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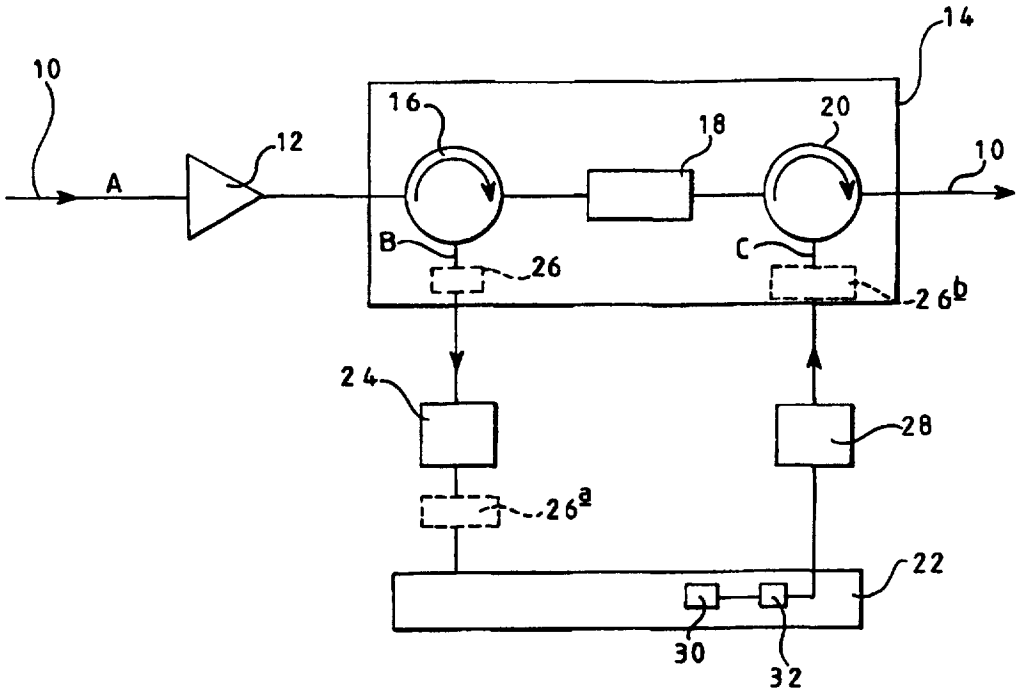

(57) Abstract

A method of, and system for, controlling the level of one or more wavelength channels added to an optical fibre trunk (10) of a WDM system from a branch terminal via a saturated amplifier (28) in which an additional wavelength signal differed from the wavelength of wanted channels is introduced to the input of the saturated amplifier (28) to reduce the level of the added wanted channel(s).

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IMPROVEMENTS IN OR RELATING TO OPTICAL ADD/DROP WAVELENGTH DIVISION MULTIPLEX SYSTEMS

This invention relates to improvements in optical add/drop wavelength division multiplex (WDM) systems and more particularly to the control of add channel level in such systems. the invention has particular application in underwater cable systems employing optical fibre cables.

In WDM transmission systems several wavelengths are transmitted along a main trunk which is provided with one or more branching units each of which is arranged to route one or more particular wavelength channels to an individual branch terminal, so called drop channels. The branch terminal is arranged to add one or more channels of the same or different wavelengths to the trunk. Such systems require the control of power levels of the added channels under normal operating and fault conditions to ensure that individual channels are not excessively impaired compared to other channels. In the case of branches which include saturated optical repeater amplifiers which introduce several dBs of compression the delicate balance of optical powers in individual channels can easily be upset or irrevocably impaired. The present invention seeks to provide simple adjustment or control of the amplitude of add channels provided by such an amplifier.

According to the invention there is provided a method of, and system for, controlling the level of one or more wavelength channels added to an optical fibre trunk of a WDM system from a branch terminal via a saturated amplifier in which an additional wavelength signal differed from the

wavelength of wanted channels is introduced to the input of the saturated amplifier to reduce the level of the added wanted channel(s).

Preferably the additional wavelength signal is variable in level, or step adjustable, to permit control of the level of the added signal(s).

Preferably the additional wavelength signal is supplied from the branch terminal.

The single drawing Figure 1 illustrates schematically by way of example only, a method and system in accordance with the invention and, for clarity of description, only a single fibre and single branch is shown although it will be appreciated that the invention is applicable to multiple fibre and/or multiple branch systems.

A main trunk 10 has an optical amplifier or repeater 12, and a branching unit 14. The branching unit has a first three port circulator 16 connected in series with a filter 18 and a second three port circulator 20. One port of the first circulator is coupled to a branch terminal 22 via a drop channel including an optical amplifier or repeater 24 and an optional filter 26. The other circulator 20 has one port connected to an add channel including an optical amplifier 28 to the branch terminal 22. The amplifier 28 is a saturated amplifier and the maximum power available is shared between the various different channel wavelengths to be added to the trunk. By providing an additional optical wavelength at a frequency not required for transmission of information on the trunk as an input to the amplifier 28,

the output level of the other wanted wavelength channels added to the trunk are reduced. The additional optical wavelength may be such that it will pass back through the filter 18 to the first circulator 16 and along the drop channel. The drop channel may include a filter 26 or 26a to prevent passage of the additional wavelength. Such a filter 26b may alternatively be provided in the add channel between the amplifier 28 and second circulator 20.

The additional optical wavelength may be provided by the branch terminal. Such an optical wavelength may be provided by an optical control signal generator 30 in the branch terminal 22 or at some other point in the system that permits routing of the signal to the input of the amplifier. The additional optical wavelength may be variable in amplitude or adjustable in steps to control the level of the channels added to the trunk. Such variation may be effected by means of an amplitude controller or attenuator 32 in the branch terminal.

The input to the optical amplifier at A has several data channels at different wavelengths. The signal at output B is split so that one or more channels is diverted to a different destination. At point C a return signal from a second destination i.e. branch terminal 22 is reinserted onto the main signal path. At point C it is important that the injected signal level is controlled so that there is no degradation of the signals passing through the main path.

With an unrepeatered drop path then the add level may be controlled directly from the terminal. With a repeatered

drop path then control of the add signal is more difficult because prior to the present invention there was no simple way by which the signal level could be controlled from the terminal because of the self regulation of the amplifiers which are in compression.

This invention relates to a method of, and system for controlling the add signal level provided by one or more amplifiers between the terminal and the add point C of the system.

Looking at an application of the invention from another viewpoint, in repeatered WDM systems the control of added signals to the trunk is critical to ensure that the pre-emphasis levels are preserved to minimise the system penalties. This can be carried out using a controlled gain amplifier prior to the injection point. The proposed method controls the level of the added signal by sending a level control signal from, for example, the terminal at the start of the system such that it takes some of the output power of the injection amplifier. By varying the pre-emphasis level of the control signal at the terminal the output level of the added signal may be varied to optimise the pre-emphasis at the injection point.

By employing, the invention, simple control of the added signal level at the injection point may be effected without the need to be able to control the gain of the injection amplifier remotely via a supervisory control channel thus making the design of the amplifier very simple.

CLAIMS:

1. A wavelength division multiplex optical transmission system having a branching unit (14) arranged to drop and add a signal to a trunk cable (10) via drop and add channels, characterised in that the add channel is fed from a branch terminal (22) via a saturated amplifier (28) and wherein additional wavelength generating means (30) is arranged to provide at the input of the amplifier (28), an additional wavelength different from wanted signal wavelengths on the trunk (10) to reduce the level of added wanted channels.

2. A system as claimed in claim 1, wherein the additional wavelength generating means (30) is provided in the branch terminal.

3. A transmission system as claimed in claim 1 or 2, wherein means (32) is provided for varying the level of the additional wavelength supplied to the input of the amplifier (28).

4. A transmission system as claimed in claim 3, wherein the means (32) for varying the level of the additional wavelength is adjustable in steps.

5. A transmission system as claimed in any one of the preceding claims, wherein a filter (26, 26a) to prevent passage of the additional wavelength is provided in the drop channel.

6. A transmission system as claimed in claim 5, wherein the filter (26) to prevent the passage of the additional wavelength is provided prior to an amplifier (24) in the drop channel.

7. A transmission system as claimed in any one of claims 1 to 5, wherein the filter (26a) to prevent the passage of the additional wavelength is provided between the saturated amplifier (28) and the branching unit (14).

8. A transmission system as claimed in any one of claims 1 to 4, wherein a filter (26b) to prevent the passage of the additional wavelength is provided in the add channel between the saturated amplifier (28) and the trunk cable 10.

9. A transmission system as claimed in any one of claims 1 to 8, wherein the branching unit (14) comprises a first three part optical circulator (16) having a first port connected to a trunk fibre (10) for incoming traffic signals, a second port coupled via a filter (18) to the first port of a second optical circulator (20) and a third port coupled to the drop channel, the second port of the second circulator is coupled to a trunk fibre (10) for outgoing traffic signals and the third port is coupled to the add channel.

10. A method of controlling the level of one or more wavelength channels added to an optical fibre trunk of a WDM

system from a branch terminal, characterised in that said one or more wavelength channels are added via a saturated amplifier in which an additional wavelength different from the wavelength of wanted channels is introduced to the input of the saturated amplifier to reduce the level of the added wanted channel(s).

11. A method as claimed in claim 10, comprising varying the level of the additional wavelength to adjust the level of the added wanted channel(s).

12. A method as claimed in claim 11, comprising varying the level of the wavelength in steps.

13. A method as claimed in any one of claims 10 to 12, comprising filtering the add wanted channel to prevent passage of the additional wavelength to the trunk.

14. A method as claimed in any one of claims 10 to 12, comprising filtering the drop channel to prevent passage of the additional wavelength from the trunk to the branch.

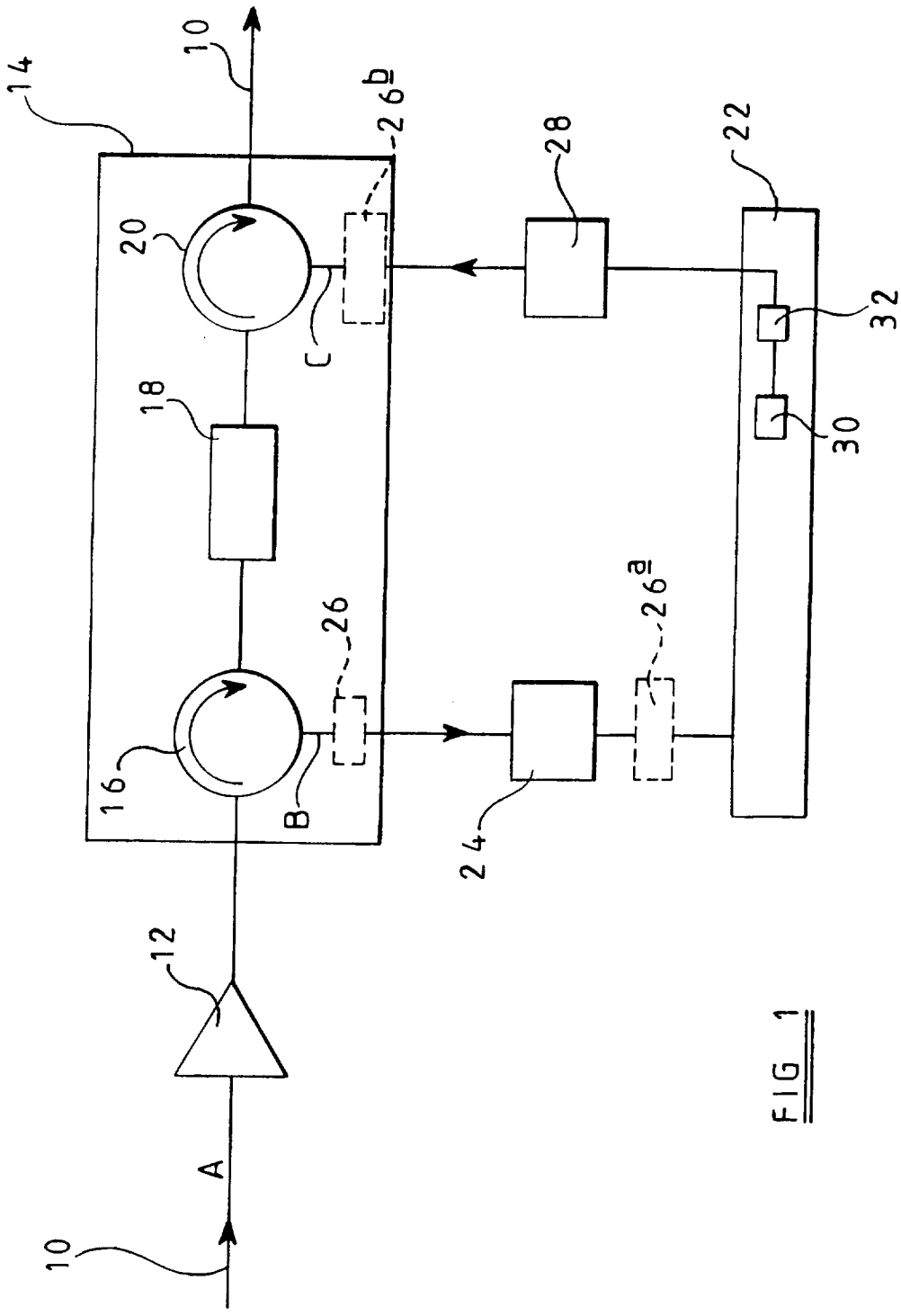

FIG 1

INTERNATIONAL SEARCH REPORT

Inter. ..onal Application No
PCT/GB 97/02217

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04J14/02 H04B10/213

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04J H04B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 617 527 A (NORTHERN TELECOM LTD) 28 September 1994 see abstract see column 1, line 31 - line 37 see column 1, line 52 - column 2, line 9 see column 2, line 51 - column 3, line 23 see column 4, line 55 - column 5, line 33	1-14
A	SHEHADEH F ET AL: "GAIN-EAUALIZED, EIGHT-WAVELENGTH WDM OPTICAL ADD-DROP MULTIPLEXER WITH AN 8-DB DYNAMIC RANGE" IEEE PHOTONICS TECHNOLOGY LETTERS, vol. 7, no. 9, 1 September 1995, pages 1075-1077, XP000527523 see page 1075, column 1 - column 2, line 20	1-14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
18 November 1997	02/12/1997

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. .onal Application No
PCT/GB 97/02217

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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