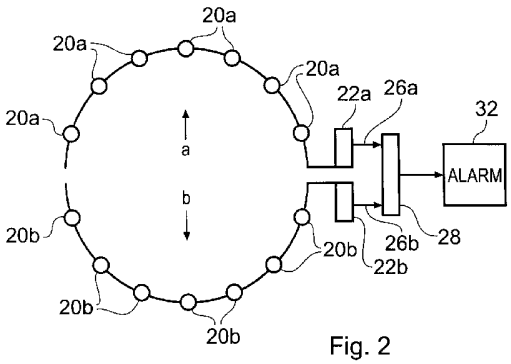

Fig. 2

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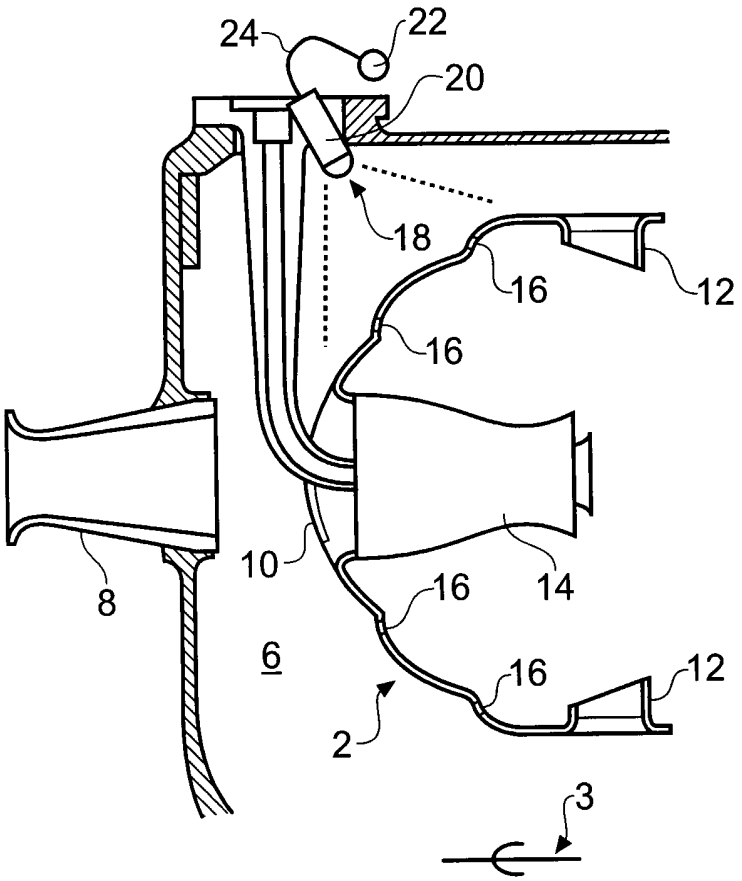
24
22
20
18
16
12
16
10
14
16
8
6
16
12
2
3

Fig. 1

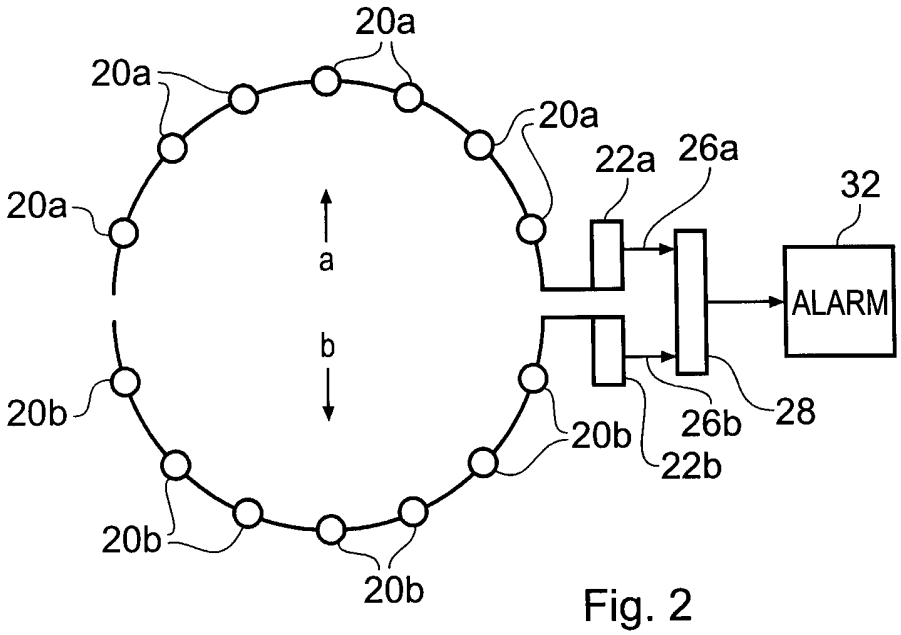
20a
20a
20a
20a
22a
26a
32
20a
a
b
ALARM
20b
20b
26b
28
22b
20b
20b
20b

Fig. 2

FIRE WARNING SYSTEM

The invention relates to fire warning systems.

In particular it concerns an engine bay fire warning system for an aircraft.

Known warning system arrangements usually employ at least one thin electrically conducting wire hung in the engine bay near the engine. The wire is outside the engine casing but forms part of an electric warning circuit. A breach of the engine casing by a fire destroys the electrical properties of the wire and thereby triggers an alarm circuit. A drawback of systems of this kind is that the warning signal is generated after a catastrophic failure has occurred. This is not a safe failure mode.

In the case of an aircraft engine the present invention seeks to avoid the above-mentioned drawback by detecting a change in radiated light emitted by the combustor casing consistent with incipient breach of the casing for example due to a combustor wall failure, the most common precursor to an engine casing overheat.

According to one aspect of the present invention there is provided a fire warning system comprising a plurality of optical sensors spaced apart around a monitored zone or object, electric circuit means connected to receive signals from each of the sensors and to compare two or more of said signals, and in the event of a difference between the compared signals exceeding a predetermined amount to energize an alarm.

According to another aspect of the present invention each of the optical sensors comprises a lens positioned in the monitored zone and a remote light sensitive signal generator.

Preferably a fibre optic conductor is arranged to convey light from the lens to the remote signal generator.

According to a further aspect of the present invention the optical sensors are spaced apart around an engine in an aircraft engine bay.

The invention will now be described in greater detail with reference to the accompanying drawings that illustrate an example of how the invention may be carried into practice. In the figures of the drawings:

Figure 1 illustrates the position of a fibre optic lens for a remote light sensor inside the interior of a gas turbine engine combustor; and

Figure 2 illustrates how a plurality of sensors arranged as in Figure 1 is connected for fire detection.

Referring firstly to Figure 1 there is shown a detail of a part cut-away view of the interior of a gas turbine engine combustor. The head end of part of the combustor chamber is indicated at 2. The overall shape of the combustor is annular and the whole shape of the chamber or inner casing is achieved by revolving the casing 2 about a centre line indicated at 3. Essentially this centre line is the axis of the engine. A cylindrical outer casing shown at 4 surrounds the inner casing.

Between the outer casing 4 and the inner casing 2 is a volume 6 into which the downstream end of a high pressure compressor outlet diffuser indicated at 8 supplies combustion and cooling air at high pressure. This diffuser outlet 8 provides an annular opening through which the entire air supply enters the combustor chamber volume. The air flow from the diffuser outlet 8 is directed at the head 10 of the combustor 2. Fuel is supplied to the interior of the combustor 2 through a number of fuel supply ducts 12 which feed a like number of fuel injectors such as the one indicated at 14.

Combustion air enters the combustion zone inside the casing 2 through a multiplicity of holes, a major proportion of the air enters through large holes, such as at 12, 14 spaced around the walls of casing 2, and through a number of smaller holes 16 distributed around the combustor head 10. These smaller holes help cool the combustor walls by

generating a cooling film flow over the outer surface and by providing a cooler zone inside the head end which helps shield it from heat radiated from the combustion zone 18.

It will be appreciated that although high pressure air leaves the outlet 8 of the compressor at a temperature significantly hotter than ambient air it has considerable capacity for cooling the structure of the combustor 2. Thus the metallic structure 2 is maintained at a temperature much lower than combustion temperatures. Therefore the chamber structure emits radiation at a level dependent upon its temperature in the red to infra-red portion of the optical spectrum. The construction of the combustor chamber 2 is such that there is no direct line of sight of hot combustion gases from outside the chamber, so observed radiation levels are those of the structure alone and not those of the hot combustion gas within the chamber 2. An optical sensor positioned to monitor the exterior of chamber 2 will thus give a reading representative of the temperature of the cooled metallic structure. In the event that the temperature of the structure rises more than the limits of its operational variation a raised level in the sensor output will indicate the increase.

In accordance with the invention a plurality of optical sensors, one of which is indicated generally at 18, are spaced apart at intervals around the combustor chamber outer casing 4. In the illustrated example each sensor 18 comprises a lens 20 positioned in the monitored zone and a remote light sensitive signal generator 22 positioned outside the zone for protection and access. The lens 20 is positioned where it has a good, unobstructed view of the zone or object being monitored, in this case the head 10 of the combustor 2. In order to obtain complete coverage of the whole of the combustor head, given the field of view and position of each sensor, fourteen such sensors are required equidistantly spaced around the combustor casing. It will be understood that the number of sensors required depends upon several factors in particular: the field of view of a sensor, the distance of the light collecting lens from the monitored object, the size and shape of the object, just to mention a few.

In this example the optical sensors are arranged to compare the light levels received from two, semi-circular circumferential zones within the combustor module. As shown in Figure 2 the plurality of sensors 18 are divided into upper and lower semi-circular zones indicated by suffixes "a" and "b" respectively added to reference numerals. Each of the seven lens 20a in the upper semi-circular array "a" is linked through a common fibre optic cable 24a to a remote light sensitive signal generator 22a. Similarly the seven lens 20b in the lower semi-circular array "b" are linked through a fibre optic cable 24b to a remote light sensitive signal generator 22b. The two signal generators 22a, 22b produce electrical signal outputs 26a and 26b according to the intensity of light conducted by the respective fibre optic links 24a, 24b. The signals 26a, 26b are supplied to a comparator circuit 28, which compares the two signal levels to detect if, within a tolerance range, they are approximately equal or if they are significantly different. Within a normal operational spread the signals will not be exactly equal but, as is normal practice, both signals may be effectively set to a "zero" level so that subsequently comparator 28 is responsive to changes in the difference between received light levels form the two zones "a" and "b". The measurement of differences allows the system to cope with progressive signal loss from signal generators 22a and 22b due, for example, to soot accretion on the lens 18.

If a significant change occurs in the difference measured between zones "a" and "b" comparator 28 generates an output 30 that is operative to energise an alarm 32. The form of the alarm may be selected as appropriate for the operating environment.

It will be appreciated that the monitored zones mat be arranged differently. In the combustor module of the example there are two semi-circular monitored zones. It may be convenient or desirable to have more such zones. Obviously overlap of the monitored zones is to be avoided otherwise changes in signal differences will not be detected. However, systems employing more sophisticated logic than the simple version of the logic described here may be conceived. So in some systems involving a multiplicity of sensors overlapping may be permitted in order to identify incipient problem sites more accurately. There need not even be an even number of zones providing the electronic circuits that "compare" the light signals are appropriately

modified or altered. So for a simple example, there could three monitored zones and therefore, nominally at least, three substantially equal signals to be compared. The comparator would be adapted to respond to a significant change of one zone relative to the other two.

The system has the advantage of detecting an incipient combustor failure prior to a catastrophic engine failure. It also has the advantage that it is passive, contains no moving parts and can be unobtrusively introduced to the combustor module.

In other embodiments of the invention alternative to fibre optics may be employed to collect conduct light form the receiving lens to the signal generators. The sensors may be mounted individually so that each objective lens leads directly to its own signal generator, although this would be more expensive and potentially less reliable.

It will be understood although the invention has been described with reference to a gas turbine propulsion engine it will find application in any environment or situation where fire efflux would present an undesirable failure case. Thus, for example the invention may be applied to any prime mover including gas turbine or internal combustion engines such as fitted to passenger vehicles, also to furnaces, boilers and power stations.

CLAIMS

1 A fire warning system comprising a plurality of optical sensors spaced apart around a monitored zone or object, electric circuit means connected to receive signals from each of the sensors and to compare two or more of said signals, and in the event of a difference between the compared signals exceeding a predetermined amount to energize an alarm.

2 A fire warning system as claimed in claim 1 wherein each of the optical sensors comprises a lens positioned in the monitored zone and a remote light sensitive signal generator.

3 A fire warning system as claimed in claim 1 or claim 2 wherein a fibre optic conductor is arranged to convey light from the lens to the remote signal generator.

4 A fire warning system as claimed in claim 3 wherein the electric circuit means is arranged to compare signals from sensors arranged to monitor zones on opposite sides of the monitored object.

5 A fire warning system as claimed in any preceding claim wherein the optical sensors are spaced apart around an engine in an aircraft engine bay.

6 A fire warning system as claimed in any preceding claim wherein the monitored object is a structure comprising part of any prime mover including gas turbine or internal combustion engines such as fitted to passenger vehicles.

7 A fire warning system as claimed in any of claims 1 to 5 wherein the monitored object is a structure comprising part of an furnace, a boiler, or a power station.

8 A fire warning system substantially as hereinbefore described with reference to the figures of the accompanying drawings.

8

Application No: GB0428016.0 **Examiner:** Sam Mirison

Claims searched: all **Date of search:** 6 April 2005

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
Y	1, 2, 3, 6, 7	JP09115076 A (MATSUSHITA ELECTRIC WORKS LTD), see abstract, and figures; Accession No.: 1997-303547[28].
Y	1, 2, 3, 6, 7	GB2239090 A (SMITHS INDUSTRIES PLC), see page 3 lines 1-9; page 4, paragraph 1; page 5; page 7 lines paragraph 2.
Y	1, 3, 6, 7	GB1527965 A (ERICSSON TELEFON AB), see page 1 lines 79 to page 2 line 11, figure 1.
Y	1, 6, 7	US3861458 A (THE AIR PREHEATER CO. INC.), see abstract, col. 1 lines 5-19; col. 1 lines 50-65; col. 2 lines 35-44; col. 3 lines 3-27.
Y	2, 3, 6	US5384467 A (PLIMON et al.), see figures, abstract; col. 2 line 63 to col. 3 line 47.
Y	3, 6	US2002/134138 A1 (PHILIPP et al.), see abstract, figures, and para. [0001]
Y	6	GB2347211 A (DEUTSCH ZENTRUM FÜR LUFT UND RAUMFAHRT; DORNIER GMBH), see abstract, figures; page 10 paragraph 3 to the end of page 11.
A	-	JP11326042 A (TOKYO SHIBAURA ELECTRIC CO) ; Accession No.: 2000-078112 [07]

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X] :

G1A

Worldwide search of patent documents classified in the following areas of the IPC[07]

A62C; F01P; F02B; F23N; G01B; G01D; G01J; G01K

The following online and other databases have been used in the preparation of this search report

ONLINE: WPI, EPODOC