

Description

This invention relates to monitoring of optical fibres.

There are in existence surveillance systems for optical fibre networks operating on optical time domain reflectometry (OTDR) principles. In these systems a high power pulse is launched into the optical fibre, this pulse travels along the fibre and is scattered by crystal inhomogeneities in the fibre, some of the scattering being backwards along the fibre to the end from which the pulse was launched. At this launch end the returning backscattering light is monitored for a period following launch of the pulse. The returning backscattered light effectively constitutes a series of 'echoes' and it is possible to determine the power level of the pulse at a point of the fibre because the power level bears a relationship to the strength of the returning backscattered signal, and the time interval between launch of the pulse and the respective return 'echo' provides, from a presumption of the propagation time, an indication of the distance along the fibre from which the light is being scattered. Over a period of time a lowering in the echo strength related to a particular location on the fibre is indicative of power loss which may be indicative of unauthorised coupling out of light, but also may be caused by other factors. A system of this type is described in FR-A-2453403. A disadvantage of using OTDR monitoring for surveillance is that the high power pulse sources required are costly and bulky. Also although power loss is detectable, the system does not provide an indication of unauthorised handling or proximity to transmission lines, for example for the purpose of sabotage, until actual damage occurs. It is also possible for power to be tapped and simultaneously injected without detection.

The present invention is concerned with providing a sensitive surveillance system that may also provide an early indication of unauthorised access to an optical fibre network.

The present invention provides a surveillance method comprising the steps of generating a cyclically-varying signal, modulating an optical beam with said signal and launching the beam into an optical fibre, and comparing at least part of the signal after transmission along the fibre with a reference signal related to the cyclically-varying signal, characterised in that the phase of the signal after transmission along the fibre is compared with the phase of the reference signal.

The invention also provides surveillance apparatus for surveying an optical fibre transmission path, the apparatus comprising generating means for generating a cyclically-varying signal and for modulating an optical beam with the cyclically-

varying signal, means for coupling the modulated optical beam into the optical fibre transmission path, and comparison means coupled to the optical fibre transmission path for comparing at least part of the signal after propagation of the signal along the optical fibre transmission path with a reference signal related to the cyclically-varying signal, characterised in that the comparison means compares the phase of the signal after propagation along the optical fibre transmission path with the phase of the reference signal.

Within the context of this specification the expression 'optical' is not restricted in its reference to the visible portion of the electromagnetic spectrum, and especially it includes the infra red and wavelengths transmittable by optical fibres.

The invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic illustration of a first embodiment of the invention in which a surveillance signal is launched into a fibre and monitored from the launch end, and

Figure 2 is a schematic illustration of a second embodiment in which the surveillance signal is monitored at the end remote from the launch of the surveillance signal.

In local or short haul communication networks there is a demand for confidential transmission and it is this type of network that is the principle concern of the invention although it is envisaged that the system may be developed for longer haul applications. In a preferred embodiment a surveillance signal is generated and transmitted along the same path as the data signals. Any available transmission window may be used for the surveillance signal, for example the data transmission may use 1300nm and the surveillance signal 1310nm or data transmissions may be spread around 1300nm and the surveillance signal transmitted at 850nm. The surveillance signal is constantly transmitted even when there is no data transmission.

The surveillance signal consists of a cyclically varying signal, for example a laser beam having a square or sinusoidally modulated amplitude. In fact the modulation may take any form in which phase difference or delay can be detected, and for a given maximum amplitude the shorter the modulation period the more sensitive it becomes to phase difference. This amplitude modulated signal is launched into the transmission fibre and propagates along the fibre until it is reflected back towards the launching end by the fibre termination at the far end of the fibre. The proportion of the surveillance signal that is reflected may be increased by providing a metallised coating on the fibre termination or by provision of a grating or other wavelength sensitive device that will selectively reflect the surveil-

lance signal. At the launching end the returning surveillance signal is compared with the launched signal for phase difference and this phase difference provides a reference value. If the transmission path is elongated then the phase difference between the launched and returning signals changes and this change is significant even for minute elongation: picking up a single fibre or disturbing a fibre by blowing on it is sufficient to change the phase difference between the launched and returning surveillance signals at surveillance signal frequencies of the order of 200 MHz. Thus by monitoring for phase difference changes from the reference value an indication of change in length of the fibre transmission line can be detected and this may indicate disturbance of the line. In general it is envisaged that frequencies greater than 50MHz will be used, preferably frequencies in excess of 100MHz and less than 300MHz.

Various factors other than disturbance may also cause changes in length of the fibre, for example thermal expansion and contraction and vibration caused by the environment such as the passage of traffic. In order to eliminate consideration of changes due to these factors the phase difference values are monitored by a microprocessor which revises the reference value taking into account changes in temperature, traffic flow conditions and other variations related to external conditions or following predictable patterns. For example, if ambient temperature increases this can be monitored directly or, as will be necessary if the change in temperature occurs at a part of the transmission line remote from the microprocessor or any related sensor, the microprocessor will take into account comparatively slow and steady changes in the phase and recognise this as a temperature variation pattern and revise the reference value. Likewise vibration patterns caused by traffic will be recognisable both from time of day expectation levels and from the magnitude of the shifts. In contrast to this in order to tap into a fibre transmission line it is necessary to expose the fibre in order to couple it to a tapping fibre and this operation necessarily disturbs the fibre to a much greater extent than mere vibration because the duct carrying the fibre package and the fibre package itself have to be opened up. This type of disturbance would not follow a recognisable or expected regular pattern and the microprocessor would shut down the communication channel or provide other indications that unusual tampering may have occurred. In some locations the vibration pattern caused by approach to the fibre without actual handling may be sufficiently different from normal ambient conditions to raise an alert condition. The sensitivity of the system may also be selected by choice of

surveillance signal frequency, the higher the frequency the more sensitive the system, so that a particular level of disturbance is necessary for detection and this can eliminate consideration of small vibrations for example.

In the system described so far the surveillance signal has been transmitted along the same fibre as the data. In practice it is usual for a transmission line package to include several separate optical fibres and as these packages are sealed the whole package is disturbed when access to a component fibre is made, so that a surveillance signal carried by one fibre in a package provides surveillance for the whole package. The technique may also be utilised as just a disturbance monitor without data transmission. In some instances greater sensitivity may be achieved by reducing the extent of packaging around a portion of fibre so as to render it more sensitive to its environment, and especially to vibration caused by approach.

It may be desirable to monitor for phase change at the end of the line remote from launch by comparing the incoming surveillance signal with a reference signal that is locally generated or transmitted to that end along the same or a different route. With this modification surveillance of more than one span of fibre may be achieved at a central monitoring location.

In a single ended (launch end monitored) system the return signal may be transmitted along a different return fibre to the outbound signal.

Referring now to the drawings, Figure 1 shows a first preferred embodiment of the invention. In this embodiment a cyclically-varying surveillance signal is generated by a signal generator 1 and this signal modulates the output of an LED or laser source 2 which is launched into an optical fibre transmission line 3, via a coupler 4. The line 3 may be a fibre that is also carrying data signals (as shown) from a data transmission source 6 or a separate fibre for surveillance only. The signal launched into the fibre 3 propagates to the remote end of the transmission line where it is reflected or returned back into the fibre by reflector 4 which may be a mirror, cleaved end, loop and coupler or such like.

If the line 3 is also carrying data, then at the far end there is a second coupler 5 which splits the light with one output going to data decoding and the other to the reflector 4. The reflected signal returns via coupler 5 (when required) along the line 3 to coupler 4 from which it is then input to a phase lock amplifier 7. The data signal (when present) is at a different wavelength λ_1 from the surveillance signal λ_2 , and λ_2 is rejected at the phase lock amplifier. The amplifier 7 also receives an input from the signal generator 1 and compares the phases of the original signal with the returning

signal and inputs the comparison to a microprocessor 8. In the microprocessor the phase change or delay is analysed and if it is found to be indicative of tampering the microprocessor signals this to a data controller 9 which in turn generates an audible alarm signal from alarm 10 and transmits a 'disable data' signal to the data transmitter 6, along line 3 and to the far end where transmission from data transmitter 11 is also disabled. A feedback loop from the microprocessor inputs phase adjustment information due for example to thermal expansion or other memorised information.

Figure 2 shows a system, again for simultaneous transmission of data and surveillance signal, in which the surveillance signal is monitored at the far end from launch. In this system the signal generator's signal is also input to a frequency to digital convertor 12 and transmitted at the data frequency. At the far end the data frequency signal splits and the signal generator frequency is recovered by a digital to frequency convertor 13 and this is input to the phase-locked amplifier 7 which also receives the surveillance signal from coupler 4. The comparison, microprocessor and data disable operate similarly to that explained with reference to Figure 1.

The data disable signal may take several forms. It may comprise a specific signal or cessation of an all-clear signal. Likewise, on receipt of the data disable signal, the data transmitter may either change or interrupt the data transmission.

Claims

1. A surveillance method comprising the steps of generating a signal, modulating an optical beam with said signal and launching the beam into an optical fibre, and comparing at least part of the signal after transmission along the fibre with a reference signal related to said signal, characterised in that said signal is a cyclically-varying signal and in that the phase of the cyclically-varying signal after transmission along the fibre is compared with the phase of the reference signal.
2. A surveillance method according to claim 1, in which at least part of the cyclically-varying signal is reflected back to the launch end of the fibre and is compared with the reference signal at the launch end.
3. A surveillance method according to claim 1 or claim 2, in which the reference signal comprises the cyclically-varying signal prior to transmission along the fibre.
4. A surveillance method according to claim 1, in

which the cyclically varying signal is digitally encoded, transmitted to the end of the fibre remote from the launch end and decoded to provide the reference signal, and the comparison and monitoring takes place at the end of the fibre remote from the launch end.

5. A surveillance method according to any one of claims 1 to 4, in which the cyclically-varying signal comprises a substantially continuously-varying, amplitude modulated signal.
6. A surveillance method according to any one of claims 1 to 5, in which, in the event of phase changes exceeding a predetermined level, information data transmitted over a transmission line under surveillance is disabled.
7. A surveillance method according to any one of claims 1 to 6, in which, in the event of phase changes exceeding a predetermined level, a warning signal is generated.
8. A surveillance method according to any one of claims 1 to 7, in which the optical beam is provided by an electro-luminescent semiconductor device.
9. A surveillance method according to any one of claims 1 to 8, in which the cyclically-varying signal has a frequency of at least 50 MHz.
10. A surveillance method according to any one of claims 1 to 9, in which phase changes consequent on environmental patterns are automatically discounted.
11. A surveillance apparatus for surveying an optical fibre transmission path (3), the apparatus comprising generating means (1) for generating a signal and for modulating an optical beam with said signal, means (4) for coupling the modulated optical beam into the optical fibre transmission path, and comparison means (7) coupled to the optical fibre transmission path for comparing at least part of the signal after propagation of the signal along the optical fibre transmission path with a reference signal related to said signal, characterised in that the generating means generates a cyclically-varying signal and in that the comparison means is adapted to compare the phase of the cyclically-varying signal after propagation along the optical fibre transmission path with the phase of the reference signal.
12. Apparatus according to claim 11, wherein the comparison means (7) includes means for gen-

signal and inputs the comparison to a microprocessor 8. In the microprocessor the phase change or delay is analysed and if it is found to be indicative of tampering the microprocessor signals this to a data controller 9 which in turn generates an audible alarm signal from alarm 10 and transmits a 'disable data' signal to the data transmitter 6, along line 3 and to the far end where transmission from data transmitter 11 is also disabled. A feedback loop from the microprocessor inputs phase adjustment information due for example to thermal expansion or other memorised information.

Figure 2 shows a system, again for simultaneous transmission of data and surveillance signal, in which the surveillance signal is monitored at the far end from launch. In this system the signal generator's signal is also input to a frequency to digital convertor 12 and transmitted at the data frequency. At the far end the data frequency signal splits and the signal generator frequency is recovered by a digital to frequency convertor 13 and this is input to the phase-locked amplifier 7 which also receives the surveillance signal from coupler 4. The comparison, microprocessor and data disable operate similarly to that explained with reference to Figure 1.

The data disable signal may take several forms. It may comprise a specific signal or cessation of an all-clear signal. Likewise, on receipt of the data disable signal, the data transmitter may either change or interrupt the data transmission.

Claims

1. A surveillance method comprising the steps of generating a signal, modulating an optical beam with said signal and launching the beam into an optical fibre, and comparing at least part of the signal after transmission along the fibre with a reference signal related to said signal, characterised in that said signal is a cyclically-varying signal and in that the phase of the cyclically-varying signal after transmission along the fibre is compared with the phase of the reference signal.
2. A surveillance method according to claim 1, in which at least part of the cyclically-varying signal is reflected back to the launch end of the fibre and is compared with the reference signal at the launch end.
3. A surveillance method according to claim 1 or claim 2, in which the reference signal comprises the cyclically-varying signal prior to transmission along the fibre.
4. A surveillance method according to claim 1, in

which the cyclically varying signal is digitally encoded, transmitted to the end of the fibre remote from the launch end and decoded to provide the reference signal, and the comparison and monitoring takes place at the end of the fibre remote from the launch end.

5. A surveillance method according to any one of claims 1 to 4, in which the cyclically-varying signal comprises a substantially continuously-varying, amplitude modulated signal.
6. A surveillance method according to any one of claims 1 to 5, in which, in the event of phase changes exceeding a predetermined level, information data transmitted over a transmission line under surveillance is disabled.
7. A surveillance method according to any one of claims 1 to 6, in which, in the event of phase changes exceeding a predetermined level, a warning signal is generated.
8. A surveillance method according to any one of claims 1 to 7, in which the optical beam is provided by an electro-luminescent semiconductor device.
9. A surveillance method according to any one of claims 1 to 8, in which the cyclically-varying signal has a frequency of at least 50 MHz.
10. A surveillance method according to any one of claims 1 to 9, in which phase changes consequent on environmental patterns are automatically discounted.
11. A surveillance apparatus for surveying an optical fibre transmission path (3), the apparatus comprising generating means (1) for generating a signal and for modulating an optical beam with said signal, means (4) for coupling the modulated optical beam into the optical fibre transmission path, and comparison means (7) coupled to the optical fibre transmission path for comparing at least part of the signal after propagation of the signal along the optical fibre transmission path with a reference signal related to said signal, characterised in that the generating means generates a cyclically-varying signal and in that the comparison means is adapted to compare the phase of the cyclically-varying signal after propagation along the optical fibre transmission path with the phase of the reference signal.
12. Apparatus according to claim 11, wherein the comparison means (7) includes means for gen-



erating an output signal indicating that the optical fibre transmission path (3) has been tampered with in response to unexpected detected phase changes over time.

13. Apparatus according to claim 12, wherein the comparison means (7) includes means for generating said output signal only if a detected phase change exceeds a predetermined changes.
14. Apparatus according to claim 12, wherein the comparison means (7) includes means for adapting to gradual changes in the condition of the optical fibre transmission path (3).
15. Apparatus according to any one of claims 11 to 14, further comprising a light transmitter (2), the cyclically-varying signal produced by the generating means (1) being applied to the transmitter to produce the modulated optical beam.
16. Apparatus according to claim 15, wherein the modulated optical beam is at a first frequency, and the apparatus further comprises a data transmitter (6) for injecting a data signal at a second frequency different from the first frequency into the optical fibre transmission path (3).
17. Apparatus according to claim 16, wherein the optical fibre transmission path (3) has a first end and a second end, the transmitter (2) and the comparison means (7) are both coupled to the optical fibre transmission path first end, and the apparatus further comprises frequency selective reflecting means, coupled to the optical fibre transmission path second end, for reflecting the first frequency signal and for passing the second frequency signal.
18. Apparatus according to claim 16 or claim 17, further comprising processing means (8), coupled to the comparison means (7) for continually monitoring the phase change, and for disabling the data transmitter (6) in response to a predetermined phase change.

Patentansprüche

1. Überwachungsverfahren das folgende Schritte aufweist: Erzeugen eines Signals, Modulieren eines Lichtstrahls mit diesem Signal sowie Einkoppeln des Strahls in eine Lichtleitfaser, und Vergleichen mindestens eines Teils des Signals, nach der Übertragung durch die Faser mit einem auf das genannte Signal bezogenen

Bezugssignal, dadurch gekennzeichnet, daß das Signal ein sich zyklisch veränderndes Signal ist und die Phase des sich zyklisch verändernden Signals nach der Übertragung entlang der Faser mit der Phase des Bezugssignals verglichen wird.

2. Überwachungsverfahren nach Anspruch 1, bei dem mindestens ein Teil des sich zyklisch verändernden Signals zurück zum Startende des Faser reflektiert und mit dem Bezugssignal am Startende verglichen wird.
3. Überwachungsverfahren nach Anspruch 1 oder 2, bei dem das Bezugssignal das sich zyklisch verändernden Signal vor der Übertragung durch die Faser umfaßt.
4. Überwachungsverfahren nach Anspruch 1, bei dem das sich zyklisch verändernde Signal digital kodiert, an das vom Startende entfernt liegende Ende der Faser übertragen und zur Lieferung des Bezugssignals dekodiert wird, und bei dem der Vergleich und die Kontrolle an dem vom Startende entfernt liegenden Ende der Faser stattfindet.
5. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 4, bei dem das sich zyklisch verändernde Signal ein im wesentlichen kontinuierlich veränderliches, amplitudenmoduliertes Signal ist.
6. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 5, bei dem im Falle, daß die Phasenänderung einen vorbestimmten Pegel überschreitet, die Informationsdaten, die über eine unter Beobachtung stehende Übertragungsleitung übermittelt werden, gesperrt werden.
7. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 6, bei dem im Falle, daß die Phasenänderung einen vorbestimmten Pegel überschreitet, ein Warnsignal erzeugt wird.
8. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 7, bei dem der Lichtstrahl durch eine elektrolumineszierende Halbleitereinrichtung geliefert wird.
9. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 8, bei dem das sich zyklisch verändernde Signal eine Frequenz von mindestens 50 Mhz hat.
10. Überwachungsverfahren nach einem beliebigen Anspruch 1 bis 9, bei dem Phasenänderungen,



die sich aus Umgebungsmustern ergeben, automatisch unberücksichtigt bleiben.

11. Überwachungsgerät zum Überwachen eines Lichtleitfaserübertragungsweges (3), wobei das Gerät aufweist: Erzeugungseinrichtungen (1) zum Erzeugen eines Signals und zum Modulieren eines Lichtstrahls mit dem Signal; Einrichtungen (4) zum Einkoppeln des modulierten Lichtstrahls in den Lichtleitfaserübertragungsweg; und Vergleichseinrichtungen (7), die an den Lichtleitfaserübertragungsweg angekoppelt und zum Vergleichen mindestens eines Teils des Signals nach der Fortpflanzung des Signals durch den Lichtleitfaserübertragungsweg mit einem auf das genannte Signal bezogenen Bezugssignal, dadurch gekennzeichnet, daß die Erzeugungseinrichtung ein sich zyklisch veränderndes Signal erzeugt, und daß die Vergleichseinrichtung für das Vergleichen der Phase des sich zyklisch verändernden Signals, nach der Fortpflanzung entlang des Lichtleitfaserübertragungsweges, mit der Phase des Bezugssignals ausgelegt ist.

12. Gerät nach Anspruch 11, bei dem die Vergleichseinrichtung (7) Mittel zur Erzeugung eines Ausgangssignals umfaßt, das als Antwort auf unerwartet im Zeitablauf entdeckte Phasenänderungen anzeigt, daß auf den Lichtleitfaserübertragungsweg (3) unbefugt eingewirkt worden ist.

13. Gerät nach Anspruch 12 bei dem die Vergleichseinrichtung (7) Mittel zur Erzeugung eines Ausgangssignals aufweist, das nur erzeugt wird, wenn eine erfaßte Phasenänderung eine vorbestimmte Änderung überschreitet.

14. Gerät nach Anspruch 12, bei dem die Vergleichseinrichtung (7) Mittel zur Anpassung an graduelle Änderungen des Zustandes des Lichtleitfaserübertragungsweges (3) aufweist.

15. Gerät nach einem beliebigen Anspruch 11 bis 14, das weiter einen Lichttransmitter (2) aufweist, wobei das von der Generatoreinrichtung (1) erzeugte, sich zyklisch verändernde Signal an den Transmitter angelegt wird, um den modulierten Lichtstrahl zu erzeugen.

16. Gerät nach Anspruch 15, bei dem der modulierte Lichtstrahl eine erste Frequenz besitzt, und das Gerät weiter einen Datentransmitter (6) zum Einkoppeln eines Datensignals mit einer, von der ersten Frequenz verschiedenen zweiten Frequenz in den Lichtleitfaserübertragungsweg (3) aufweist.

17. Gerät nach Anspruch 16, bei dem der Lichtleitfaserübertragungsweg (3) ein erstes Ende und ein zweites Ende besitzt, wobei der Transmitter (2) und die Vergleichseinrichtung (7) an das erste Ende des Lichtleitfaserübertragungsweges angekoppelt sind; und bei dem das Gerät weiter frequenzselektive Reflexionsmittel aufweist, die an den zweiten Lichtleitfaserübertragungsweg zum Reflektieren des Signals mit der ersten Frequenz und zum Durchlassen des Signals der zweiten Frequenz angekoppelt sind.

18. Gerät nach Anspruch 16 oder 17, das weiter an die Vergleichseinrichtung (7) angeschlossene Verarbeitungseinrichtungen (8) zur kontinuierlichen Überwachung und zum Deaktivieren des Datentransmitters (6) als Antwort auf eine vorbestimmte Phasenänderung aufweist.

Revendications

1. Un procédé de surveillance comprenant les étapes consistant à engendrer un signal, moduler un faisceau optique à l'aide dudit signal et lancer le faisceau dans une fibre optique et comparer, à un signal de référence lié audit signal, au moins une partie du signal après transmission le long de la fibre, caractérisé en ce que ledit signal est un signal à variation cyclique et en ce que la phase du signal à variation cyclique après transmission le long de la fibre est comparée avec la phase du signal de référence.

2. Un procédé de surveillance selon la revendication 1, dans lequel au moins une partie du signal à variation cyclique est réfléchi vers l'extrémité de lancement de la fibre et est comparé avec le signal de référence à l'extrémité de lancement.

3. Un procédé selon la revendication 1 ou la revendication 2, dans lequel le signal de référence comprend le signal à variation cyclique avant transmission le long de la fibre.

4. Un procédé selon la revendication 1 dans lequel le signal à variation cyclique est encodé numériquement, transmis à l'extrémité de la fibre distante de l'extrémité de lancement et décodé pour fournir le signal de référence, et la comparaison et la surveillance s'effectuent à l'extrémité de la fibre distante de l'extrémité de lancement.

5. Un procédé de surveillance selon l'une quelconque des revendications 1 à 4, dans lequel



le signal à variation cyclique comprend un signal modulé en amplitude à variation sensiblement continue.

6. Un procédé de surveillance selon l'une quelconque des revendications 1 à 5 dans lequel, dans le cas de variations de phase dépassant un niveau prédéterminé, une donnée d'information transmise par la ligne de transmission sous surveillance est invalidée. 5
7. Un procédé de surveillance selon l'une quelconque des revendications 1 à 6 dans lequel, dans le cas de variations de phase dépassant un niveau prédéterminé, un signal d'alarme est engendré. 10
8. Un procédé de surveillance selon l'une quelconque des revendications 1 à 7 dans lequel le faisceau optique est fourni par un dispositif électroluminescent semi-conducteur. 15
9. Un procédé de surveillance selon l'une quelconque des revendications 1 à 8 dans lequel la fréquence du signal à variation cyclique est d'au moins 50 MHz. 20
10. Un procédé de surveillance selon l'une quelconque des revendications 1 à 9 dans lequel des variations de phase résultant de configurations d'environnement sont automatiquement éliminées. 25
11. Un appareil de surveillance destiné à surveiller un trajet de transmission (3) par fibres optiques, l'appareil comprenant un moyen générateur (1) pour engendrer un signal et moduler un faisceau optique à l'aide dudit signal, un moyen (4) de couplage du faisceau optique modulé dans le trajet de transmission par fibres optiques et un moyen de comparaison (7) couplé au trajet de transmission par fibres optiques pour comparer, à un signal de référence lié audit signal, au moins une partie du signal après propagation du signal le long du trajet de transmission par fibres optiques, caractérisé en ce que le moyen générateur engendre un signal à variation cyclique et en ce que le moyen de comparaison est apte à comparer, à la phase du signal de référence, la phase du signal à variation cyclique après propagation le long du trajet de transmission par fibres optiques. 30
12. Appareil selon la revendication 11, dans lequel le moyen de comparaison (7) inclut un moyen de génération d'un signal de sortie indiquant, en réponse à des variations inattendues de la 35

phase détectée au cours du temps, que le trajet de transmission (3) de fibre optique a été manipulé.

13. Appareil selon la revendication 12, dans lequel le moyen de comparaison (7) inclut un moyen pour n'engendrer ledit signal de sortie que si une variation de phase détectée dépasse une variation prédéterminée. 40
14. Appareil selon la revendication 12 dans lequel le moyen de comparaison (7) inclut un moyen prévu pour s'adapter à des variations progressives de la condition du trajet de transmission (3) par fibres optiques. 45
15. Appareil selon l'une quelconque des revendications 11 à 14, comprenant de plus un émetteur lumineux (2), le signal à variation cyclique produit par le moyen générateur (1) étant appliqué à l'émetteur pour produire le faisceau optique modulé. 50
16. Appareil selon la revendication 15, dans lequel le faisceau optique modulé est à une première fréquence et l'appareil comprend en outre un émetteur de données (6) pour injecter dans le trajet de transmission (3) par fibres optiques un signal de données à une deuxième fréquence différente de la première fréquence. 55
17. Appareil selon la revendication 16, dans lequel le trajet de transmission (3) par fibres optiques comprend une première extrémité et une deuxième extrémité, l'émetteur (2) et le moyen de comparaison (7) sont tous deux couplés à la première extrémité de trajet de transmission par fibres optiques, et l'appareil comprend en outre des moyens réfléchissants sélectifs vis-à-vis de la fréquence, couplés à la deuxième extrémité du trajet de transmission par fibres optiques afin de réfléchir le signal à la première fréquence et de laisser passer le signal à la deuxième fréquence.
18. Appareil selon la revendication 16 ou la revendication 17, comprenant en outre un moyen de traitement (8), couplé au moyen de comparaison (7), pour surveiller de façon continue la variation de phase et pour invalider l'émetteur de données (6) en réponse à une variation de phase prédéterminée.

