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H04B 10/08

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H4B BK8C

(56) Documents Cited
GB 2245120 A GB 2074424 A EP 0449475 A2
WO 92/17008 A1 US 4211920 A

(58) Field of Search
UK CL (Edition L) H4B BK16 BK16D BK8 BK8B BK8C
INT CL[5] H04B

(54) Monitor for optical transmission system

(57) The system includes optical repeaters 1, each including an optical amplifier 6 and a control circuit 14 for controlling the optical transmission. Each optical repeater transmits management information to the next optical repeater. The control circuit checks and examines the status of the optical amplifier and obtains monitoring information. The control circuit generates management information in accordance with the monitoring information and the management information transmitted 16 from the upstream side optical repeater. The management information is converted 17 to an optical signal and transmitted to the next optical repeater.

The management information includes an ID code for a failed optical repeater and the status of the failure. Thus the receiving station can determine failure of an optical repeater and the status. The priority of the management information can be changed by the receiving station, and thus the receiving station can detect the status of the optical transmission line.

FIG. 1

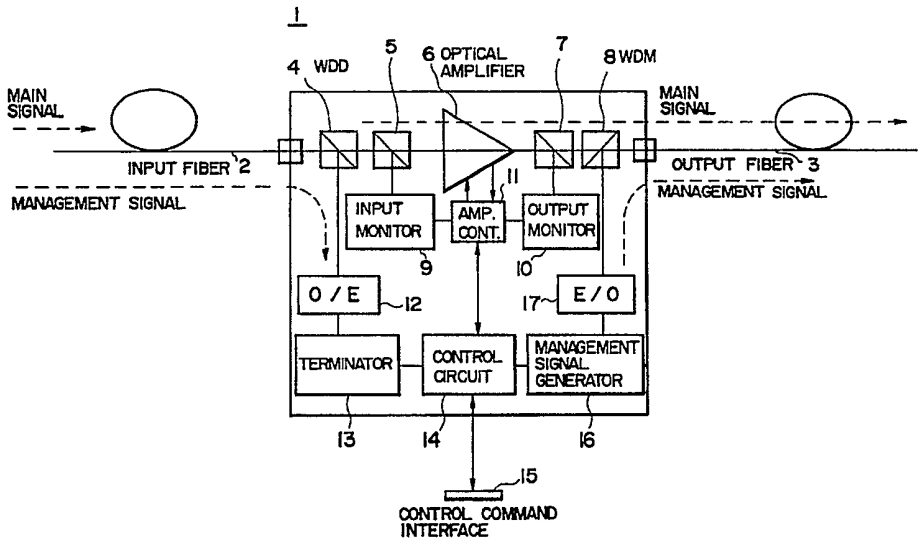

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FIG. 1

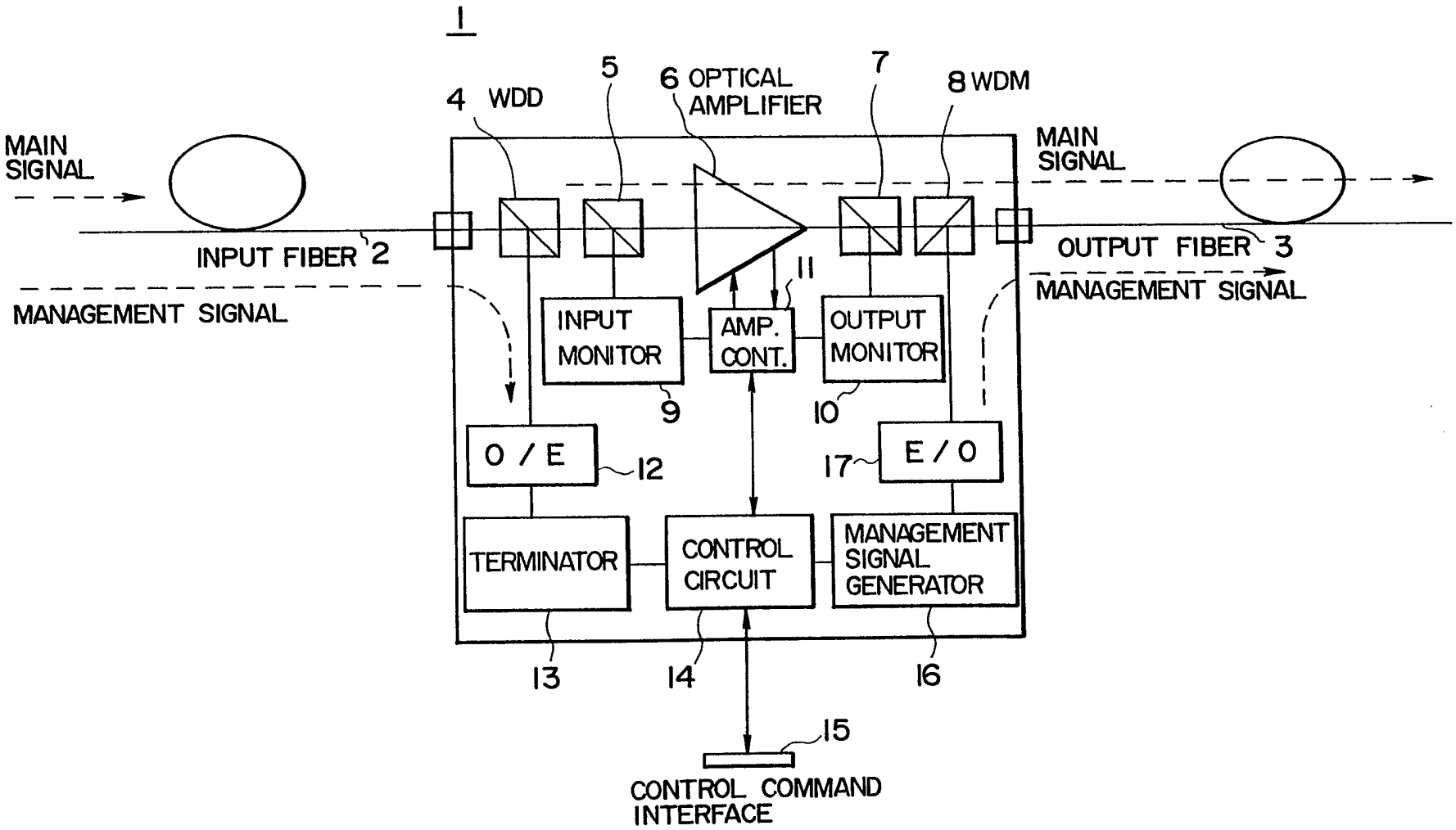

1
4 WDD
5
6 OPTICAL AMPLIFIER
7
8 WDM
MAIN SIGNAL
MAIN SIGNAL
INPUT FIBER 2
OUTPUT FIBER 3
MANAGEMENT SIGNAL
MANAGEMENT SIGNAL
11
INPUT MONITOR
AMP. CONT.
OUTPUT MONITOR
9
10
O / E
12
17
E / O
TERMINATOR
CONTROL CIRCUIT
MANAGEMENT SIGNAL GENERATOR
13
14
16
15
CONTROL COMMAND INTERFACE

FIG. 2

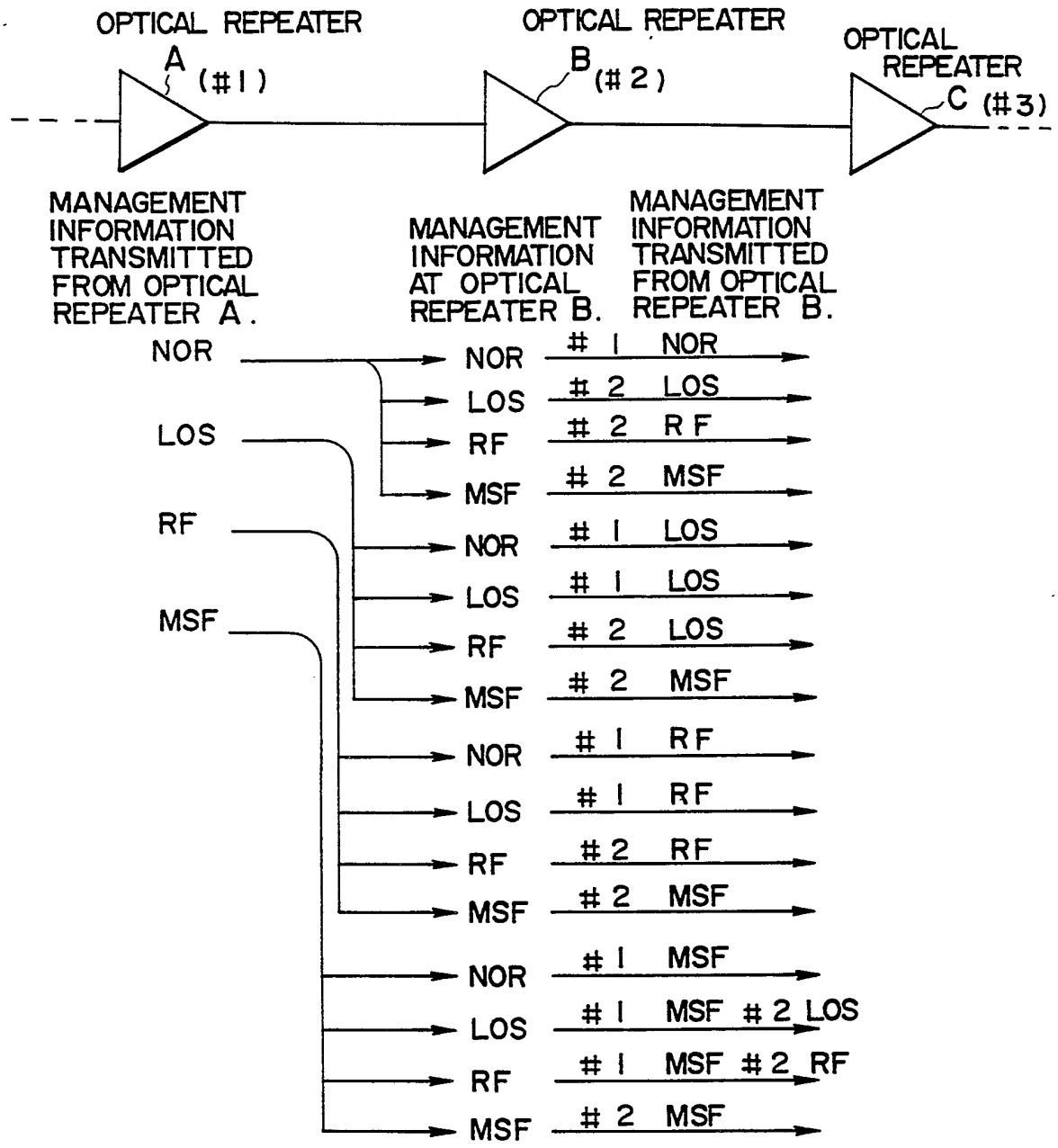
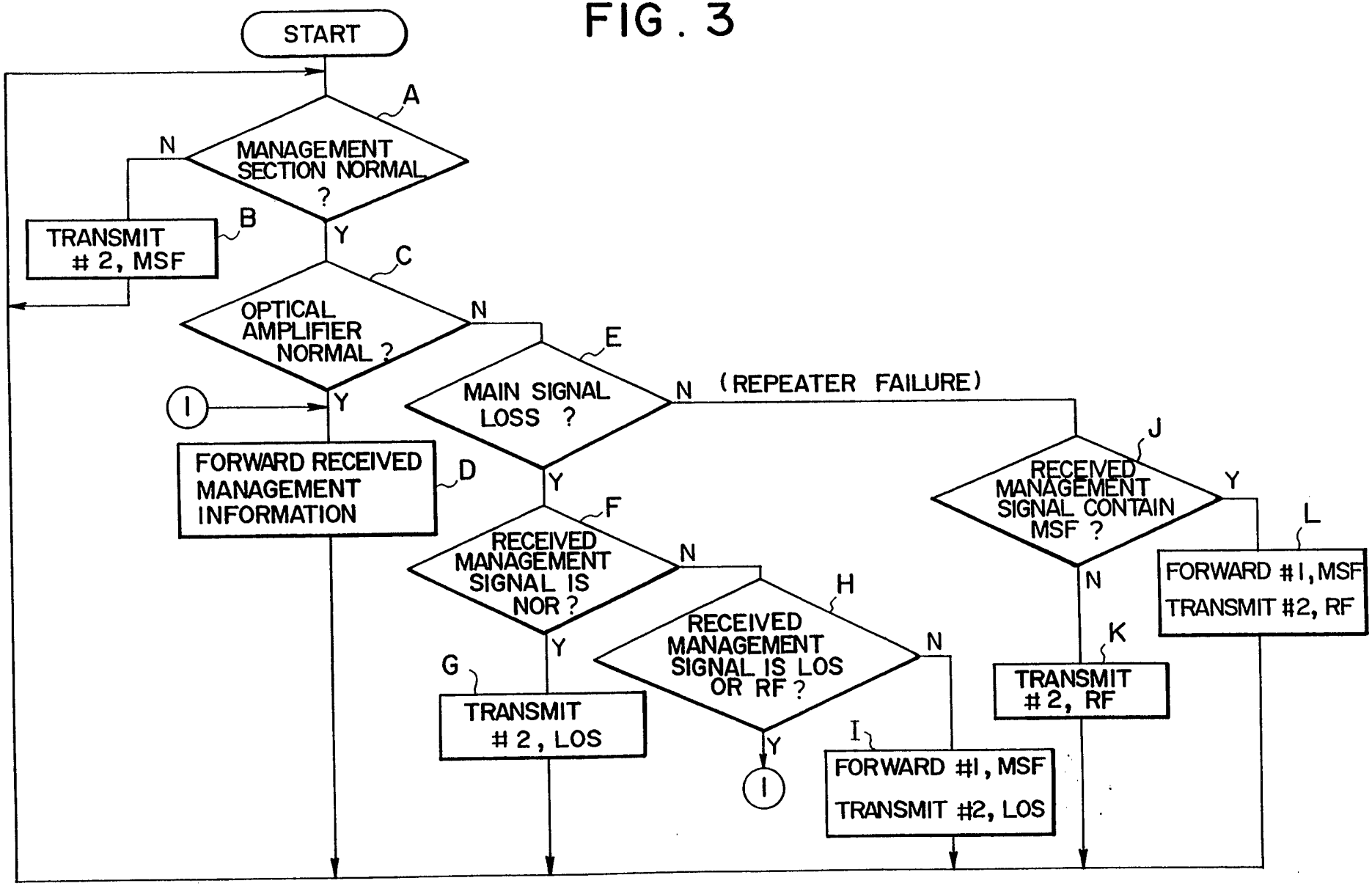

OPTICAL REPEATER A (#1)
OPTICAL REPEATER B (#2)
OPTICAL REPEATER C (#3)
MANAGEMENT INFORMATION TRANSMITTED FROM OPTICAL REPEATER A.
MANAGEMENT INFORMATION AT OPTICAL REPEATER B.
MANAGEMENT INFORMATION TRANSMITTED FROM OPTICAL REPEATER B.
NOR
LOS
RF
MSF
NOR
LOS
RF
MSF
NOR
LOS
RF
MSF
NOR
LOS
RF
MSF
NOR
LOS
RF
MSF
#1 NOR
#2 LOS
#2 RF
#2 MSF
#1 LOS
#1 LOS
#2 LOS
#2 MSF
#1 RF
#1 RF
#2 RF
#2 MSF
#1 MSF
#1 MSF #2 LOS
#1 MSF #2 RF
#2 MSF

FIG. 3


START
A
MANAGEMENT SECTION NORMAL ?
N
Y
TRANSMIT #2, MSF
B
C
OPTICAL AMPLIFIER NORMAL ?
N
Y
E
MAIN SIGNAL LOSS ?
N (REPEATER FAILURE)
Y
FORWARD RECEIVED MANAGEMENT INFORMATION
D
F
RECEIVED MANAGEMENT SIGNAL IS NOR ?
N
Y
G
TRANSMIT #2, LOS
H
RECEIVED MANAGEMENT SIGNAL IS LOS OR RF ?
N
Y
I
FORWARD #1, MSF
TRANSMIT #2, LOS
J
RECEIVED MANAGEMENT SIGNAL CONTAIN MSF ?
Y
N
L
FORWARD #1, MSF
TRANSMIT #2, RF
K
TRANSMIT #2, RF

TITLE OF THE INVENTION

METHOD AND APPARATUS FOR ALARM SURVEILLANCE FOR AN OPTICAL TRANSMISSION SYSTEM

FIELD OF THE INVENTION

This invention relates to an optical transmission system for transmitting an optical signal, and to an optical repeater apparatus which is disposed in the optical transmission system. And more specifically, relates to a control and management of the optical transmission system and the optical repeater apparatus.

DESCRIPTION OF THE RELATED ART

An optical transmission techniques are more adopted in the tele-communication field. The optical transmission system connect between transmitting station and receiving station. In practical optical transmission system, one or more optical repeater is required for amplifying the light signal on the optical transmission system.

One conventional method of such optical repeating transmission is disclosed in the Japanese Leid-Open Patent No.91-258036. In this disclosure, unique frequency is given to each optical repeater, and each optical repeater modulates an management signal by the unique frequency. The management signal of each optical repeater are wavelength multiplexed and transmitted to the next optical repeater or the receiving station.

Other conventional method is disclosed in the Japanese Leid-Open Patent No.91-258038. This method, also, gives unique frequency to each optical repeater. The each optical repeater modulates a management signal by the unique frequency, and then modulates an output of a pump light by the modulated management signal. The modulated pump light is transmitted to the next optical repeater or the receiving station.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an optical repeater apparatus which utilize common frequency for modulating the management signal at each optical repeater. It is another object of this invention to provide an optical repeater apparatus which management-information-priority is easily changeable. It is still another object of this invention to provide an optical transmission system, a failure point is easily detected.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 shows schematic diagram of this invention.
FIG.2 shows an optical transmission line on which this invention is adopted.
FIG.3 shows a flowchart of the function and operation of the optical repeater.

DESCRIPTION OF THE PREFFERED EMBODIMENT

An optical repeater apparatus 1 amplifies an input optical signal inputted at input fiber 2, and outputs an amplified optical signal at output fiber 3. The other end of the input fiber 2 or output fiber 3 is connected to the other optical repeater apparatus, transmitting station, or receiving station (Not Shown).

The configuration of the optical repeater is explained hereinbelow. An optical signal on an optical transmission line is inputted at input fiber 2. The inputted optical signal is separated to main signal and management signal at wavelength division demultiplexer (WDD) 4. The main signal is then applied to an optical amplifier 6 via an optical coupler 5. The optical amplifier 6 amplifies the main signal and outputs to wavelength division multiplexer (WDM) 8 via an optical coupler 7.

The optical coupler 5 divides the portion of the inputted main signal and applies the divided main signal to an input monitor 9. The optical coupler 7 divides the portion of amplified main signal and applies the divided main signal to an output monitor 10. Monitoring information from the input monitor 9 and the output monitor 10 are fed to an amplifier controller 11.

The management signal is converted to an electric signal at opt/electric converter 12, and applied to a terminator 13. The terminator 13 reconstructs management information transmitted from another optical repeater which is disposed upstream on the optical transmission line. The management information is applied to

a control circuit 14. The information from the amplifier controller 11 is also applied to the control circuit 14. The control circuit 14 is connected to control command interface 15. Control commands are applied to the control circuit 14 via the control command interface 15.

The control circuit 14 outputs management information in accordance with information from the amplifier controller 11, the terminator 13, and the control commands applied at the control command interface 15. The management information is applied to a management signal generator 16. The management signal generator 16 generates the management signal, which includes the management information. The management signal is converted to an optical signal at an electric/opt converter 17. The management signal is then applied to the wavelength division multiplexer 8, and transmitted to the other optical repeater, or the receiving station.

The control command interface 15 is connected to another network, namely, a Telecommunication Management Network (TMN. Not Shown). The TMN connects each optical repeater, the transmitting station, and the receiving station. Control commands are transmitted on the TMN. The control commands have higher priority than that of the management information transmitted on the optical transmission line.

Next, a function of the optical repeater is explained hereinbelow. In the optical transmission line, the main signal having the first

wavelength and the management signal having the second wavelength are wavelength division multiplexed and transmitted. The wavelength division demultiplexer 4 has a wavelength filter, which passes the first wavelength and reflects the second wavelength, thereby the first wavelength and the second wavelength are separated. The wavelength division multiplexer 8 has a wavelength filter, which passes the first wavelength and reflects the second wavelength, thereby the first wavelength and the second wavelength are re-multiplexed.

Preferably, an Erbium Doped Fiber Amplifier (EDFA) is utilized as the optical amplifier 6. The input main signal is amplified and outputted to the output fiber 3 via the optical coupler 7 and the wavelength division multiplexer 8.

The inputted main signal is divided at the optical coupler 5. While the amplified main signal is divided at the optical coupler 7. A dividing ratio of the optical couplers are, for example, 1/10 respectively. The input main signal is monitored at the input monitor 9, while the amplified main signal is monitored at the output monitor 10. By comparing an input signal monitoring information and an output signal monitoring information at the amplifier controller 11, amplifying ratio of the optical amplifier can be obtained.

The amplifier controller 11 outputs other monitoring information containing, for example, "Normal" which indicates that the status of the optical amplifier is normal, "Amplifier Failure" which indicates

that the optical amplifier is in failure, "Loss of Signal" which indicates that there is no input main signal. The monitoring information also containing the amplifying ratio of the optical amplifier 6.

The control circuit 14 monitors and controls the function and operation of the optical repeater. The control circuit 14 generates the management information in accordance with the management information transmitted from another optical repeater, monitoring information from the amplifier controller 11, and the control command applied the control command interface 15. The management information generated at the control circuit 14 are following.

NOR (Normal) :indicates that the status of the optical amplifier is normal.
LOS (Loss of Signal) :indicates that there is no input main signal.
RF (Repeater Failure) :indicates that the operation of the optical repeater is in failure.
MSF (Management Section Failure) :indicates that the management function of the optical repeater is in failure.

These management information is inputted to the management signal generator 16 and transmitted to the next optical repeater by being contained in the management signal.

In FIG.2, an optical transmission line is described. The optical transmission line shown in FIG.2 has optical repeater A having an ID

code #1, optical repeater B having an ID code #2, and optical repeater C having an ID code #3. The function and operation of the optical repeater B (#2) is hereinunder explained. FIG.3 is a flowchart of the function and operation of the optical repeater 2. It is noted that similar function and operation is performed at each optical repeater. Such function and operation can be achieved by the microprocessor at the control circuit of each optical repeater.

First, at STEP A, the optical repeater B examines the status of the management section, that is, opt/electric converter 12, terminator 13, control circuit 14, management signal generator 16, electric/opt converter 17, input monitor 9, and output monitor 10. In case the status of the management section is in failure, the optical repeater B transmits an ID code #2 and MSF to the next optical repeater C at STEP B. The transmitted management information from the optical repeater A and the monitoring information from the amplifier controller 11 is ignored in this situation.

In case the status of the management section is normal, the optical repeater B then examines the status of the optical amplifier 6 at STEP C. When the optical amplifier 6 is normal, the optical repeater B transmits the ID code #1 and management information, each is transmitted from the optical repeater A through to the optical repeater C at STEP D.

In the contrary, when the optical amplifier 6 is in failure, the optical repeater B examines whether the main signal is presented at

the input fiber 2 or not at STEP E. When the main signal from the optical repeater A is down, the optical repeater B then examines the management information from the optical repeater A at STEP F.

At STEP F, in case that the management information from the optical repeater A contains NOR, it is indicated that the transmission failure occurred on the transmission line between optical repeater A and optical repeater B. In this situation, the optical repeater B transmits the ID code #2 and LOS at STEP G. While the management information from the optical repeater A does not contain NOR but contains LOS (STEP H), it is indicated that the management function at the optical repeater B is normal, but the main signal is down at the optical repeater A. Similarly, the management information from the optical repeater A does not contain NOR but contains RF, it is indicated that the management function at the optical repeater B is normal, but the management function at the optical repeater A is in failure. In these situations, the optical repeater B transmits the ID code #1 and the LOS or RF transmitted from the optical repeater A through to the optical repeater C at STEP D.

At STEP H, in case the transmitted management information from the optical repeater A doesn't contain neither LOS nor RF, but contains MSF, it is indicated that the management section of the optical repeater A is in failure and the optical repeater A cannot transmit the management information. According to this situation, the optical repeater B transmits to the next optical repeater C the

ID code #2 and LOS, in addition to the ID code #1 and MSF transmitted from the optical repeater A at STEP I.

In case the optical amplifier 6 is in failure, the optical repeater B examines whether the main signal is presented at the input fiber 2 or not at STEP E. When the main signal from the optical repeater A is presented at the input fiber 2, but the management section is in failure, the optical repeater B examines the management information transmitted from the optical repeater A at STEP J. At STEP J, in case that the examined management information doesn't contain MSF, the optical repeater B transmits the ID code #2 and RF to the optical repeater C at STEP K. While the examined management information contains MSF, the optical repeater B transmits the ID code #2 and MSF, in addition to the transmitted ID code #1 and MSF from the optical repeater A at STEP L.

In the optical transmission line, especially utilizing EDFA amplifier, large electric power is produced and transmitted to the next optical repeater when optical signal is re-inputted after several msec of duration of the main-signal-loss. This may destroy the optical amplifier of the next optical repeater. For preventing this situation, and for preventing the overcurrent of the optical amplifier when a driving current of the laser light source for pump light increases beyond a predetermined level, the amplifier controller halts to drive the optical amplifier. The optical repeater of the invention is able to detect the status of another optical amplifier at an upstream side even if the main signal being down.

As explained above, the optical repeater B transmits the management information transmitted from the optical repeater A through to the optical repeater C, in case that the status of the management section of the optical repeater B is in normal. While the optical repeater B terminates the management information transmitted from the optical repeater A, and transmits the status of the optical repeater B to the optical repeater C in case that the optical repeater B is in failure. In this situation, however, the transmitted management information from the optical repeater A contains MSF, the optical repeater B cannot transmit the management information according to the status of the optical repeater A. In such situation, the optical repeater B transmits the status of the optical repeater B, in addition to the status of the optical repeater A.

The receiving station receives the management information. By detecting and analyzing the received information, the receiving station determines whether failure occurs on the transmission line or not, and what kind of failure occurs on the line, if it occurs. As explained above, the management information has priority on transmission to the next optical repeater or the receiving station. For example, according to the management section failure, MSF is transmitted to the next optical repeater. The receiving station thus easily detect that the management section failure occurred at particular optical repeater. In this situation, however, the receiving

station cannot determine the status of the optical amplifier. Accordingly, priority change is provided in this invention.

Priority change is achieved by the control command applied to the control circuit 14. The control command is applied from the receiving station or Network management system (Not Shown) via the control command interface 15. The control circuit 14 changes the priority of the management information in accordance with the control commands. Thereby the receiving station detect NOR, LOS, or RF of another priorities. As a result, failure point is easily detected.

In this embodiment, the frequency for modulating the management information is common to each optical repeater. Thus, an additional optical repeater is easily introduced. Furthermore, position conversion of the optical repeater, maintenance of the optical transmission line are also easily achieved. The main signal and the management signal are wavelength division multiplexed and transmitted on common optical fiber in this embodiment, each signal, however, can be transmitted on another optical fiber respectively.

WHAT IS CLAIMED IS:

1 An optical repeater apparatus for amplifying and transmitting an optical signal, comprising:

an optical amplifier means for amplifying an optical signal;

monitoring means for monitoring a status of the optical amplifying means, and for generating monitoring information;

managing means for generating management information;

wherein the managing means further comprises a receiving means for receiving management signal inputted to the optical repeater apparatus,

control means for generating the management information in

accordance with the monitoring information and the received management

signal, and;

transmitting means for transmitting the management information.

2 The optical repeater apparatus according to claim 1, the receiving means further comprising opt/electric converter means for converting the received management signal to an electric signal;

and the transmitting means further comprising electric/opt converter means for converting the management information to an optical signal.

3 The optical repeater apparatus according to claim 1, the management information includes an identification code of the

optical repeater and status information of the optical repeater apparatus.

4 The optical repeater apparatus according to claim 3, the status information indicates the status of the optical repeater apparatus.

5 The optical repeater apparatus according to claim 1, further comprising

an input monitoring means for monitoring the inputoptical signal of the optical amplifier means, and;

output monitoring means for monitoring the output optical signal of the optical amplifier means.

6 The optical repeater apparatus according to claim 5, the input monitoring means generates input signal monitoring information and the output monitoring means generates output signal monitoring information, wherein the input signal monitoring information and the output signal monitoring information are applied to the monitoring means.

7 A method for operating an optical repeater apparatus disposed on an optical transmission line, comprising an optical amplifier means and a managing means for generating management information, for amplifying and transmitting an optical signal on the optical transmission line, comprising the steps of:

receiving a management signal from other optical repeater apparatus;

examining a status of the managing means;

examining a status of the optical amplifier means in case the status of the managing means is normal, and;

forwarding received management signal in case the status of the optical amplifier means is in normal.

8 The method according to claim 7, wherein the optical repeater apparatus generates and transmits the management information in case the managing means is in failure.

9 The method according to claim 7, wherein the method further comprises the steps of:

examining whether an optical signal is present or not;

detecting the received management signal in case the optical signal is not present, and;

generating and transmitting the management information in case the optical repeater at an upstream side is in normal.

10 The method according to claim 9, wherein the optical repeater apparatus generates and transmits the management information, and forwards the received management signal, in case the optical repeater apparatus at an upstream side loses optical signal input, or the optical amplifier means of the optical repeater apparatus at an upstream side is in failure.

11 The method according to claim 7, wherein the method further comprises the steps of:

detecting the received management signal, and;

generating and transmitting management signal in case the management function of the optical repeater apparatus at an upstream side is in normal.

12 The method according to claim 11, wherein the optical repeater apparatus generates and transmits the management information, and forwards the received management signal in case the management function of the optical repeater apparatus at an upstream side is in failure.

13 An optical transmission system comprising:

transmitting station for transmitting an optical signal;

receiving station for receiving the optical signal, and;

at least one optical repeater for amplifying and repeating the optical signal;

wherein the optical repeater detecting management signal transmitted on the optical transmission system and generating management information,

and wherein the receiving station detects the management information and analyzes a failure occurred on the optical transmission system.

14 An optical repeater apparatus substantially as hereinbefore described with reference to the accompanying drawings.

15 A method of operating an optical repeater apparatus substantialy as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition L) H4B (BK8, BK8B, BK8C, BK16, BK16D)

(ii) Int Cl (Edition 5) H04B

Search Examiner

DR E PLUMMER

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

17 SEPTEMBER 1993

Documents considered relevant following a search in respect of claims 1, 7, 13 AT LEAST

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2245120 A (STC)	1-4, 13
X	GB 2074424 A (GEC)	1-6, 13
X	EP 0449475 A2 (ATT)	1-4, 13
P,X	WO 92/17008 A1 (BT)	13
X	US 4211920 (WAKABAYASHI)	1-4, 13

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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