

U.S. Patent No. 7,706,641
IPR2025-01441

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CYBERSECURE IPS, LLC,
Petitioner,

v.

NETWORK INTEGRITY SYSTEMS, INC.,
Patent Owner,

Patent No. 7,706,641
Issue Date: April 27, 2010
Title: Monitoring individual fibers of an optical cable for intrusion

Inter Partes Review No.: IPR2025-01441

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 7,706,641**

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Exhibit No.	Exhibit Name
1001	U.S. Patent No. 7,706,641 (the “’641 Patent”)
1002	’641 Patent File History
1003	Expert Declaration of Dr. Alexis Méndez
1004	U.S. Patent No. 5,093,568 (“Maycock”)
1005	U.S. Patent No. 5,177,354 (“Tomita”)
1006	U.S. Patent Publication No. 2005/0244116A1 (“Evans”)
1007	U.S. Patent No. 5,649,036 (“Anderson”)
1008	U.S. Patent No. 5,552,881 (“Jezewski”)
1009	U.S. Patent No. 6,630,992 (“Vobian”)
1010	U.S. Patent No. 6,559,437 (“Pope”)
1011	U.S. Patent No. 5,335,104 (“Johnson”)
1012	Reserved
1013	U.S. Patent Publication No. 2002/0015200A1
1014	B. Danielson, “Optical time-domain reflectometer specifications and performance testing,” Applied Optics, Vo. 24, No. 15 (August 1, 1985)
1015	U.S. Patent No. 5,708,500
1016	U.S. Patent No. 5,321,541
1017	U.S. Patent No. 4,477,725
1018	U.S. Patent Nos. 6,522,434
1019	U.S. Patent No. 6,493,124
1020	U.S. Patent No. 5,026,141
1021	U.S. Patent No. 4,450,434
1022	U.S. Patent No. 5,680,104
1023	U.S. Patent Publication No. 2004/0071382A1
1024	E6000C Mini-OTDR User’s Guide (March 2002)
1025	EXFO FTB-100B Mini-OTDR Specification (2001)
1026	Independent Claim Correlation Table

CLAIM LISTING

Element	Claim Language
1.0	A method for detecting movement of optical fibers of an optical fiber cable comprising:
1.1	providing a optical fiber cable having a first end and a second end, the cable having a plurality of fibers each of which extends from the first end to the second end;
1.2	monitoring a plurality of fibers of the cable by detecting movement of the fiber at locations along the length of the fiber by:
1.3	providing at least one source of light for injection onto the fibers;
1.4	providing at least one sensor arrangement for receiving light transmitted through the fibers;
1.5	injecting light from the at least one source into one end of each of the fibers to be monitored;
1.6	in the at least one sensor arrangement, detecting a series of received light signals which have been transmitted along the fibers to be monitored;
1.7	in the at least one sensor arrangement, comparing at least some of the received light signals relative to data obtained from previously received ones of the received light signals to detect changes in the received light signals relative to the previously received light signals;
1.8	in the at least one sensor arrangement, analyzing the changes to determine any changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;

Element	Claim Language
1.9	generating an alarm in response to the detection of any such changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
1.10	and using optical communication components to communicate light from the at least one source to more than one of the fibers of the optical fiber cable and to communicate light from more than one of the fibers of the optical fiber cable to the at least one sensor arrangement such that the number of fibers of the optical fiber cable monitored is greater than the number of sources and greater than the number of sensor arrangements.
2	The method according to claim 1 wherein the light is injected from the at least one source into said one end of a first of the fibers to be monitored at the first end of the cable and wherein there is provided at least one jumper at the second end of the cable connected between the first fiber of the optical fiber cable and a second fiber of the optical fiber cable so as to loop the monitor light exiting from the first fiber into the second fiber so as to use in monitoring the first and second fibers said at least one source as a common single source.
3	The method according to claim 1 wherein there is provided at the first end of the cable a plurality of jumpers each connected between an exit end of a first fiber and an entry end of a next fiber so as to loop the monitor light exiting from the first fiber into the next fiber and wherein there is provided at the second end of the cable a second plurality of jumpers each connected between an exit end of a next fiber and an entry end of a subsequent fiber so as to loop the monitor light exiting from the next fiber into the subsequent fiber such that the light from a common single source passes thorough each fiber sequentially.
4	The method according to claim 3 wherein the source and the sensing arrangement are arranged at a first end of the cable and at the second end of the cable is provided a passive unit forming the series of jumpers defining the communication components.

Element	Claim Language
5	The method according to claim 3 wherein there is provided a single source and a single sensing arrangement and wherein the monitored fibers are treated as one fiber therebetween.
8.0	A method for detecting movement of optical fibers comprising:
8.1	providing at least one source of light for injection onto the fibers;
8.2	providing at least one sensor arrangement for receiving light transmitted through the fibers;
8.3	injecting light from the at least one source into one end of each of the fibers to be monitored;
8.4	in the at least one sensor arrangement, detecting a series of received light signals which have been transmitted along the fibers;
8.5	in the at least one sensor arrangement, comparing at least some of the received light signals relative to data obtained from previously received ones of the received light signals to detect changes in the received light signals relative to the previously received light signals;
8.6	in the at least one sensor arrangement, analyzing the changes to determine any changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
8.7	generating an alarm in response to the detection of any such changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;

Element	Claim Language
8.8	and using optical communication components to communicate light from the at least one source to more than one of the fibers and to communicate light from more than one of the fibers to the at least one sensor arrangement such that the number of fibers monitored is greater than the number of sources and greater than the number of sensor arrangements;
8.9	wherein the at least one sensing arrangement includes a locating arrangement for detecting the location of a detected movement and wherein there is provided a stored table of fiber lengths of the plurality of fibers which allows the at least one sensing arrangement to determine which fiber of the plurality of fibers has moved.
9.0	A method for detecting movement of optical fibers comprising:
9.1	providing at least one source of light for injection onto the fibers;
9.2	providing at least one sensor arrangement for receiving light transmitted through the fibers;
9.3	injecting light from the at least one source into one end of each of the fibers to be monitored;
9.4	in the at least one sensor arrangement, detecting a series of received light signals which have been transmitted along the fibers;
9.5	in the at least one sensor arrangement comparing at least some of the received light signals relative to data obtained from previously received ones of the received light signals to detect changes in the received light signals relative to the previously received light signals;

Element	Claim Language
9.6	in the at least one sensor arrangement, analyzing the changes to determine any changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
9.7	generating an alarm in response to the detection of any such changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
9.8	and using optical communication components to communicate light from the at least one source to more than one of the fibers and to communicate light from more than one of the fibers to the at least one sensor arrangement such that the number of fibers monitored is greater than the number of sources and greater than the number of sensor arrangements;
9.9	wherein there is provided a plurality of wavelength division multiplexers (WDMs) such that each monitored fiber has connected thereto at an entry end and an exit end a respective pair of the WDMs for separating the light from the source from a data signal transmitted simultaneously with the monitoring light through the fiber.
10	The method according to claim 9 wherein all transmission on monitored cable is the monitor wavelength of the light source multiplexed to the data wavelength.
11	The method according to claim 9 wherein all loop-backs between WDMs are at the monitor wavelength.
12.0	A method for detecting movement of optical fibers of an optical fiber cable comprising:
12.1	providing a plurality of optical fiber cables arranged in a hub-and-spoke arrangement where each optical fiber cable extends from a main unit at a central location to one of a plurality of remote units;

Element	Claim Language
12.2	each optical fiber cable having a first end and a second end, the cable having a plurality of fibers;
12.3	monitoring a plurality of fibers of the optical fiber cables by detecting movement of the fibers at locations along the length of the fibers by:
12.4	providing at least one source of light at the main unit for injection onto the fibers;
12.5	providing at least one sensor arrangement for receiving light transmitted through the fibers;
12.6	injecting light from the at least one source at the main unit into one end of the each of the fibers to be monitored;
12.7	in the at least one sensor arrangement, detecting a series of received light signals which have been transmitted along the fibers to be monitored;
12.8	in the at least one sensor arrangement, comparing at least some of the received light signals relative to data obtained from previously received ones of the received light signals to detect changes in the received light signals relative to the previously received light signals;
12.9	in the at least one sensor arrangement, analyzing the changes to determine any changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
12.10	generating an alarm in response to the detection of any such changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;

Element	Claim Language
12.11	and using optical communication components to communicate light from the at least one source at the main unit to more than one of the fibers and to communicate light from more than one of the fibers to the at least one sensor arrangement such that the number of fibers monitored is greater than the number of sources and greater than the number of sensor arrangements
12.12	wherein at least one of the fibers of more than one of the cables is monitored by the light injected into the fibers from said at least one source of light at the main unit.
13.0	A method for detecting movement of optical fibers comprising:
13.1	providing at least one source of light for injection onto the fibers;
13.2	providing at least one sensor arrangement for receiving light transmitted through the fibers;
13.3	injecting light from the at least one source into one end of each of the fibers to be monitored;
13.4	in the at least one sensor arrangement, detecting a series of received light signals which have been transmitted along the fibers;
13.5	in the at least one sensor arrangement, comparing at least some of the received light signals relative to data obtained from previously received ones of the received light signals to detect changes in the received light signals relative to the previously received light signals;
13.6	in the at least one sensor arrangement, analyzing the changes to determine any changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;

Element	Claim Language
13.7	generating an alarm in response to the detection of any such changes which are indicative of manipulation of the optical fiber causing movement of a portion thereof along the length thereof;
13.8	and using optical communication components to communicate light from the at least one source to more than one of the fibers and to communicate light from more than one of the fibers to the at least one sensor arrangement such that the number of fibers monitored is greater than the number of sources and greater than the number of sensor arrangements;
13.9	wherein there is provided a plurality of optical switches each arranged at a respective end of a respective fiber to be monitored.
14	The method according to claim 13 wherein the optical switches are arranged to break the circuit of a pair of fibers in the event that a movement is detected.
15	The method according to claim 13 wherein the optical switches are arranged to redirect the monitor wavelength round a fiber pair, thereby bypassing a broken link.
16	The method according to claim 13 wherein the optical switches are arranged to scan fibers to identify which one has been intruded, precluding the need for locating.

I. GROUNDS FOR STANDING

Petitioner certifies that U.S. Patent No. 7,706,641 (the “’641 Patent”) is available for *Inter Partes* review (“IPR”), and Petitioner is not barred/estopped from requesting such review on the Grounds identified herein.

II. RELIEF REQUESTED

Petitioner petitions for IPR and cancellation of Claims 1-5 and 8-16 of the ’641 Patent under the following Grounds:

Ground #	Challenged Claims	Ground	Section(s)
1	1-2, 8-16	Maycock	§§102/103
2	1-2 and 8	Evans	§§102/103
3	8 and 12	Tomita with Jezwinski and Vobian	§103
4	1, 9-10, and 12	Anderson with Jezwinski	§103
5	3-5	Evans with Pope	§103

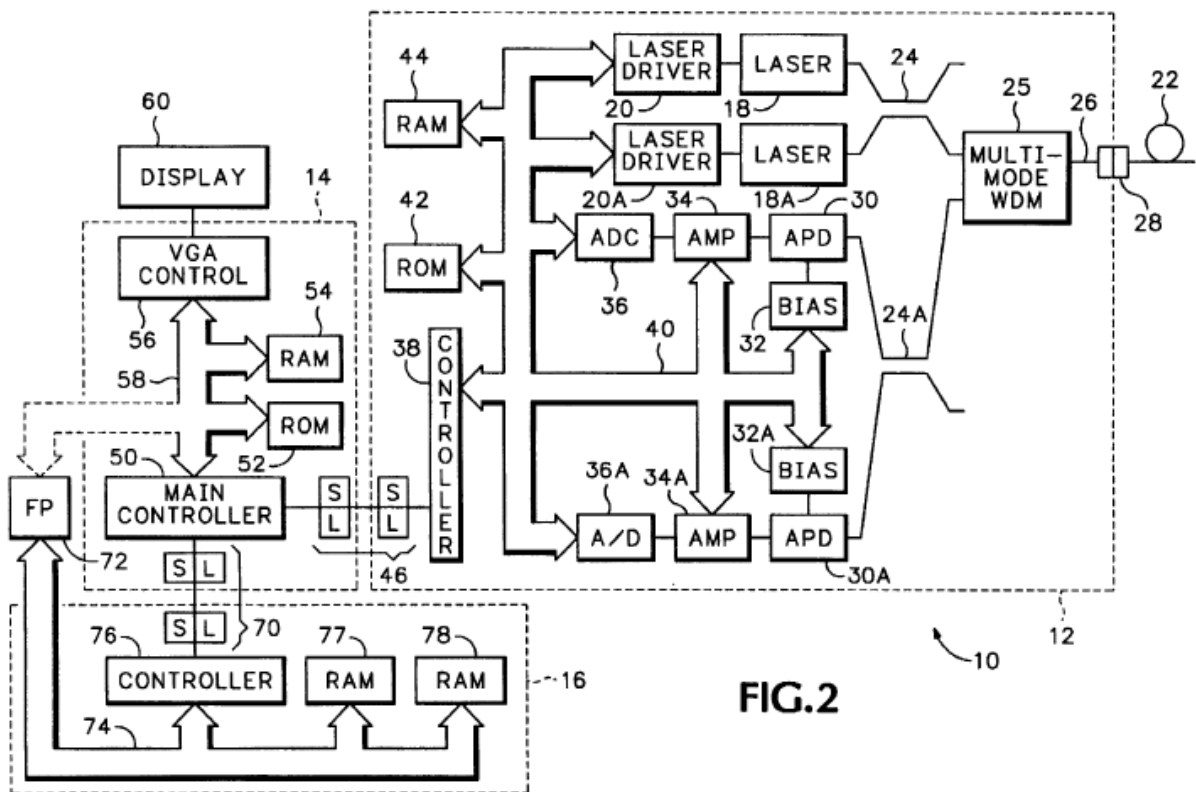
This Petition is supported by the Declaration of Dr. Alexis Méndez, an expert in the field of fiber optic technology. EX1003, ¶¶1-14.

III. STATE OF THE ART

A. Optical Time-Domain Reflectometer (OTDR)

OTDR devices, and other fiber optic testing techniques, have long been known in the art. See EX1003, ¶¶37-47; EX1014, Introduction. A person of ordinary skill in the art (“POSA”) would have known OTDR techniques (EX1003, ¶¶37-38; EX1015, 1:11-62) and that OTDR and other optical fiber test devices inherently consist of a light emitter and receiver. *Id.*, ¶39. Testing fibers requires

injecting light into the line, and detecting those signals. *Id.*, ¶¶40-43; EX1015, 5:56-6:44, Fig. 2); EX1024, 67-68; EX1025; EX1005, 1:41-48, Fig. 1; EX1009, 5:4-6:6:57, Fig. 1.



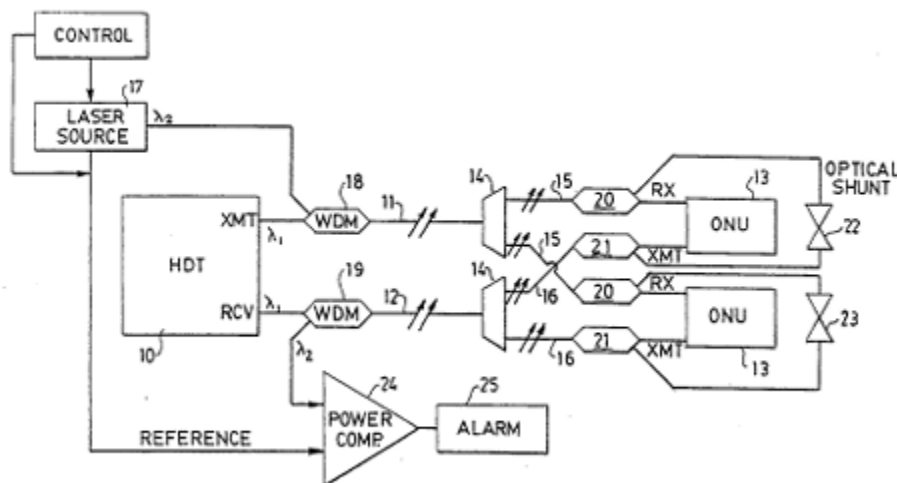
EX1015, Fig. 2 (OTDR 10 depicting light source (lasers 18 and 18a), a receiver (photodetectors 30 and 30a), and internal memory (RAM 44 and ROM 42)).

Using OTDR and similar fiber testing systems for active fiber monitoring was known in the art. EX1003, ¶¶43-44; EX1016, 3:28-30; 10:9-11:37; Fig. 12. OTDR systems are sensitive, and can detect breaks and small bends (microbending) in the fiber optic line. EX1003, ¶¶43-44; EX1017, Abstract. Prior

to the '641 Patent, OTDR was known to determine the length of an optical fiber and store that value in internal memory for later use—fiber length is measured automatically, saved with the trace in memory, and later retrieved for event analysis or pass/fail comparison. EX1003, ¶¶45-47; *see also* EX1024, 58-70, 98-100; EX1025; EX1008, 7:33-50, 7:66-8:3, 9:47-48.

B. Multiplexing/Demultiplexing Devices

Well-known multiplexing/demultiplexing devices, including wavelength-division multiplexers (WDMs), were widely used in optical systems well before the priority date of the '641 Patent (EX1003, ¶48-49) enabling multiple optical signals, at distinct wavelengths, to be combined into a single optical fiber for transmission, and separated back into individual wavelength channels at the receiving end. WDM systems were frequently described in the prior art, as depicted below. *Id.*, ¶¶49-50.



EX1011, Fig. 1.

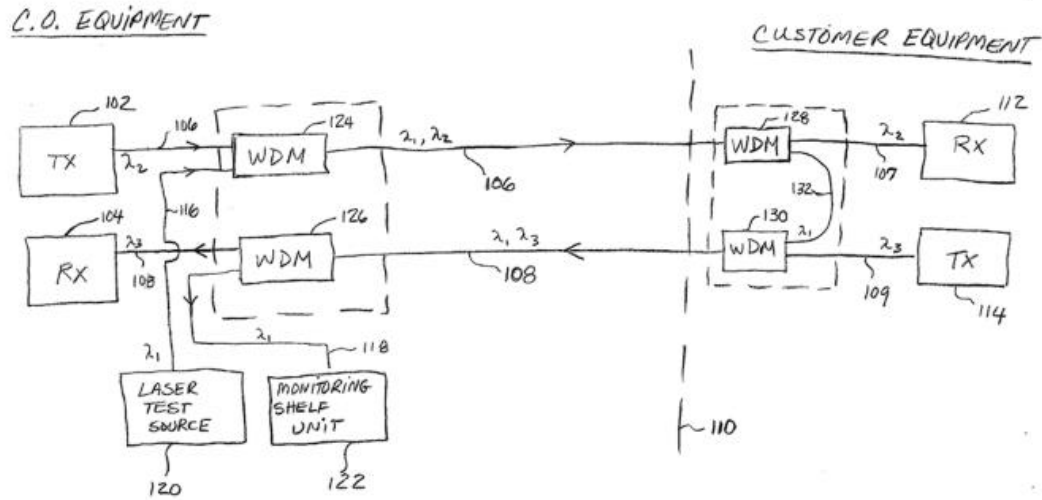
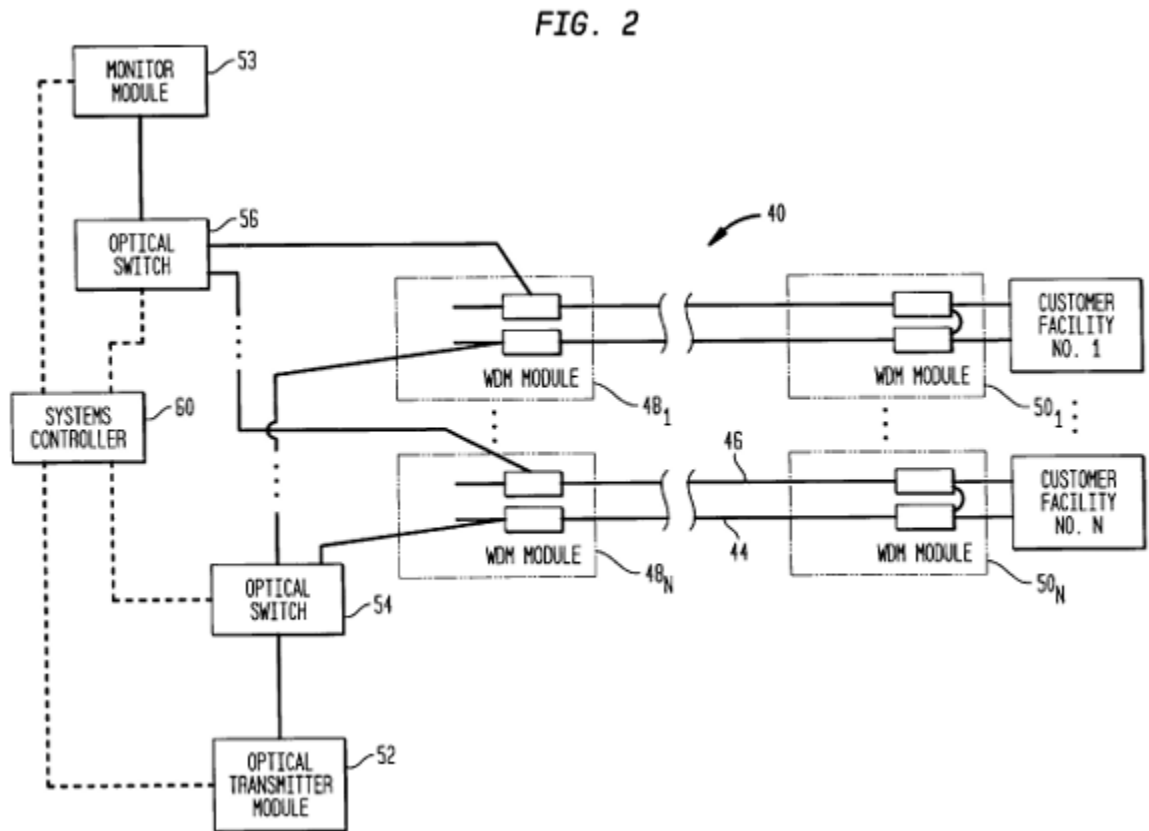


FIG. 2

EX1013, Fig. 2.



EX1018, Fig. 2.

Each example depicts WDMs on both sides of the monitored fibers.

EX1003, ¶51. WDM components were available off-the-shelf products, used in many applications, and could routinely be inserted into existing fiber optic infrastructure. *Id.*, ¶52.

C. Looping Monitor Signal

Looping a monitoring signal from one fiber in a cable to a second fiber in the same cable was a well-established practice in the optical communications and testing fields well before the priority date of the '641 Patent. *Id.*, ¶¶53-55; EX1004,

Figs. 1, 4-5; EX1019, Abstract; EX1006, [0041], Fig. 4; EX1010, 5:45-65, Fig. 5.

Such loopback arrangements were widely used in the art. EX1003, ¶56; *supra* §III.B. Looping between fibers required no modification to the cable itself—only the interconnection at access points such as patch panels, splice trays, or network interface devices. These methods were routinely applied in various fiber optic systems. *Id.*

D. Fiber Optic Sensitivity to Movement

A POSA would have been familiar with well-known fiber optic movement sensor applications, including monitoring structures for movement (EX1020, Abstract), intrusion detection sensors (EX1021, Abstract; EX1022, 1:14-3:67; EX1023, ¶[0022]) and monitoring data transmission fibers/cables for movement to detect intrusions (EX1010, Abstract; EX1006, Abstract; EX1009, Abstract, 9:7-16). EX1003, ¶57.

A POSA would have recognized these fiber optic systems as compatible with each other because the systems provide similar architecture and achieve similar goals, namely detecting movement of the fiber. EX1003, ¶58. Each of the above examples includes a light source and sensor arrangement where light injected into the fiber(s) is detected, compared against either a known value, or previously received light signals, and determines whether there is any disturbance along the fibers. Such systems were well known in the art. *Id.*

A POSA would have understood that the above described techniques, as well as other fiber fault detection and testing techniques described herein, were sensitive to disturbances, perturbations, and other movements of the fiber. *Id.*, ¶59. Any reference to fiber monitoring via detecting faults, signal loss, tampering, tapping, disturbances, vibrations, etc., were techniques that would inherently detect movement of the fiber (i.e., if the fiber is physically cut, spliced, etc.). *Id.* Accordingly, it was well-known in the art that such fault detection techniques, when used to actively monitor a fiber, would detect movements along the fiber length. *Id.*

E. Modularity of Fiber Optical System Components

A POSA would have understood that fiber optic systems are inherently modular, allowing components from one system to be integrated into another with minimal difficulty. *Id.*, ¶60. Light transmission through fibers is governed by physical, optical, and regulatory standards, consistent across different systems. *Id.* As a result, fiber optic components from different vendors, and intended for different applications, can be substituted or incorporated into existing networks without requiring any fundamental redesign of the underlying fiber infrastructure. *Id.*, ¶¶60-62. Fiber optic systems are highly adaptable, cost-effective to upgrade, and well-suited to incorporating components and configurations developed for other optical networks/applications with a high expectation of success. *Id.*

Modifying or adding software components of a fiber optic monitoring or communication system on existing computer hardware was straightforward. *Id.*, ¶63. Fiber test instruments, OTDRs, and centralized monitoring systems were routinely coupled to computers for control, data acquisition, analysis, and display. *Id.*; EX1004, 5:21-23; EX1008, 3:31-37. Once the optical measurement hardware provides the data signal, the choice of analysis technique is a matter of design choice and software processing—changing analysis methods could predictably be accomplished by simply modifying/substituting the software running on the existing processor, without any change to the optical hardware, which would have been routine design choices for POSAs seeking to alter or enhance the way measurement data is interpreted or displayed. EX1003, ¶64.

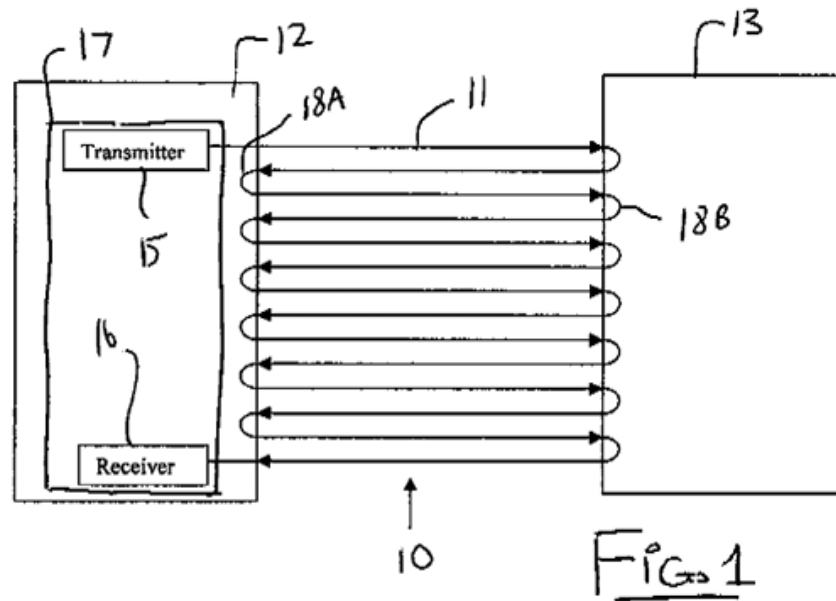
IV. THE '641 PATENT

A. Specification

The '641 Patent issued on April 27, 2010 and claims priority to a provisional application filed August 3, 2005. It discloses monitoring multiple fibers by injecting light from a source into the fibers and using sensors to detect signal changes indicating manipulation, using optical communication components to monitor more fibers than light sources and sensor arrangements. EX1001, Abstract; 1:60-2:31; 2:25-31. Jumpers loop monitoring light through multiple fibers, allowing one light source to monitor several fibers. EX1001, 2:31-35. Cable

10 includes fourteen (14) individual fibers, which are looped via jumpers

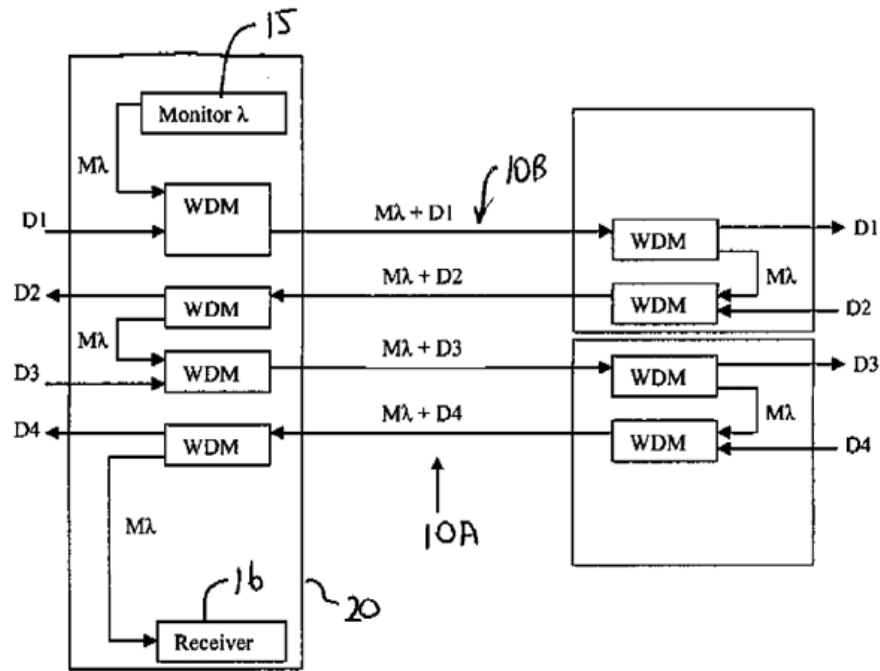
18A/18B:



EX1001, Fig. 1.

WDMs combine/separate monitoring signals and data signals, enabling simultaneous data transmission and fiber monitoring. EX1001, 2:59-64. The system can incorporate optical switches to manage fiber connections, redirect monitoring signals, and identify compromised fibers without additional locating hardware. EX1001, 3:7-17. Figure 3 depicts one monitor signal $M\lambda$ multiplexed/demultiplexed with different data signals (D1-D4) through two cables (10A/10B) each with two fibers, servicing separate remote units.

FIG. 3



EX1001, Fig. 3.

B. Prosecution History

The application that issued as the '641 Patent was filed on August 2, 2006. A Non-Final Rejection issued on February 5, 2009, rejecting the claims based on prior art references from the Examiner's search. Applicant submitted an Amendment and Request for Reconsideration on August 5, 2009, with amended claims to overcome the rejection. EX1002, 1-34, 88-98, 111-125, 131-136.

V. LEVEL OF ORDINARY SKILL IN THE ART

A POSA as of August 3, 2005 would have had at least a bachelor's degree in electrical engineering, physics, or a related discipline (or an equivalent degree), and ~2 years' experience working with optical fiber systems. EX1003, ¶¶30-34. Additional education could substitute for experience, and vice versa. *Id.*

VI. CLAIM CONSTRUCTION

A claim is construed using the standard in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316-1317 (Fed. Cir. 2005) (en banc). For purposes of this proceeding, Petitioner does not believe that any claim terms need construction to resolve the unpatentability issues presented in this Petition.

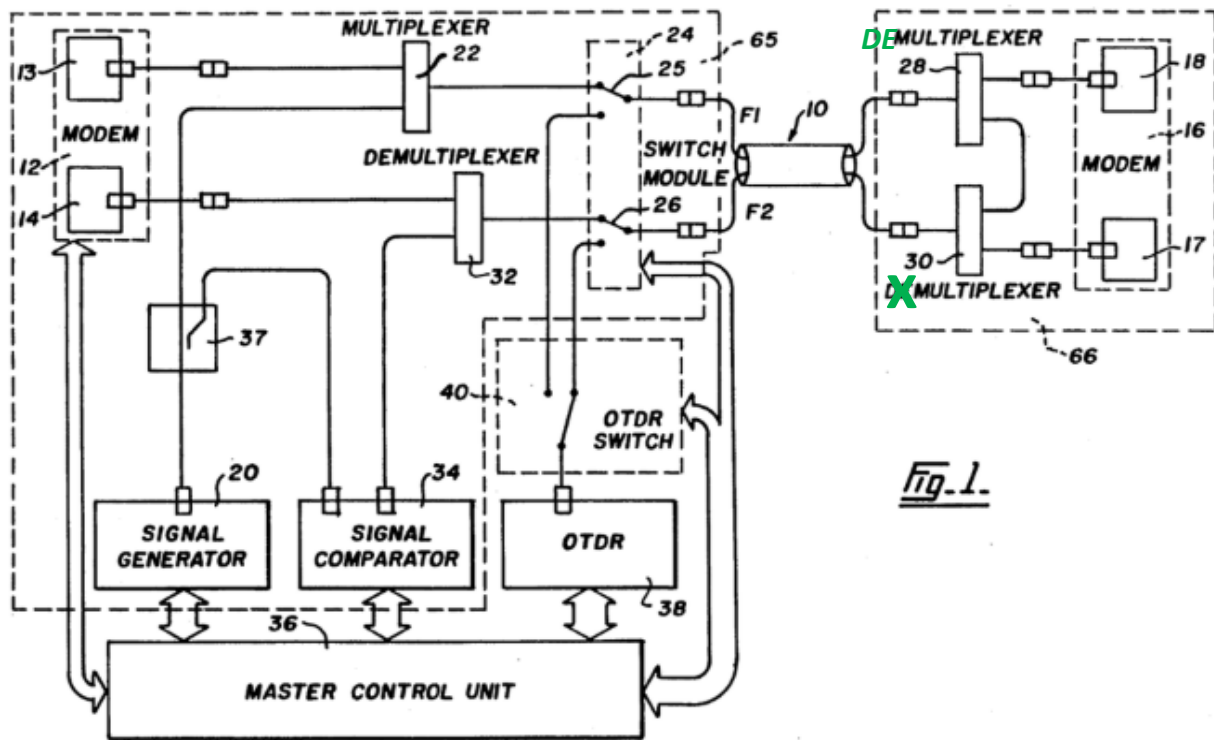
VII. OVERVIEW OF ASSERTED PRIOR ART

A. Maycock

Maycock issued March 3, 1992, and is prior art under at least §102(b).

Maycock describes a “monitoring system [that] continuously monitors fibre [sic] optic cables for faults and then enables automatic location of the fault in the cable” using both a continuous optical monitoring channel and after an intrusion is

detected, an OTDR to locate intrusions. EX1004, Abstract; 1:8-24. Figures 1¹ exemplifies the system:.



EX1004, Fig. 1 (annotated); see EX1003, ¶¶71-73.

B. Tomita

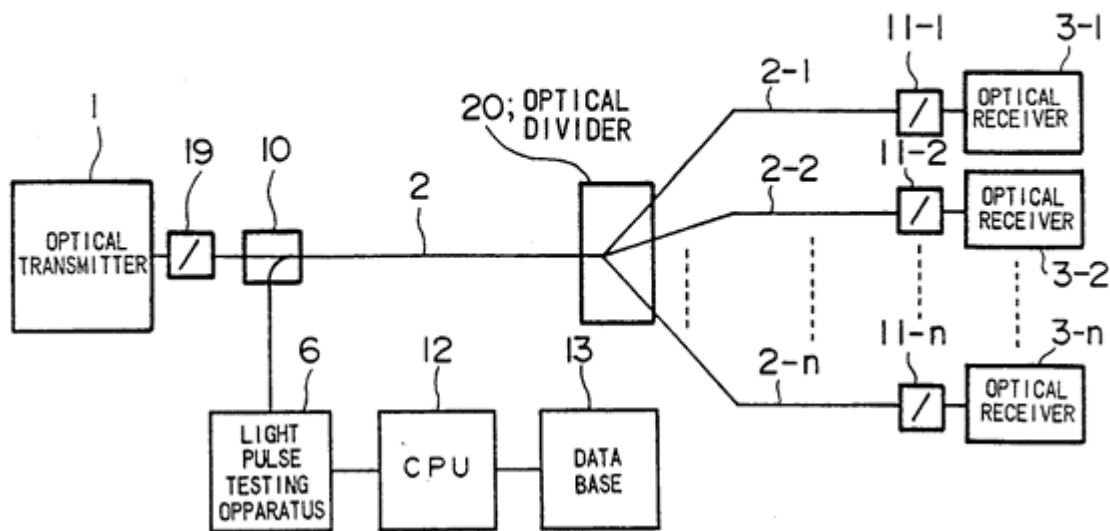
Tomita issued January 5, 1993, and is prior art under at least §102(b).

Tomita describes “a device and a method for distinguishing... faults, whether the faults exist in an optical fiber cable or in another optical apparatus.” EX1005,

¹ A POSA would have understood that Figure 1 in Maycock contains errors in that “MULTIPLEXER 28” should be “DEMULTIPLEXER 30” and “DEMULTIPLER 30” should be “MULTIPLEXER 30.” EX1003, ¶71, n.2; EX1004, 4:14-33.

1:5-14; EX1005, 2:66-3:24; 8:14-12:10; EX1003, ¶74. Tomita's third embodiment provides a one-to-n optical divider connecting multiple subscriber lines, each containing its own filter-based reflector positioned near the subscriber's receiver:

FIG. 11



EX1005, Fig. 11.

Normal/baseline reflection positions (fiber lengths) and intensities are stored in a database for each branch. EX1005, 8:14-38; EX1003, ¶¶75-77. By comparing baseline to live measurements, the pulse-testing apparatus can determine whether a fault or intrusion occurred and the location along the specific fiber that was affected. EX1003, ¶78.

C. Evans

Evans was filed April 28, 2004, published November 3, 2005, and is prior art under at least §102(e).

Evans describes cable installations with eight monitoring optical fibers to detect tampering, damage, or intrusion attempts. EX1006, [0013]–[0015], [0031]–[0033], Fig. 1; EX1003, ¶79.

All embodiments include a light source for injecting light into the monitoring fibers and a detector, so that loss or change of the received signal provides an alarm. EX1006, [0016], [0036]–[0037], [0043], Figs. 2–8. Evan teaches using OTDR. EX1006, [0023], [0043]. Evans further discloses multiple variations for creating the monitoring loop and return signal. EX1006, [0036]–[0045], Figs. 2–8; EX1003, ¶¶79–81.

D. Anderson

Anderson issued on July 15, 1997, and is prior art under at least §102(b).

Anderson describes a remote fiber test system in which a central hub uses a mechanical optical switch to selectively connect an OTDR to fibers in multiple optical links. The system supports testing dark fibers (unused fibers reserved for testing) and active transmission fibers in a distributed fiber network, linking the central hub to various remote units. EX1007, 25:44–26:65, Fig. 22; EX1003, ¶¶83–84.

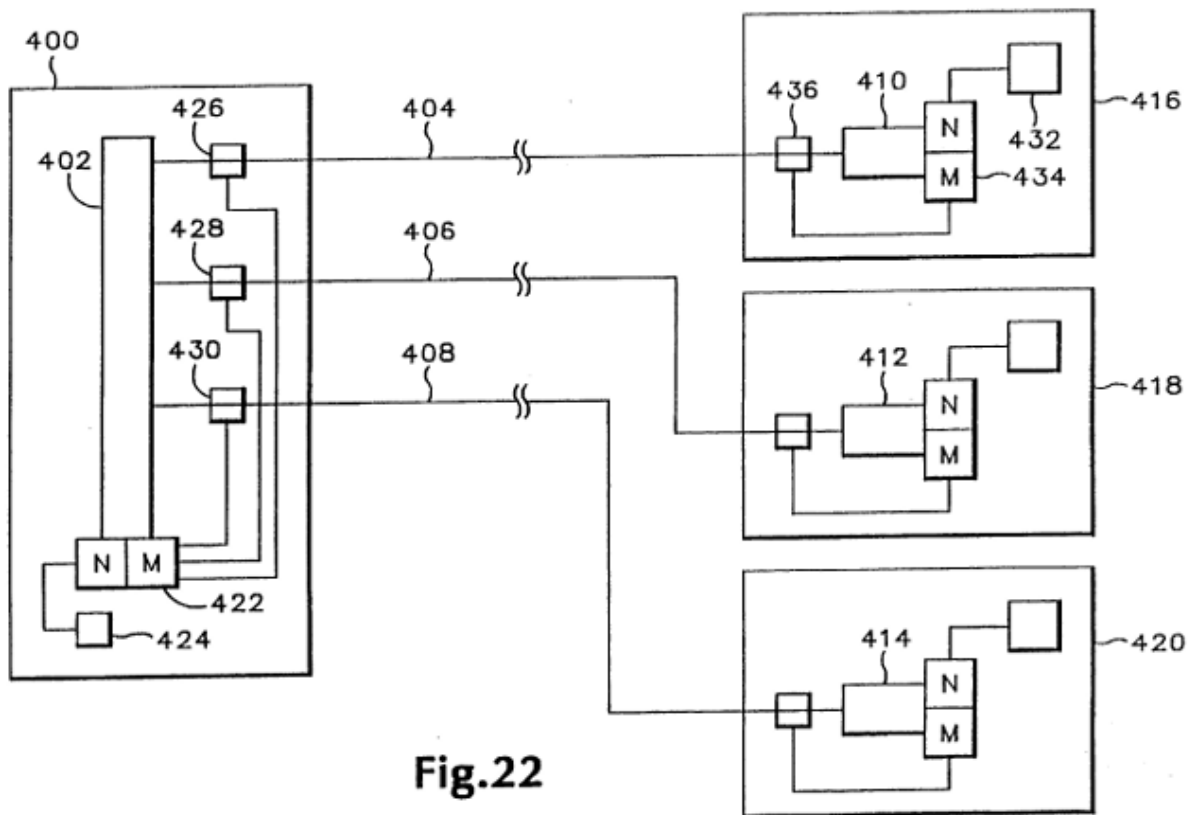


Fig.22

EX1007, Fig. 22; EX1003, ¶¶83-87.

E. Jezwinski

Jezwinski issued September 3, 1996, and is prior art under at least §102(b).

Jezwinski describes an automated fiber network monitoring and scanning system that uses OTDR-based techniques to rapidly detect changes in fibers, determine the type and location of abnormality, and provide alarms. EX1003, ¶¶88-90; EX1008, Abstract, 1:65-2:43; 10:50-11:5. The techniques taught in Jezwinski are applicable to converting other multi-fiber switching or branching systems into

actively monitored intrusion/fault detection systems. *See* EX1003, ¶90; *infra* §§VIII.C, VIII.D; (Grounds 3-4).

F. Vobian

Vobian issued October 7, 2003, and is prior art under at least §102(b).

Vobian describes monitoring optical transmission paths without disturbing data traffic. The system launches a control signal at a wavelength different from the regular transmission signal into the fiber, and analyzes the reflected signal with a detection unit. EX1009, Abstract; 1:8-2:34; EX1003, ¶91. Vobian teaches use of OTDR, and other techniques, to achieve a system for anti-tampering monitoring of active optical links using WDM coupling. EX1009, 8:15-10:26, Figs. 1-3; EX1003, ¶¶91-93.

G. Pope

Pope issued May 6, 2003, and is prior art under at least §102(b).

Pope describes an optical fiber sensor embedded in the insulation of a cable connected by shunts forming a continuous series-connected loop. EX1010, 5:45-6:4, Fig. 5; EX1003, ¶¶94-95.

VIII. GROUNDS OF UNPATENTABILITY

All features of the Challenged Claims were well known in the prior art. *See* EX1003, ¶¶96-429.

Many limitations from independent claims 1, 8-9, and 12-13 are identical or substantially similar. *See* EX1026. Where a limitation is addressed below, it applies equally to the other corresponding limitation(s).

A. Ground 1

Claims 1-2 and 8-16 of the '641 Patent are anticipated and/or obvious over Maycock. EX1003, ¶¶97-210.

1. Claim 1

a. [1.0]

Maycock discloses a monitoring system that “continuously monitors fibre [sic] optic cables for faults” “in order to detect unauthorized intrusions into the cables.” EX1004, Abstract, 1:8-12, 3:62-4:42, 5:34-64, 8:29-32.

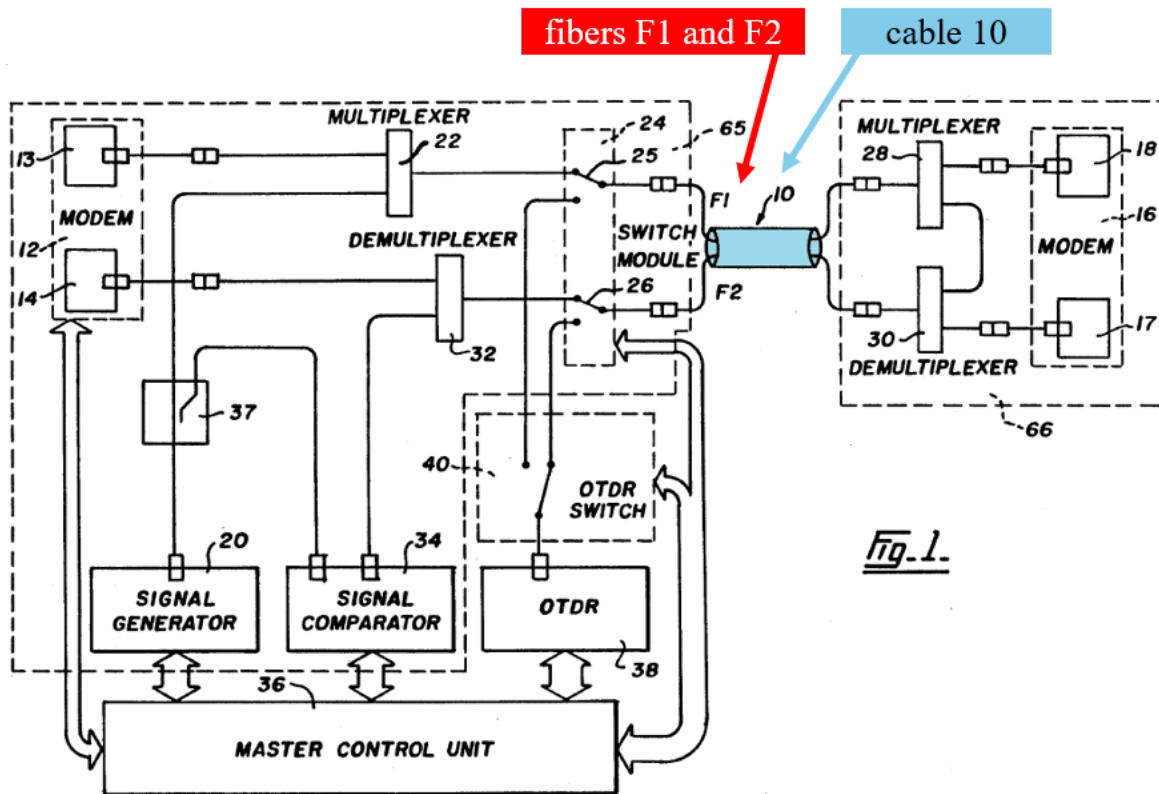
A POSA would have understood that any such break or intrusion would move the optical fibers. *Supra* §III.D; EX1003, ¶100.

Maycock discloses monitoring multiple fibers (F1/F2) in a single cable in Figure 1 and monitoring multiple fibers in multiple cables in Figures 4-5. EX1004, 3:62-4:42, 5:34-52, Figs. 1 & 4-5.

b. [1.1]

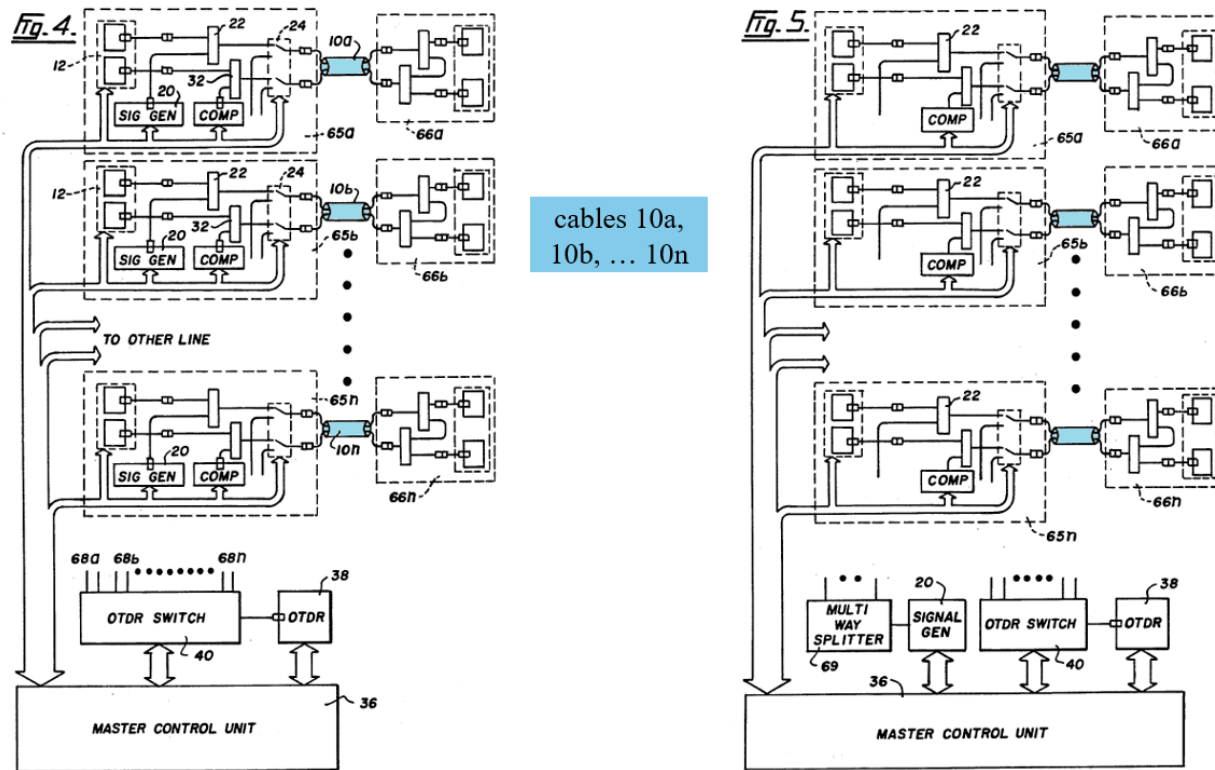
Maycock discloses an optical fiber cable (cable 10) having a “near end” (first end) and “remote end” (second end) where the monitoring system of cable 10

has fibers F1/F2 (a plurality of fibers) which extend from the near and remote ends:
ends:



EX1004, Fig. 1 (annotated), 3:63-4:9; 9:1-3 (“...means for connecting said optical monitor signal as an output signal to a **first end** of the fiber optic cable for transmission to a **second end** thereof...” (emphasis added).

In Figures 4-5, each cable (cables 10a-10n) has a near end (first end) and remote end (second end) and each cable has two fibers (unlabeled, but similar to F1/F2 of Figure 1), which extend from the near and remote ends:



EX1004, Figs. 4-5 (annotated), 5:34-52.

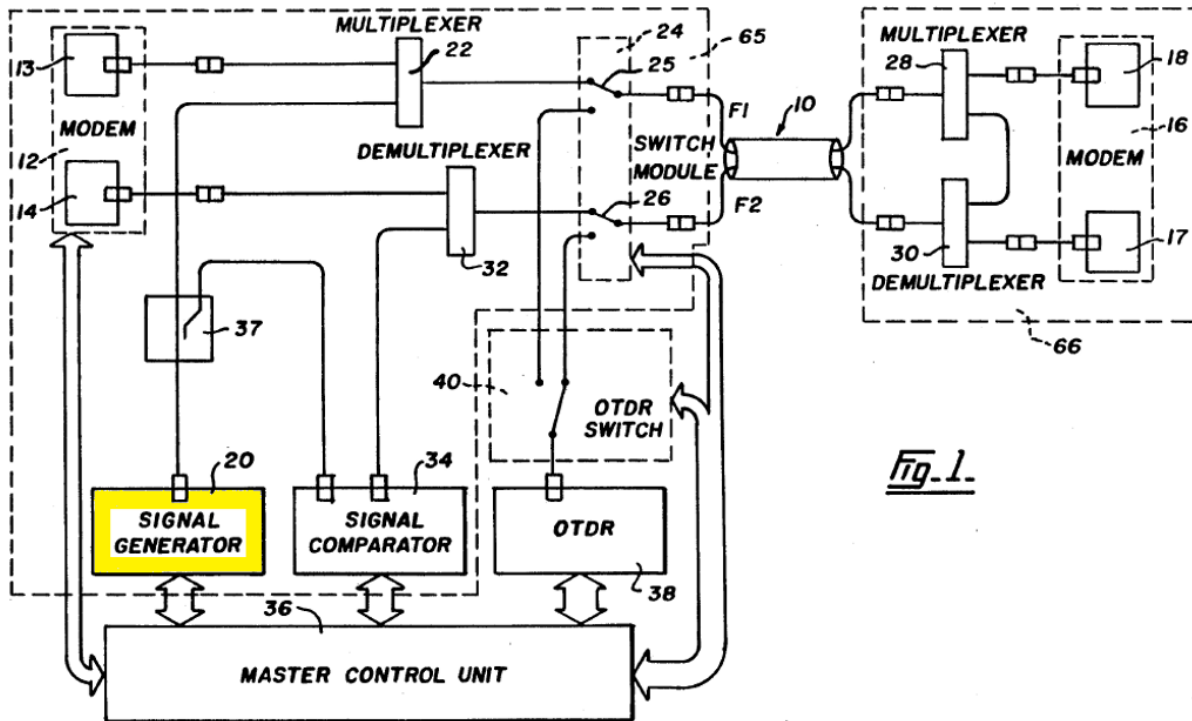
c. [1.2]

Maycock discloses monitoring fibers F1/F2 in cable 10 by detecting intrusions along the length of the fiber. EX1004, Abstract, 8:29-32, EX1003, ¶107. Maycock discloses a system that detects and locates “any unauthorized attempt to collect data from the cables,” which a POSA would understand constitutes detecting “movement” or “manipulation” of the cable. EX1004, 1:21-23, 3:61-67, 8:29-32, Fig. 1; EX1001, 4:8-8; EX1003, ¶¶107-108.

In Figures 4-5, at least two fibers of each cable are monitored in the same way as Figure 1. EX1004, 5:34-52, Figs. 4-5.

d. [1.3]

Maycock discloses “monitor signal generator 20” (source of light), which generates a “detection or monitor signal, comprising light”:



EX1004, Fig. 1 (annotated), 4:10-13.

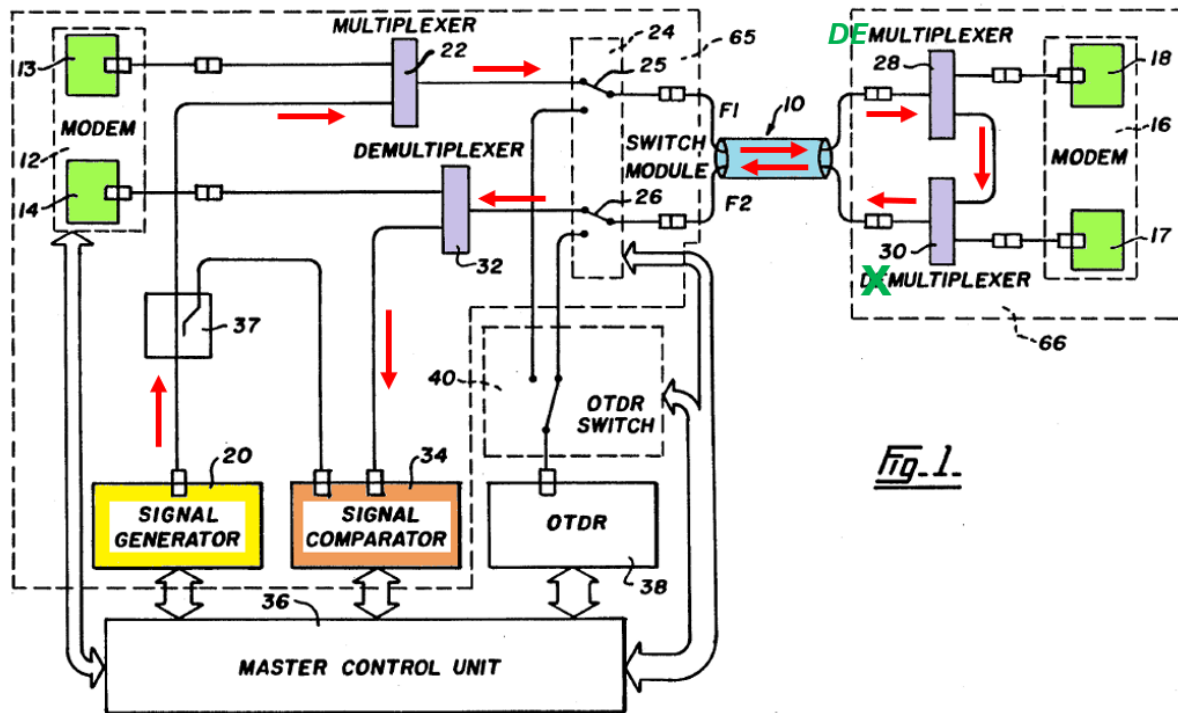
The signal generator 20 comprises “laser source 43” which may alternatively “may be replaced by a LED source.” EX1004, 4:54-60, Fig. 2.

Maycock discloses a detection signal (light) from the signal generator 20 is multiplexed with an optical transmission signal from transmitter 13 by multiplexer 22 and connected to cable 10 (and fiber F1) through switch 25 in signal path switch

module 24. EX1004, 4:14-22; Fig. 1. Thus, detection signal is injected onto F1 in this manner. *Id.*

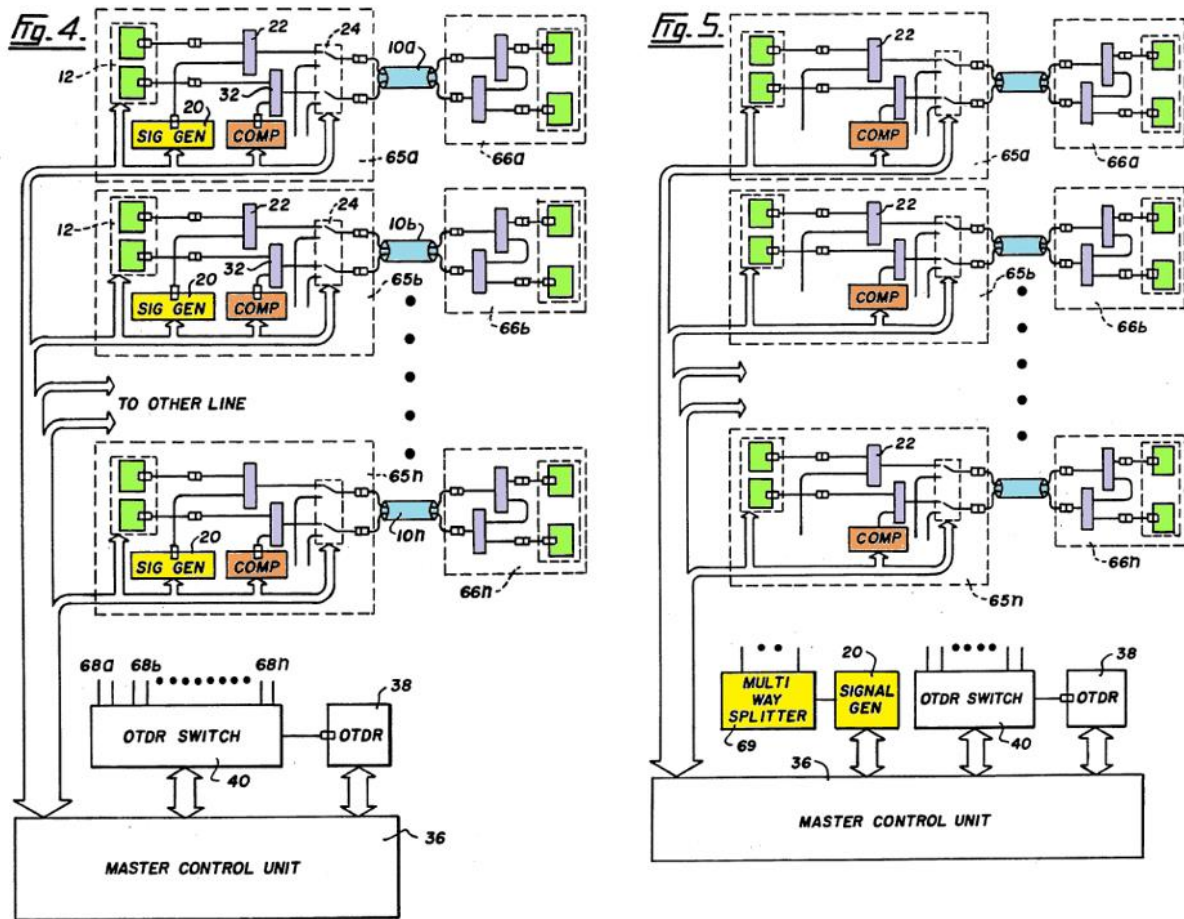
At the remote end of the cable (the second end), the multiplexed signal from F1 is demultiplexed with demultiplexer 28, which “separates the optical transmission signal from the detection signal.” EX1004, 4:23-33; Fig. 1.² The demultiplexed data transmission signal is supplied to receiver 18 and the demultiplexed detection signal is multiplexed with an optical transmission signal from transmitter 17 with multiplexer 30. *Id.* This multiplexed signal is connected to cable 10 (and fiber F2). *Id.* Thus, detection signal is injected onto F2 in this manner. *Id.*

² Maycock’s Figure 1 contains errors. *Supra* §VII.A.



EX1004, Fig. 1 (annotated).

In Figures 4-5, Maycock discloses the same system, but for monitoring multiple cables; in Figure 5, “common signal generator 67” can be used as a single source via a multi-way splitter:



Id., Figs. 4-5 (annotated), 5:34-52; EX1003, ¶¶114-115.

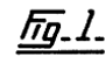
“When the system detects a fault or intrusion in the cable 10,” the master control unit 36 controls the switch module 24 to “immediately terminat[e] the transmission” of data/monitor signals from multiplexer 22 to fiber F1, and operates a switch module 40 to enable OTDR 38 to be used on any fibers monitored by the system. EX1004, 5:54-65. The master control unit “processes the output data of length versus attenuation, provided by the OTDR.” EX1004, 6:3-6 Accordingly,

after an intrusion is detected, the OTDR 38 operates as a light source and sensor arrangement. *Supra* §III.A.

***e.* [1.4]**

Maycock's discloses a "signal comparator 34" and "master control unit 36" (sensor arrangement for receiving light) that receives a "return detection signal" transmitted through the cable. EX1004, 4:34-43; Fig. 1. The multiplexed signal that travels on F2 is demultiplexed with demultiplexer 32 and the separated detection signal is connected to signal comparator 34. *Id.* This detection signal has been transmitted through fibers F1/F2. *Supra* §VIII.A.1.d.

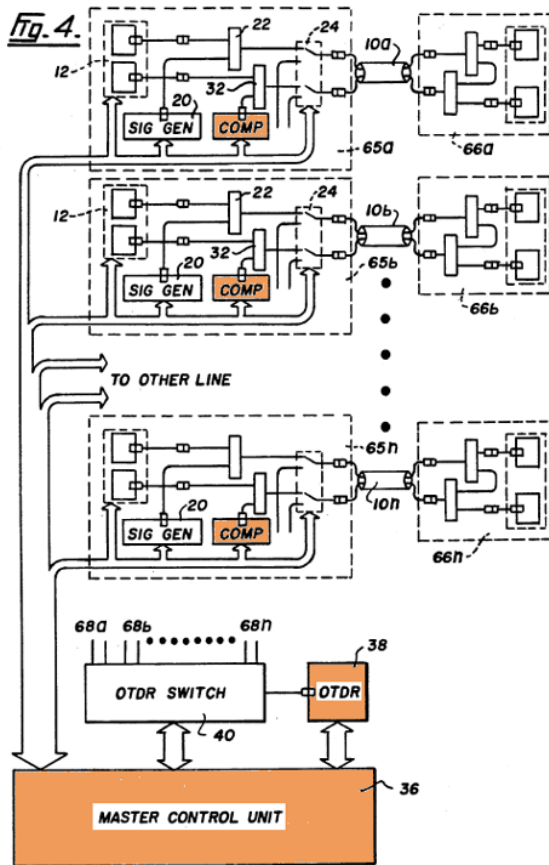
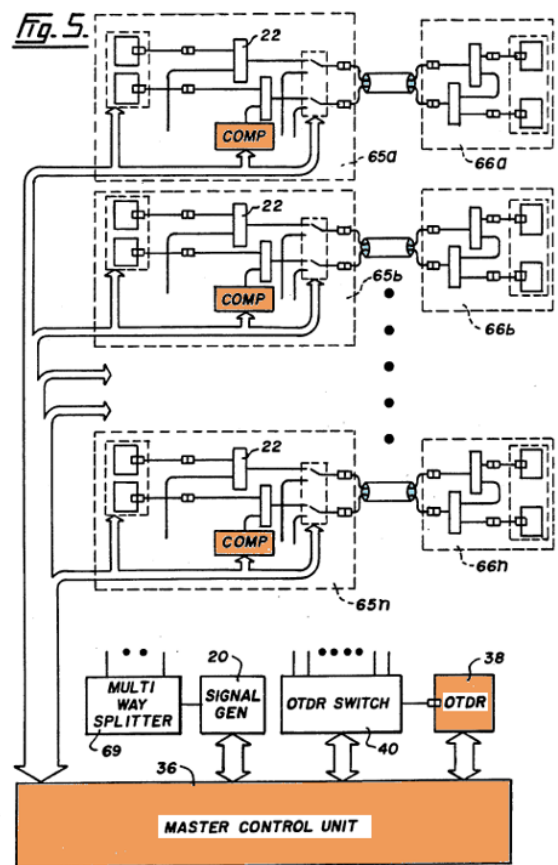
Signal comparator 34 includes "detector 31 for changing the optical return detection signal ... into an analog electrical signal." EX1004, 4:44-49. The "master control unit 36" processes data from the comparator, acting as part of the overall sensing and analysis arrangement. *Id.*, 6:3-6, 6:37-46.



EX1004, Fig. 1 (annotated); EX1003, ¶119.

Maycock discloses the functionality of signal comparator 34 “may be fulfilled by the master control unit 36.” *Id.*, 5:17-20.

In Figures 4-5, each cable has its own signal comparator 34 and share a single OTDR 38 and master control unit 36:



EX1004, Figs. 4-5 (annotated), 5:34-52; EX1003, ¶121.

Maycock teaches that OTDR 38 can be used on any fibers monitored by the system, (*supra* §VIII.A.1.d) such that the OTDR 38 can serve as a sensor arrangement. *Supra* §III.A.

f. [1.5]

The detection signal is injected into one end of each of the fibers to be monitored (F1/F2) of cable 10 and the source of light is signal generator 20. *Supra* §VIII.A.1.d; EX1004, 4:14-33; Fig. 1. The detection signal is injected into one end of F1 from switch 25 (which originates from signal generator 20). *Id.* The detection

signal is injected into one end of F2 from multiplexer 30 (which is transmitted from F1). *Id.*

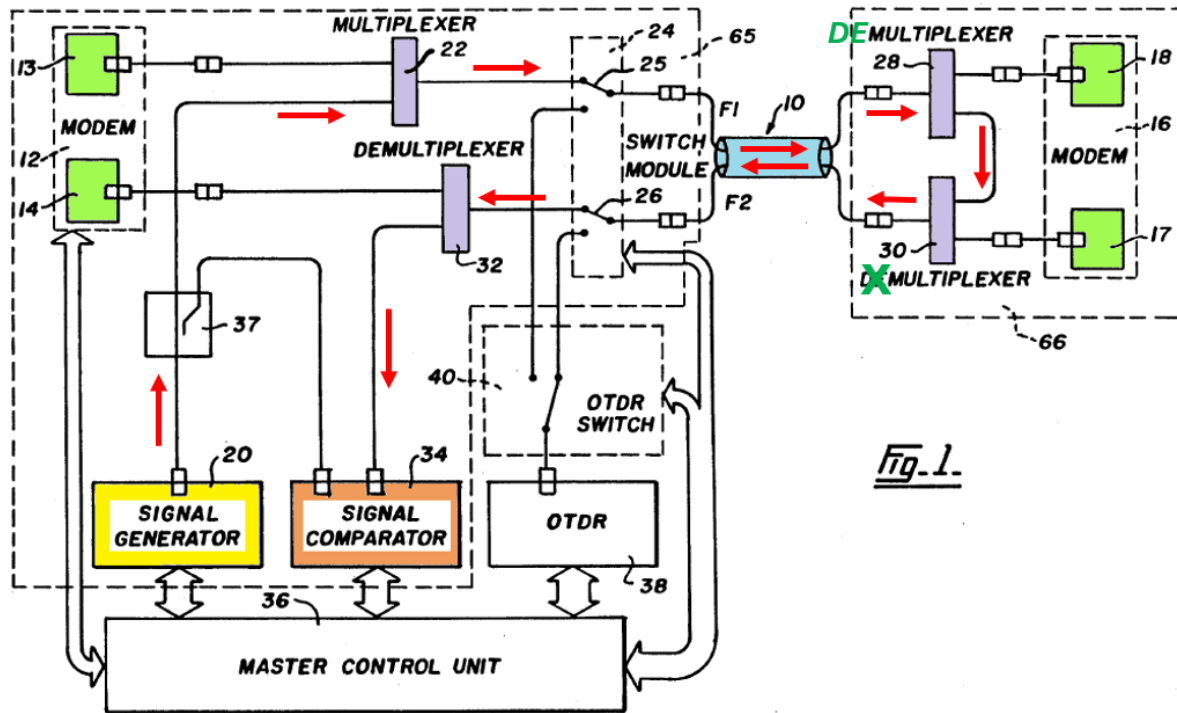
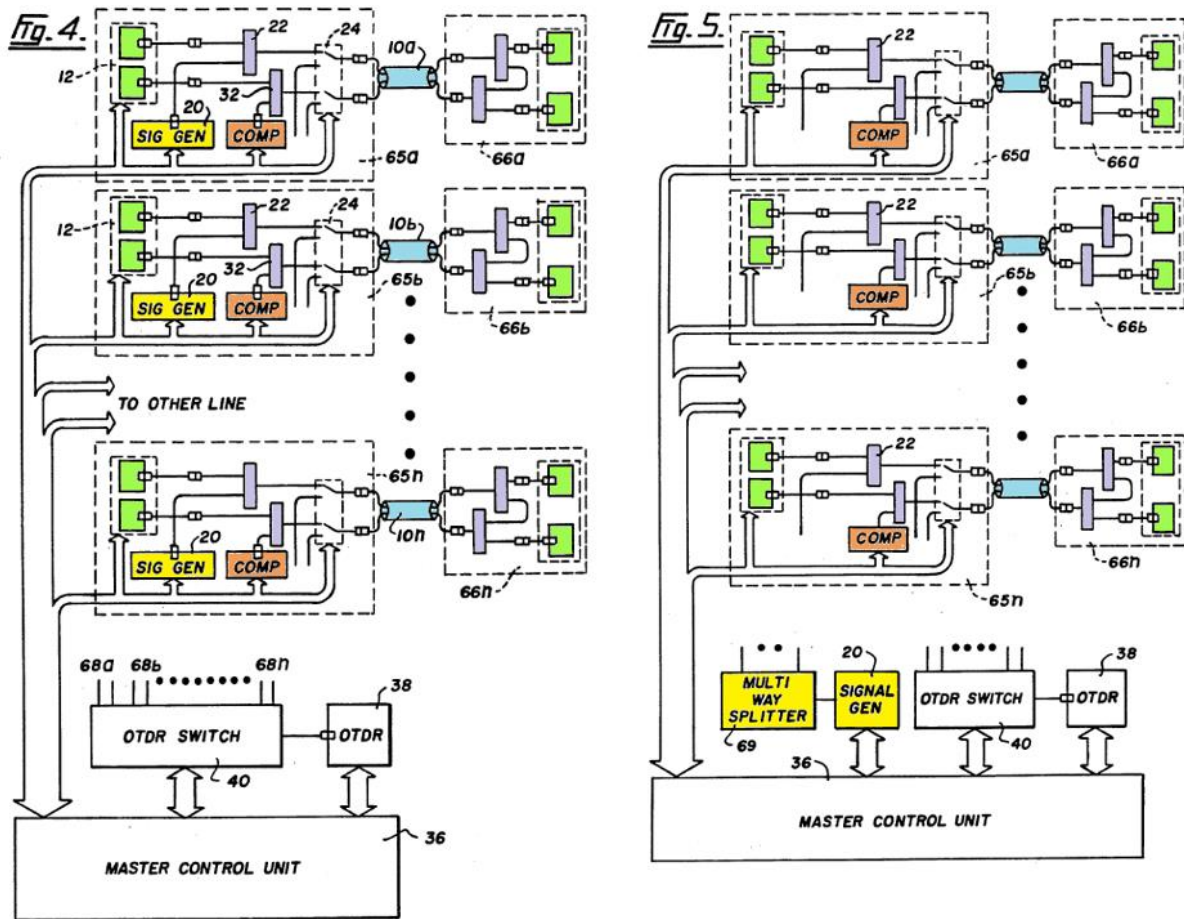


Fig. 1.

EX1004, Fig. 1 (annotated).

In Figure 4, each cable has a signal generator 20; in Figure 5 there is a common signal generator 67 that is connected through a “multi way splitter 69 to the multiplexer 22 of each near end unit 65a-65n”:

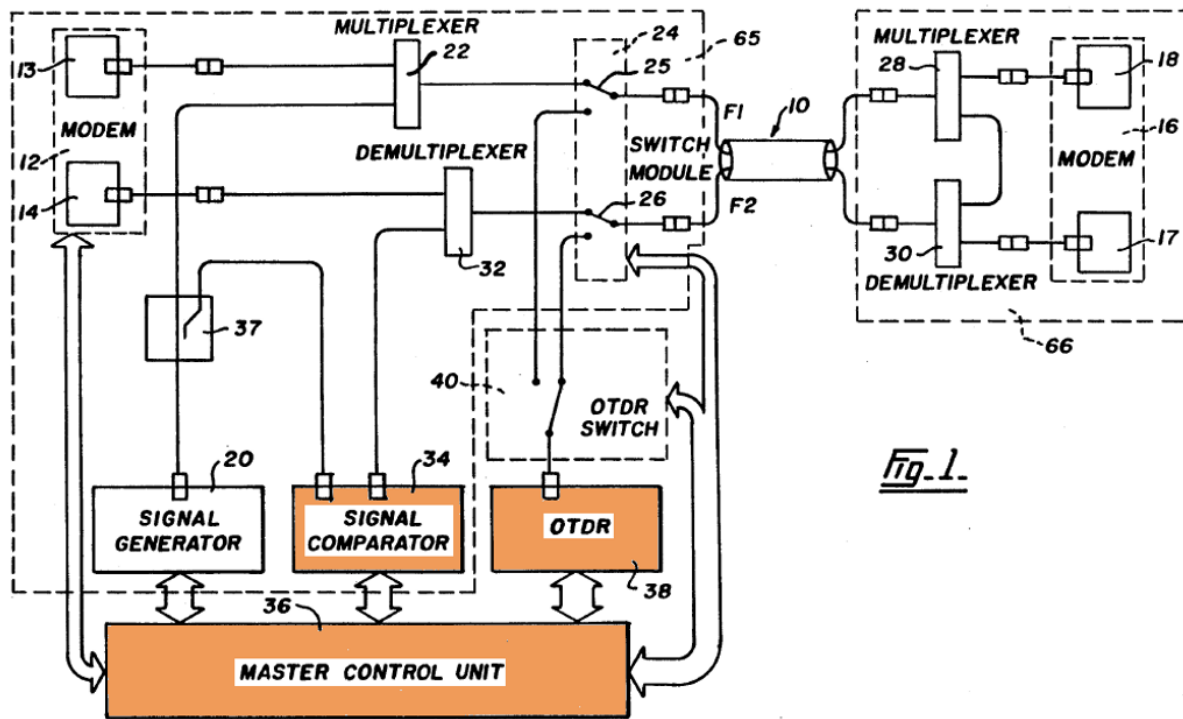


EX1004, Figs. 4-5 (annotated), 5:34-52; EX1003, ¶126.

Maycock teaches that OTDR 38 can be used on any fibers monitored by the system, (*supra* §§VIII.A.1.d-VIII.A.1.e) such that the OTDR 38 can inject light into any monitored fiber via OTDR switch 40. *Supra* §III.A.

g. [1.6]

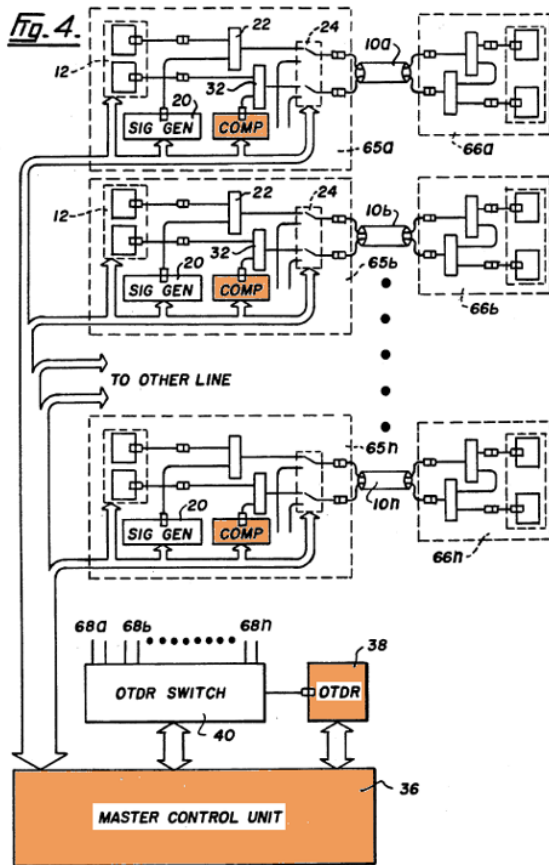
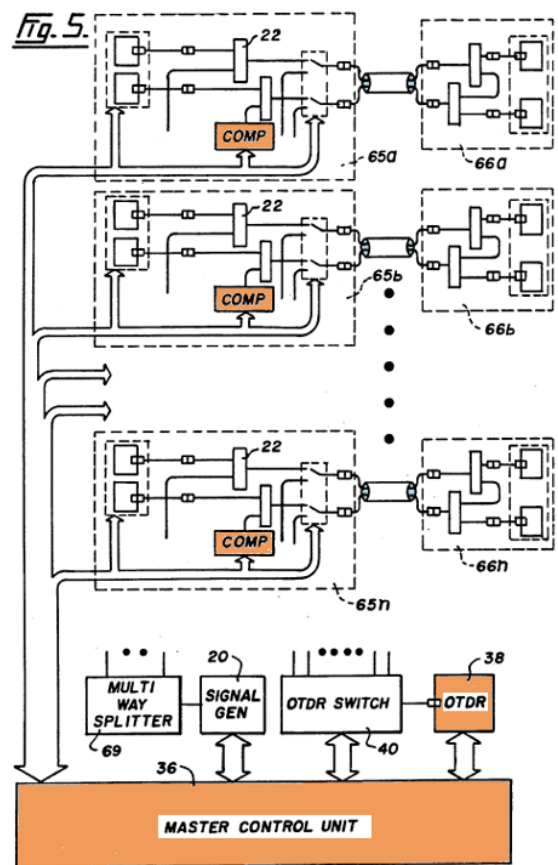
Maycock discloses comparator 34 and master control unit 36 detect a series of light pulse signals transmitted through the fibers. EX1004, 5:3-11, 5:12-20.



EX1004, Fig. 1 (annotated); EX1003, ¶129.

This series of light pulses travel along the fibers to be monitored (F1/F2) before reaching comparator 34. *Supra* §§VIII.A.1.d-VIII.A.1.e.

In Figures 4-5, each cable has its own signal comparator 34 and share a single OTDR 38 and master control unit 36:



EX1004, Figs. 4-5 (annotated), 5:34-52.

Maycock teaches that OTDR 38 can be used on any fibers monitored by the system, (*supra* §VIII.A.1.d) such that OTDR 38 can serve as a sensor arrangement to detect received light signals. *Supra* §III.A.

h. [1.7]

Maycock discloses comparing signals received by comparator 34 and master control unit 36 to “a reference value stored in a history file” whereby a different “level” is allocated to the received signal “depending on whether the value is higher than, lower than or equal to the reference value in the history file” and once

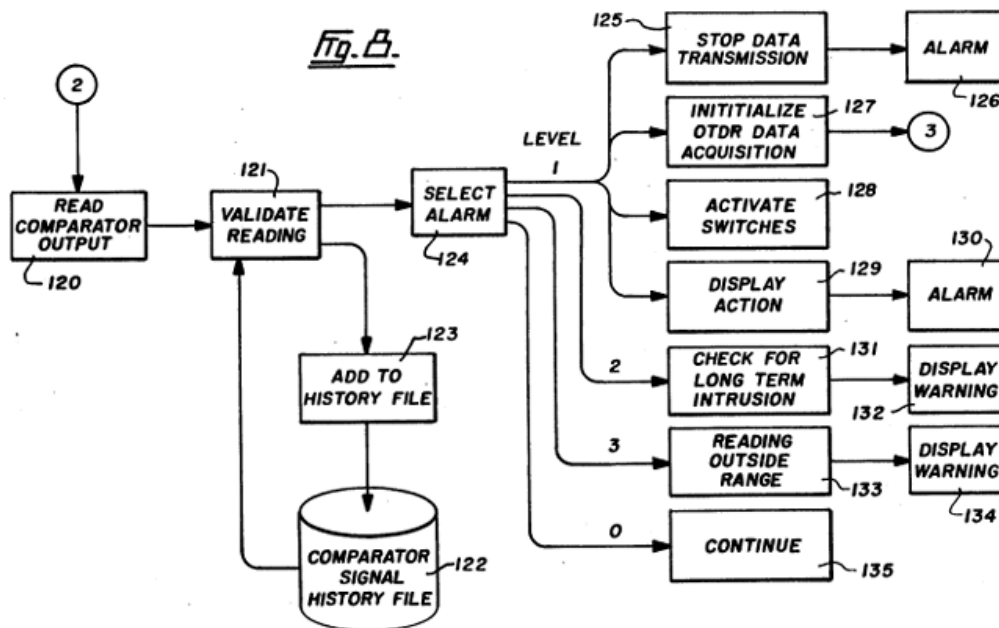
validated, the signal reading is “added to the comparator signal history file...to be available for future reference.” EX1004, 7:46-57, Fig. 8.

Thus, the received signals are compared to previously detected signals to detect changes. *Id.*; EX1003, ¶135.

i. [1.8]

Maycock discloses comparing received signals to previously received signals. *Supra* §VIII.A.1.h. Maycock teaches that master control unit 36 receives output from the comparator to validate and analyze the signals for those indicative of manipulation. EX1003, ¶137.

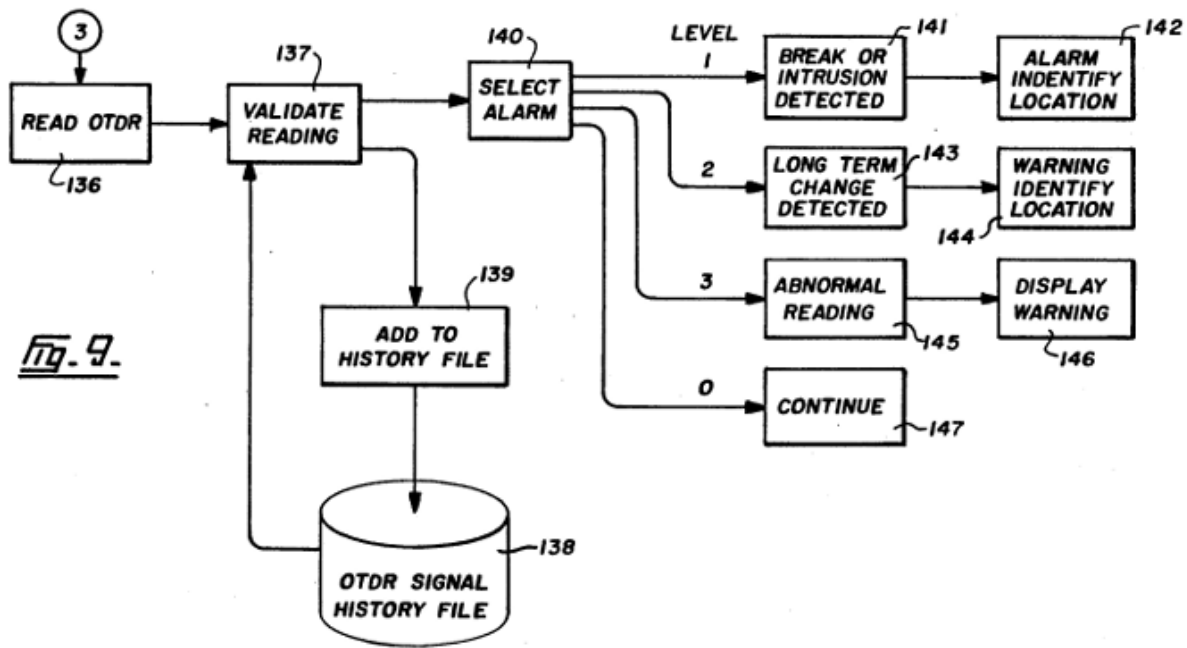
For example, Maycock teaches the master control unit analyzes the output from the comparator. EX1004, Fig. 8; EX1003, ¶138. Validation comprises “sampling and averaging, and comparing the average result to a reference value store in a history file” such that a “level” is allocated as higher, lower, or equal to the reference value—including whether the detected issue “represents detection of longterm intrusion,” an immediate intrusion concern, or simply outside a normal range:



EX1004, Fig. 8, 7:46-8:17.

Maycock teaches that signal changes trigger “operation of the OTDR.”

EX1004, 7:59-66. The “output from the OTDR 38 is read into the master control unit 36” and the data is analyzed “by comparison with reference data from an OTDR signal history file 138” which “consists of a statistical line fit to data using leased squares or another algorithm.” EX1004, 8:9-32, Fig. 9.



Accordingly, the OTDR uses an algorithm to analyze detected changes to determine if there was a “break or intrusion,” the “location of the intrusion,” whether the changes are indicative of a “long term change,” or other “abnormal reading is detected,” in other words, which changes are indicative of manipulation/movement of the optical fiber. EX1004, 8:28-38; EX1003, ¶140; *supra* §III.D.

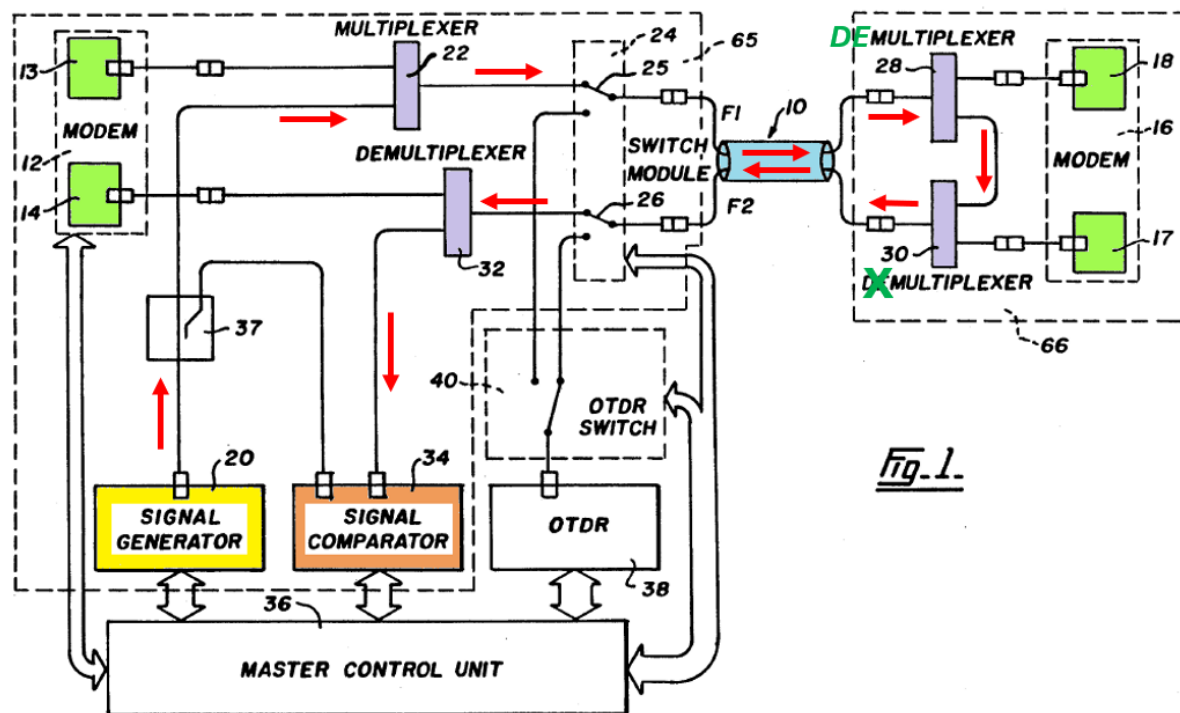
j. [1.9]

Maycock discloses that where the compared signal indicates an intrusion “an alarm is provided and the location of the intrusion is identified.” EX1004, 8:17-33, Figs. 8-9.

k. [1.10]

Maycock discloses a single signal generator 20 with light source 43 (*supra* §VIII.A.1.d) for injecting light into a plurality of fibers (F1/F2) (*id.*), and a single sensor arrangement comprising comparator 34 and master control unit 36 (*supra* §VIII.A.1.e), such that one light source and one sensor arrangement monitors two or more optical fibers (e.g., F1/F2). *Id.*

Maycock discloses use of switches (e.g., “two 2-way switches 25 and 26” in “switch module 24”) as well as a connection jumper cable connecting the far ends of fibers F1/F2 (*supra* §VIII.A.1.f; *infra* §VIII.A.2) as optical communication components that allow light from the signal generator to be communicated to both fibers F1/F2:



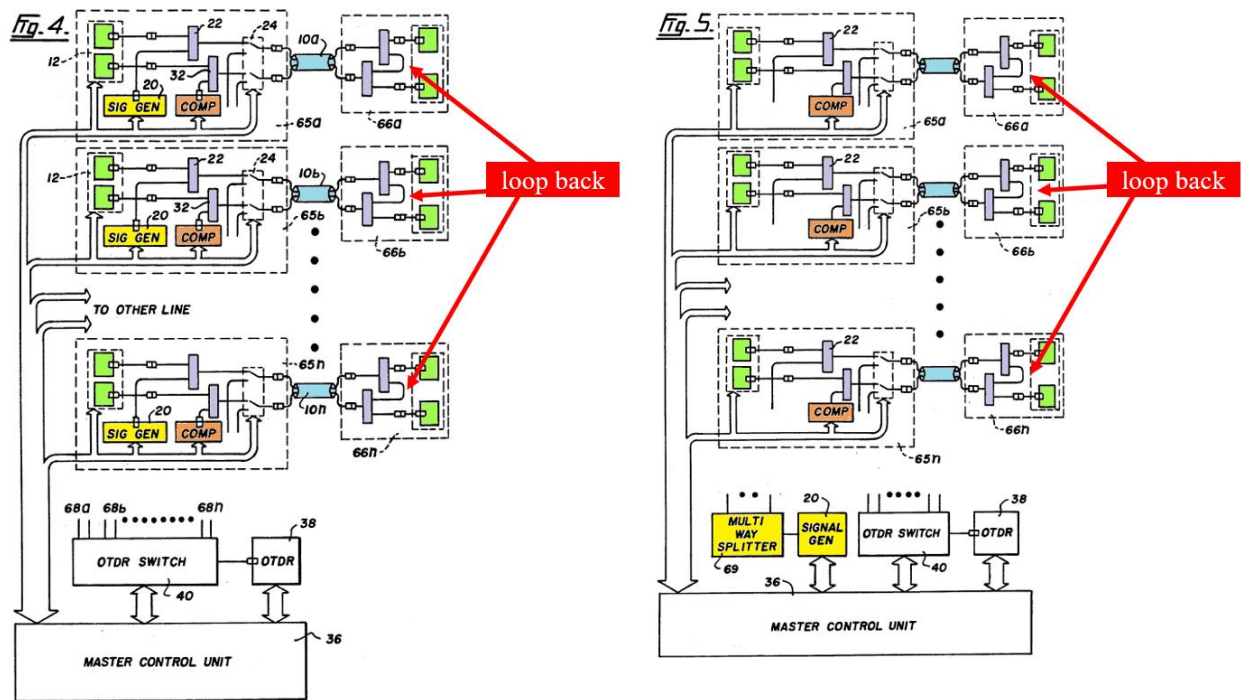
EX1004, Fig. 1 (annotated), 4:14-23; EX1003, ¶145.

This element is also met by the embodiments shown in Figures 4-5.

EX1003, ¶146.

In Figure 4, there is one light source (signal generator 20) and one signal comparator 34 (part of the sensor arrangement) to monitor two fibers of each cable. EX1004, 5:34-52, Fig. 4. There is a single OTDR 38 and a single master control unit 36 for all of the cables. *Id.* Therefore, Maycock's Figure 4 discloses monitoring six fibers with only three signal generators 20 and only three signal comparators 34. *Id.*, Fig. 4; EX1003, ¶147.

In Figure 5, there is only one light source (signal generator 20) for all of the cables (six fibers shown in Figure 5) and there is one signal comparator 34 (part of the sensor arrangement) to monitor two fibers of each cable. EX1004, 5:34-52, Fig. 5. There is a single OTDR 38 and a single master control unit 36 for all of the cables. *Id.* Therefore, Maycock's Figure 5 discloses monitoring six fibers with only one signal generator 20 and only three signal comparators 34. *Id.*, Fig. 5; EX1003, ¶148.



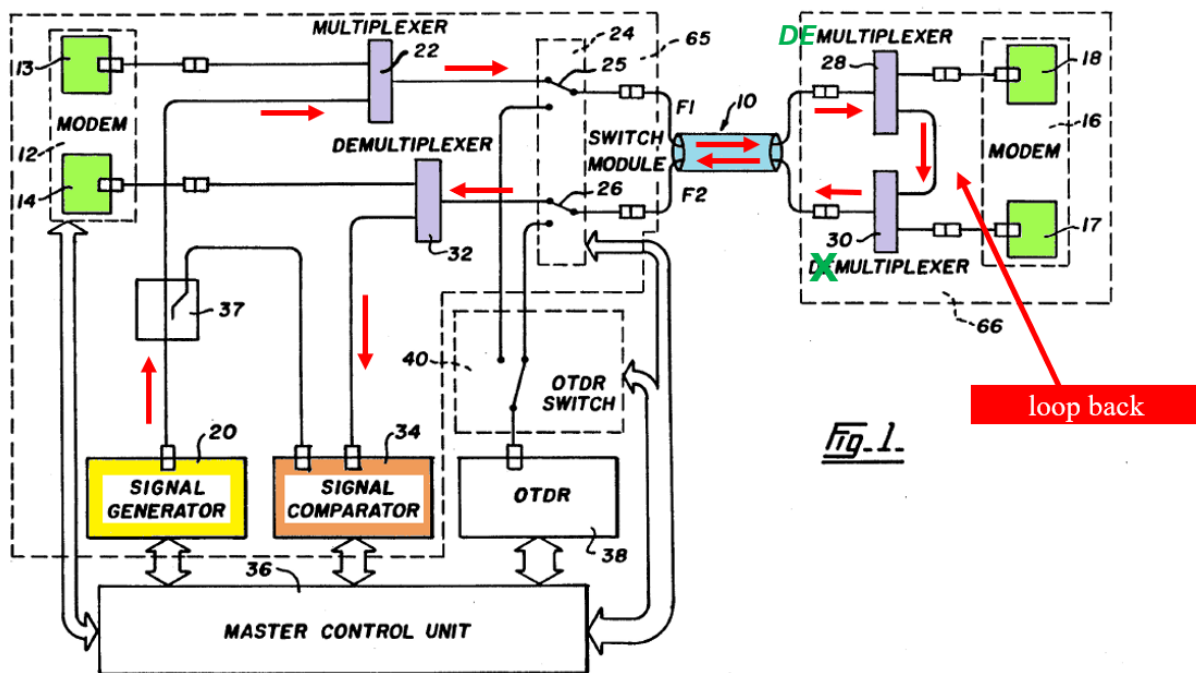
EX1004, Figs. 4-5 (annotated).

Alternatively, even if OTDR 38 is counted as a separate light source and sensor arrangement (*supra* §§VIII.A.1.d-VIII.A.1.e), Maycock's Figures 4-5 disclose monitoring more fibers (i.e., six fibers, fibers F1/F2 in each cable) than light sources (i.e., two light sources, including the signal generator 20 and OTDR 38) and sensor arrangements (i.e. four sensor arrangements, including three signal comparators 34 and the OTDR 38). EX1003, ¶149.

Maycock discloses that its "system may be configured to monitor as many fibers as can be selected by the OTDR switch 40," indicating that more fibers of the cable could be monitored without increasing the number of light sources or sensor arrangements. EX1004, 6:47-49.

2. Claim 2

Maycock discloses injecting light from signal generator 20 into one end of F1 (from switch 25), and the light travels along the cable and enters F2 via a jumper at the remote end (second end) of the cable connection after the detection monitor signal is separated from the optical transmission signal via demultiplexer 28 and multiplexed via multiplexer 30 with optical transmission signal from transmitter 17:



EX1004, Fig. 1 (annotated), 4:23-43; EX1003, ¶152; *supra* §VIII.A.1.f.

In this manner, the detection signal is injected into one end of F1 at the first of end of cable, exits F1 at the remote end (second end) of cable 10, loops into fiber F2 via the jumper at the remote end of cable 10, such that signal generator 20

serves as a common signal source of light for both fibers F1/F2. *Id.*; EX1003, ¶153.

3. Claim 8

a. [8.0]-[8.8]

See [1.0], [1.3]-[1.10]. *Supra* §§VIII.A.1.a, VIII.A.1.d-VIII.A.1.k.

b. [8.9]

Maycock discloses locating a detected intrusion/movement by processing data including “length versus attenuation, provided by the OTDR” where the OTDR is the “locating arrangement for detecting the location” of the detected intrusion. EX1004, 6:3-6. Accordingly, a POSA would have understood that the OTDR and master control unit contains the claimed “table of fiber lengths” to accommodate such analysis. EX1004, 7:63-8:2, Fig. 9; EX1003, ¶158. For example, it was well known in the art that OTDR devices calculate and store fiber lengths in the OTDR internal memory for use in setting test parameters and later retrieved for event analysis or pass/fail comparison. *Supra* §III.A; EX1003, ¶158.

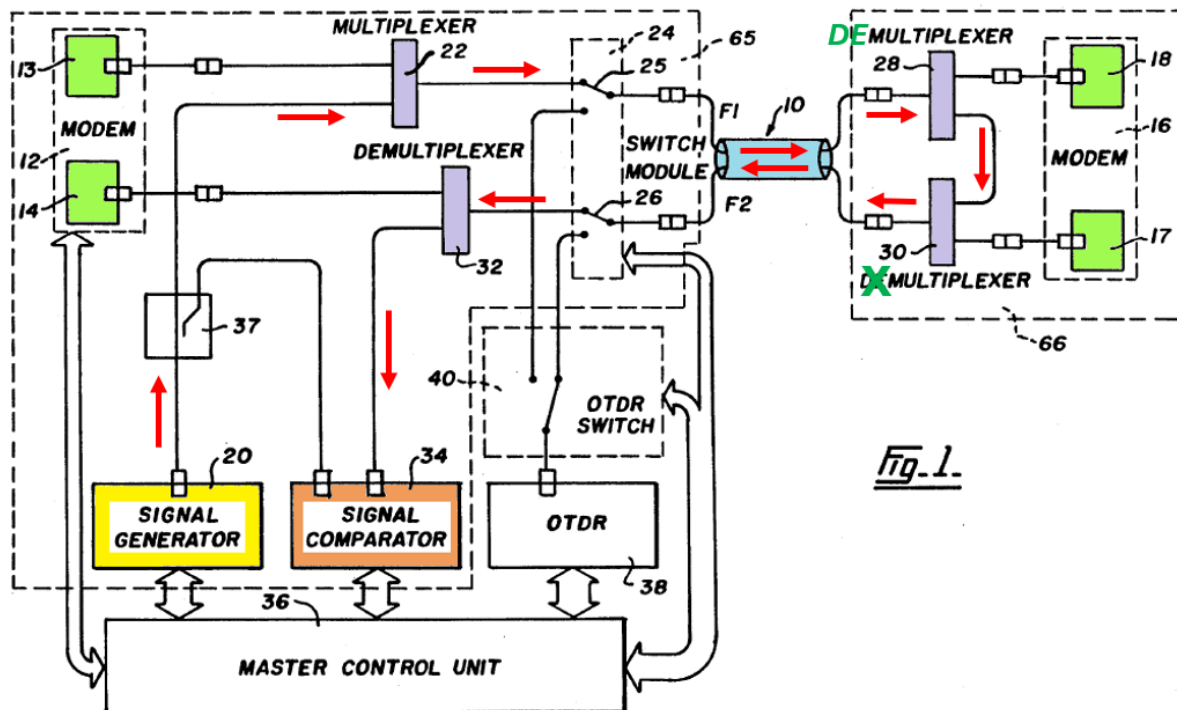
4. Claim 9

a. [9.0]-[9.8]

See [1.0], [1.3]-[1.10]. *Supra* §§VIII.A.1.a, VIII.A.1.d-VIII.A.1.k.

b. [9.9]

Maycock discloses a plurality of WDMs (multiplexers 22 and 30; demultiplexers 28 and 32). EX1004, Fig. 1. Each monitored fiber (F1/F2) has a WDM at an entry end and an exit end:



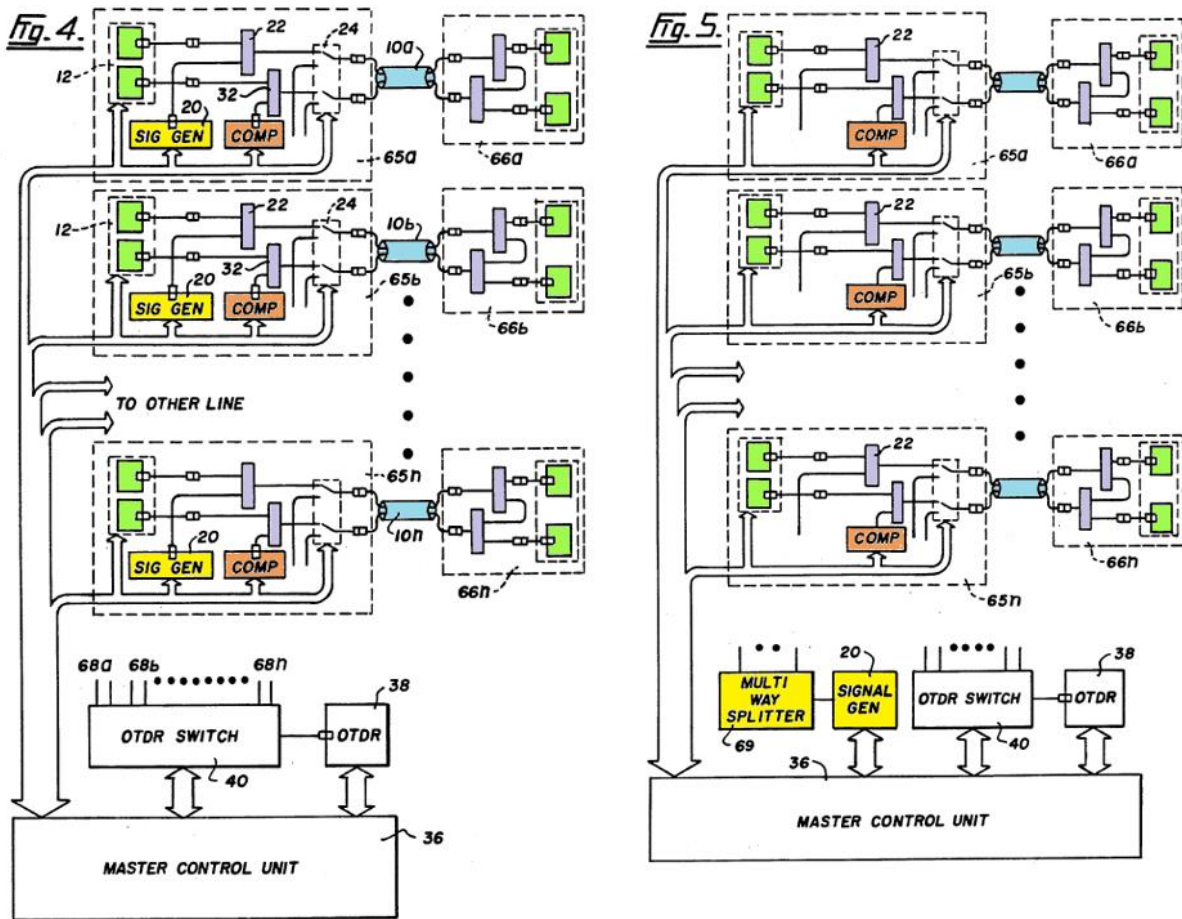
EX1004, Fig. 1 (annotated), 4:14-37; EX1003, ¶163.

Fiber F1 has multiplexer 22 at an entry end that multiplexes the monitoring light from signal generator 20 with the data signal from transmitter 13. EX1004, 4:14-37; Fig. 1. The two signals are transmitted simultaneously through F1 as a multiplexed signal. *Id.* Fiber F1 has a demultiplexer 28 at its exit end that demultiplexes the monitoring light from the data signal. *Id.* Thus, F1 has a pair of

WDMs (multiplexer 22/demultiplexer 28); demultiplexer 28 separates the data signal from the monitoring light. *Id.*; EX1003, ¶164.

Fiber F2 has a multiplexer 30 that multiplexes the monitoring light (from F1, which originated from signal generator 20) with the data signal from transmitter 17. *Id.* The two signals are transmitted simultaneously through F1 as a multiplexed signal. *Id.* Fiber F2 has a demultiplexer 32 at its exit end that demultiplexes the monitoring light from the data signal. *Id.* Thus, F2 has a pair of WDMs (multiplexer 30/demultiplexer 32); demultiplexer 32 separates the data signal from the monitoring light. *Id.*; EX1003, ¶165.

In Figures 4-5, each fiber of each cable has a pair of WDMs as described for fibers F1/F2 of Figure 1:



EX1004, Figs 4-5 (annotated), 5:34-52.

To the extent it is argued Maycock does not expressly disclose use of WDMs, it would have been obvious to a POSA that Maycock's multiplexing/demultiplexing devices could be WDMs. EX1003, ¶167. At the time of the invention, it was well-known that a multiplexer/demultiplexer as shown in Maycock (i.e., different wavelength monitor and transmission signals being combined) could be, and routinely was, implemented as a WDM when the combined signals were at different wavelengths. *Id.* The detection signal in

Maycock is explicitly described as “light of a wavelength different from that of the data transmission signal” (EX1004, 4:10-13), which is exactly the input condition for a wavelength-selective WDM. *Id.*

A POSA would have found it obvious to use WDMs where Maycock discloses multiplexers/demultiplexers, because WDMs were widely available as off-the-shelf parts before the relevant date, and substituting such a WDM for the general multiplexer/demultiplexer in Maycock would have been a simple, predictable design choice to achieve low-loss wavelength combining/separation in the same network arrangement. *Supra* §§III.B, III.E; EX1003, ¶168.

5. Claim 10

Maycock discloses the transmission on fibers F1/F2. EX1004, 4:14-37; Fig. 1. The transmission on F1 is the multiplexed signal of the detection signal from the signal generator 20 (the monitor wavelength of the light source) and the optical transmission signal (the data wavelength) from transmitter 13. *Id.*

The transmission of F2 is the multiplexed signal of the detection signal from the signal generator 20 (that has been transmitted via fiber F1) and the optical transmission signal from transmitter 17. *Id.*

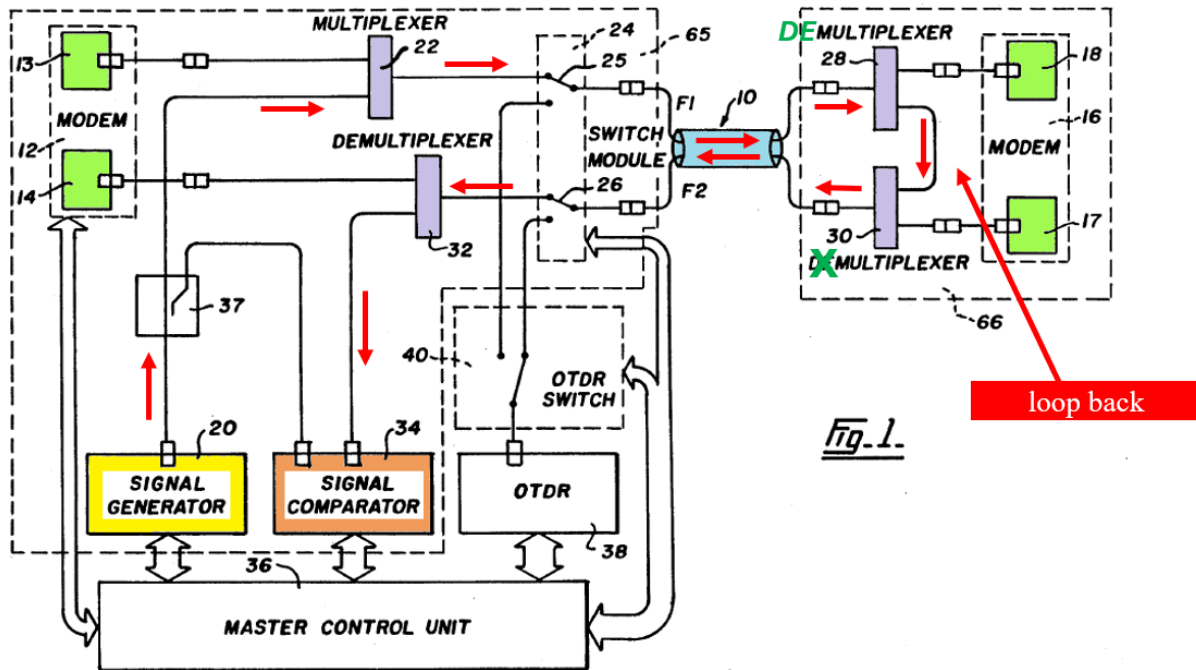
Maycock does not disclose any other transmission on monitored cable (cable 10), other than in operating the OTDR after an alarm. *See generally* EX1004; EX1003, ¶172.

In Figures 4-5, the transmission on the fibers is the same as fibers F1/F2, respectively (the monitor wavelength of the light source multiplexed to the data wavelength). *Id.*; *id.*, 5:34-52, Figs. 4-5.

Maycock does not disclose any other transmission on monitored cables Figures 4-5, other than in operating the OTDR after an alarm. *See generally* EX1004.

6. Claim 11

Maycock discloses a loop-back between WDMs (between demultiplexer 28 and multiplexer 30). EX1004, 4:14-37; Fig. 1; EX1003, ¶176. This loop-back is at the monitor wavelength because the optical transmission signal has been separated from the monitor signal using demultiplexer 28, and only the monitor signal is transmitted on the loop-back. *Id.* Therefore, the only loop-back in Figure 1 is at the monitor wavelength:



EX1004, Fig. 1 (annotated), 4:14-37; EX1003, ¶176.

In Figures 4-5, the transmission on each loop-back is the same as show in Figure 1 (at the monitor wavelength). EX1004, 4:14-37, 5:34-52; Figs. 1 & 4-5. Therefore, all loop-backs between WDMs in Figures 4-5 are at the monitor wavelength:



EX1004, Figs. 4-5 (annotated), 4:14-37, 5:34-52; EX1003, ¶177.

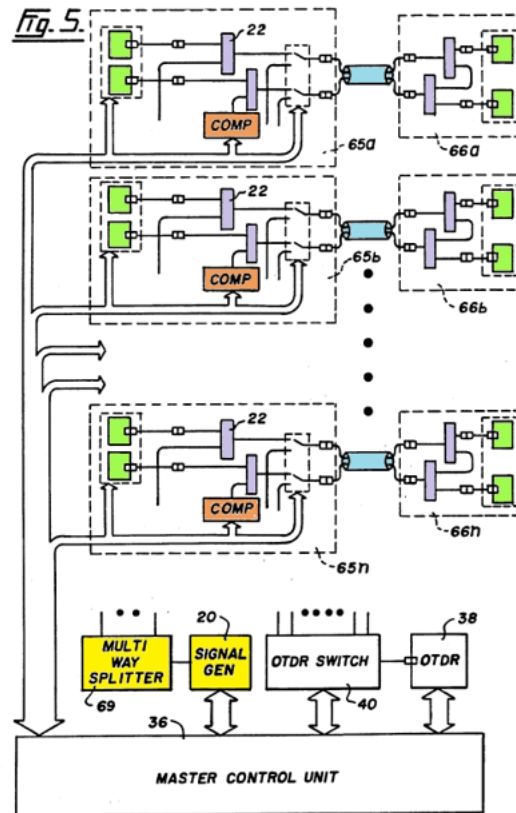
7. Claim 12

a. [12.0]

See [1.0]. Supra §VIII.A.1.a.

b. [12.1]

In Figure 5, Maycock discloses a plurality of optical fiber cables arranged in a hub-and-spoke arrangement where the cables extend from multi-way splitter 69 to multiplexers 22 at near end units 65a-65n:



EX1004, Fig. 5 (annotated); EX1003, ¶182.

The main unit at a central location includes multi-way splitter 69 and signal generator 20. EX1004, Fig. 5. Cables extend from multi-way splitter in a hub-and-spoke arrangement to a plurality of remote units, such as multiplexers 22. EX1004, Figs. 1 & 5.

The multiplexed signal is transmitted on cables 10a-10n to further remote units, including demultiplexers 28 and modems 16 at each far end unit 66a-66n.

EX1004, Figs. 1 & 5.

c. [12.2]/[12.3]

See [1.1]/[1.2]. *Supra* §§VIII.A.1.b-VIII.A.1.c.

d. [12.4]

See [1.3]. *Supra* §VIII.A.1.d.

Maycock's source of light for injection onto the fibers is at the main unit.

Supra §VIII.A.7.b.

e. [12.5]

See [1.4]. *Supra* §VIII.A.1.e

f. [12.6]

See [1.5]. *Supra* §VIII.A.1.f.

Maycock's source of light for injecting into the fibers to be monitored is at the main unit. *Supra* §VIII.A.7.b.

g. [12.7]-[12.10]

See [1.6]-[1.9]. *Supra* §§VIII.A.1.g-VIII.A.1.j.

h. [12.11]/[12.12]

See [1.10]. *Supra* §VIII.A.1.k.

Maycock's source of light for monitoring the cables is at the main unit.

Supra §VIII.A.7.b.

8. Claim 13

a. [13.0]-[13.8]

See [1.0], [1.3]-[1.10]. *Supra* §§VIII.A.1.a, VIII.A.1.d-VIII.A.1.k.

b. [13.9]

Maycock discloses optical switches at an end of the fibers F1/F2 to be monitored. EX1004, 4:14-24, Figs. 1 & 4-5. Maycock discloses “switch module 24” that “includes two 2-way switches 25 and 26” (plurality of optical switches) that control the connection to F1 and F2 at their respective ends:

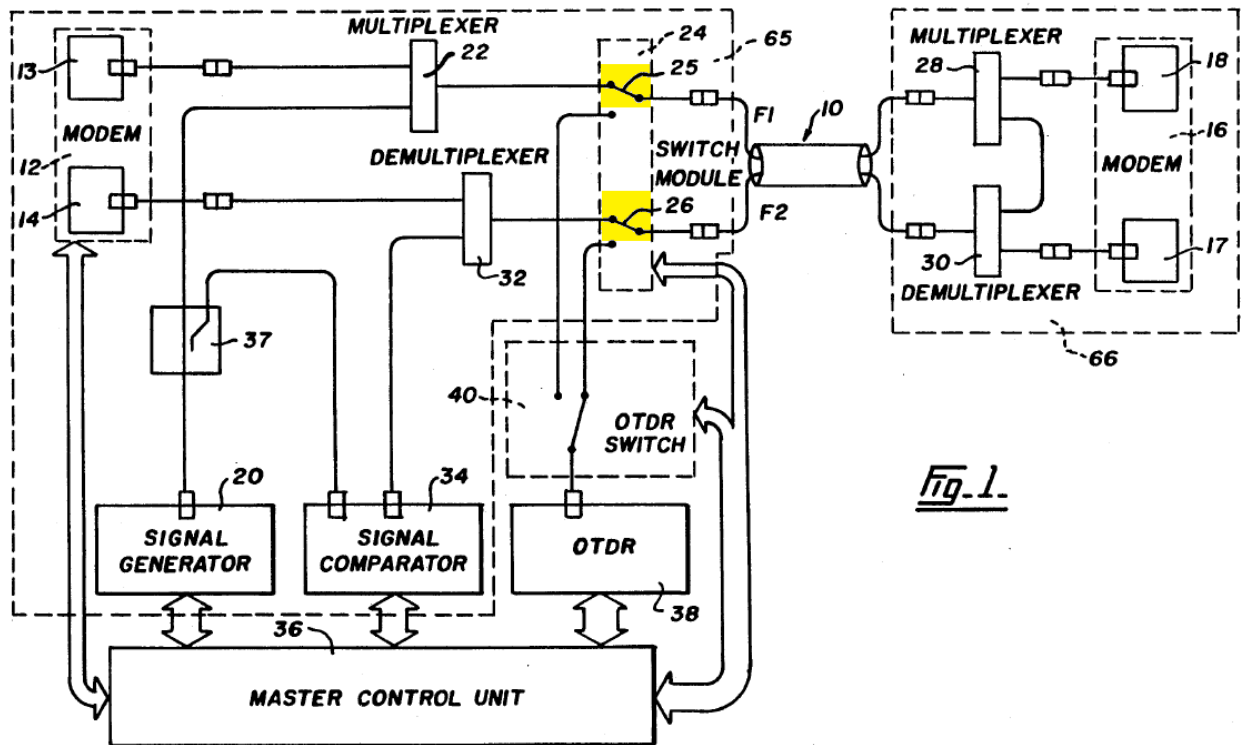


Fig. 1.

EX1004, Fig. 1 (annotated), 4:14-24; EX1003, ¶201.

9. Claim 14

Maycock discloses that “[w]hen the system detects a fault or intrusion in the cable 10, the master control unit 36 controls the switch module 24 so as to disconnect the multiplexer 22 and the demultiplexer 32 from the cable 10, thus

immediately terminating the transmission of data through the cable 10.” EX1004, 5:54-59.

Therefore, switch module 24 containing two 2-way switches 25 and 26 terminates the transmission, breaking the circuit. EX1004, 7:9-62, Figs. 1 & 4-5; EX1003, ¶204.

10. Claim 15

Maycock discloses switch module 24 with switches 25 and 26, as well as OTDR switch 40 that allow “OTDR 38 to be used on either of the two fibers F1/F2 of the cable 10, or on the fibers of other fiber optic cables being similarly monitored, the number of the cables being dependent on the number of ports of the OTDR switch 40.” EX1004, 8:41-61; Figs. 2 & 4-5. Thus, Maycock discloses that if F1 has a broken link, the switches can redirect the monitor wavelength of the OTDR to F2, thereby bypassing F1, and vice versa. *Id.*; EX1003, ¶206.

11. Claim 16

Maycock discloses that F1 is connected to switch 25 and F2 is connected to switch 26, and both switch 25 and 26 are connected to master control unit:

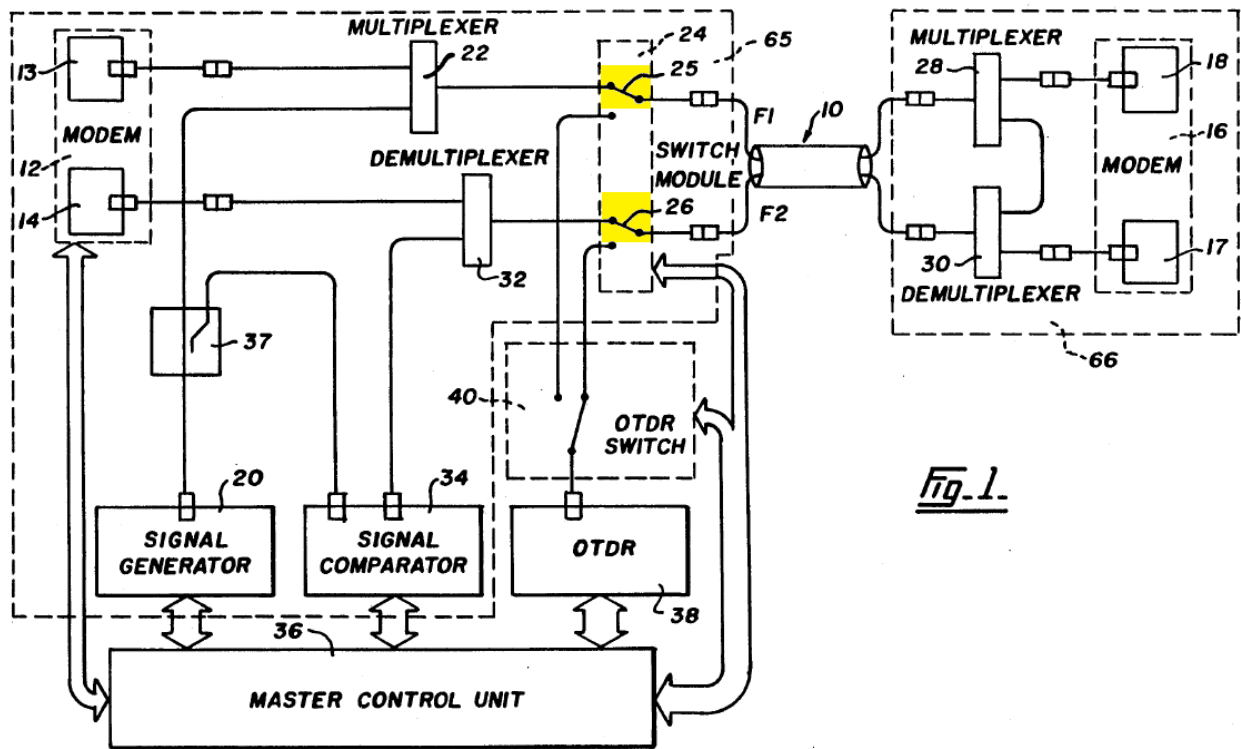


Fig. 1.

EX1004, Fig. 1 (annotated).

A POSA would have understood that switches 25 and 26 detect whether there is transmission or no transmission on the cables connected to it. EX1003, ¶209. If there is an intrusion on F1 that stops transmission, switch 25 would detect a lack of transmission through F1. *Id.* Similarly, if there is an intrusion on F2 that stops transmission, switch 26 would detect a lack of transmission on F2. *Id.* Accordingly, Maycock's switches 25 and 26 are arranged to identify which one of F1 or F2 has been intruded, precluding the need for locating. *Id.*

In Figures 4-5, the switches used for each fiber of each cable would likewise identify which fiber/cable had been intruded, precluding the need for locating. *Id.*,

¶210. If F1 of the first cable were intruded, then transmission would stop along that fiber, but the remaining fibers of the other monitored cables would still be transmitting. *Id.*

B. Ground 2

Claims 1-2 and 8 of the '641 Patent are invalid as anticipated and/or obvious over Evans. EX1003, ¶¶211-265.

1. Claim 1

a. [1.0]

Evans discloses a fiber optic cable monitoring system to provide “an immediate alarm indicative of any tampering” with the cable. EX1006, Abstract, [0006].

A POSA would have understood that any such tampering would move the fibers. *Supra* §III.D; EX1003, ¶214.

b. [1.1]

Evans discloses a fiber optic cable that includes “eight silica-glass based multimodal optical fibers (12)” (plurality of fibers) “uniformly spaced about the circumference” of the cable and “transmission fibers (3)” that carry data transmission:

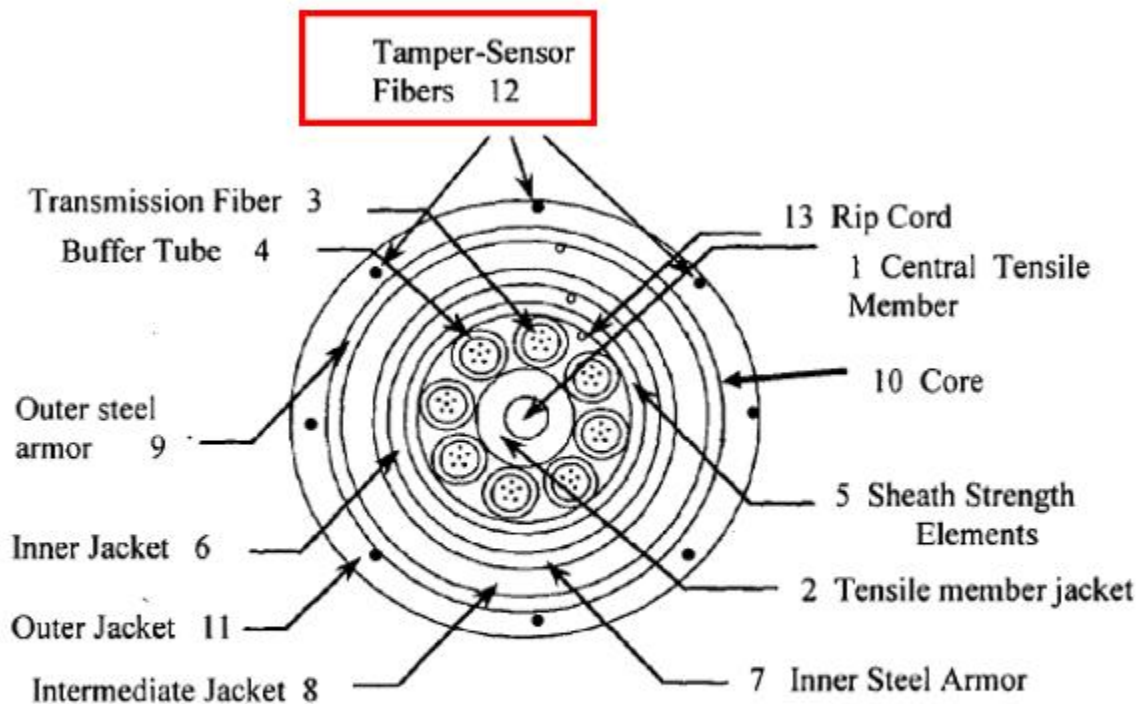
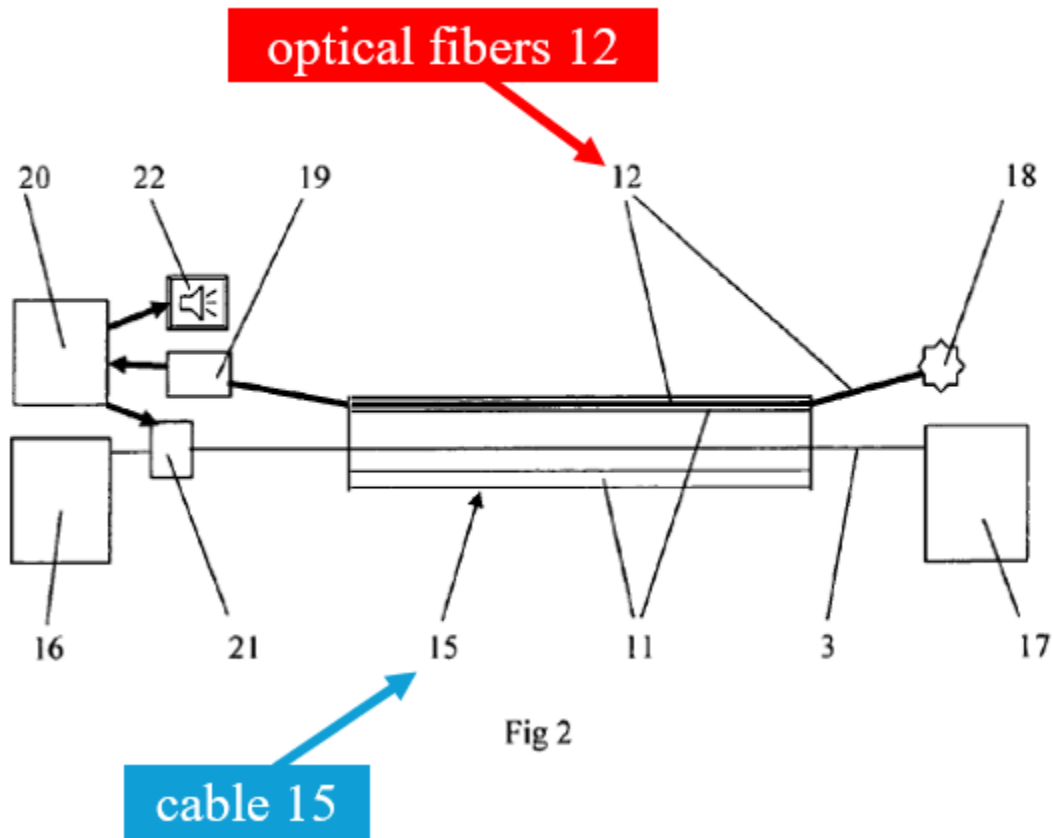


Fig 1

EX1006, Fig. 1 (annotated), [0035], [0032].

In Figure 2, optical fibers 12 of cable 15 extend “between a data transmitter 16” at one end and “receiver 17” at a second end:



EX1006, Fig. 2 (annotated), [0036], Figs. 3-8 (other embodiments).

c. [1.2]

Evans discloses a system to detect “tampering with the cable,” which is specifically designed with “a sufficient number of optical fibers 12 for tamper sensing purposes to ensure that there is minimal risk that an opening sufficiently large to enable the cable to be tapped can be made through the jacket without breaking or damaging at least one of these invisible fibers.” EX1006, [0032]. Evans

discloses “[a] single fiber may be adequate, . . . , but in most cases a plurality of fibers distributed around the circumference of the cable will be preferred.” *Id.*, [0014].

Optical fibers 12 are referred to as the “monitoring fibers,” “sensor fibers,” or “tamper-sensor fibers” because they are used to detect movement along the length of the fiber. *Id.*, Abstract, [0006]-[0016], [0031]-[0033], Figs. 1-8; EX1003, ¶220.

d. [1.3]

Evans discloses that monitor optical fibers 12 are “illuminated by an optical signal source 18,” which can be “a light-emitting diode, a laser, or even an incandescent lamp or a gas-discharge lamp, each with or without means for modulating to provide a pulsating signal, with or without data significance”:

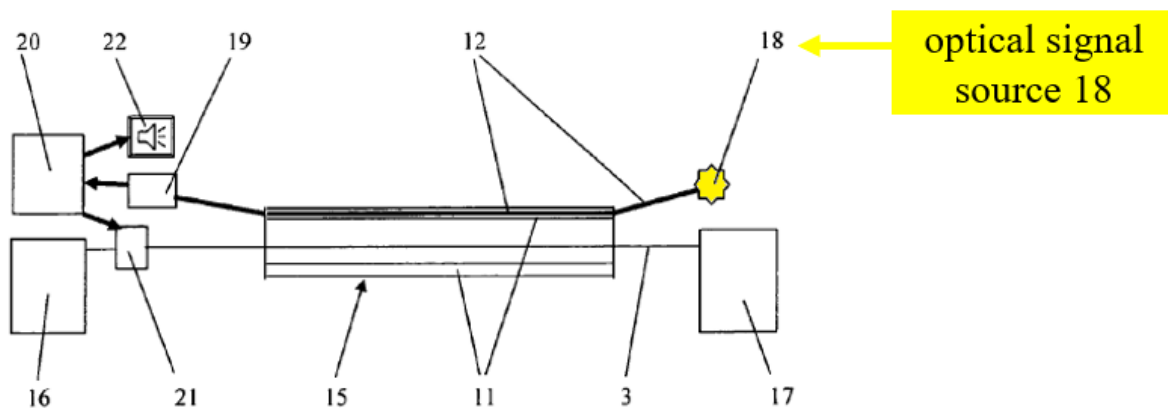


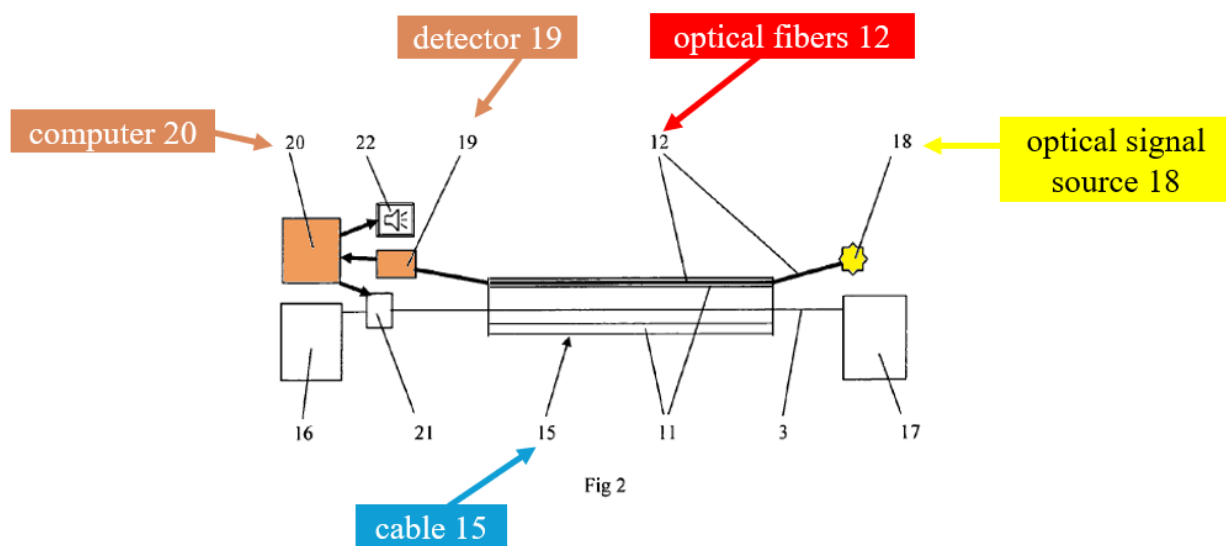
Fig 2

EX1006, Fig. 2 (annotated), [0036]-[0037], Figs. 3-8; EX1003, ¶222.

Evan discloses the light is injected onto the monitored fibers. *Id.*, [0016]-[0017], [0036]-[0037], [0041]-[0045], Figs. 2-8.

e. [1.4]

Evans discloses detector 19 and computer 20 (i.e., sensor arrangement) that “observes the optical signal transmitted by the monitor fiber 12” whereby the “detector provides input to a computer 20 or other circuitry (which may be entirely conventional)”:



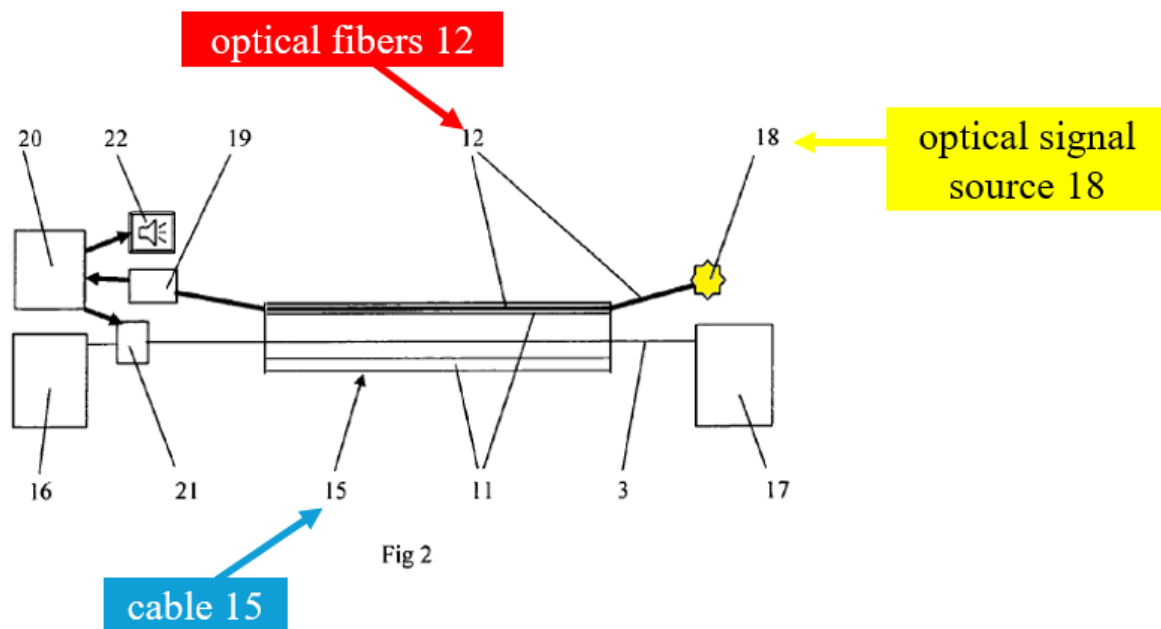
EX1006, Fig. 2 (annotated), [0036], Figs. 4-5 & 7-8; EX1003, ¶225.

In Figure 3, this is performed by one or more detectors 26, a logic device, and a computer. EX1006, [0039]-[0040], Fig. 3.

In Figure 6, detector 19 can be an “OTDR instrument” which both provides “a pulsed light source” and “a detector responsive to transmit time from launch of the signal to its return” allowing the OTDR to be used both as a light source and as part of the sensor arrangement. EX1006, [0043], Fig. 6.

***f.* [1.5]**

Evans discloses that monitor optical fibers 12 are “illuminated by an optical signal source 18”:



EX1006, Fig. 2 (annotated), [0036], Figs. 4, 7-8.

Evans discloses other sources of light, including transmitter 16 (Figure 3), dual-wavelength light source 30 (Figure 5), and OTDR instrument (Figure 6).

EX1006, [0038]-[0039], [0042]-[0043], Figs. 3 & 5-6.

Evans discloses it is preferable to use a plurality of monitoring fibers, such as the eight monitoring fibers:

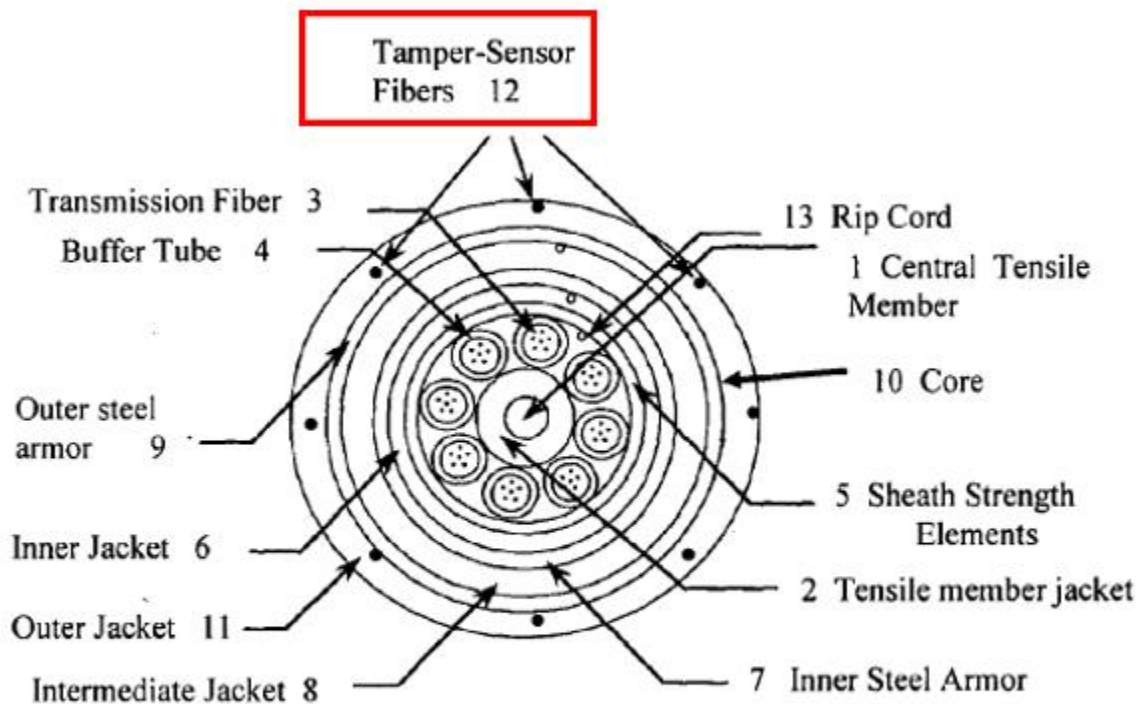


Fig 1

EX1006, Fig. 1 (annotated), [0014]; EX1003, ¶231.

Evans discloses that the fibers are monitored by injecting light into one end, and detecting after it has passed through the length of fiber. EX1004, [0016]-[0017]. Therefore, Evans discloses that if multiple fibers are monitored, light is injected into one end of each of the fibers to be monitored. *Id.*; EX1003, ¶232.

g. [1.6]

Evans discloses that “detector 19” “observes the optical signal transmitted by the monitor fiber 12” and “provides input to a computer 20 or other circuitry (which may be entirely conventional) so as to turn off an optical switch 21

controlling the input to the illustrated transmission fiber and sound or otherwise activate an alarm 22, both in the event that the signal received at the detector from the monitor fiber disappears or significantly changes in character.” EX1006, [0036]; Figs. 2, 4-5 & 7-8.

In Figure 6, OTDR instrument serves as the detector. EX1006, [0043], Fig. 6.

In Figure 3, there are multiple detectors 26 connected to a logic device 27, which sends a signal to computer 20. EX1006, [0039], Fig. 3. Evans discloses individual detectors 26 could be replaced by an optical coupler and a single detector. EX1006, [0040]; EX1003, ¶236.

h. [1.7]

Evans discloses “[t]his invention seeks to provide an immediate alarm indicative of any tampering with the cable.” EX1006, [0006].

The “detector 19” receives light signals from monitor fibers 12. *Supra* §VIII.B.1.g. Detector 19 “observes the optical signal transmitted by the monitor fiber 12” and input “to turn off an optical switch 21 controlling the input to the illustrated transmission fiber and sound or otherwise activate an alarm 22, both in the event that the signal received at the detector from the monitor fiber disappears or ***significantly changes in character.***” EX1006, [0036] (emphasis added). Because detector 19 assesses whether the light signals from the monitor fibers “significantly

changes in character,” it compares the received light signals relative to data obtained from previously received ones of the received light signals to detect changes. *Id.*; EX1003, ¶239.

In Figure 3, this is performed by one or more detectors 26, a logic device, and a computer. EX1006, [0039]-[0040], Fig. 3.

In Figure 6, this function is performed by OTDR instrument. EX1006, [0043], Fig. 6.

i. [1.8]

Evans discloses “[t]his invention seeks to provide an immediate alarm indicative of any tampering with the cable.” EX1006, [0006].

“[D]etector 19” provides input to a computer or other circuitry regarding whether the optical signal from monitoring fibers 12 “disappears” or “changes in character,” which are indicative of manipulation *Supra* §VIII.B.1.g-VIII.B.1.h; EX1006, [0025] (preferably detector includes “automatic means for suspending transmission of some or all of the transmission channels in the event it ceases to detect the optical signal expected from the embedded fiber, or from any one of plural embedded fibers”), [0006]. The “computer 20” or other circuitry thus analyzes the received light signals in order to determine whether they have changed in character and to initiate an alarm response. EX1006, [0036], [0039].

In Figure 6,

a detector responsive to the transit time from launch of the signal to its return after distributed Rayleigh scattering reflection. The instrument functions in its usual way to observe reflected intensity as a function of time from launch and in the event of a change not only provides an alarm indication but also provides an estimate of the position along the length of the cable at which interference or damage appears to have occurred, so facilitating the apprehension of those responsible and/or repair.

EX1006, [0043]; EX1003, ¶244.

The OTDR detector and computer not only compare signals, but analyzes diffraction patterns and provides an estimate of the location of the cable movement/interference. *Id.* Accordingly, a POSA would understand that detector 19 (OTDR) and computer 20 arrangement analyze the changes to determine which are indicative of movement, and where such movement occurred along the cable.

EX1003, ¶245; *supra* §III.D.

***j.* [1.9]**

Evans discloses generating an “alarm indicative of any tampering with the cable.” EX1006, [0006], [0025]. Detector 19 and computer 20 (or other circuitry) activate an alarm “both in the event that the signal received at the detector from the

monitor fiber disappears or significantly changes in character.” *Supra* §§VIII.B.1.g-VIII.B.1.i; EX1006, [0036]; *id.*, [0025], [0039].

A POSA would have understood that when the cable is tampered with (i.e., movement of a portion), the alarm response is generated, and the location can be determined. EX1003, ¶248.

Further, in the OTDR embodiment, a change provides an alarm and further analysis of the estimated position of the intrusion. EX1006, [0043].

k. [1.10]

In the “Summary of the Invention,” Evans discloses using “at least one monitoring optical fiber,” but also discloses “in most cases a plurality of [monitoring] fibers distributed around the circumference of the cable will be preferred.” EX1006, [0007]-[0014]. Evans describes the “Summary of the Invention” has having “a source of optical signal” and “a detector.” *Id.*, [0016].

In Figure 2, Evans discloses a single light source (optical signal source 18) and a single sensor arrangement (detector 19 and computer 20 or other circuitry). *Id.*, [0036]. Evans discloses using “at least one monitor optical fiber 12,” such that Evans discloses using one or more than one monitor optical fiber 12. *Id.* In addition, Evans states in the “Summary of the Invention” that it is preferable to have more than one monitor optical fiber. *Id.*, [0014]. Therefore, in Figure 2, Evans discloses

using more than one monitor optical fiber 12, but only one light source and only one sensor arrangement. EX1006, Figs. 1-2, [0007]-[0014], [0036].

Similarly, given Evans' teaching to use multiple monitor fibers 12, Figure 6 would include multiple monitor fibers, but only one detector and one light source (OTDR, which serves as the detector and light source). *Id.*; Fig. 6, [0043]. OTDR injects a pulsed light onto the fibers, which is reflected back using reflector 32. *Id.*

In Figure 3, Evans discloses monitoring two of the fibers 12, with one light source (using an "optical splitter 25" to split the light to the two monitor fibers 12) and that the signal can be detected by a single detector. EX1006, [0038]-[0040], Fig. 3.

In Figure 4, Evans discloses that light source 18 and detector 19 are on the same end of the cable, with "two monitor fibers 12 being completed by a fiber loop 29" (i.e., a jumper cable). EX1006, [0041], Fig. 4. There are at least two fibers of the cable that are being monitored via the same light source and detector, with only one light source and one sensor arrangement, which means the number of monitored fibers is greater than the number of light sources and number of sensor arrangements. *Id.*

Evans teaches optical communication components such as detectors, an OTDR (in Figure 6), jumpers (i.e. fiber loop 29 in Figure 4), splitters (i.e. optical splitter 25 in Figure 3), and reflectors (in Figure 6) that allow light from the light

source to be communicated along the monitor fibers 12, across the various embodiments. EX1003, ¶256.

2. Claim 2

Evans discloses injecting light from a light source into the first end of the fibers to be monitored. *Supra* §VIII.B.1.d.

Evans discloses an embodiment that loops the monitor signal to a second fiber via a jumper (fiber loop 29) at the far end of the cable that connects two of the fibers 12 to loop the monitor light signal from the first fiber into the second fiber:

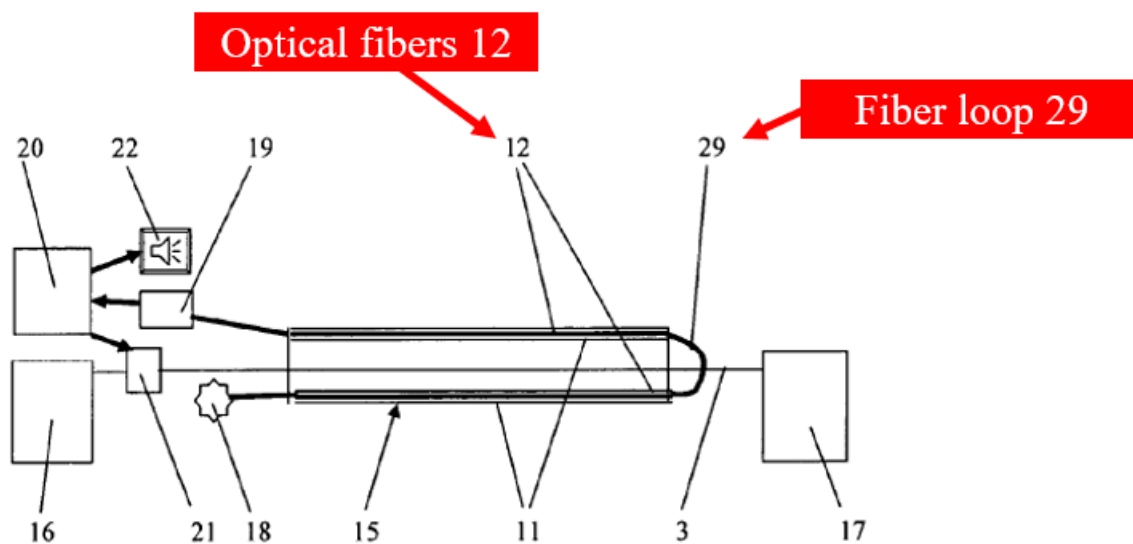


Fig 4

EX1006, Fig. 4 (annotated), [0041]; EX1003, ¶259.

3. Claim 8

a. [8.0]-[8.8]

See [1.0], [1.3]-[1.10]. *Supra* §§VIII.B.1.a, VIII.B.1.d-VIII.B.1.k.

b. [8.9]

In Figure 6, Evans discloses using an OTDR instrument, which “functions in its usual way” and “provides an estimate of the position along the length of the cable at which interference or damage appears to have occurred, so facilitating the apprehension of those responsible and/or repair.” EX1006, [0043].

A POSA would have understood that the OTDR and master control unit contains the claimed “table of fiber lengths” to accommodate such analysis. EX1003, ¶265. It was well known in the art that OTDR devices calculate and store fiber lengths in the OTDR internal memory for use in setting test parameters and later retrieved for event analysis or pass/fail comparison. *Id.*; *supra* §III.A.

C. Ground 3

Claims 8 and 12 of the '641 Patent are invalid as obvious over Tomita in view of Jezwinski and Vobian. EX1003, ¶¶266-332.

1. Claim 8

a. [8.0]

Tomita teaches methods and systems to detect faults and the location of faults in fiber optic transmission systems. EX1005, 2:16-3:24. Specifically, Tomita teaches an optical transmission system with a “light pulse testing apparatus 6”

connected to “CPU 12” and “data base 13” which serve as a light source and sensor arrangement to inject light into fibers and determine where a fault occurred, where one transmitter is sending data signals to a plurality of receivers. EX1005, 4:27-33; 6:45-7:44, Fig. 11; EX1003, ¶268.

To the extent it is argued that Tomita teaches post-fault location methods, rather than a method for detecting movement of optical fibers, it would have been obvious to a POSA that Tomita’s light pulse testing apparatus 6 could be used to detect movement in the fibers. EX1003, ¶269. For example, a POSA could change the “optical coupler 10” to a WDM or other similar multiplexing coupler, which has long been known in the art. EX1005, 3:62-4:42, Figs. 1 & 4-5; EX1011, 3:28-56, Fig. 1; EX1003, ¶269.

For example, a POSA could have combined Tomita with Vobian. Vobian teaches use of a “multiplexer coupler” 114 so that a monitor “control signal having control wavelength λ_2 ” and a data “operational wavelength λ_1 ” can be simultaneously provided to the fiber 101. EX1009, 5:4-17, Fig. 1; EX1003, ¶270. Moreover, Vobian discloses detecting “any tampering with the transmission path” for example “‘eavesdropping’ on the data communication traffic by tapping off even the smallest amounts of power can be registered.” EX1009, 7:24-30.

With such a modification, the light pulse testing apparatus 6 could operate continuously and monitor for faults because the data signal from the transmitter 1

would be combined with the test light pulse signal via the WDM 10, and then the data and test light pulse signals would be separated by the WDMs 11-1, 11-2, 11-n. EX1003, ¶271.

A POSA would have understood that any such fault, tampering, or eavesdropping on the fiber would involve movement the optical fibers. *Supra* §III.D; EX1003, ¶272.

i. Motivation/Expectation of Success

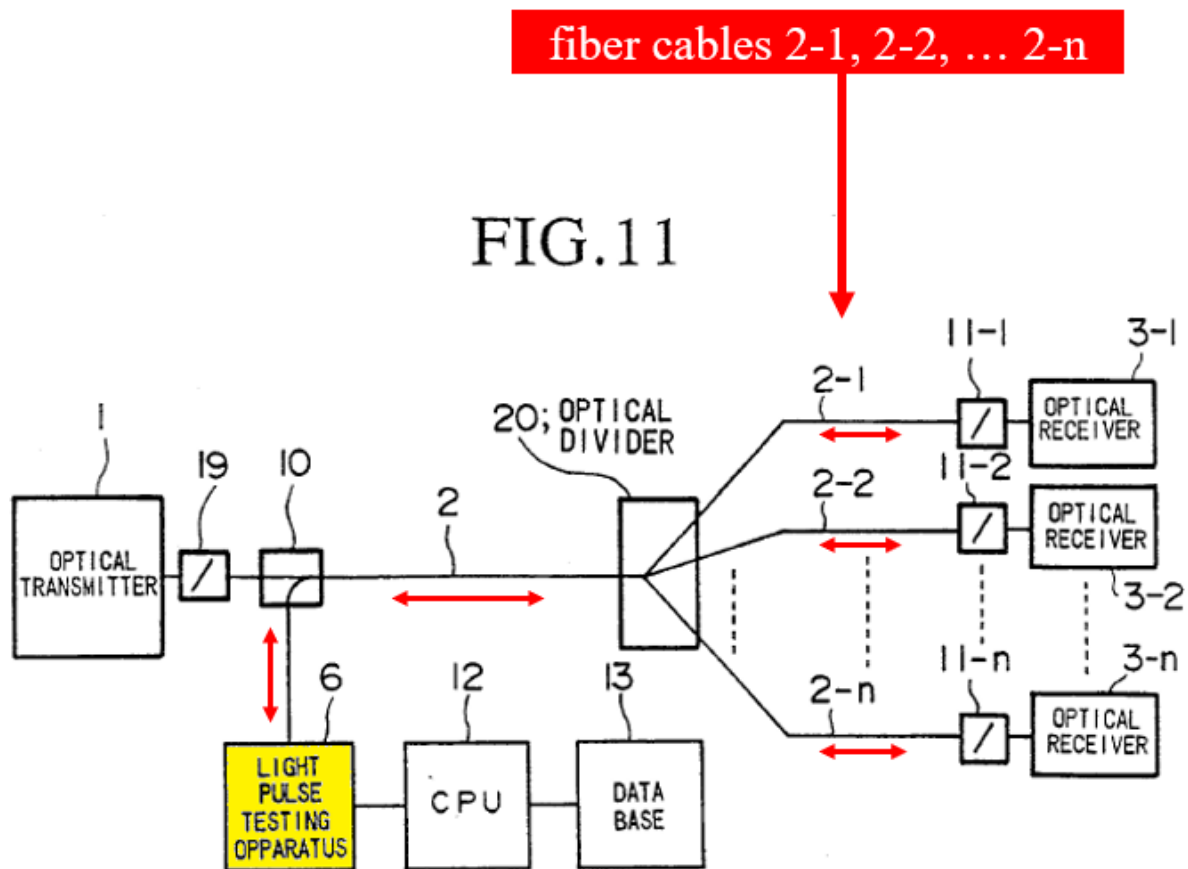
A POSA would have been motivated to make such a modification to eliminate down time as the test pulse could be performed simultaneously with data transmission, and would also eliminate the need for a person to manually “set[] the light pulse testing apparatus 6 working” since the light pulse testing apparatus could operate continuously. EX1005, 6:50-55, 9:25-30; EX1003, ¶273.

Such a modification would have been well within the capabilities of a POSA as it involves changing out components for known components via simple substitution. EX1003, ¶274. Such a substitution would be likely to succeed, as the optical coupler 10 from Tomita already provides a two-input to one-output coupling, and replacing that coupler with a multiplexing coupler was well known. *Supra* §III.B. Fiber optic components were easily interchangeable. *Id.*; *supra* §III.E.

b. [8.1]

Tomita discloses light pulse testing apparatus 6, which is “composed of a light source 7 emitting test pulse light λ_t ” (EX1005, 1:41-44) (i.e., light source) where the “test pulse light λ_t ” is “emitted from the light pulse testing apparatus 6 into the transmission path (the optical fiber 2)” (i.e., injected onto the fibers).

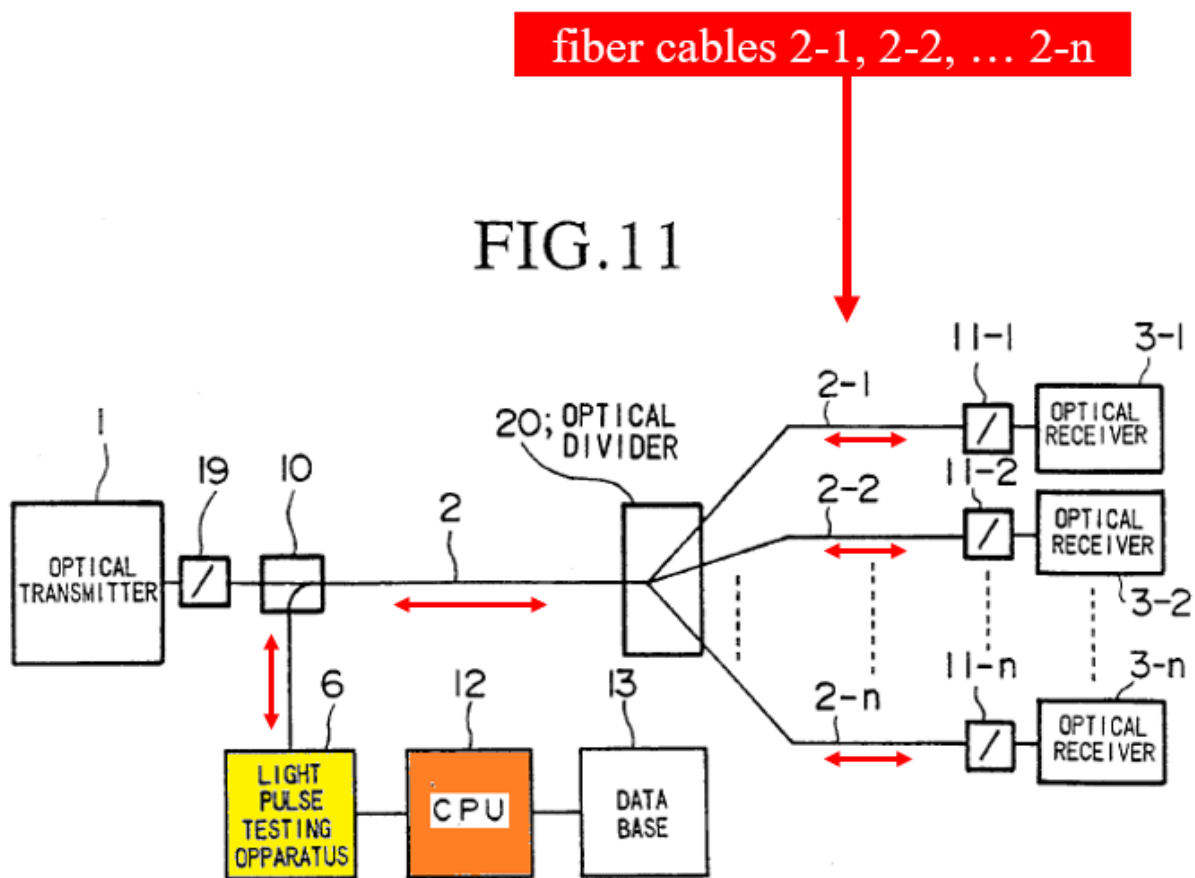
EX1005, 6:56-59, 9:30-33, Figs. 9, 15.



EX1005, Fig. 11 (annotated); EX1003, ¶276.

c. [8.2]

Tomita teaches “light pulse testing apparatus 6” includes “a light pulse receiver 9 receiving test light λ_t ” (EX1005, 1:41-46) and is controlled by a central processing unit CPU 12 (EX1005, 4:30-32) (collectively a sensor arrangement), which “detects the intensity of the test pulse light” including where the fault occurred. EX1005, 6:59-62, 9:33-36.

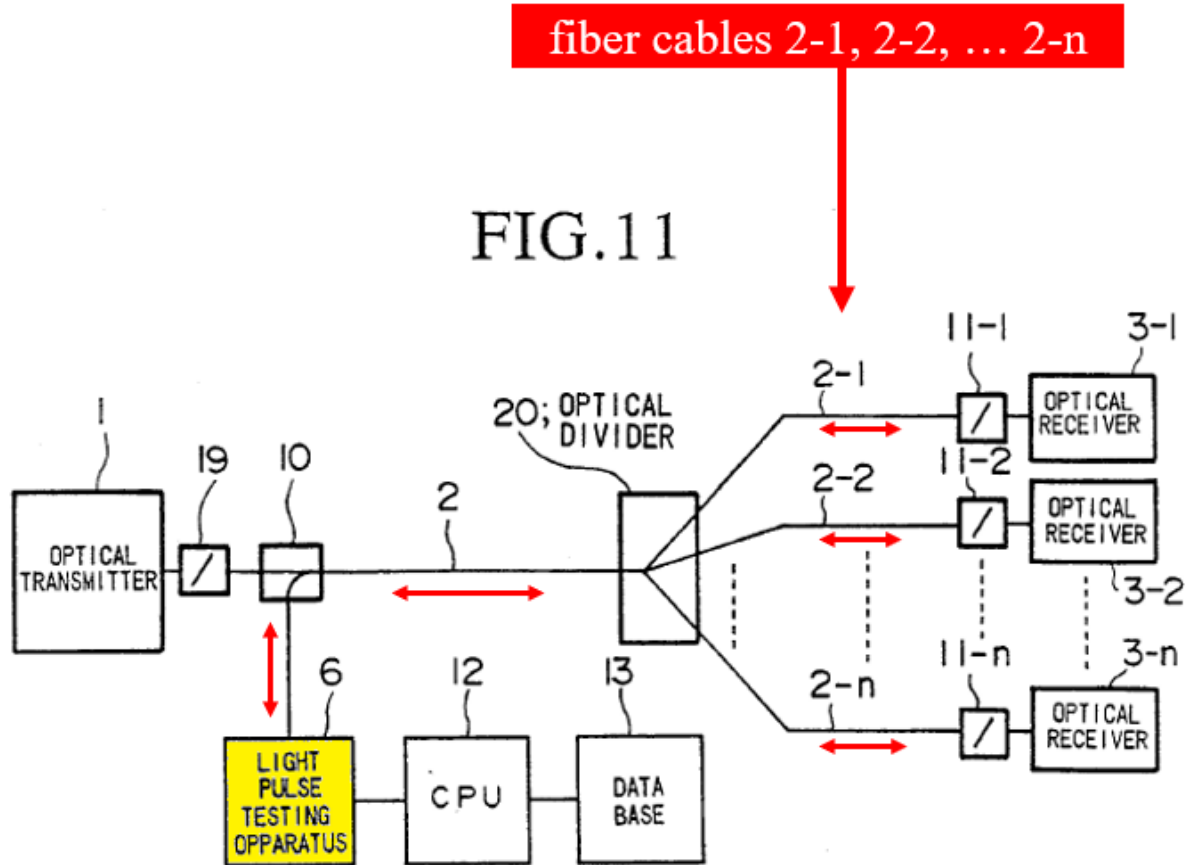


EX1005, Fig. 11 (annotated); EX1003, ¶277.

d. [8.3]

Tomita discloses injecting light from the light pulse testing apparatus 6 onto the monitored fibers (*supra* §VIII.C.1.b). Further, Tomita teaches that while “description about the number of optical fibers in cable 2 is omitted...in actuality cable 2 is constituted by a bundle of optical fibers.” EX1005, 10:51-55.

In Figure 11, where one light pulse testing apparatus 6 is used for a plurality of receivers, light is injected into each fiber. EX1005, 9:31-36 (system “introduces” (i.e. injects) “the test pulse light λ_t emitted from the light pulse testing apparatus 6 into the transmission path (the optical fiber 2) and detects the intensity of the test pulse light reflected back by each filter type distinguishing device 11-1, 11-2, and 11-n and the reflecting position.”).



EX1005, Fig. 11 (annotated); EX1003, ¶281.

e. [8.4]

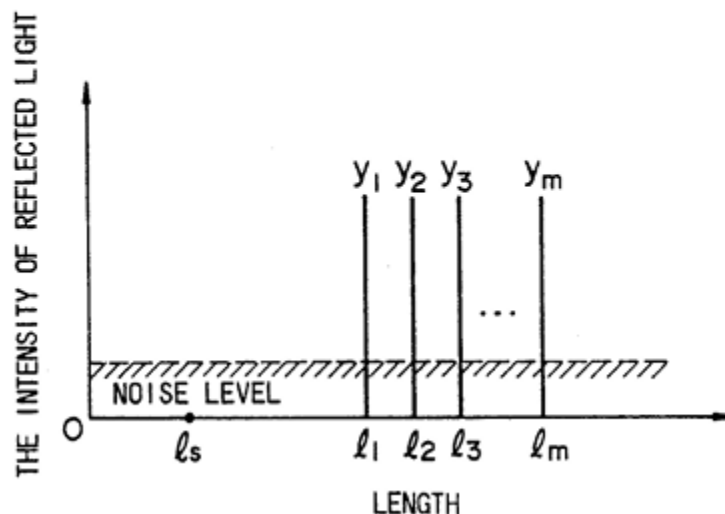
Tomita discloses that light pulse testing apparatus 6 and CPU 12 “detects the intensity of the test pulse light reflected back by each filter type distinguishing device 11-1, 11-2, and 11-n and the reflecting position.” EX1005, 9:31-36; *supra* §VIII.C.1.c.

f. [8.5]

Tomita discloses comparing the received test light pulses λ_t to previously received light pulses taken during a normal operation, which is stored in “data base 13” and is “beforehand detected by the light pulse testing apparatus 6 at the normal state of the optical path (optical fiber cable 2).” EX1005, 6:21-25, 9:36-40.

Figure 12 provides “graph showing intensity (level) of reflected test pulse light and distance from pulse testing apparatus 6 to optical filter type fault distinguishing device (reflecting position), which were beforehand detected by the light pulse testing apparatus 6 at the normal states of the optical paths 2, 2-1, 2-2, 2-n.” EX1005, 8:39-44, Fig. 12.

FIG.12



EX1003, ¶286.

Because the “distances between the optical receivers 3-1, 3-2, and 3-n...are generally different from each other” the known length/position of each receiver during a normal state is stored in the data base 13. EX1005, 8:31-64, 9:36-40; EX1003, ¶287. Accordingly, when the system operates in an abnormal state (e.g., a fault), the CPU 12 “compares the values (normal data) read from the data base 13 with the values (abnormal data) detected.” EX1005, 9:41-44.

g. [8.6]

Tomita discloses comparing received test light pulses λ_t to previously received light pulses taken during normal operation stored in data base 13 (*supra* §VIII.C.1.f). Tomita discloses analyzing the received signals to determine where the fault occurred, and what part of the system (e.g., cable 2-1, 2-2, 2-n, or some other component of the system) was manipulated. EX1005, 9:41-10:47, Fig. 15.

To the extent it is argued that Tomita teaches post-fault location methods, rather than a method for detecting movement of optical fibers, it would have been obvious to a POSA that Tomita’s light pulse testing apparatus 6 could be used to continuously monitor the fibers to detect movement by substituting WDMs (*supra* §VIII.C.1.a) such that the CPU’s analysis of received test pulse light signals could operate concurrently with data transmission. EX1003, ¶290. A POSA would have found such a simple substitution obvious, and would have been motivated for the same reasons discussed. *Id.*; *supra* §VIII.C.1.a.

Alternatively, it would have been obvious to combine the teachings of Tomita with Vobian, which teaches continuous monitoring of a fiber optic cable for movement. EX1003, ¶290. Specifically, Vobian teaches a method, e.g., depicted in Figure 1, where a light source (transmitter 103) injects light into the monitored fiber via multiplexer coupler 114, and the reflected monitor light signal is detected by detecting device 105, comprising both a monitor measuring instrument 106 and control measuring instrument 107. *Id.*; EX1009, 5:4-25, Fig. 1.

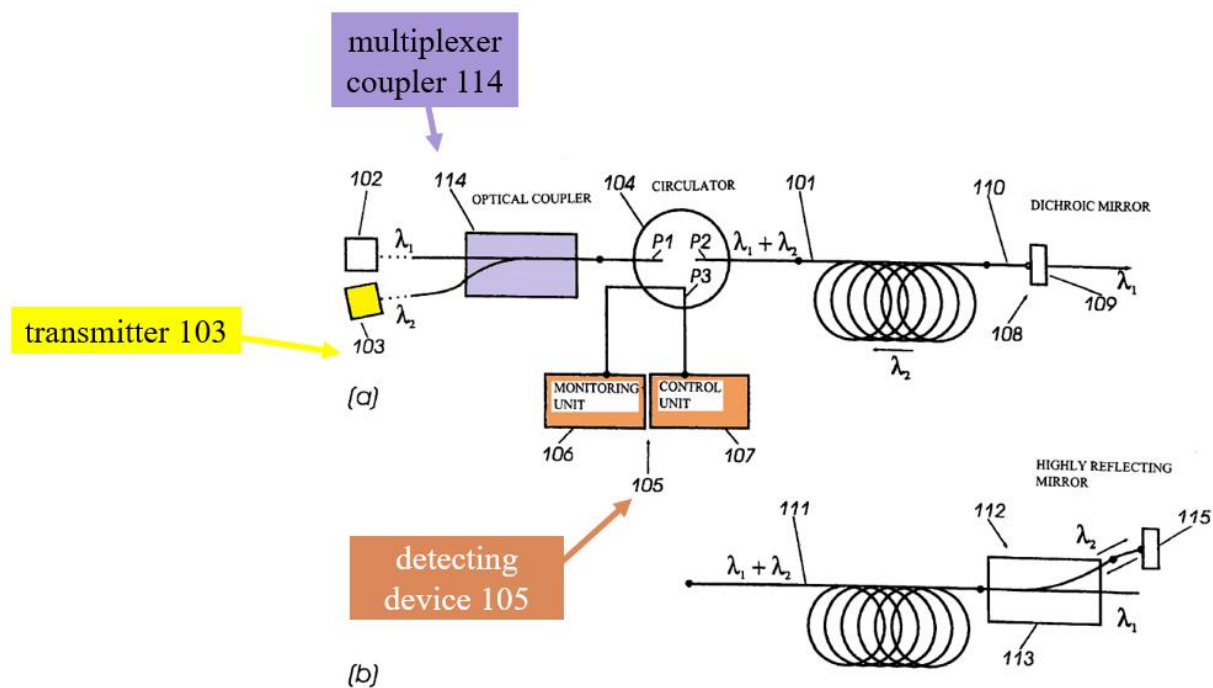


Fig. 1 BASIC DESIGN FOR CONTROL AND MONITORING MEASUREMENTS

EX1009, Fig. 1 (annotated).

The “detecting device can include a data processing system for further analysis of the detector signals.” EX1009, 4:23-52. Furthermore, Vobian teaches a

method of monitoring that is “based on the fact that the polarization state (SOP) of a signal transmitted via a fiber path is sensitive to the bending and vibration of the fiber: when the fiber is tampered with, its birefringence is locally changed, causing the polarization state of the signal to also change abruptly” which is “by far more sensitive than the attenuation method, and...makes it impossible for someone to tamper with the cable without it being discovered.” EX1009, 9:7-16; EX1003, ¶291.

For example, a “polarization-sensitive element (polarizer, polarization beam splitter, polarization-dependent fiber coupler, etc.)” can be used as part of the detecting device, the data processing system can analyze the received reflection data and polarization state data to determine where there are “disturbances or manipulations.” EX1009, 10:3-26; EX1003, ¶292.

Vobian’s teachings regarding analyzing changes indicative of manipulation of the optical fiber causing movement of a portion thereof would be incorporated into Tomita. EX1003, ¶293. For example, Tomita already includes a CPU 12, which with the appropriate software could take on the role of Vobian’s data processing system for further analysis of the detector signals. *Id.* Moreover, a POSA would have found it obvious to combine Vobian’s teaching of using a polarization-sensitive element for heightened sensitivity for detecting disturbances along the fiber path with Tomita. *Id.*

i. Motivation/Expectation of Success

A POSA would have been motivated to combine the polarization-sensitive element from Vobian's detector (sensor arrangement) with Tomita to allow for a more sensitive system to detect tampering events into the fibers, and also to exchange the multiplexer coupler from Vobian as the optical coupler 10 in Tomita, to allow continuous and simultaneous monitoring with data transmission without the need to have a user activate the light pulse testing apparatus 6. *Id.*, ¶294.

A POSA would have had a reasonable expectation of success with the modification, because both Tomita and Vobian relate to monitoring and finding problems with a fiber optic line, and the modification to Tomita would be minor involving conventional components and methods as disclosed in Vobian. *Id.*, ¶295. Such a substitution would be likely to succeed, as optical coupler 10 from Tomita already provides a two-input to one-output coupling, and replacing that coupler with a multiplexing coupler was well known. *Supra* §III.B. Further, Tomita already has a CPU 12 that would be capable of running the software-based polarization and other intrusion detection analyses taught in Vobian, via a simple software change to the CPU in Tomita, and adding a polarization sensitive element to Tomita's detector. EX1003, ¶295. Fiber optic components and software based analysis were easily interchangeable. *Supra* §III.E.

Accordingly, the Tomita-Vobian combination discloses this element.
EX1003, ¶296.

h. [8.7]

Tomita discloses that when “trouble occurs in the optical transmission system, an alarm signal is generated.” EX1005, 9:25-26. It would have been obvious to a POSA that Tomita’s light pulse testing apparatus 6 could be used to continuously monitor the fibers to detect movement by substituting WDMs (*supra* §VIII.C.1.a) such that when the CPU’s detects a change indicative of a fault, an alarm would sound. EX1003, ¶298.

A POSA would have found such a simple substitution obvious, and would have been motivated for the same reasons discussed (*supra* §VIII.C.1.a), including specifically to remove a middle step from the operation of the system and only signal an alarm in the event of a fault, reducing the need for user involvement and reducing system down time for the user to run the test. EX1003, ¶298.

Alternatively, it would have been obvious to combine the teachings of Tomita with Jezwinski, which discloses generating an alarm in response to the detection of any such changes which are indicative of manipulation. *Id.*, ¶299. Specifically, Jezwinski discloses that once an alarm condition has been initiated, a computer both provides an “alarm display” on a graphic interface, and likewise can be configured to “communicate the alarm” for example, by “automatically

dial[ing] one or more pager phone numbers...in order to alert individuals outside the maintenance center of the alarm condition” and further transmitting a pager or facsimile transmission “to one or more selected individuals associated with the fiber optic network where the problem has been detected.” *Id.*; EX1008, 10:50-67.

i. Motivation/Expectation of Success

It would have been obvious to combine this teaching from Jezwinski into the system of Tomita. For example, both references relate to methods for scanning optical fibers for any issues—a POSA would have recognized the benefit of providing notice of important information resulting from the fiber monitoring methods, including the presence of an intrusion attempt, and the location along the fiber where such an attempt occurred, and which fiber is affected. EX1003, ¶300.

Such a modification would have been easy to accomplish with a high level of success, given the fact that the only changes would be software updates to the CPU 12 in Tomita to configure it to provide an alert in response to the analyzed signal indicated an intrusion attempt. *Id.*, ¶301. Fiber optic components and software based analysis were easily interchangeable between different fiber optic systems. *Supra* §III.E,

Indeed, Tomita teaches that where “trouble occurs in an optical transmission system, an alarm signal is generated” such that a “checker receives the alarm signal and is notified of the trouble.” EX1005, 9:25-40. A POSA would understand that

the only real modification is to provide an alarm *after* the analysis (*supra* §VIII.C.1.g) such that the alarm can indicate an intrusion attempt, which fiber is affected, and the location of the disturbance. EX1003, ¶302.

Accordingly, the Tomita-Vobian-Jezwinski combination discloses this element. EX1003, ¶303.

***i.* [8.8]**

In Figure 11, Tomita discloses that there are at least three monitored fibers (on cables 2-1, 2-2, 2-n) which are all monitored by one light pulse testing apparatus and CPU 12. *Supra* §§VIII.C.1.a-VIII.C.1.c. Accordingly, the at least three monitored fibers is greater than the one light source and sensor arrangement. EX1003, ¶305.

Further, Tomita discloses optical coupler 10 and optical filters 11 (which would be obvious to replace with WDMs, *supra* §VIII.C.1.a) and an optical divider 20, which represent optical communication components that communicate light to and from light pulse testing apparatus and CPU 12 (one light source and sensor arrangement). EX1005, 4:27-30, 8:21-34, Fig. 11; EX1003, ¶306.

***j.* [8.9]**

Tomita discloses that the light pulse testing apparatus and CPU 12 operate in a normal state to store the “reflecting position” (i.e. length) of each fiber in the “data base 13.” EX1005, 8:31-64, 9:41-44, Figs. 12-14; *supra* §VIII.C.1.f . Tomita

discloses analyzing the differences in light intensity and position to determine where in the system a fault occurred, i.e. which fiber of 2-1, 2-2, 2-n has moved via a fault. EX1005, 8:65-9:20, Figs. 13-14; *supra* §VIII.C.1.g.

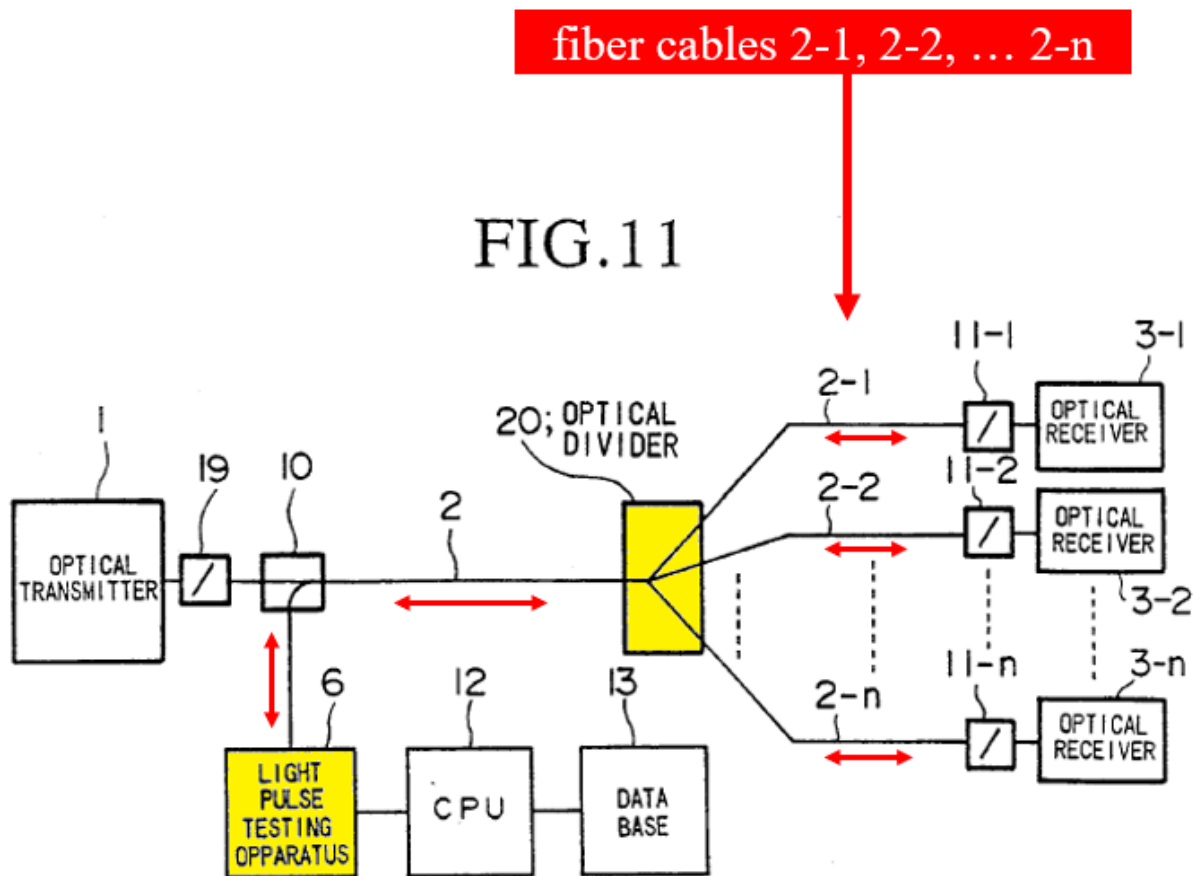
2. Claim 12

a. [12.0]

See [8.0]. *Supra* §VIII.C.1.a.

b. [12.1]

Tomita discloses a plurality of optical fiber cables arranged in a hub-and-spoke arrangement where the cables (2-1, 2-2, 2-n) extend from optical divider 20:



EX1005, Fig. 11 (annotated), 8:17-38; EX1003, ¶313.

The main unit at a central location includes optical divider 20 and light pulse testing apparatus 6. EX1005, Fig. 11. Cables 2-1, 2-2, and 2-n extend from optical divider 20 in a hub-and-spoke arrangement to a plurality of remote units (optical receivers 3-1, 3-2, 3-n) in subscriber homes. EX1005, Fig. 11, 8:17-38.

To the extent Tomita does not disclose optical divider 20 and light pulse testing apparatus 6 at a same, central location, it would have been obvious to place them at the same, central location to test subscriber cables branching out in different directions. EX1003, ¶315. A POSA would have understood and been motivated to arrange Tomita's Figure 11 to include the divider 20 in a central location so that the testing elements for the fiber system were easily accessible. *Id.* And a shorter length between the light pulse testing apparatus reduces the chance of any issues before the divider 20, allowing the system to more accurately detect and determine the characteristics of faults along lines 2-1, 2-2, and 2-n. *Id.* Such configurations of a central hub servicing and monitoring multiple remote locations was well known in the art. *Id.*; EX1004, Figs. 4-5; EX1007, Fig. 22. Fiber optic components were easily interchangeable between different fiber optic systems, such that the divider 20 could easily be modified to be within a central hub. *Supra* §III.E.

c. [12.2]

Each of the optical fiber cables of Tomita's Figure 11 has a first end and a second end. EX1005, Fig. 11.

It is inherent that each cable has a plurality of fibers because cable 2 has a bundle of fibers and data transmission to subscriber homes by telecommunications companies (such as assignee of Tomita) used cables with a plurality of fibers. EX1003, ¶318. Moreover, Tomita expressly teaches that "the description about the number of optical fibers in cable 2 is omitted, because in actuality cable 2 is constituted by a bundle of optical fibers." EX1005, 10:51-54.

d. [12.3]

In Figure 11, Tomita discloses that there are at least three monitored fibers, i.e., one fiber in each of cables 2-1, 2-2, 2-n. EX1005, Fig. 11. All of these cables are monitored by detecting movement of the fibers along their length. *Supra* §VIII.C.1.

e. [12.4]

See [8.1]. *Supra* §VIII.C.1.b.

Tomita's source of light for injection onto the fibers is at the main unit. *Supra* §VIII.C.1.b.

f. [12.5]

See [8.2]. *Supra* §VIII.C.1.c.

g. [12.6]

See [8.3]. *Supra* §VIII.C.1.d.

Tomita's source of light for injecting into the fibers to be monitored is at the main unit. *Supra* §VIII.C.2.b.

h. [12.7]-[12.10]

See [8.4]-[8.7]. *Supra* §§VIII.C.1.e-VIII.C.1.h.

i. [12.11]/[12.12]

See [8.8]. *Supra* §VIII.C.1.i.

The source of light for monitoring the cables is at the main unit. *Supra* §VIII.C.2.b.

D. Ground 4

Claims 1, 9-10, and 12 of the '641 Patent are obvious over Anderson in view of Jezwinski. *See* EX1003, ¶¶333-414.

1. Claim 1

a. [1.0]

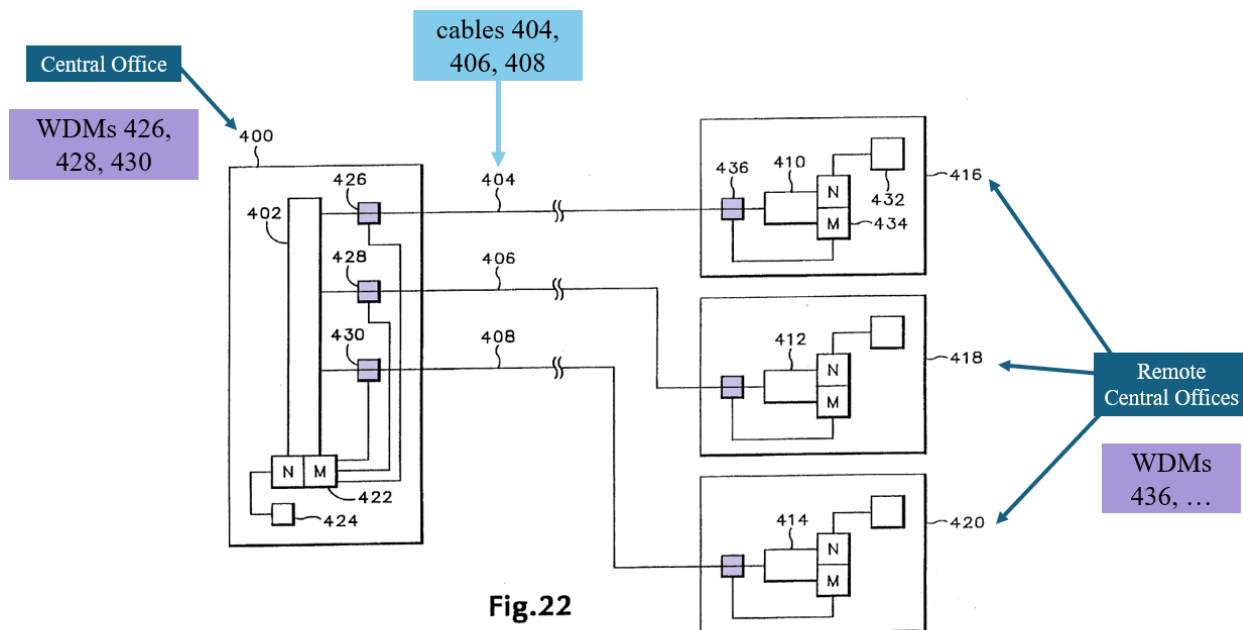
Anderson discloses a remote fiber test system for optical fiber bundles, including an embodiment where OTDR is used to detect the “presence of anomalies in the fiber, such as reflections, losses, and the like.” EX1007, 26:27-29, 25:57-26:46, Abstract.

A POSA would have understood that Anderson's system detects movement of optical fibers because, at the time of the invention, OTDR detected even small

movement of an optical fiber, such as a vibration. EX1003, ¶336; *supra* §§III.A; III.D.

b. [1.1]

Anderson teaches that each of cables 404, 406, and 408 comprises “optical transmission fibers for carrying optical communications and an optical test fiber, also called a ‘dark fiber’” such that each cable has a plurality of fibers including both active transmission fibers and dark test fibers, and as depicted in Figure 22, each cable has a first end connecting to a respective WDM 426, 428, and 430 at the “Central Office 400” and a second end connecting to a respective WDM at one of the respective “Remote Central Offices 416, 418, and 420”:



EX1007, Fig. 22 (annotated), 25:57-67; EX1003, ¶338.

c. [1.2]

Anderson discloses a “remote fiber test system” and a switch for an optical system, including an OTDR device to detect the “presence of anomalies in the fiber, such as reflections, losses, and the like.” EX1007, 26:27-29, Abstract, 25:57-26:46.

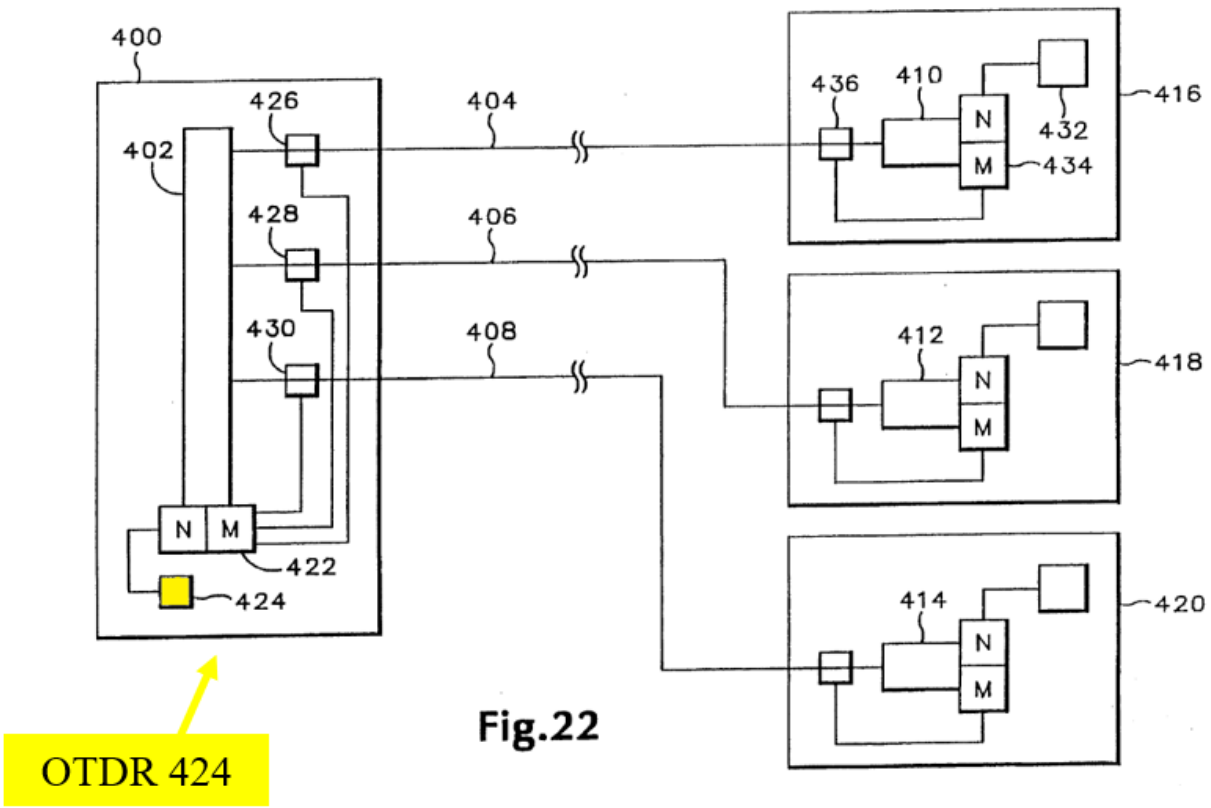
A POSA would have understood that such OTDR techniques, long understood in the art, provide a method for monitoring and detecting faults indicative of movement/tampering at location along the fibers. EX1003, ¶341.

Anderson discloses that OTDR 424 can be used with WDMs, such that the “tests can be performed while active transmissions are occurring in the fiber.” EX1007, 26:36-46. A POSA would have understood that conventional OTDR techniques, when used on active fibers, can be used to monitor those fibers for faults indicative of movement. EX1003, ¶341; *supra* §§III.A; III.D.

Alternatively, using OTDR 424 to actively monitor the fibers for faults indicative of movements was obvious in view of Jezwinski, for the same reasons discussed with respect to the Tomita-Jezwinski combination. *Supra* §VIII.C.1. A POSA would have been motivated to make such a combination, and reasonably expected success, for the same reasons. *Supra* §VIII.C.1; *infra* §§VIII.D.1.g-VIII.D.1.i.

d. [1.3]/[1.4]

Anderson discloses OTDR 424 (a light source) that “launches optical pulses” into multiple fibers within fiber links 404, 406, and 408:



EX1007, Fig. 22 (annotated), 26:23-24; EX1003, ¶344.

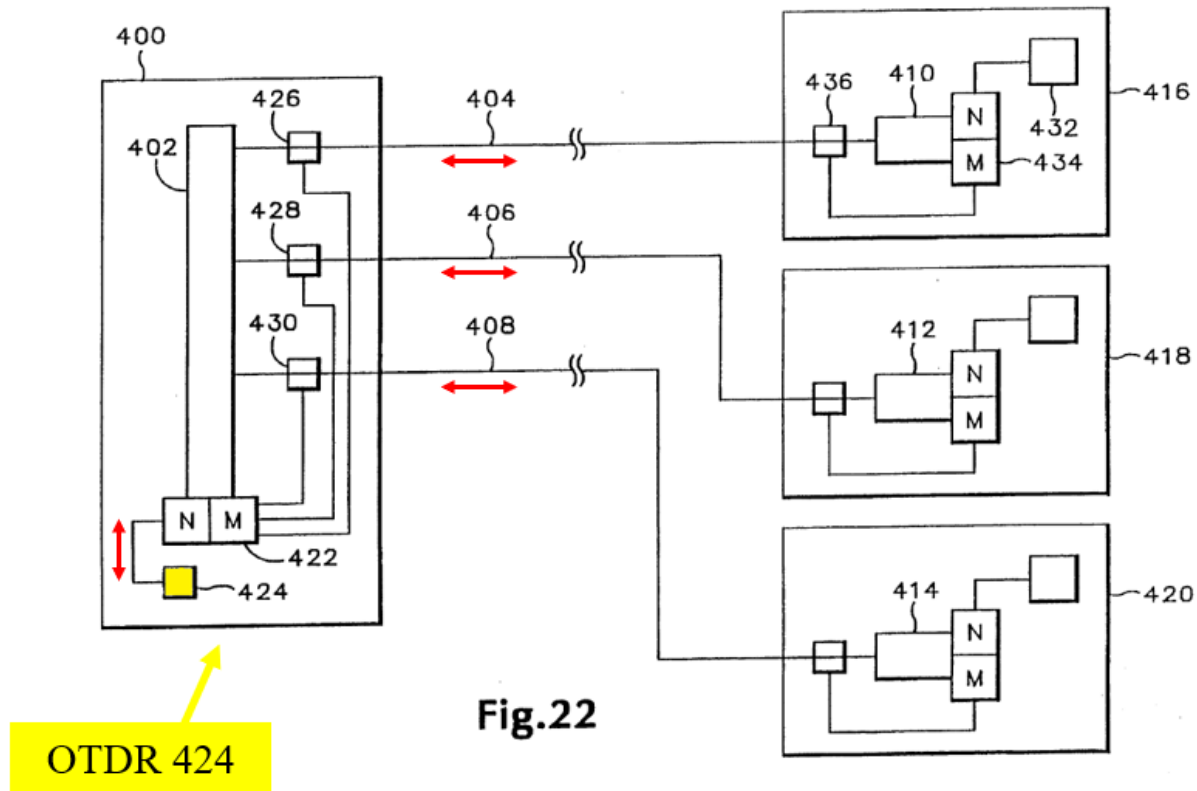
“The optical fiber links 404, 406, and 408 consist of optical transmission fibers for carrying optical communications and an optical test fiber, also called a ‘dark fiber’ in the industry.” EX1007, 25:64-67. Anderson discloses that OTDR 424 also receives “reflected optical backscatter signal” and “processes the return optical signal.” *Id.*, 26:24-29, Fig. 22.

Anderson discloses that OTDR 424 can inject light into either a “dark fiber” or the “optical transmission fibers” where light from OTDR 424 is directed to the appropriate fiber through switch 422, which is coupled to fiber links 404, 406, 408 via WDMs 426, 428, 430, respectively. EX1007, 26:2-46, Fig. 22.

Accordingly, the OTDR is both a light source and a sensor for receiving light transmitted through the fibers of fiber links 404, 406, and 408. *Id.*, 25:64-26:24; EX1003, ¶347.

e. [1.5]

Anderson discloses that OTDR 424 “launches optical pulses” into multiple fibers within fiber links 404, 406, and 408 (*supra* §VIII.D.1.d):

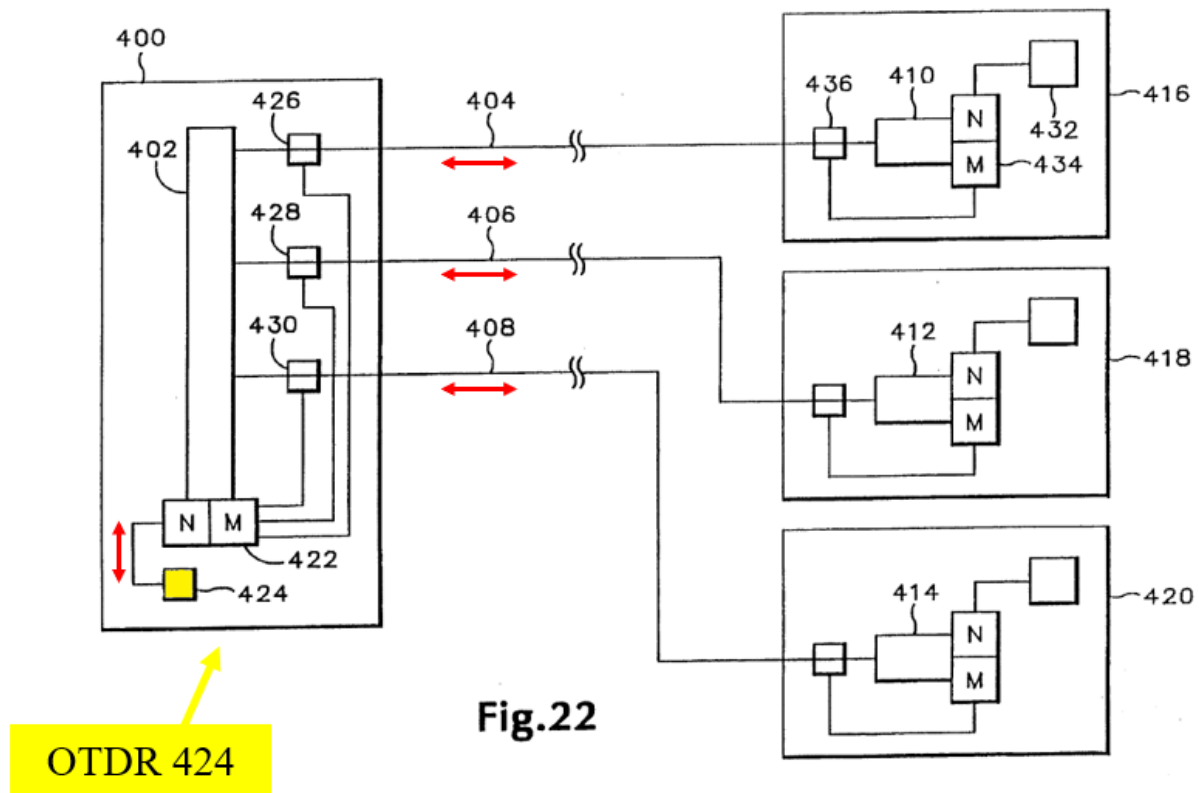


EX1007, Fig. 22 (annotated), 26:23-24.

Accordingly, Anderson discloses injecting light from OTDR 424 into one end of each fiber to be monitored. EX1007, 26:23-46, Fig. 22; EX1003, ¶350.

f. [1.6]

Anderson discloses that OTDR 424 receives “reflected optical backscatter signal” and “processes the return optical signal” (*supra* §VIII.D.1.d).



EX1007, Fig. 22 (annotated), 26:24-29.

As an example, “output port 1 of the switch 424 maybe coupled to the ‘dark fiber’ of the optical fiber link 404 through WDM 426” and after the “OTDR 424 launches optical pulses into the ‘dark fiber’” of link 404, “the return reflected optical backscatter signal is coupled to the OTDR 424 through the WDM 426 and the optical switch 422” after which, “OTDR 424 processes the return optical signal and produces a display or table indicating the presence of anomalies in the fiber, such as reflections, losses, and the like.” EX1007, 26:21-29.

Anderson discloses that “[a]dditional commands can be sent to the optical switch 422 for aligning any of the other output fiber or ports to the input fiber or port for examining the other ‘dark fibers’ in the other optical links.” EX1007, 26:29-35.

Anderson also discloses that OTDR 424 can inject and detect light signals in the data transmission fibers. EX1007, 26:36-46.

Accordingly, Anderson teaches receiving light signals that have been transmitted along the fibers. EX1007, 25:57-26:46; EX1003, ¶356.

g. [1.7]

Anderson teaches using OTDR 424 to test both active and dark fibers. *Supra* §§VIII.D.1.a-VIII.D.1.f.

Anderson discloses “OTDR 424 processes the return optical signal and produces a display or table indicating the presence of ***anomalies*** in the fiber, such as reflections, losses, and the like.” EX1007, 26:21-29 (emphasis added). OTDR 424 would not be able to detect “anomalies” without comparing the received light signals relative to data from previously received light signals. *Id.*; EX1003, ¶359. Accordingly, it is inherent that Anderson discloses this element. *Id.*; *supra* §§III.A; III.D.

Alternatively, it would have been obvious to compare the received light signals with data from previously received light signals to detect changes, as disclosed by Jezwinski. EX1003, ¶360.

Jezwinski discloses an OTDR device that sends “a pulse of light down an optical fiber span” and a wavelength different than the data transmission wavelength, such that “tests may be conducted on both dark/unused optical fibers and live/used optical fibers.” EX1008, 4:39-47. Jezwinski a “test system controller (TSC),” which is a “computer that provides a graphics-based user interface, and...acts as the controller for the automated system” namely by controlling the OTDR located at a “central office-based measurement unit (OMU).” EX1008, 3:21-33, Fig. 1.

Jezwinski discloses a “launch cycle of an OTDR test,” where the TSC “sends a control packet 30” with specific testing parameters for each fiber, including for example “pulse width, wavelength, distance/range, test time, and fiber under test.” EX1008, 4:55-61. Once configured, Jezwinski discloses that for each fiber, there is an associated “reference flag” which “indicates whether or not a reference trace has been generated and stored for the fiber under test.” EX1008, 6:58-61. “Once a reference trace is stored for the fiber under test, the reference flag is set and future traces for that fiber are compared to the reference trace to locate

faults in the fiber.” EX1008, 6:61-64 (emphasis added), Figs. 3A-3B, Abstract, 7:33-8:20, 9:66-10:1.

Accordingly, Jezwinski discloses comparing received light signals relative to data obtained from previously received ones of the received light signals to detect changes. *Id.*; EX1003, ¶363.

A POSA would have found it obvious to combine the teachings of Jezwinski with Anderson by using the OTDR testing method and TSU computer taught in Jezwinski in place of the OTDR 424 in Anderson, given that both references are in the same field and both use an OTDR device to test fibers. EX1003, ¶364.

i. Motivation/Expectation of Success

A POSA would have been motivated to combine Jezwinski with Anderson because Jezwinski itself describes a more sophisticated OTDR setup that has advantages over the prior art, such as reducing “both the time for detecting a fault in the network and the amount of memory required to store trace data points” as well as providing other improvements such as a computer with a user interface to facilitate a user’s experience. EX1008, 1:5-10; EX1003, ¶365.

For example, Anderson already discloses that in Figure 22, a “central office computer” controls the switch 422 for operation with OTDR 424. EX1007, 26:10-35. A POSA would have understood that Anderson discloses a computer that can control the OTDR just like the TSU computer in Jezwinski does—it would not

even involve the addition of any components, other than connecting the computer to the OTDR—and simple software changes would allow Anderson to perform the OTDR testing method from Jezwinski. EX1003, ¶366.

Such a change was well-within the capabilities of a POSA, and would have had a high likelihood of success given that both Anderson and Jezwinski teach using an OTDR device to monitor active and dark fibers, and the changes to Anderson would primarily involve software changes to the computer to facilitate the OTDR method taught in Jezwinski. *Id.*; *supra* §§III.A; III.E.

Accordingly, the Anderson-Jezwinski combination discloses this element.

h. [1.8]

Anderson discloses analyzing the changes for the “presence of anomalies in the fiber, such as reflections, losses, and the like” and a POSA would have understood this analysis to include detecting movement of optical fibers. *Supra* §VIII.D.1.a, §III.D.

Alternatively, it would have been obvious to combine the teachings of Anderson with Jezwinski. *Supra* §VIII.D.1.g.

Jezwinski discloses that after a fault is detected in the comparison step discussed, “the fiber is immediately retested...one or more additional times to confirm that a fault in fact does exist,” which helps reduce “false indication[s] of failure.” EX1008, 6:65-7:4. If multiple faults are detected, an “alarm condition” is

initiated, and the TSC “can conduct a more in depth fault location test to provide exact information regarding fault type and the location of the fault.” EX1008, 10:20-54. In other words, the “TSC 18 analyzes measurement data” and “presents the interpreted results to the user.” EX1008, 3:31-37.

Accordingly, Jezwinski teaches analyzing changes to determine what type of fault occurred and its location. EX1008, 3:31-37, 6:65-8:20, 10:20-54. This analysis would determine if the fault is indicative of manipulation because, at the time of the invention, OTDR detected small movement of a fiber. EX1003, ¶373; *supra* §§III.A; III.D.

It would have been obvious to combine this teaching from Jezwinski into the system of Anderson. EX1003, ¶374. Both systems use an OTDR device, and have computers to control components of their systems (*supra* §VIII.D.1.g). For the same reasons, a POSA would have been motivated to include the fault type analysis taught in Jezwinski into Anderson for the reasons discussed *supra* §VIII.D.1.g, and for the additional benefit of differentiating between different types of faults. *Id.*

For example, Anderson discloses the OTDR can detect and process return signals indicative of “anomalies in the fiber, such as reflections, losses, and the like.” EX1007, 26:26-29. A POSA would have recognized the benefits of adding the fault type analysis from Jezwinski, by providing greater detail about the

detected fault, which fiber(s) were affected, the fault's location, and the signal loss characteristics. EX1003, ¶375.

Such a modification would have been easy to accomplish with a high level of success (*supra* §VIII.D.1.g), given the fact that the only changes would be software updates to the computer in Anderson, and connecting the computer to the OTDR 424 to provide the appropriate control. EX1003, ¶376; *supra* §§III.A; III.E.

Accordingly, the Anderson-Jezwinski combination discloses this element.

i. [1.9]

Jezwinski discloses that once an alarm condition has been initiated, and the TSC performs its analysis of the received data to determine the fault type and the location of the fault (*supra* §VIII.D.1.h), the TSC both provides an “alarm display” on the graphic interface, and likewise can be configured to “communicate the alarm” for example, by “automatically dial[ing] one or more pager phone numbers...in order to alert individuals outside the maintenance center of the alarm condition” and further transmitting a pager or facsimile transmission “to one or more selected individuals associated with the fiber optic network where the problem has been detected.” EX1008, 10:50-67.

Thus, Jezwinski discloses generating an alarm in response to the detection of any such changes which are indicative of a fault, including location of the same. EX1008, 10:50-67; EX1003, ¶380.

It would have been obvious to combine this teaching from Jezwinski into the system of Anderson. Both references rely on an OTDR device, and have computers to control components of their systems (*supra* §VIII.D.1.h). For the same reasons, a POSA would have been motivated to include the alarm generation taught in Jezwinski into Anderson for the reasons discussed (*supra* §VIII.D.1.h), and for the additional benefit of providing notice of important information resulting from the OTDR fiber monitoring methods, including the presence of a fault, fault type, fault location, and which fiber is affected. EX1003, ¶382.

Such a modification would have been easy to accomplish with a high level of success, given the fact that the only changes would be software updates to the computer in Anderson (*supra* §VIII.D.1.h), and connecting the computer to the OTDR 424 to provide the appropriate control and ability to generate an alarm and send out the alert, as taught in Jezwinski. EX1003, ¶382; *supra* §§III.A; III.E.

Accordingly, the Anderson-Jezwinski combination discloses obvious this element.

j. [1.10]

Anderson discloses various optical communication components including switch 422 and WDMs 426, 428, 430, and likewise discloses how light can be injected/received by OTDR 424 through both dark fibers and active data

transmission fibers in the fiber links 404, 406, and 408. *Supra* §§VIII.D.1.e-VIII.D.1.f.

Accordingly, Anderson discloses that the total number of monitored fibers (at least two fibers for each of the three fiber links) is greater than the sole light source and sensor arrangement OTDR 424. EX1007, Fig. 22; EX1003, ¶385.

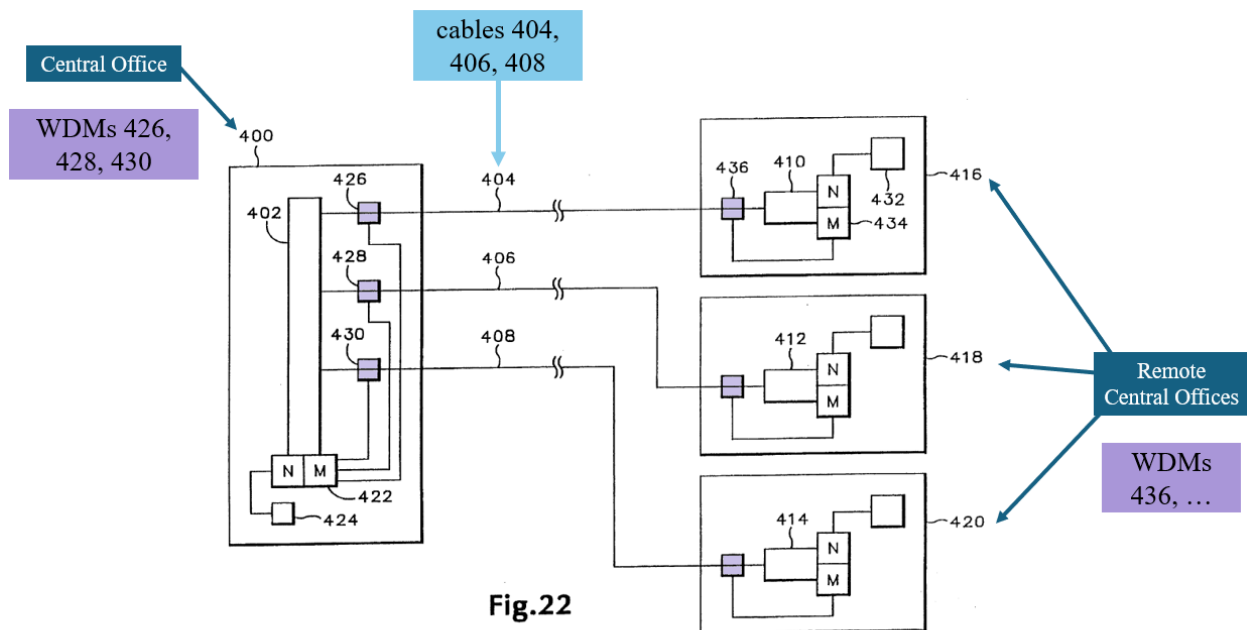
2. Claim 9

a. [9.0]-[9.8]

See [1.0], [1.3]-[1.10]. *Supra* §§VIII.D.1.a, VIII.D.1.d-VIII.D.1.j.

b. [9.9]

Anderson discloses a plurality of WDMs 426, 428, and 430 at an entry end of the fiber links 404, 406, and 408, and a plurality of WDMs at the exit end of the fiber links:



EX1007, Fig. 22 (annotated), 26:2-65; EX1003, ¶390.

Anderson discloses that OTDR 424 can inject light into either a “dark fiber” or the “optical transmission fibers” where light from OTDR 424 is directed to the appropriate fiber through switch 422, which is coupled to fiber links 404, 406, 408 via WDMs 426, 428, 430, respectively. EX1007, 26:2-46, Fig. 22.

Anderson discloses:

In examining active transmission fibers with an OTDR, the Wavelength of the optical output of the OTDR 424 is different from the wavelength of the active optical transmissions over the transmission fibers. For example, if the transmission link is operating at 1310 nm wavelength, then the OTDR 424 operates at 1550 nm wavelength for examining the transmission fibers of the link. These tests can be performed while active transmissions are occurring in the fiber.

EX1007, 26:38-46.

Because Anderson discloses that these tests can be performed while active transmissions are occurring, it is inherent that WDMs 426, 428, and 430 multiplex the transmission wavelength with the OTDR test wavelength to allow the transmission of both signals at the same time. EX1003, ¶393. It is inherent that the WDMs at the opposite ends (436 and similar components in 418 and 420) demultiplex the data transmission wavelength from the OTDR signal in order to

transmit the data transmission wavelengths for use by the remote offices 416, 418, and 420. EX1003, ¶393; *supra* §III.B.

3. Claim 10

Anderson discloses testing the active transmission fibers by multiplexing the OTDR wavelength (the monitor wavelength) with the data transmission wavelength. *Supra* §VIII.D.2.b.

When the OTDR is used to monitor active transmission fibers, all transmission on the active fibers is the OTDR monitor wavelength (1550 nm) multiplexed to the data wavelength (1310 nm). EX1007, 26:6-46; EX1003, ¶396.

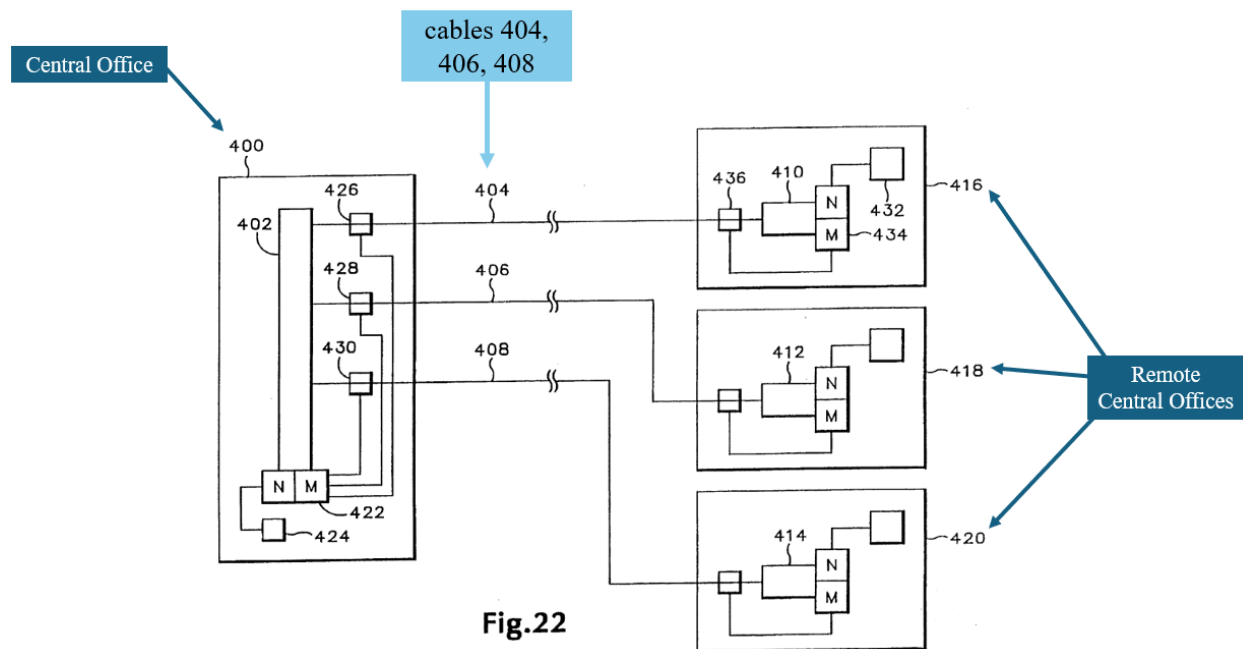
4. Claim 12

a. [12.0]

See [1.0]. *Supra* §VIII.D.1.a.

b. [12.1]

Anderson discloses a plurality of optical fiber cables (cables 404, 406, 408) arranged in a hub-and-spoke arrangement where each optical fiber cable extends from a main unit at a central location, which includes the components at the Central Office 400:



EX1007, Fig. 22 (annotated).

The cables extend to a plurality of remote units, including the components at the Remote Central Offices, such as the WDMs 436, and SDH/SONET receiver instruments 432. EX1007, Fig. 22, 25:57-26:36; EX1003, ¶402.

c. [12.2]-[12.3]

See [1.1]-[1.2]. *Supra* §§VIII.D.1.b -VIII.D.1.c.

d. [12.4]

See [1.3]. *Supra* §VIII.D.1.d.

Anderson's source of light for injection onto the fibers is at the main unit.

Supra §VIII.D.1.b-VIII.D.1.d..

e. [12.5]

See [1.4]. *Supra* §VIII.D.1.d.

f. [12.6]

See [1.5]. *Supra* §VIII.D.1.e.

Anderson's source of light for injecting into the fibers to be monitored is at the main unit. *Supra* §VIII.D.1.b-VIII.D.1.d.

g. [12.7]-[12.10]

See [1.6]-[1.9]. *Supra* §§VIII.D.1.f-VIII.D.1.i.

h. [12.11]/[12.12]

See [1.10]. *Supra* §VIII.D.1.j.

Anderson's source of light for monitoring the cables is at the main unit.
Supra §VIII.D.1.b-VIII.D.1.d.

E. Ground 5

Claims 3-5 of the '641 Patent are obvious over Evans in view of Pope.
EX1003, ¶¶415-429.

1. Claim 3

Evans discloses each and every element of Claim 1. *Supra* §VIII.B.1.

Evans discloses using a jumper to connect multiple fibers in the cable at the far end. *Supra* §VIII.B.2.

It would have been obvious to a POSA that the "fiber loop 29" disclosed in Evans (the jumper) could be used a plurality of times on both sides of the cable, as shown in Figure 4 below:

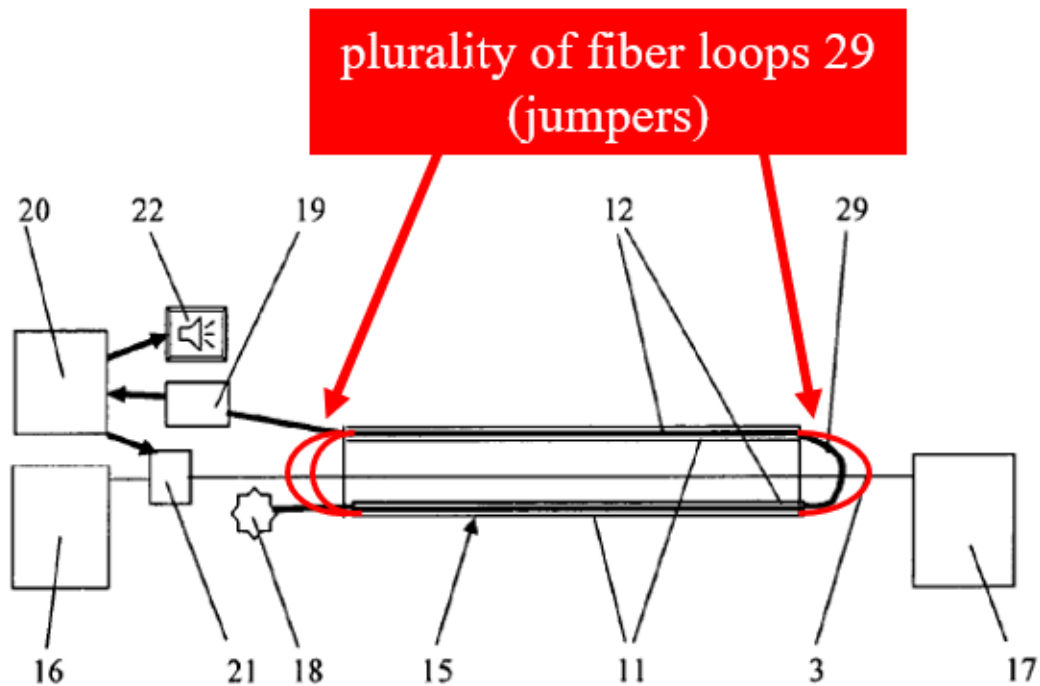


Fig 4

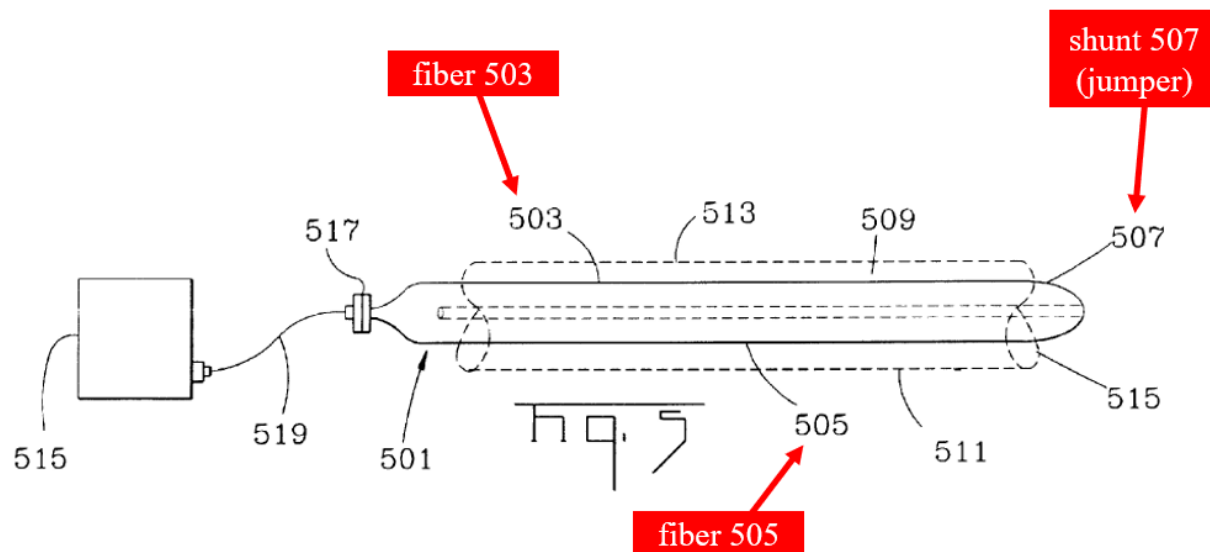
EX1006, Fig. 4 (annotated/modified).

For example, Evans' preferred cable embodiment includes eight monitor optical fibers 12. EX1006, [0034]-[0035], Fig. 1; *supra* VIII.B.1.b. It would have been obvious to a POSA that if each monitor optical fiber 12 were to have a monitor signal travel through it, an easy way to do so would be to include a plurality of "fiber loops 29" disclosed in Figure 4 to connect the end of each fiber to the next fiber in the cable. EX1003, ¶419.

In the modified Figure 4 above, for example, the monitor signal would travel through a first fiber and loop through fiber loop 29 originally depicted in black to a second fiber—the addition of three fiber loop 29 jumpers on the near end and three

fiber loop 29 jumpers on the far end of the cable would allow the monitor signal to travel through each of the eight optical monitor fibers (12) of Evans' preferred cable embodiment. EX1003, ¶420.

Such arrangements of jumpers to loop the monitor signal were well known in the art. *Supra* §III.C. For example, Pope teaches an “optical fiber sensor, disposed in the insulation of a wire or cable, provides a means of detecting damage to the insulation of the wire or cable.” EX1010, Abstract. Pope teaches a fiber optic sensor in a cable, including “at least one fiber optic source portion 503” and “at least one optic return portion 505” that are connected via a jumper (i.e., shunt portion 507):



EX1010, Fig. 5 (annotated), 5:45-51; EX1003, ¶421.

In a preferred embodiment, the fiber optic sensor “comprises four or more longitudinal sensor portions” that are each “connected by shunt portions [507] to form a single series-connected loop.” EX1010, 5:52-65. Accordingly, Pope discloses a fiber optic sensing arrangement where a monitor signal is looped through a cable through jumpers (i.e. shunt portions 507) creating a series-connected loop. *Id.*; EX1003, ¶422.

It would have been obvious to a POSA in view of Pope’s teachings regarding looping a monitor signal through a cable in a series-connected loop via jumpers (shunt portions 507) could easily be implemented in Evans’ Figure 4. EX1003, ¶423. For example, by looping such a monitoring signal through the cable in Evans by adding fibers to be monitored as described.

a. Motivation/Expectation of Success

It would have been well within the capabilities of a POSA to make such a modification, as it only involves adding elements already disclosed in Evans in order to make use of each of the monitor optical fibers (12) from the preferred cable embodiment. EX1003, ¶424. A POSA would have been motivated to add jumpers in order to fully utilize all the optical monitor fibers available, allowing built-in redundancy for monitoring the cable via multiple monitor fibers. *Id.* A POSA would have had a high expectation of success, given that the modification would merely involve adding additional fiber loops already taught in Evans, and

the addition of known components to fiber optical systems was easily accomplished. *Id.*; *supra* §§III.C;III.E.

2. Claim 4

In Evans' Figure 4 modified with the multiple jumpers of Pope, Evans' light source 18 and sensor arrangement (detector 19 and computer 20) are on the same end of the cable. EX1006, Fig. 4, [0041]. Pope's series of jumpers (*supra* §VIII.E.1) at the second end of the cable is a series of jumpers defining the communication components. EX1003, ¶426.

3. Claim 5

In Evans' Figure 4, single light source 18 and single sensing arrangement (detector 19 and computer 20) are arranged such that multiple monitored fibers (two shown in Evans' Figure 4) are treated as one fiber therebetween. *Supra* §VIII.B.1.d-VIII.B.1.e.

In Evans' Figure 4 modified with the multiple jumpers of Pope, Evans' single light source 18 and single sensing arrangement (detector 19 and computer 20) would similarly be arranged such that multiple monitored fibers (more than two of Evans' fibers) are treated as one fiber therebetween. EX1003, ¶429.

IX. MANDATORY NOTICES

A. Real Party-In-Interest

Petitioner identifies CyberSecure IPS LLC (Petitioner) as a real party-in-interest (“RPI”). Petitioner is owned and managed by American Networking Solutions, LLC and Sohntech Solutions, LLC.

B. Related Matters

The ’641 Patent is the subject of the following matter, which may be affected by a decision in this proceeding: *Network Integrity Systems, Inc. v. Cybersecure IPS LLC*, Case No. 8:25-cv-01974-TDC (D. Md.) filed on April 7, 2025.

Petitioner is not aware of any post-grant proceeding before the Office involving the ’641 Patent. *See* 37 C.F.R. §§42.8(b)(3), 42.8(b)(4), 42.10(a), and 42.10(b).

C. Counsel and Service Information

Pursuant to 37 C.F.R. §§42.8(b)(3) and 42.10(a), Petitioner provides the following counsel and service information.

Pursuant to 37 C.F.R. §42.10(b), a Power of Attorney accompanies this Petition.

D. Service Information

Per 37 C.F.R. §42.8(b)(4), Petitioner provides the following service information for designated counsel:

Lead Counsel	Back-Up Counsel
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Petitioner consents to service via email at foley_cybersecure_ipr@foley.com

X. PAYMENT OF FEES

The required fee is paid by credit card, with authorization to charge any fee deficiencies and credit overpayments to Deposit Acct. No. 190741.

XI. CONCLUSION

Trial should be instituted and the Challenged Claims cancelled.

U.S. Patent No. 7,706,641
IPR2025-01441

Respectfully submitted,

Dated: August 22, 2025

By: /Kimberly K. Dodd/

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CERTIFICATE UNDER 37 C.F.R. §42.24(D)

The undersigned certifies that the foregoing Petition for *Inter Partes* Review, excluding any table of contents, mandatory notices under 37 C.F.R. §42.8, certificates of service or word count, or appendix of exhibits, contains 13,736 words according to the word-processing program used to prepare this document (Microsoft Word), which is less than the 14,000 allowed under 37 C.F.R. §42.24(a)(1)(i).

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Petition for *Inter Partes* Review together with all exhibits and other papers filed therewith was served on August 22, 2025 via FedEx to patent owner at the address below:

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WINNIPEG MB R2G1P9
CANADA

A courtesy copy with all exhibits and other papers filed therewith was sent to litigation counsel via email:

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