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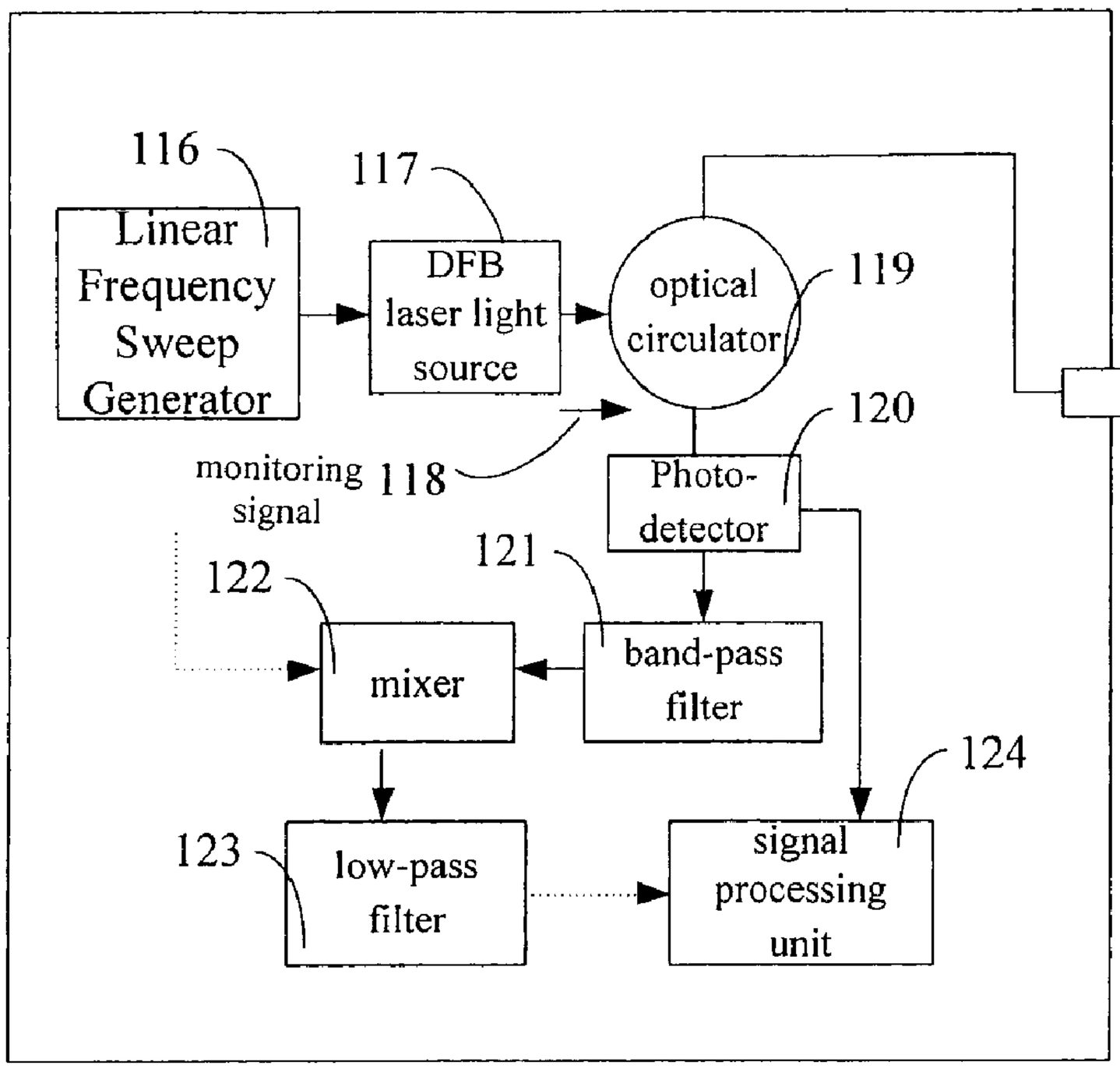
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(54) Titre : METHODE D'ESSAI SUR RESEAU DE FIBRE OPTIQUE DE REFLECTOMETRE DE GAMME DE FREQUENCE OPTIQUE

(54) Title: OPTICAL FIBER NETWORK TEST METHOD OF AN OPTICAL FREQUENCY DOMAIN REFLECTOMETER



(57) Abrégé/Abstract:
An optical fiber network test method of an optical frequency domain reflectometer, which is to use the optical testing apparatus and method of the prevent invention to combine the characters of filtering, reflecting and transmission of light of the wave reflecting unit,

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(57) Abrégé(suite)/Abstract(continued):
applying on any optical fiber test or point-to-point or point-to-multipoint optical fiber network. Thus, the optical fiber testing apparatus and method is constructed, and the goals of achieving the optical fiber network test method of the optical frequency domain reflectometer or confirming simultaneously the position of the barrier router and the barrier optical fiber connection point/end point/start point can be accomplished.

ABSTRACT OF THE DISCLOSURE

An optical fiber network test method of an optical frequency domain reflectometer, which is to use the optical testing apparatus and method of the prevent invention to combine the characters of filtering, reflecting and transmission of light of the wave reflecting unit, applying on any optical fiber test or point-to-point or point-to-multipoint optical fiber network. Thus, the optical fiber testing apparatus and method is constructed, and the goals of achieving the optical fiber network test method of the optical frequency domain reflectometer or confirming simultaneously the position of the barrier router and the barrier optical fiber connection point/end point/start point can be accomplished.

OPTICAL FIBER NETWORK TEST METHOD OF AN OPTICAL FREQUENCY DOMAIN REFLECTOMETER

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a method for testing an optical fiber network comprising an optical frequency domain reflectometer which may be applied on any optical fiber test method of the optical frequency domain reflectometer or any optical fiber test or point-to-point or point-to-multipoint passive optical network.

2. DESCRIPTION OF THE PRIOR ART

With the rapid growth of the global internet due to the communication revolution, traditional networks are unable to address the requirements of high-speed information transmission. The maturation of industrial technology and diversified application of optical-electro products timely supply a best solution for the large bandwidth requirements of the rapidly-growing global internet, high-quality multimedia networks, and a variety of data communications. Therefore, many types of optical communication network forums appear one after another, wherein the optical fiber gradually becomes widely accepted. In response to the large amount of usage and required services, the invention of convenient test and monitoring methods for optical fiber for such special network forum is truly needed.

Processing the test/monitor of the optical fiber has been a difficult question due to the framework design of optical fibers. One monitoring method is Optical Time Domain Reflectometer (OTDR), but such a test method requires a lot of

time, which has a large impact on effectiveness. It is obvious that there are still many drawbacks of the conventional method mentioned above, which is not well designed and in extreme need of improvement. In comparison to such traditional test/monitor methods by optical power or Optical Time Domain Reflectometer, the present invention provides a simpler, more effective and cheaper test method.

Based on the drawbacks of the conventional method mentioned above, the inventor of the present invention was eager to proceed with an improvement and innovation. After many years of earnest researches, the inventor successfully achieved the herein disclosed optical fiber network test/monitor method of an optical frequency domain reflectometer.

SUMMARY OF THE INVENTION

The present invention relates to an optical fiber network test method of an optical frequency domain reflectometer. When the service system has a problem, it is possible to test/monitor whether the optical fiber has been disconnected, the presence of optical reflection or whether there is too much optical loss all at a transmission location, such as a facilities room. To clarify where the question is: is it on the service system, optical route or connector? By indicating the correct position of optical fiber barriers and connectors the cost of maintenance and operation can be lowered.

To achieve the above mentioned invention of the optical fiber network test method of the optical frequency domain reflectometer, which uses an optical fiber test and measure apparatus to test/ monitor the quantity of optical power reflected by the optical fiber and provides a method to determine the distance of I-OFMCW (Incoherent-Optical Frequency-Modulated Continuous-Wave). Thus, we can simultaneously confirm the positions of optical events such as a barrier router and

connector. The method is to use the test distance of testing or monitoring the quantity of optical power reflected by the optical fiber and provides a way to measure the distance of I-OFMCW (Incoherent-Optical Frequency-Modulated Continuous-Wave), and analyze these data to determine the latest status of the optical fiber. When barrier events such disconnection or deterioration on optical fiber or connector occur, the present invention can quickly analyze a solution and provide a basis for providing alerts and handling the barrier event.

The present invention provides an optical fiber network test method of an optical frequency domain reflectometer, which possesses the following advantages when compared to other conventional methods:

1. The present invention may test/monitor the optical fiber at a transmission location through the reflection at the router's end (the optical fiber's cross-section or optical fiber's connector opening) or equip a wave reflector monitor, which provides a feasible, reliable and effective test/monitor method of the optical fiber.

2. There is no near blind area of the optical fiber measurement of the present invention; and the blind area of event is also small, which is helpful for the optical fiber router reflection testing.

3. The present invention provides both methods for I-OFMCW optical fiber test method, and point-to-point or point-to-multipoint (such as: Passive Optical Network, PON) the latest status testing method. Through these methods, the goal of quick and large scale monitoring is adapted to be achieved, and the test of router barrier position and the test of low speed are adapted to be solved.

4. The present invention provides a single-ending and long-term

automatically optical fiber network test/monitor, which the present invention provides for better service quality through quickly and correctly clarifying the barrier events on service system or optical fiber router, and processing the preventive maintenance for the latest status.

5. The present invention may not only lower the network maintenance cost of human interaction, but also ensure the reliability and stability of optical fiber network, thus upgrade the maintenance efficiency. The economic benefit is very obvious.

BRIEF DESCRIPTION OF THE DRAWINGS

Please refer to the detailed description and the drawings of the present invention, which can further understand the technical contents and the goal effects of the present invention; the drawings comprising as follow:

Figure 1 provides an architecture diagram of the optical fiber network monitor or test method of an optical frequency domain reflectometer of the present invention;

Figure 2 provides a schematic diagram, in which the operation principles of FMCW show the beat notes produced by the different routers;

Figure 3 provides a diagram of point-to-point optical access router monitor method; and

Figure 4 provides a diagram of point-to-multipoint passive optical fiber network monitor or test method of the optical frequency domain reflectometer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to an optical fiber network test method of an

optical frequency domain reflectometer.

Referring to the Figures 1 and 2, Figure 1 is an architecture diagram of the optical fiber network monitor or test method of an optical frequency domain reflectometer of the present invention; Figure 2 is a schematic diagram, in which the operation principle of FMCW show the beat notes produced from the different distances. As shown in Figure 1, the test/monitor method processing is as follows: a linear frequency scanning signal producer (sweep generator) 116 modulates a DFB laser light source 117 and the optical signal of monitoring signal 118 is transmitted through an optical circulator 119, and the optical signal is transmitted to the end of the optical fiber transmission system through an optical cable 126. After reflection by the optical fiber's cross-section, the monitoring wave returns back along the original route, passing through the optical cable 126 and then enters into an optical circulator 119. A photodetector 120 is configured for transforming the electro-optical signal and examining the wave-optical power. The photodetector 120 transmits the value of the optical power to a signal processing unit 124 and the electrical signal transformed by the electro-optical signal to a band-pass filter 121, thus the monitoring-required electrical signal is adapted for filtering. Figure 2 shows that the mixer 122 combines the reflected wave and the transmitted wave FMCW to produce a beat note action following which a low-pass filter 123 filters out the high frequency noise. The signal processing unit 124 is configured to carry out a spectrum analysis thereby obtaining the steady beat note and the optical power value and analyzing and calculating the beat note 191 and the reflected optical power value. The characteristics of any other reflection events in the optical fiber transmission system may be known through testing the different frequencies and the

corresponding power values.

The optical fiber network test method of the present invention is configured to be applied as the point-to-point optical access route monitor method shown in Figure 3. The procedure of the main monitored method is monitoring in a facilities room 110. An optic transmission apparatus 111 is configured to transmit the optical signal of the carrier signal 112 to the wavelength division multiplexing components 113. The processing method of monitor/test apparatus is a linear frequency scanning signal source 116 that modulates a DFB laser light source 117, and the optical signal of a monitoring signal 118 is adapted to be transmitted through an optical circulator 119. A route selector 115 transmits the signal to one of the wavelength division multiplexing component(s) 113. The wavelength division multiplexing component 113 combines the carrier signal 112 and monitoring signal 118 and then transmits the combined signal; before passing through the optical fiber 114, the optical cable 126 out of the facilities room 110 to the ends of the transmission system, the optical signal passes through the monitoring wave reflecting unit 127. Therefore, the carrier signal 112 may enter into optical network unit 128 by passing through the monitoring wave reflecting unit 127 and then provides user services. The monitoring wavelength is reflected when the monitoring wavelength optical signal of the monitoring signal 118 enters into the monitoring wave reflecting unit 127, wherein the specifications of the monitoring wave reflecting unit 127 in each transmission route are the same. The reflected monitor wave returns back along the original route, passes through the optical cable 126, optical fiber 114 and then enters into the wavelength division multiplexing components 113 and passing through the optical route selector and the optical circulator 119. The photodetector 120 transforms the

electro-optical signal and provides tests for the wave-optical power examination. The photodetector 120 transmits the tested value of the optical power to a signal processing unit 124, and then transmits the electrical signal transformed by the electro-optical signal to a band-pass filter 121, thus the monitoring-required electrical signal is filtered. The mixer 122 provides that the reflected wave and transmitted wave FMCW produce a beat note action shown as Figure 2; the low-pass filter 123 subsequently filters out the high frequency noise, and the signal processing unit 124 carries out a spectrum analysis to obtain the steady beat note and the optical power value. A control computer 125 selects the beat note 191 and the reflected optical power value, and then carries out analysis and calculations; thus the latest status of the entire optical fiber route may be obtained. An impediment on a given point-to-point optical access results in the optical power test value being reduced while the beat note 191 changes. After analyzis and comparing by the control computer 125, the distance of the occurred point of impediment along the transmission route may be determined, providing a basis for alert and handling as will be discussed below.

The optical fiber network test method of the present invention may also be applied on a point-to-multipoint passive optical fiber network as shown in Figure 4. The procedure of the main monitored method is monitoring in the facilities room 110; an optic transmission apparatus 111 is configured to transmit the optical signal of the carrier signal 112 to the wavelength division multiplexing component(s) 113. The processing method of the monitor apparatus is a linear frequency scanning signal producer 116 which modulates a DFB laser light source 117, and the optical signal of monitoring signal 118 is adapted to be transmitted

through an optical circulator 119. A route selector 115 transmits the signal to one of the wavelength division multiplexing components 113, which combines the carrier signal 112 and monitor signal 118 and then transmits the combined signal; before passing through the optical fiber 114, the optical cable 126 out of the facilities room 110, and the optical splitter 129 of the routes to the ends of the routes, the optical signal passes through a monitoring wave reflecting unit 127. Therefore, carrier signal 112 may enter into the optical network unit 128 by passing through the monitoring wave reflecting unit 127 and then provides user services. The monitoring signal is reflected when the monitoring wavelength optical signal of the monitor signal 118 enters into the monitoring wave reflecting unit 127, wherein the specifications of the monitoring wave reflecting unit 127 in every route are the same. The reflected monitor signal returns back along the original route, passes through the optical splitter 129, the optical cable 126, and optical fiber 114 and then enters into the wavelength division multiplexing components 113, passing through the optical route selector and the optical circulator 119. The photodetector 120 transforms the electro-optical signal and provide for testing of the wave-optical power. The photodetector 120 transmits the test value of the optical power to a signal processing unit 124, and transmits the electrical signal transformed by the electro-optical signal to a band-pass filter 121, thus the monitoring-required electrical signal is supposed to be filtered. The mixer 122 makes the reflected wave and transmitted wave FMCW produce a beat note action as shown in Figure 2; the low-pass filter 123 subsequently filters out the high frequency noise, the signal processing unit 124 carries out a the spectrum analysis to obtain a steady beat note and an optical power value. A control computer 125 selects the beat note 191 and the reflected optical power value, and

then carries out an analysis and calculations. As the distance between route selection and the ends of the optical cable route are different, each reflected signal from the splitter to the end and the signal reflected by the end will be different due to the time difference. By analyzing the different beat note signal and comparing the provisioning data of the optical fiber network, the latest status of all optical fiber routes may be obtained. When there is a barrier or impediment on a particular network, the optical power test value is reduced, while the beat note 191 is modified. After analyzing and calculating comparison by the control computer 125, the distance of the occurred barrier point of the particular route may be determined, and therefore provide a basis for the alert and handling as discussed below.

The present invention may also be applied more broadly. As shown in the Figures 3 and 4, the prevent invention is configured to be connected with a plurality of wavelength division multiplexing components 113 and the optical network apparatus collocating with the optical channel (route) selector (OCS) 115. Through switching the different test procedures to change the optical route, both the quantity of to-be-monitored optical networks and region are expanded, thus the operation efficiency of the test apparatus is able to be increased and the unit cost reduced.

The above disclosure is related to the detailed technical contents and inventive features thereof. Persons skilled in this art may proceed with a variety of modifications and replacements based on the disclosures and suggestions of the invention as described without departing from the characteristics thereof. Nevertheless, although such modifications and replacements are not fully disclosed in the above descriptions, they have substantially been covered in the

following claims as appended.

Many changes and modifications in the above described embodiment of the invention can, of course, be carried out without departing from the scope thereof. Accordingly, to promote the progress in science and the useful arts, the invention is disclosed and is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. An optical fiber network test method comprising:

providing a linear frequency scanning signal source, wherein the frequency modulation rate of a produced wavelength is a continuously linear variation frequency modulation signal;

providing a DFB laser light source wherein an output of said linear frequency scanning signal source modulates a light signal of the DFB laser to produce an incoherent optical frequency modulated continuous wave (I-OFMCW) signal as a monitoring optical signal;

providing an optical circulator for transmitting said monitoring optical signal into an optical selector and receiving a reflected monitoring optical signal;

providing a photodetector for receiving said reflected monitoring optical signal from said optical circulator and converting said reflected monitoring optical signal into an electrical signal and amplifying said electrical signal;

providing a band-pass filter for removing noise from said electrical signal;

providing a mixer for combining said monitoring optical signal and said filtered reflected monitoring optical signal;

providing a low-pass filter for removing high frequency noise and harmonic noise signals from said combined signals and allowing only a filtered low frequency beat note monitoring signal to be passed; and

providing a signal processing unit for analysing a spectrum of said filtered beat note monitoring signal, wherein a result of said spectrum analysis is used to control a computer's monitor and alert and calculate a position of a barrier end point.

2. The method of claim 1, wherein the steps comprising:

setting an optical fiber network test method of the optical frequency domain reflectometer apparatus in a facilities room, and one of providing a monitoring wave reflecting unit and letting a break in the optical fiber reflect;

processing the optical fiber network test method of the optical frequency domain reflectometer in order by selecting a to-be-tested optical channel using optical channel selector (OCS) switches, integrating the testing wave optical signal by the wavelength division multiplexing components into service wave optical signal, and then transmitting the optical signal into the to-be-tested optical fiber; the optical signal being transmitted by the splitter through the optical cable to the ends of the selected route, and respectively entering into the testing/monitoring wave reflecting unit or letting the break in the optical fiber reflect;

the testing wave reflecting unit only reflecting the testing/monitoring wave optical signal back to the facilities room; the photodetector in facilities room simultaneously accepting and measuring the intensity of the optical signal reflected from the optical fiber network, thus determining a loss of optical power of the optical fiber routes and the beat note signal of frequency modulated continuous wave signal:

analyzing the loss of optical power to measure whether the optical fiber route is normal; analyzing the beat note signal of FMCW, measuring the length of the optical fiber and the optical fiber within which the loss of optical power indicates an error, thereby detecting a barrier event point.

3. The method of claim 1 and 2, comprising an optical channel selector (OCS) connecting with a plurality of wavelength division multiplexing

components, accessing the network through switching the optical channel selector, wherein a monitoring apparatus and method are configured to monitor a plurality of optical access networks.

4. The method of claim 2, wherein measuring the optical routes comprises:

measuring whether a router's testing wave optical power declines, which is a router barrier event;

measuring whether a router's testing wave optical power is less than the default vale, which is an error of the router;

measuring whether a router's testing wave optical power is close to the default vale, which the router is normal.

5. The method claim 2,wherein the barrier event point is detected by the optical fiber through mathematically calculating and analyzing a steady beat note signal produced by the transmitting and reflecting frequency modulated continuous wave signal.

6. The method of claim 2, wherein the testing wave produced by the optical fiber barrier event testing apparatus is incoherent optical frequency modulated continuous wave (I-OFMCW) signal.

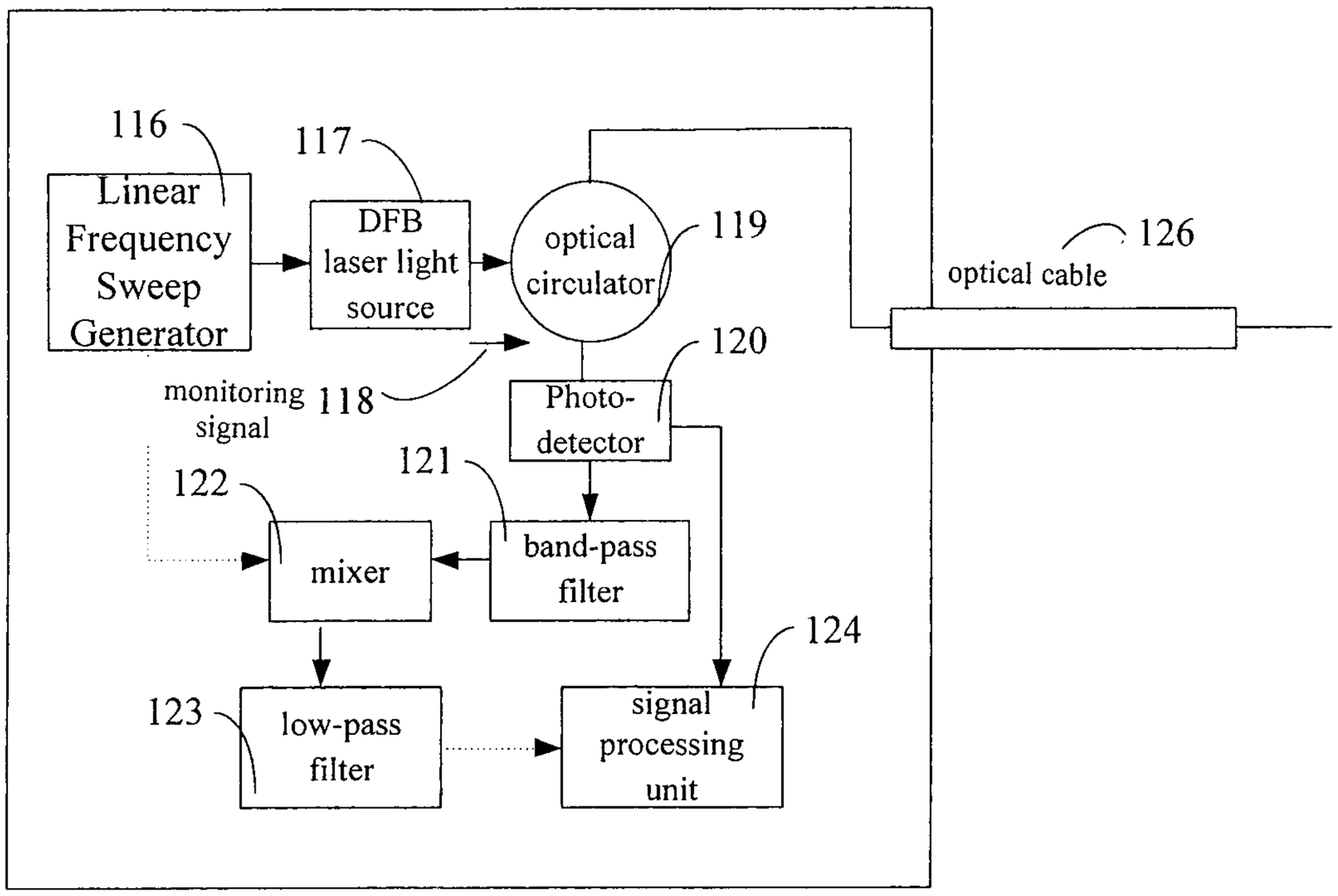

116
Linear Frequency Sweep Generator
117
DFB laser light source
optical circulator
119
126
optical cable
120
monitoring signal
118
Photo-detector
121
122
mixer
band-pass filter
124
123
low-pass filter
signal processing unit

Fig. 1

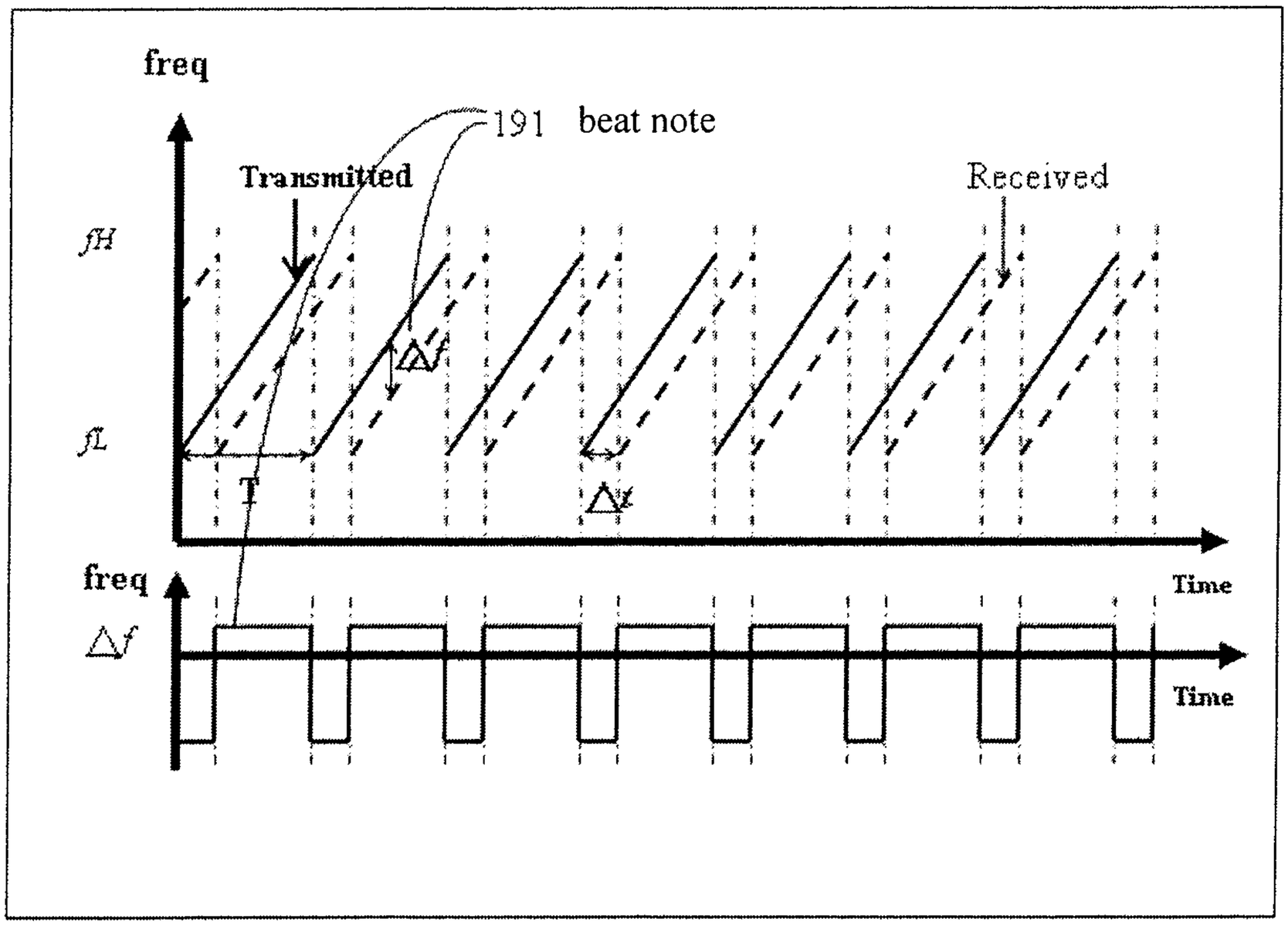

freq
191
beat note
Transmitted
Received
fH
fL
Δf
T
Δf
freq
Δf
Time
Time

Fig. 2

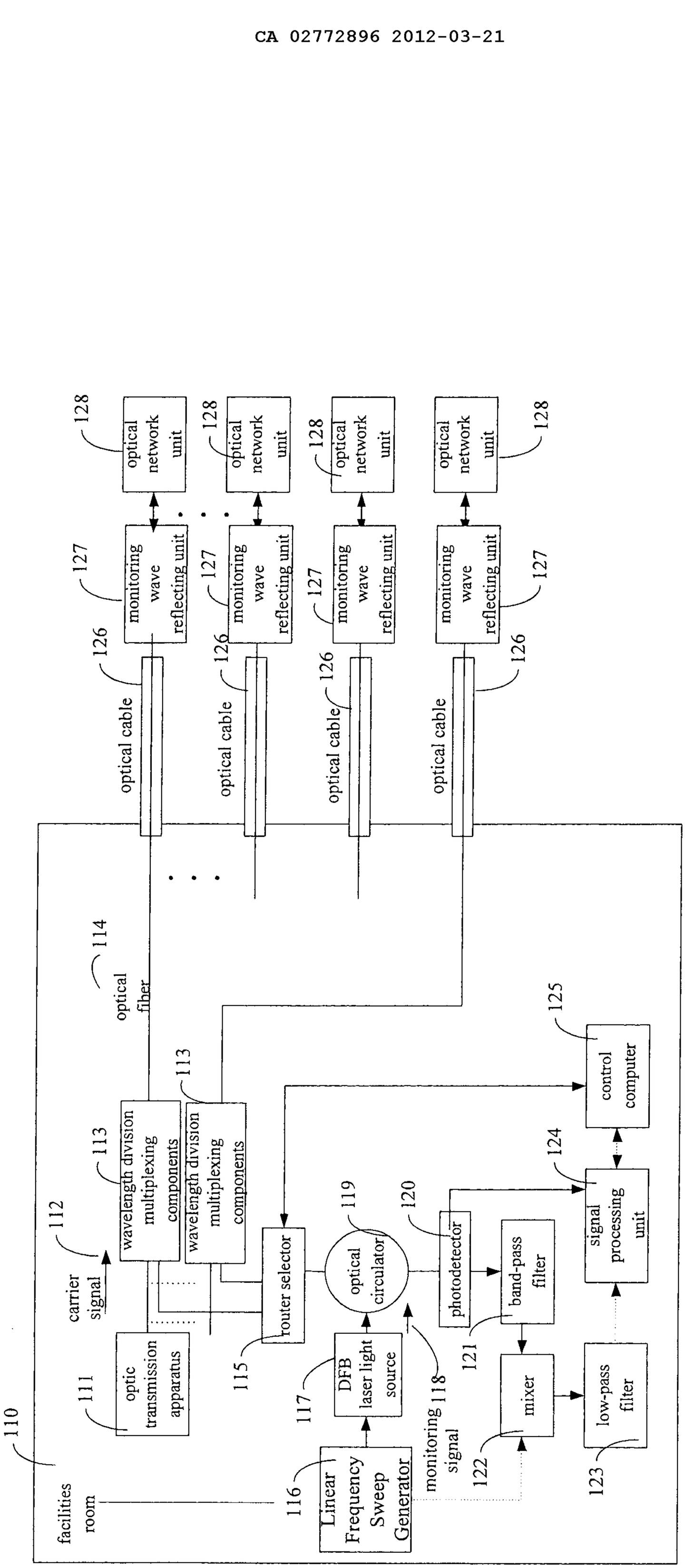

facilities room
110
carrier signal
112
optic transmission apparatus
111
wavelength division multiplexing components
113
optical fiber
114
router selector
115
Linear Frequency Sweep Generator
116
DFB laser light source
117
monitoring signal
118
optical circulator
119
photodetector
120
band-pass filter
121
mixer
122
low-pass filter
123
signal processing unit
124
control computer
125
optical cable
126
monitoring wave reflecting unit
127
optical network unit
128

Fig. 3

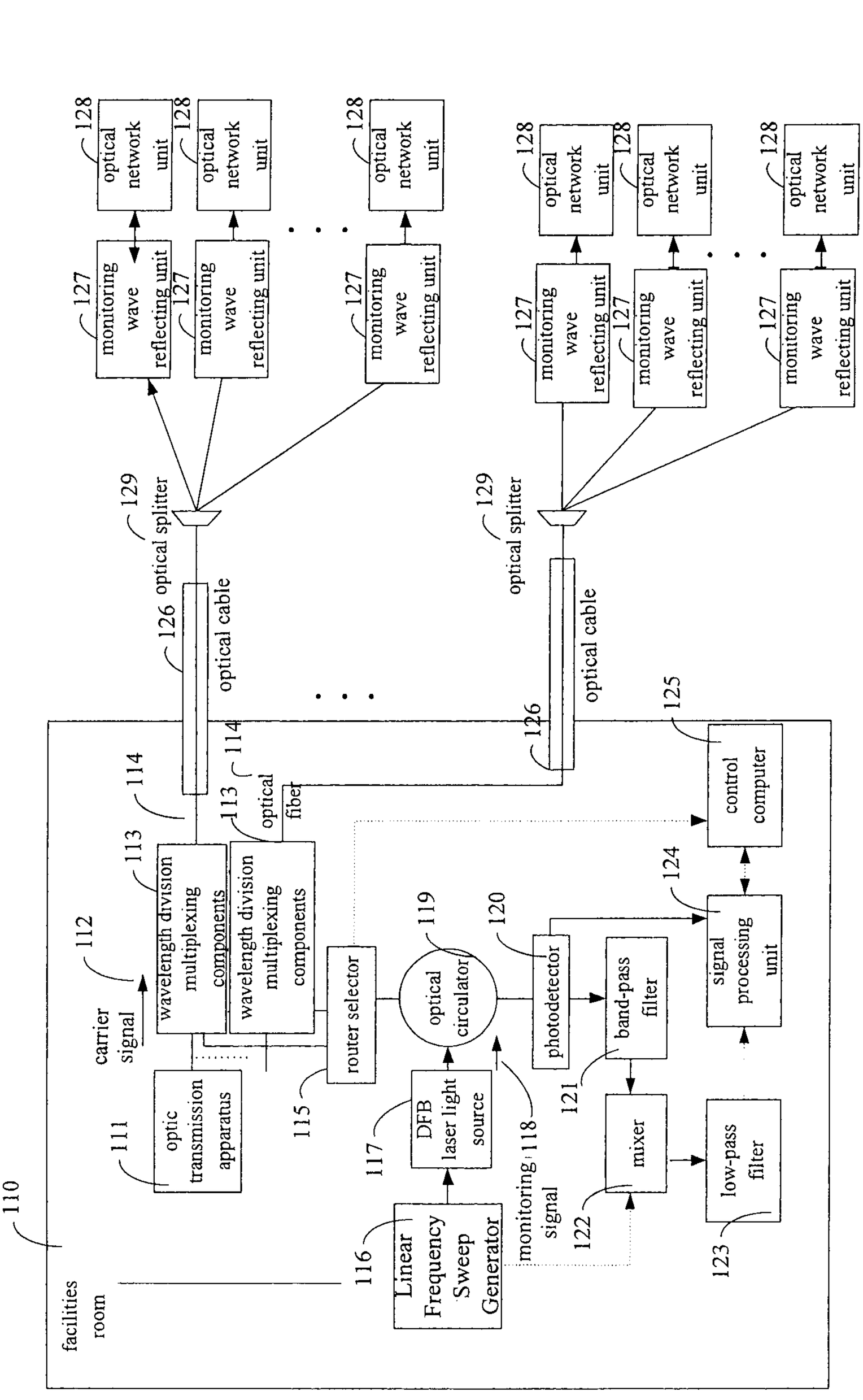
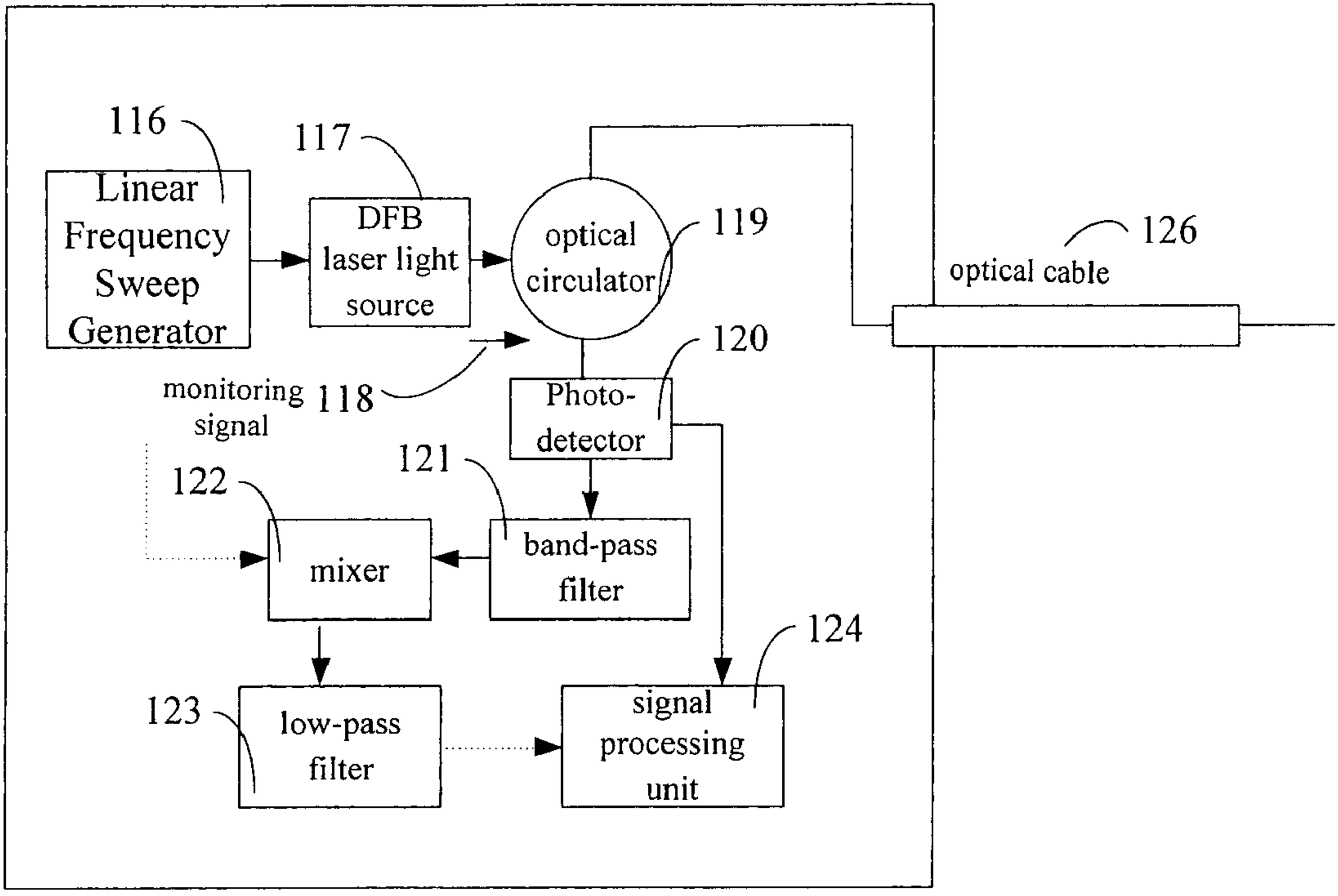

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low-pass filter
124
signal processing unit
125
control computer
126
optical cable
127
monitoring wave reflecting unit
128
optical network unit
129
optical splitter

Fig. 4


116
Linear Frequency Sweep Generator
117
DFB laser light source
optical circulator
119
126
optical cable
monitoring signal
118
120
Photo-detector
121
122
band-pass filter
mixer
124
123
low-pass filter
signal processing unit