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Patent Summary

(12) Patent Application:	(11) **CA 2156204**
(54) English Title:	HIGH RESOLUTION TEMPERATURE SENSING DEVICE
(54) French Title:	CAPTEUR DE TEMPERATURE A HAUTE RESOLUTION

Abstract
Patent Details
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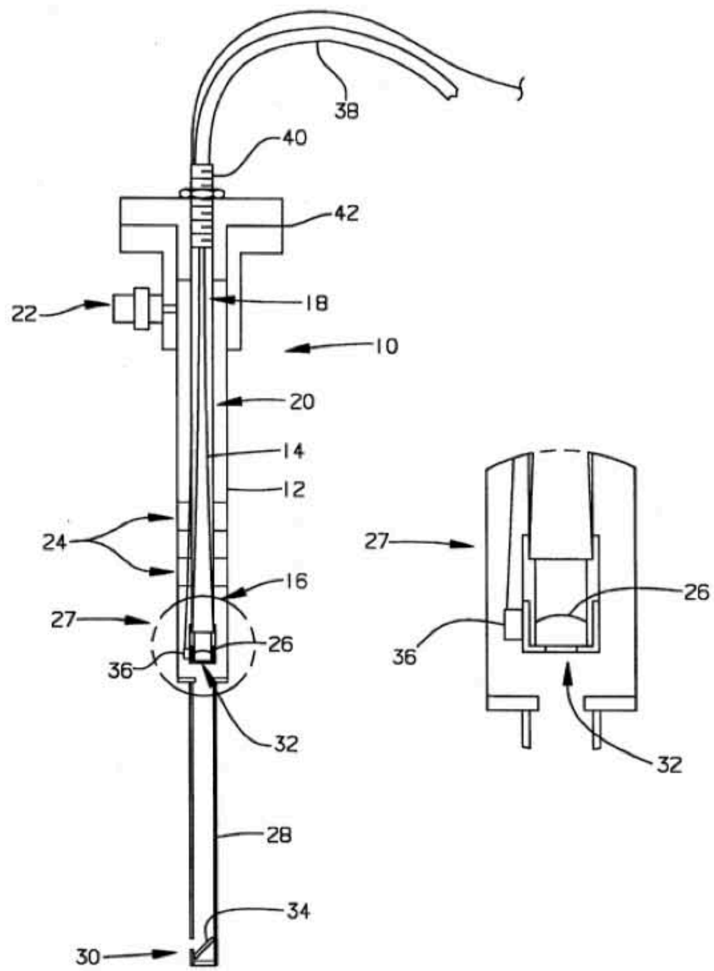
Representative Drawing

Representative Drawing



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Abstracts

English Abstract

A probe for a pyrometer includes a bore, an optical fiber disposed within the bore and having substantially larger diameter at a first end than at a second end. A lens is disposed within the bore and has a focal length substantially equal to the distance between the optical fiber and the lens. A bore extension is connected to the bore and includes a pair of apertures through which energy indicative of temperature passes prior to reaching the lens.

Patent Details

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(45) Issued:	
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(19)(CA) APPLICATION FOR CANADIAN PATENT (12)

(54) High Resolution Temperature Sensing Device

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(30) (US) 315,512 1994/09/30

(57) 1 Claim

Notice: This application is as filed and may therefore contain an incomplete specification.

Abstract of the Disclosure

High Resolution Temperature Sensing Device

A probe for a pyrometer includes a bore, an optical fiber disposed within the bore and having substantially larger diameter at a first end than at a second end. A lens is disposed within the bore and has a focal length substantially equal to the distance between the optical fiber and the lens. A bore extension is connected to the bore and includes a pair of apertures through which energy indicative of temperature passes prior to reaching the lens.

Claims

1. A probe for a pyrometer, comprising:

a bore being adapted to extend into a device and to receive energy indicative of temperature;

a tapered optical fiber disposed within said bore and having a substantially larger diameter at a first end than at a second end;

a lens disposed within said bore and having a focal length substantially equal to the distance between the first end of said optical fiber and said lens, said lens focusing said energy indicative of temperature on said first end of said tapered optical fiber;

a cooling system having an air port and a plurality of forced convection fins.

a member including a first aperture; and

a bore extension including a second aperture, said energy indicative of temperature travelling through said first and second apertures prior to reaching said lens.

Fig_1_

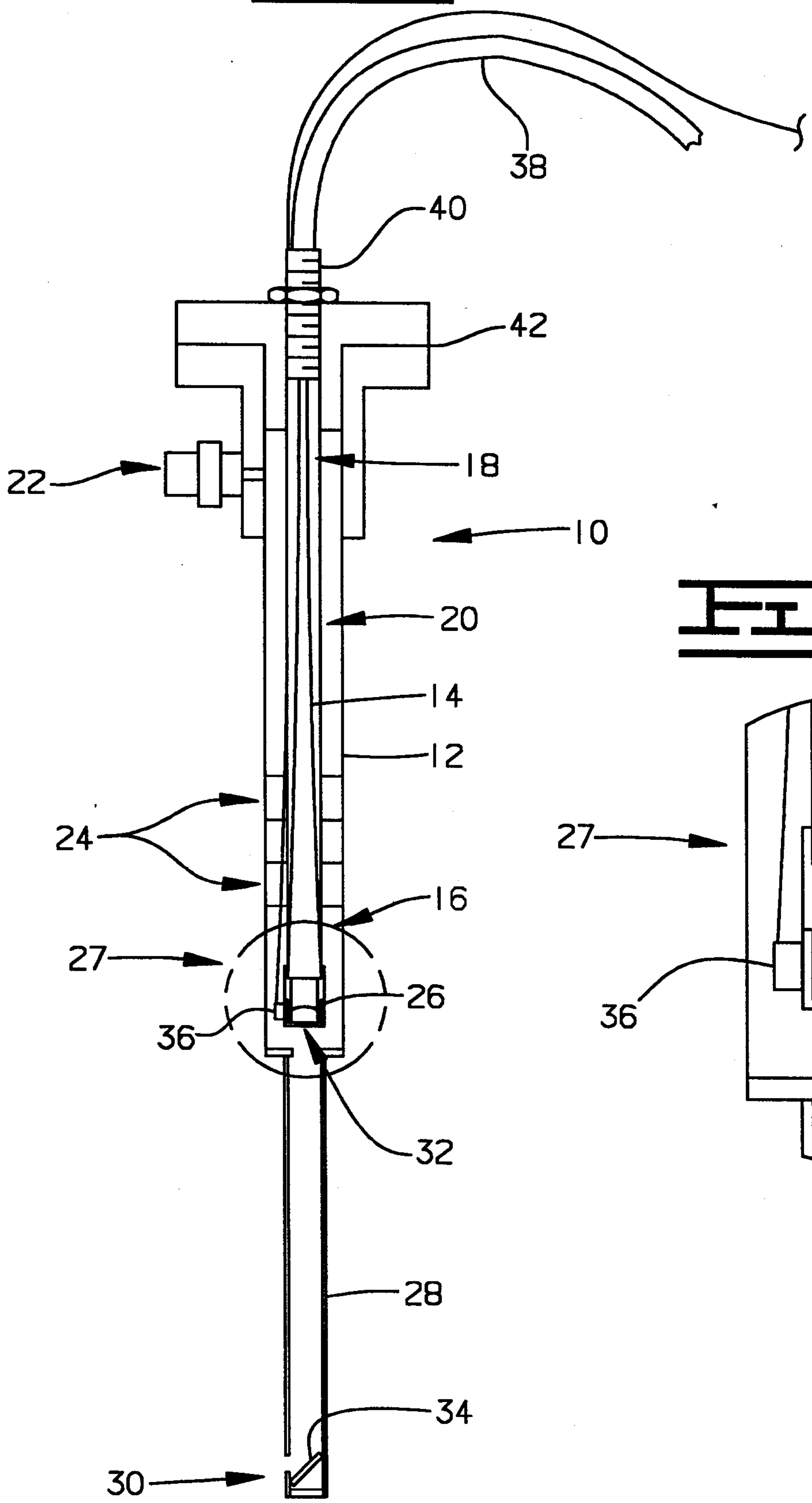


Fig_1a_

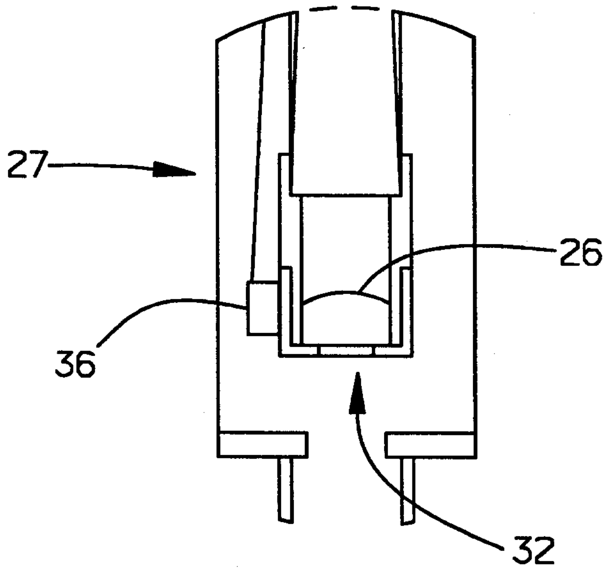
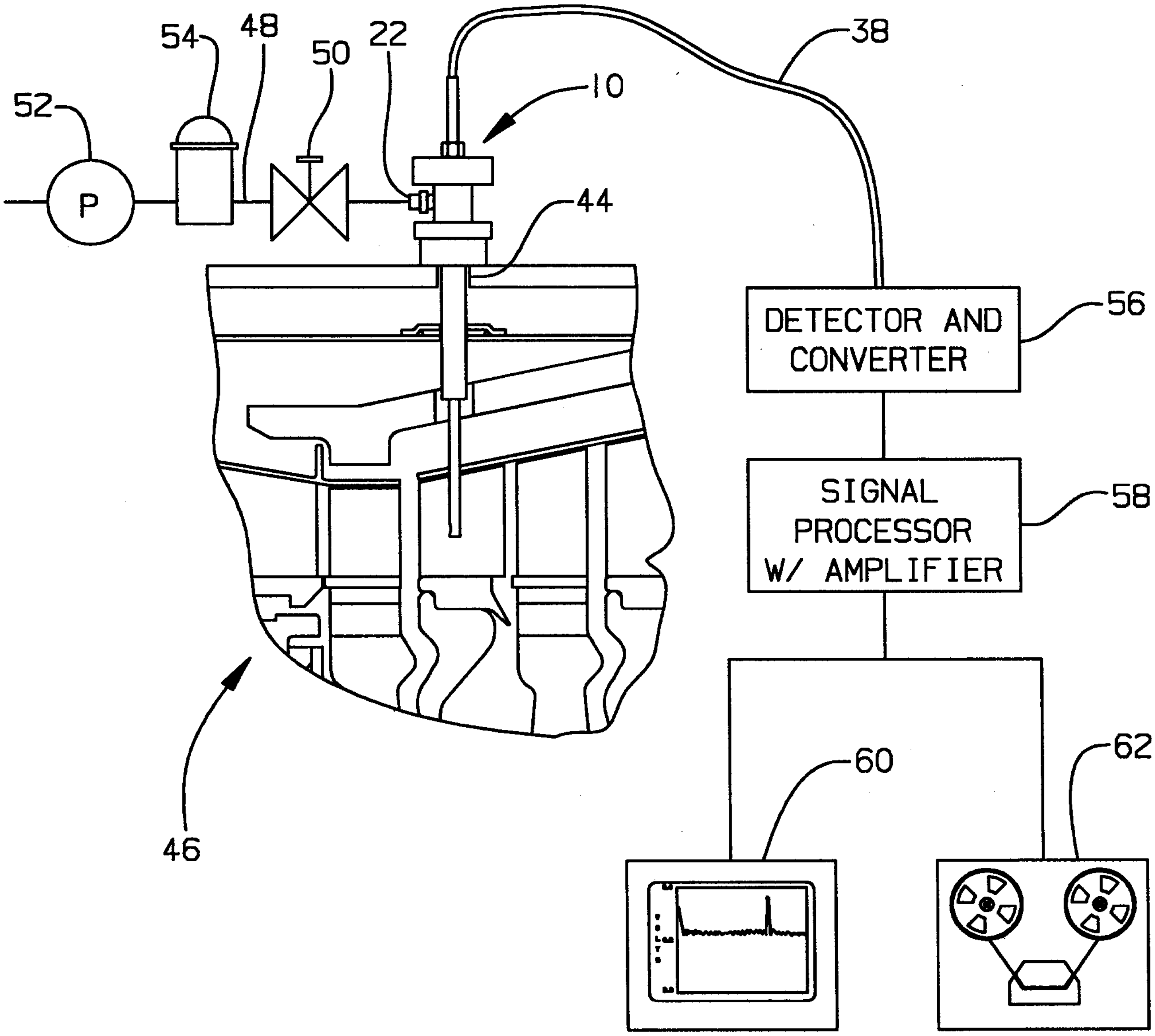
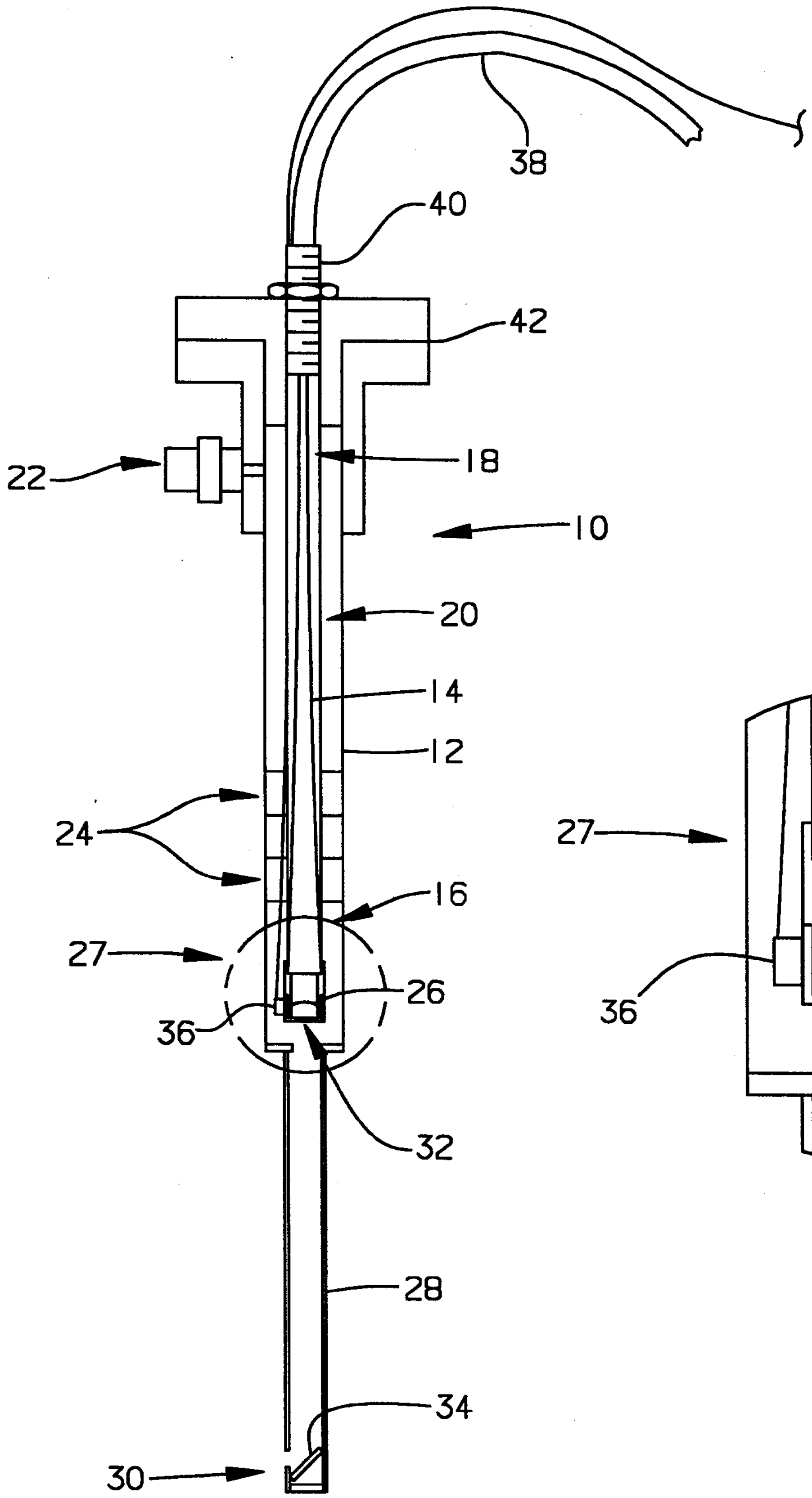


Fig_2_



Kirby, Eades, Gale, Baker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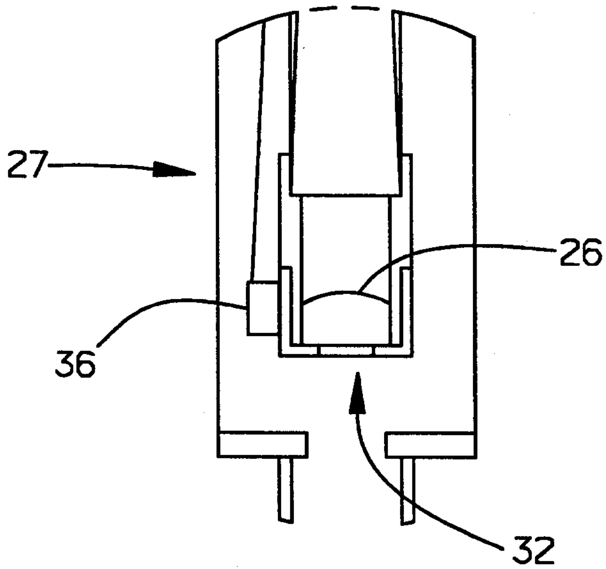
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Description

High Resolution Temperature Sensing Device

Technical Field

The invention relates generally to a device for obtaining temperature data, and more particularly, to a device for obtaining temperature data in response to energy being emitted by an object.

Background Art

As is well known in the art of gas turbine engines, real time temperature data of the engine components is critically important for definition of engine life. Known component metal surface temperature measurement techniques have significant limitations. For example, thermocouples have often been used to measure internal temperatures; however, such devices are typically expensive, have very limited life, do not provide accurate indications of turbine blade and inlet gas temperatures, and often require installation procedures damaging other engine components. Application of infrared cameras for a standard turbine configuration is limited to external surfaces because, for internal inspection, a large optical window is required.

To address this problem, optical pyrometers have been developed. These pyrometers are typically inserted in borescope ports that are built into most gas turbine engines. Several major problems are associated with known pyrometers.

Since these pyrometers transmit energy indicative of temperature through a series of lenses within the probe, changes in temperature of the probe cause the probe to expand or contract and thereby change the relative position and distance between the lenses. This results in a change in the output of the pyrometer based on the temperature of the probe rather than any change in the temperature at the point of interest within the engine.

Known pyrometers also have relatively poor resolution requiring a large target size to provide sufficient energy to gain useful information. These pyrometers also are sensitive to distance. That is, accurate readings can only be obtained when measuring the temperature of points that are a predefined distance from the probe. This results from the energy entering the probe being relatively uncollimated.

Existing pyrometers are also limited to applications for object temperatures above approximately 1100° F.

The present invention is directed to overcoming one or more of the problems as set forth above.

Disclosure of the Invention

The present invention avoids the disadvantages of known probes by substantially reducing the effects of temperature variation and by providing a more collimated field of view that is relatively independent of distance.

In one aspect of the invention, a probe for a pyrometer includes a bore, an optical fiber disposed within the bore and having a substantially larger diameter at a first end than at a second end, and a lens disposed within the bore and having a focal length substantially equal to the distance between the optical fiber and the lens.

The invention also includes other features and advantages which will become apparent from a more detailed study of the drawings and specifications.

Brief Description of the Drawings

For a better understanding of the present invention, reference may be made to the accompanying drawings, in which:

Fig. 1 is a diagrammatic, cut-away view of a probe; and

Fig. 2 is a diagrammatic illustration of the probe inserted in a gas turbine engine and connected to analysis and recording devices and to an air cooling system.

Best Mode for Carrying Out the Invention

In Fig. 1, a probe is generally represented by the element number 10. A bore 12 is provided and surrounds a tapered optical fiber 14. In the preferred embodiment, the tapered optical fiber is formed of chalcogenide and is jacketed in stainless steel. The tapered optical fiber 14 is advantageously of substantially larger diameter at a first end 16 of the fiber than at a second end 18.

A cooling chamber 20 is defined between the bore 12 and the jacket material of the tapered optical fiber 14. The cooling chamber 20 is connected to a high pressure air port 22. Advantageously, two sets of four forced convection cooling fins 24 are located in the cooling chamber 20 near the first end 16 of the tapered optical fiber 14. The cooling fins 24 in each set of four are equally spaced around the circumference of the cooling chamber 20. The cooling fins 24 are advantageously formed of a material having a relatively good thermal conductivity, such as aluminum.

A sapphire lens 26, or other lens having similar optical properties, is located within an end cap 27 to the jacket material of the tapered optical fiber. The lens 26 is displaced from the first end 16 of the tapered optical fiber 14 a distance substantially equal to its focal length. The jacket end cap 27 includes a first aperture 32.

A bore extension 28 is connected to one end of the bore 12 near the lens 26. The bore extension 28 is preferably cylindrical in shape and has a longitudinal axis that is substantially collinear with the longitudinal axis of the bore 12. The bore extension 28 includes a second aperture 30. In the preferred embodiment, the first and second apertures 30, 32 are disposed at substantially a right angle to each other, are round, and have the same diameter. A mirror 34 is located between the first and second apertures such that energy entering the second aperture 30 is directed toward the first aperture 32. In the preferred embodiment, the mirror 34 is either gold-plated or formed of alloyed gold. While the invention is disclosed with the first and second apertures 30,32 being disposed at a right angle to each other, it should be understood that other angles may be selected depending upon the desired direction for the field of view.

Advantageously, a k-type thermocouple 36 is located on the jacket of the tapered optical fiber 14 near the first end 16. The electrical signal from the thermocouple is delivered to a display (not shown) to indicate the temperature of the jacket.

The second end 18 of the tapered optical fiber 14 is connected to a second optical fiber 38 via an SMA adapter 40 of a type well-known in the art. The SMA adapter 40 is located within a copper gasket 42.

Turning now to Fig. 2, the probe 10 is shown extending through a borescope port 44 of a gas turbine engine 46. An air line 48 is included to provide air to the high pressure air port 22. A valve 50 is included together with a pump 52, or other external air supply system, to control the air delivered to the high pressure air port 22. An air filter 54 is also included in the preferred air supply system. Advantageously, the pump 52 provides a pressure of 80-120 psia to the high pressure air port 22.

The second optical fiber 38 is connected to an infrared photodiode detector and converter 56 for producing an electrical signal in response to the received optical energy. The signal from the photodiode detector and converter 56 is delivered to a signal processor 58 which is connected to one or both of a visual display 60 or a recording device 62.

In the preferred embodiment, the probe 10 is rotatable to provide a three-hundred-sixty degree view and extendable and retractable within the borescope port 44.

Industrial Applicability

As is well known in the art, each point within a gas turbine engine 46 emits optical energy indicative of the amount of heat at that particular point. In operation, the probe 10 extends through the borescope port 44 of a gas turbine engine 46 or any other device for which knowledge of internal temperatures is important. The emitted optical energy is recorded and analyzed to determine the temperature at various points within the engine 46 to forecast expected life of the components and to improve engine design.

Due to the extreme temperatures within the engine 46, the thermal characteristics of the materials included in the probe cause the dimensions of the probe to change when temperature of the probe changes. This area of the probe 10 is particularly critical because dimension changes in this area affect the location of the focal point of the lens 26 relative to the end of the tapered optical fiber 14.

The problems caused by thermal effects in this area are reduced by the tapered optical fiber 14 being at its largest diameter at the first end 16. This provides a larger "target" for energy being focused on the fiber by the lens 26. Thus even if thermal expansion or contraction causes the focal point of energy passing through the lens 26 to move, there is an improved likelihood that the tapered optical fiber 14 will continue to receive the energy.

The use of a chalcogenide optical fiber allows energy in the infrared spectrum to be analyzed. This characteristic allows the probe to be used in connection with lower temperatures, down to approximately 450°F. Similarly, the longer wavelength energy in the infrared spectrum improves the spatial resolution of the system by allowing energy from smaller spots within the engine 46 to be sampled.

When the first aperture is directed toward a particular point, optical energy indicative of temperature at that point enters the second aperture 30 and is directed to the first aperture 32 by the mirror 34. The use of two apertures provides a more collimated field of view making the received energy relatively less dependent upon the distance from the point of interest within the engine 46. The sapphire lens 26 also improves collimation.

Other aspects, objects, and advantages of this invention can be obtained from a study of the drawings, the disclosure, and the appended claims.

Claims

1. A probe for a pyrometer, comprising:

a bore being adapted to extend into a device and to receive energy indicative of temperature;

a tapered optical fiber disposed within said bore and having a substantially larger diameter at a first end than at a second end;

a lens disposed within said bore and having a focal length substantially equal to the distance between the first end of said optical fiber and said lens, said lens focusing said energy indicative of temperature on said first end of said tapered optical fiber;

a cooling system having an air port and a plurality of forced convection fins.

a member including a first aperture; and

a bore extension including a second aperture, said energy indicative of temperature travelling through said first and second apertures prior to reaching said lens.

Abstract of the Disclosure

High Resolution Temperature Sensing Device

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High resolution temperature sensing device
CA 2156204 A1

Publication number	CA2156204 A1
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Publication date	Mar 31, 1996
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Priority date	Sep 30, 1994
Inventors	Cengiz Camci, 8 More »
Applicant	Cengiz Camci, 9 More »
Export Citation	BiBTeX, EndNote, RefMan

Classifications (5), Legal Events (1)

External Links: CIPO, Espacenet

ABSTRACT

A probe for a pyrometer includes a bore, an optical fiber disposed within the bore and having substantially larger diameter at a first end than at a second end. A lens is disposed within the bore and has a focal length substantially equal to the distance between the optical fiber and the lens. A bore extension is connected to the bore and includes a pair of apertures through which energy indicative of temperature passes prior to reaching the lens.

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a cooling system having an air port and a plurality of forced convection fins.

a member including a first aperture; and a bore extension including a second aperture, said energy indicative of temperature travelling through said first and second apertures prior to reaching said lens.

DESCRIPTION (OCR text may contain errors)

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Description Hiqh Resolution Temperature Sensing Device Technical Field The invention relates generally to a device for obtaining temperature data, and more particularly, to a device for obtaining temperature data in response to energy being emitted by an object.

Background Art As is well known in the art of gas turbine engines, real time temperature data of the engine components is critically important for definition of engine life. Known component metal surface temperature measurement techniques have significant limitations. For example, thermocouples have often been used to measure internal temperatures; however, such devices are typically expensive, have very limited life, do not provide accurate indications of turbine blade and inlet gas temperatures, and often require installation procedures damaging other engine components. Application of infrared cameras for a standard turbine configuration is limited to external surfaces because, for internal inspection, a large optical window is required.

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Known pyrometers also have relatively poor resolution requiring a large target size to provide sufficient energy to gain useful information. These pyrometers also are sensitive to distance. That is, accurate readings can only be obtained when measuring the temperature of points that are a predefined distance from the probe. This results from the energy entering the probe being relatively uncollimated.

Existing pyrometers are also limited to applications for object temperatures above approximately 1100 F.

The present invention is directed to overcoming one or more of the problems as set forth above.

Disclosure of the Invention The present invention avoids the disadvantages of known probes by substantially reducing the effects of temperature variation and by providing a more collimated field of view that is relatively independent of distance.

In one aspect of the invention, a probe for a pyrometer includes a bore, an optical fiber disposed within the bore and having a substantially larger diameter at a first end than at a second end, and a lens disposed within the bore and having a focal length substantially equal to the distance between the optical fiber and the lens.

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fins 24 are advantageously formed of a material having a relatively good thermal conductivity, such as aluminum.
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The problems caused by thermal effects in this area are reduced by the tapered optical fiber 14 being at its largest diameter at the first end 16.
This provides a larger "target" for energy being focused on the fiber by the lens 26. Thus even if thermal expansion or contraction causes the focal point of energy passing through the lens 26 to move, there is an improved likelihood that the tapered optical fiber 14 will continue to receive the energy.
The use of a chalcogenide optical fiber allows energy in the infrared spectrum to be analyzed.
This characteristic allows the probe to be used in connection with lower temperatures, down to approximately 450F.

Similarly, the longer wavelength energy in the infrared spectrum improves the spatial resolution of the system by allowing energy from smaller spots within the engine 46 to be sampled.

When the first aperture is directed toward a particular point, optical energy indicative of temperature at that point enters the second aperture 30 and is directed to the first aperture 32 by the mirror 34. The use of two apertures provides a more collimated field of view making the received energy 2ls62o~

relatively less dependent upon the distance from the point of interest within the engine 46. The sapphire lens 26 also improves collimation.

Other aspects, objects, and advantages of this invention can be obtained from a study of the drawings, the disclosure, and the appended claims.

CLASSIFICATIONS

International Classification	G01J5/04, G01J5/08, G01J5/10
Cooperative Classification	G01J5/041
European Classification	G01J5/04B

LEGAL EVENTS

Date	Code	Event	Description
Aug 17, 1998	FZDE	Dead	