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(71) Applicant *(for all designated States except US)*: **AFL TELECOMMUNICATIONS, LLC** [US/US]; P.O. Box 3127, Spartanburg, South Carolina 29304-3127 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **FLORA, Dennis** [US/US]; 112 Washington Street, Penacook, New Hampshire 03303 (US). **THEBERGE, Christopher** [US/US]; 5112 Alton Woods, Concord, New Hampshire 03301 (US).

(74) Agents: **PELLEGRINI, Carl, J.** et al.; Sughrue Mion, PLLC, 2100 Pennsylvania Avenue, NW, Suite 800, Washington, District of Columbia 20037-3213 (US).

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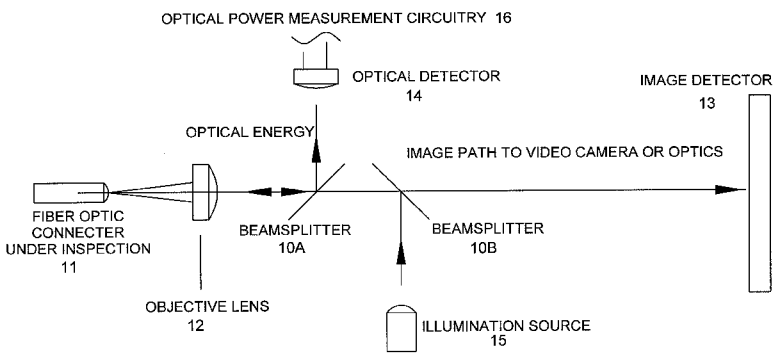
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(54) **Title**: FIBER OPTIC CONNECTOR INSPECTION MICROSCOPE WITH INTEGRAL OPTICAL POWER MEASUREMENT

Figure 1



(57) **Abstract**: A fiber optic inspection microscope including an objective lens, an optical detector, an image detector, an illumination source, and first and second beamsplitters, wherein the first beamsplitter is in a first optical path between the objective lens, the image detector and the optical detector, wherein the first beamsplitter allows passage of an optical image to the image detector, wherein the first beamsplitter directs optical energy to the optical detector, wherein the second beamsplitter is in a second optical path between the illumination source and the objective lens, and wherein the second beamsplitter directs light from the illumination source to the objective lens.

FIBER OPTIC CONNECTOR INSPECTION MICROSCOPE WITH INTEGRAL OPTICAL POWER MEASUREMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[01] This application is based upon and claims the benefit of priority from United States Provisional Application No. 61/331,443, filed May 5, 2010 in the United States Patent and Trademark Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

1. Field

[02] The invention is related to a fiber optic connector inspection microscope which integrates optical power measurement into the same optical path.

2. Related Art

[03] Fiber optic inspection microscopes have been available for over a decade. Examples of such inspection microscopes include the following: JDSU FBP-SM05, Noyes VFS2 and Exfo FIP-400D. More recent variations include the combination of a separate optical power meter in the same package but with a separate test port for optical power measurement. Examples of such inspection microscopes include the JDSU HP2 Series. Recent variations also include the provision of dual inspection methods including one built in microscope for connector end inspection and a second port which accommodates a probe style microscope commonly used to inspect connector ends, bulkheads and adapters common in the industry. Examples of such an inspection microscopes includes the JDSU HP2 Series Option.

[04] However, there is a need for microscopes that reduce the handling (and potential for contamination) of the fiber optic connector. As a result, an objective of the invention is to provide an optical inspection microscope that integrates optical power

measurement into the same optical path. An application for such a microscope would be for inspecting optical fiber patch panels. The microscope would be able to indicate that power is present on a fiber that was thought to be dark (i.e. disabled and without traffic). This would indicate that corrective action is need by the user as an optical fiber service may have been interrupted. Another application could be a quick test of optical power present on connectors at the time of new equipment deployment. This application would provide a power indication without introducing the additional handling steps required by current products.

SUMMARY

[05] Exemplary implementations of the present invention address at least the above problems and/or disadvantages and other disadvantages not described above. Also, the present invention is not required to overcome the disadvantages described above, and an exemplary implementation of the present invention may not overcome any of the problems listed above.

[06] A first embodiment of the fiber optic inspection microscope includes an objective lens, an optical detector, an image detector, an illumination source, and first and second beamsplitters, wherein the first beamsplitter is in a first optical path between the objective lens, the image detector and the optical detector, wherein the first beamsplitter allows passage of an optical image to the image detector, wherein the first beamsplitter directs optical energy to the optical detector, wherein the second beamsplitter is in a second optical path between the illumination source and the objective lens, and wherein the second beamsplitter directs light from the illumination source to the objective lens.

[07] Another feature of the first embodiment of the fiber optic microscope includes optical power measurement circuitry connected to the photodetector.

[08] A second embodiment of the fiber optic inspection microscope includes an objective lens, an optical detector, an image detector, an illumination source, a movable

mirror, and a beamsplitter, wherein the movable mirror is configured to be moved into and out of a first optical path between the objective lens, the image detector and the optical detector, wherein the movable mirror, when it is out of the first optical path, allows passage of an optical image to the image detector, wherein the movable mirror, when it is in the first optical path, directs optical energy to the optical detector, wherein the beamsplitter is in a second optical path between the illumination source and the objective lens, and wherein the beamsplitter directs light from the illumination source to the objective lens.

[09] Another feature of the second embodiment of the fiber optic microscope includes optical power measurement circuitry connected to the photodetector.

BRIEF DESCRIPTION OF THE DRAWINGS

[10] FIG. 1 is a schematic representation of an embodiment of the invention.

[11] FIGs. 2 and 3 are a schematic representation of an alternative embodiment of the invention.

DETAILED DESCRIPTION

[12] The following detailed description is provided to assist the reader in gaining a comprehensive understanding of the methods, apparatuses and/or systems described herein. Various changes, modifications, and equivalents of the systems, apparatuses and/or methods described herein will suggest themselves to those of ordinary skill in the art. Descriptions of well-known functions and structures are omitted to enhance clarity and conciseness.

[13] Hereinafter, the exemplary embodiments will be described with reference to accompanying drawings.

[14] Figure 1 illustrates one possible configuration of a fiber optic inspection microscope with integral power measurement capability. The invention includes an optical beam separation element, such as a beamsplitter 10A. An optical image on an optical path

from the fiber optic connector 11 under inspection, through the objective lens 12 of the microscope and back to an image sensor 13 (such as an analog or digital camera, or inspection optics such as an eyepiece) is intercepted by the beamsplitter 10A and a portion of the returned optical energy is passed to an optical photodetector 14. The photodetector is connected to conventional optical power measurement circuitry 16, for the purpose of optical power measurement or possibly for examination of other transmitted analog or digital content. The measurement circuitry can be part of the microscope or in close proximity to the microscope, such as in a display unit.

[15] An example of a photodetector 14 is a Germanium or InGaAs (indium gallium arsenide) PIN (positive intrinsic negative) photodiode. However, other photodetectors could be used.

[16] The microscope may also include an illumination source 15 to illuminate the end face of the fiber optic connector under inspection. In many microscopes, there already exists another beamsplitter 10B used to pass visible illumination from a light source through the objective lens to illuminate the end face of the fiber optic connector under inspection. However, in this invention, the light source would be momentarily disabled to avoid optical energy from it causing a measurement error. The disabling of the light source can be accomplished by various electromechanical means including mechanical switch, electronic switch, mechanical blocking mechanism or any means of removing the drive current to the source. The beamsplitter 10A added by this invention or possibly an existing beamsplitter arranged in a dual use configuration, passes the optical energy to the photodetector.

[17] The photodetector may be fabricated from a variety of standard materials which are appropriate for the wavelengths expected on the system under test. Several possible examples would be large area InGaAs (indium gallium arsenide) or Germanium photodetectors.

[18] In an alternate arrangement shown in Figures 2 and 3, a common port is still used for inspection, but the first beamsplitter 10A is removed and the image path is moved from the photodetector to the normal imaging optics. A mirror 17 is moved to one of two positions by any electromechanical means. In image mode (Figure 2), the mirror is moved out of the image path. In power measurement mode (Figure 3), the mirror re-directs any optical energy from the connector being inspected to the photodetector.

[19] There may be cost or performance issues that dictate the use of one method over the other. The image path may be moved by various means (mirror or other re-directing device along with electro-mechanical, optical or other methods) to allow it to impinge upon a photodetector or to pass to the normal imaging optics.

[20] Advantages of the invention include reduced testing time which results in reduced cost of maintenance or installation, as well as less handling of the fiber optic connector as it no longer must be inserted into a secondary port for measurement. This reduces the risk of contamination of a clean connector.

[21] Although a few exemplary embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

LISTING OF CLAIMS

What is claimed:

1. A fiber optic inspection microscope comprising:

an objective lens;

an optical detector;

an image detector;

an illumination source;

a first beamsplitter; and

a second beamsplitter;

wherein said first beamsplitter is in a first optical path between said objective lens, said image detector and said optical detector;

wherein said first beamsplitter allows passage of an optical image to said image detector;

wherein said first beamsplitter directs optical energy to said optical detector;

wherein said second beamsplitter is in a second optical path between said illumination source and said objective lens; and

wherein said second beamsplitter directs light from said illumination source to said objective lens.

2. The microscope of claim 1, further comprising optical power measurement circuitry connected to said photodetector.

3. A fiber optic inspection microscope comprising:

an objective lens;

an optical detector;

an image detector;

an illumination source;

a movable mirror; and

a beamsplitter;

wherein said movable mirror is configured to be moved into and out of a first optical path between said objective lens, said image detector and said optical detector;

wherein said movable mirror, when it is out of said first optical path, allows passage of an optical image to said image detector;

wherein said movable mirror, when it is in said first optical path, directs optical energy to said optical detector;

wherein said beamsplitter is in a second optical path between said illumination source and said objective lens; and

wherein said beamsplitter directs light from said illumination source to said objective lens.

4. The microscope of claim 3, further comprising optical power measurement circuitry connected to said photodetector.

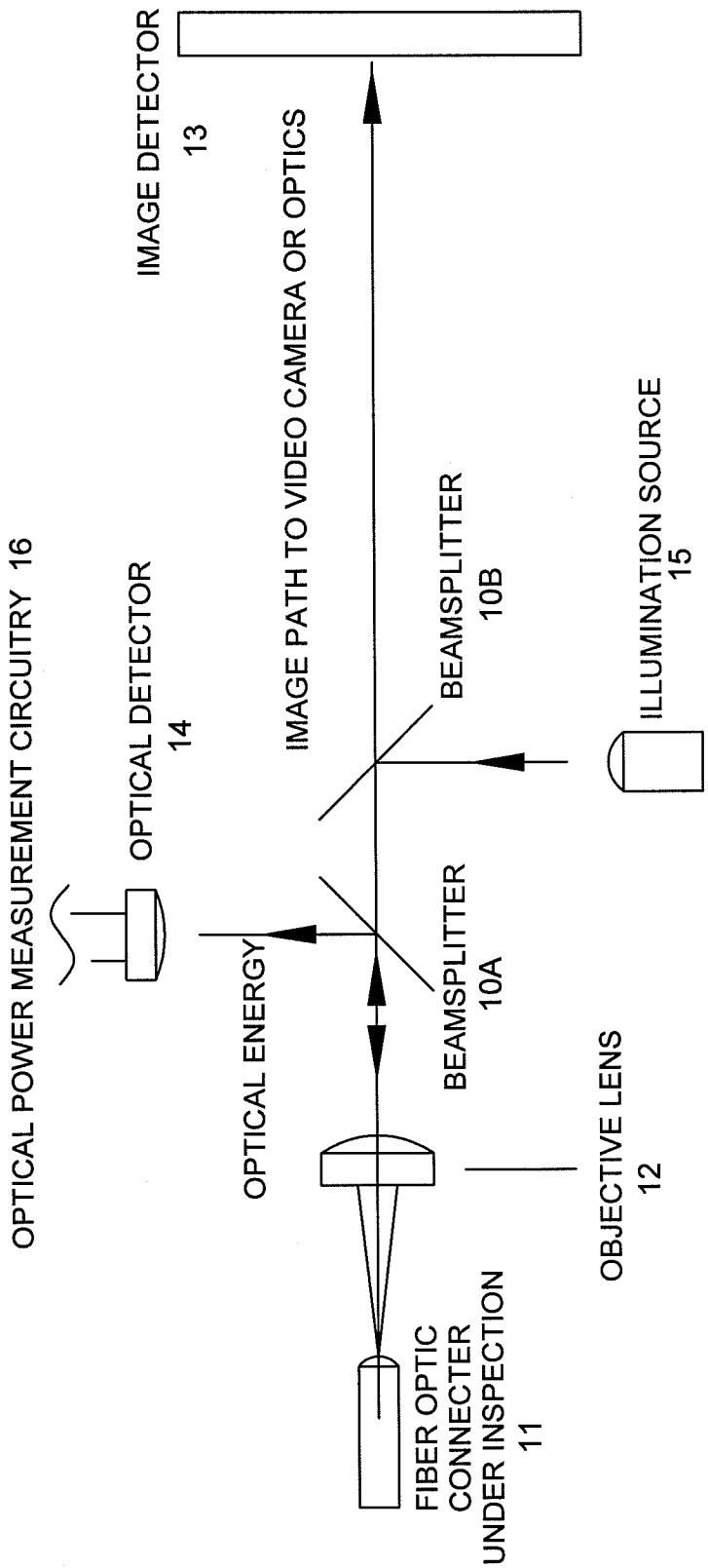

IMAGE DETECTOR
13
IMAGE PATH TO VIDEO CAMERA OR OPTICS
BEAMSPLITTER
10B
ILLUMINATION SOURCE
15
OPTICAL POWER MEASUREMENT CIRCUITRY 16
OPTICAL DETECTOR
14
OPTICAL ENERGY
BEAMSPLITTER
10A
OBJECTIVE LENS
12
FIBER OPTIC
CONNECTER
UNDER INSPECTION
11

Figure 1

Figure 2

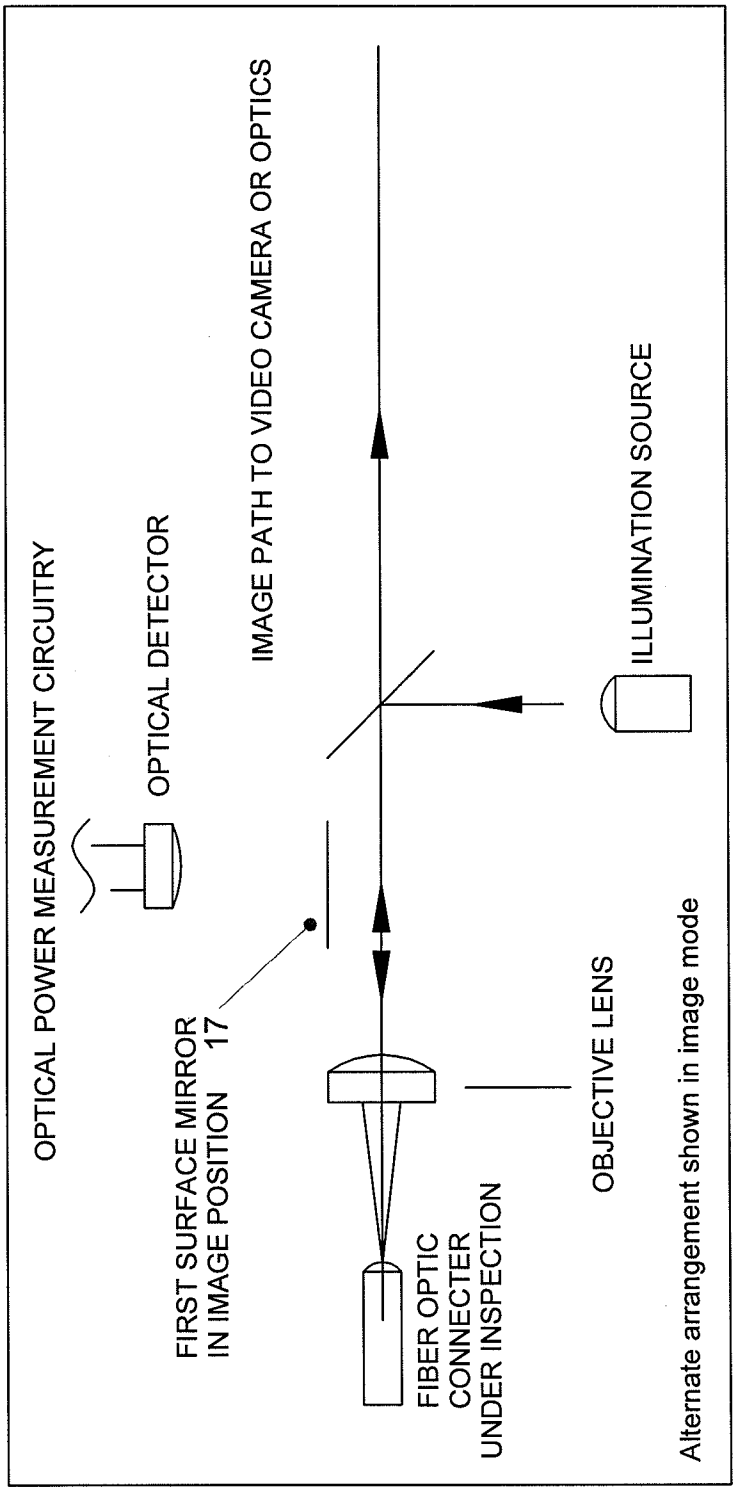
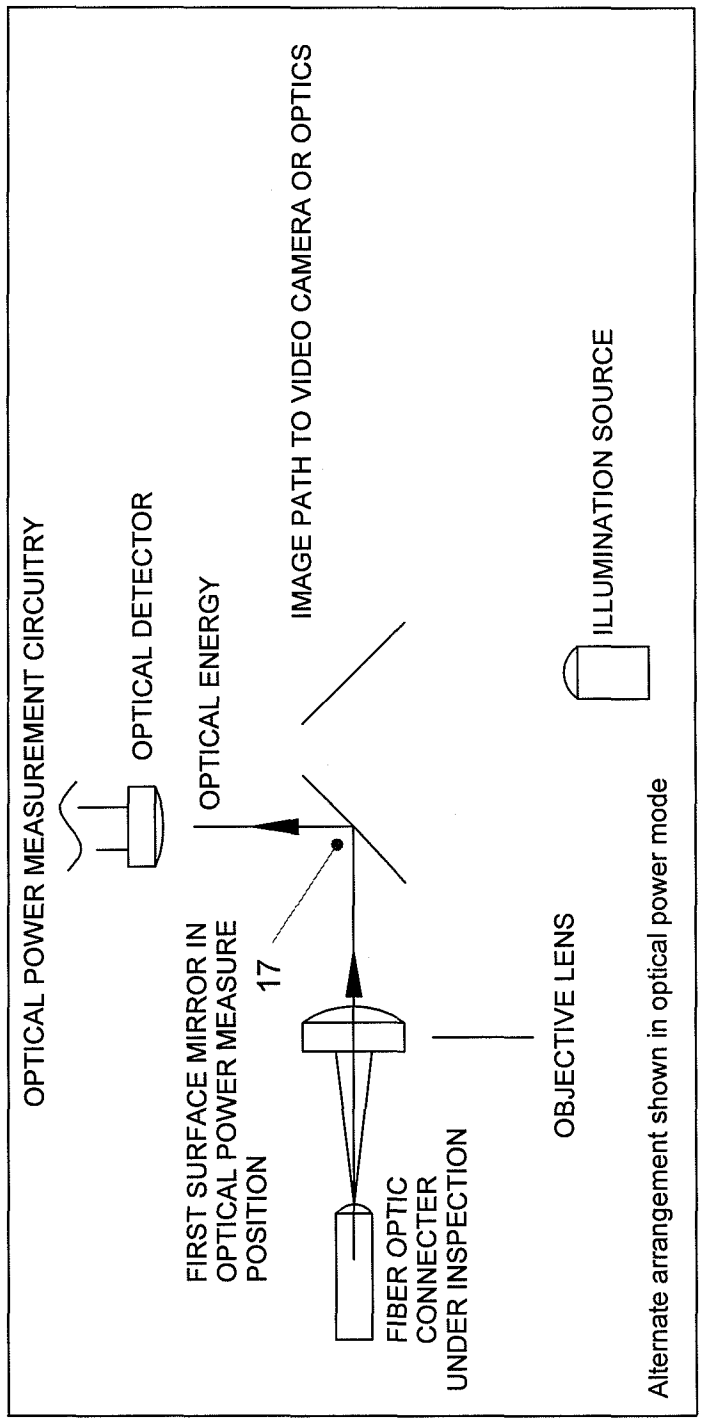

OPTICAL POWER MEASUREMENT CIRCUITRY
OPTICAL DETECTOR
IMAGE PATH TO VIDEO CAMERA OR OPTICS
ILLUMINATION SOURCE
FIRST SURFACE MIRROR
IN IMAGE POSITION 17
FIBER OPTIC
CONNECTER
UNDER INSPECTION
OBJECTIVE LENS
Alternate arrangement shown in image mode

Figure 3


OPTICAL POWER MEASUREMENT CIRCUITRY
OPTICAL DETECTOR
OPTICAL ENERGY
IMAGE PATH TO VIDEO CAMERA OR OPTICS
ILLUMINATION SOURCE
FIRST SURFACE MIRROR IN OPTICAL POWER MEASURE POSITION
17
FIBER OPTIC CONNECTER UNDER INSPECTION
OBJECTIVE LENS
Alternate arrangement shown in optical power mode

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/035375

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G02B 7/04 (2011.01)
USPC - 250/201.4
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - G02B 7/04, 27/40; G01J 5/02 (2011.01)
USPC - 250/201.4, 201.3, 339.12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPTO EAST System (US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT), MicroPatent,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 5,432,330 A (NAKAMURA) 11 July 1995 (11.07.1995) entire document	1 --- 2-4
Y	US 4,803,497 A (KENNEDY JR et al) 07 February 1988 (07.02.1988) entire document	2, 4
Y	US 5,841,139 A (SOSTEK et al) 24 November 1998 (24.11.1998) entire document	3-4
A	US 5,122,648 A (COHEN et al) 16 June 1992 (16.06.1992) entire document	1-4
A	US 5,305,759 A (KANEKO et al) 26 April 1994 (26.04.1994) entire document	1-4
A	US 5,764,363 A (OOKI et al) 09 June 1998 (09.06.1998) entire document	1-4
A	US 6,169,289 B1 (WHITE et al) 02 January 2001 (02.01.2001) entire document	1-4

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Date of the actual completion of the international search	Date of mailing of the international search report
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