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(56) Documents cited
GB 2244595 A GB 2230912 A US 5050949 A
US 4954786 A US 4886334 A

(58) Field of search
UK CL (Edition K) **H1C CEA CEX, H3X**
INT CL⁵ **H01S**
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(54) **Optical pre-amplifier/receiver arrangement**

(57) An optical pre-amplifier/receiver arrangement for an optical fibre telecommunications system wherein the pre-amplifier (11) is an optical amplifier having an automatic gain control (16) whereby the optical output of the pre-amplifier applied to the receiver input is maintained constant.

Fig. 3.

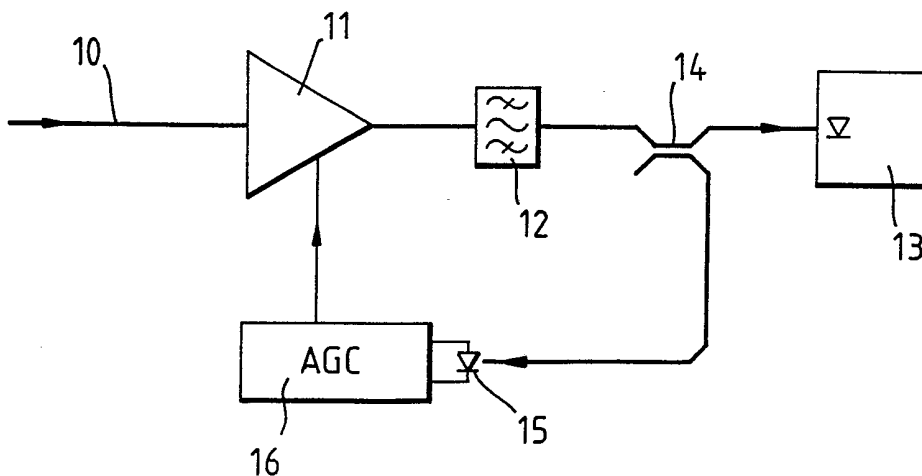


Fig.1(a)

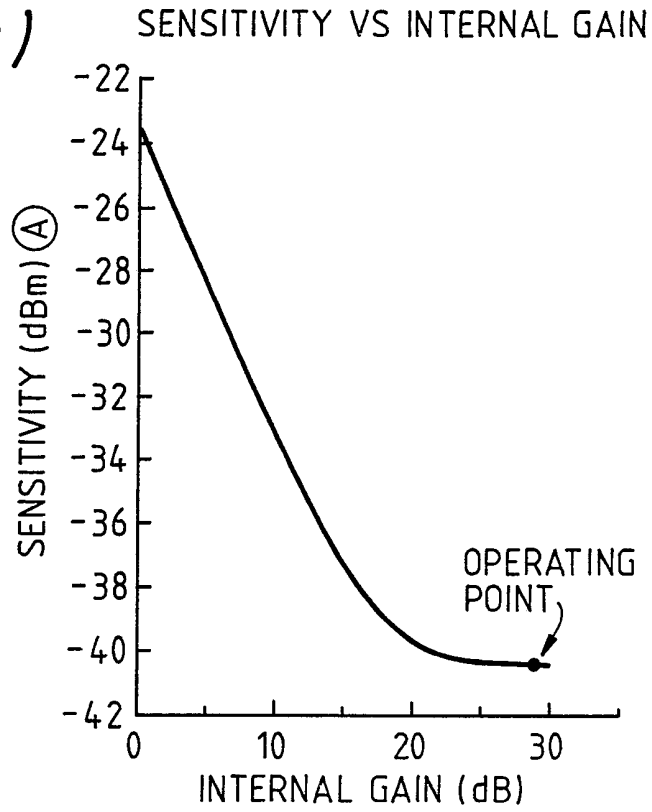


Fig.1(b)

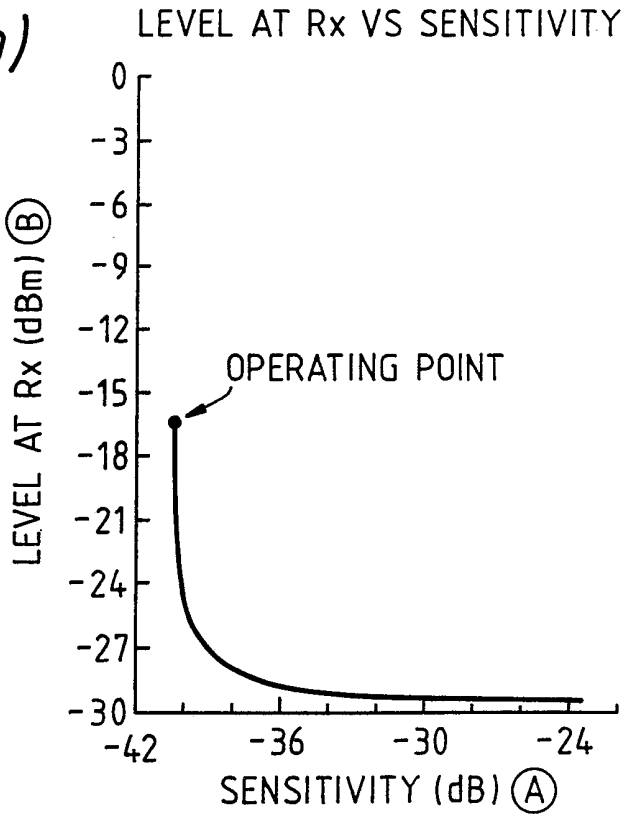


Fig.2.

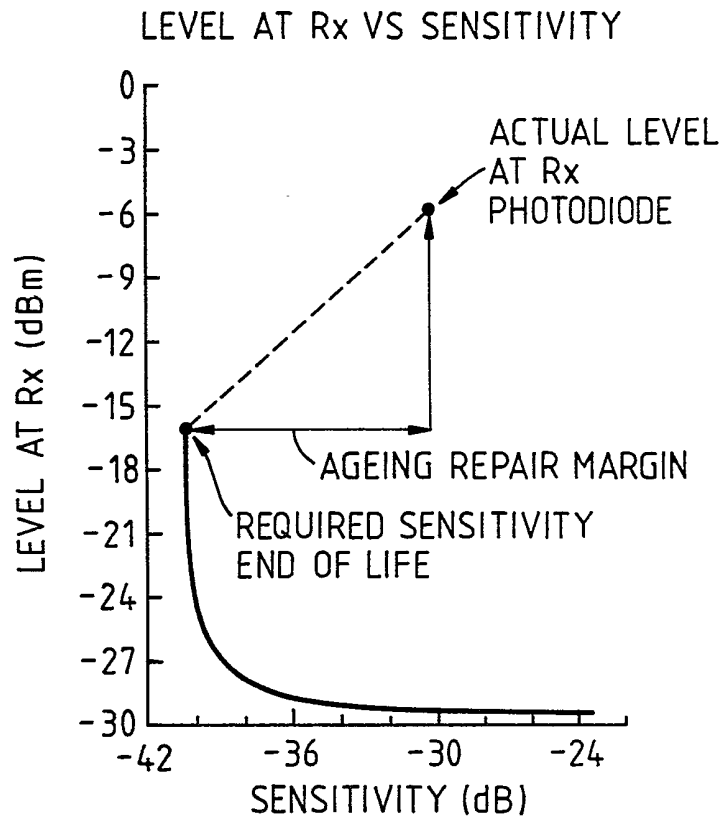


Fig.3.

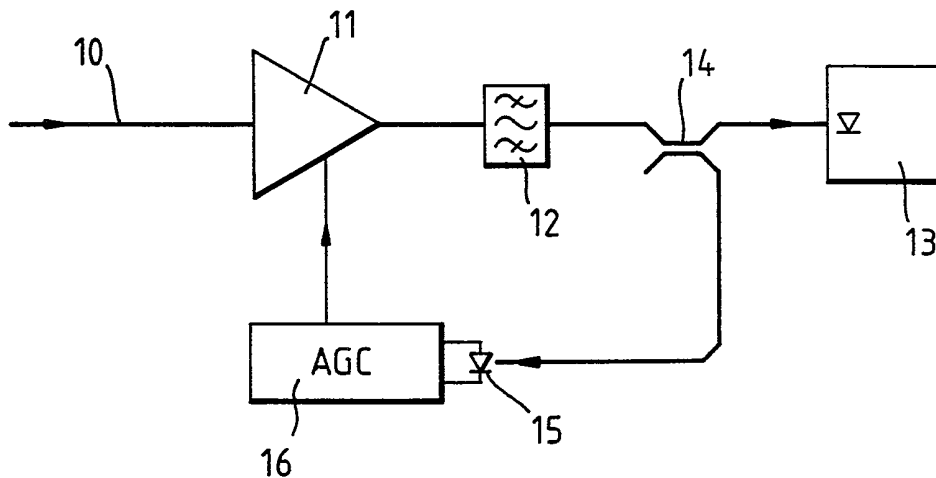
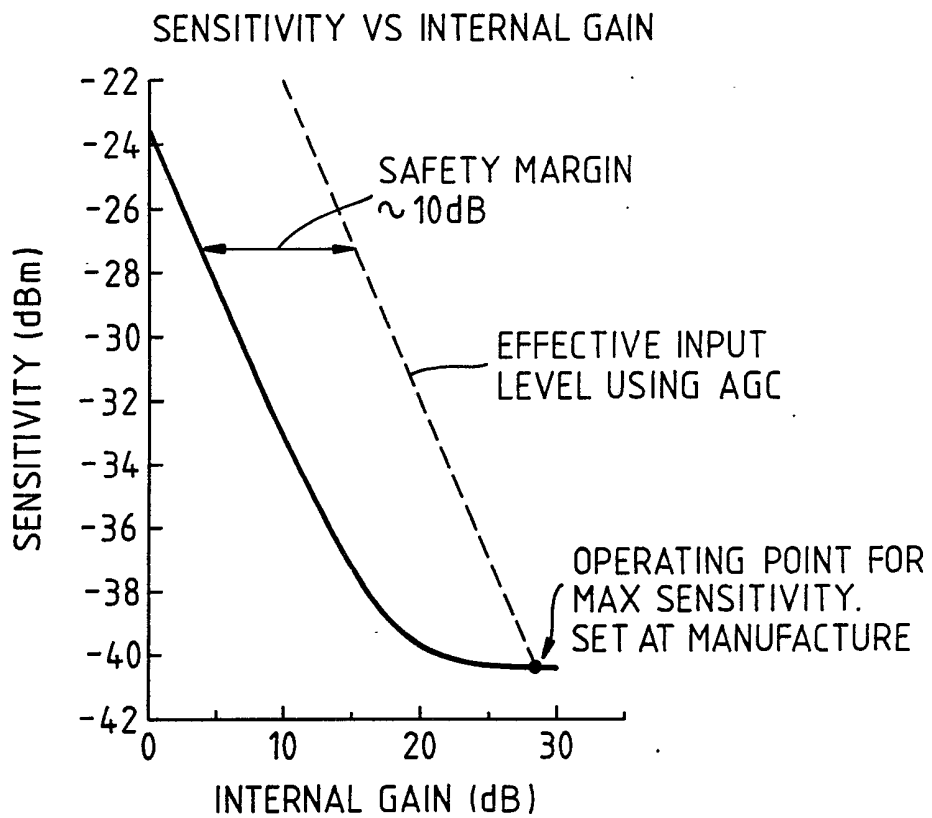


Fig. 4.



Optical pre-amplifier/receiver arrangement

This invention relates to an optical pre-amplifier/receiver arrangement for use in long haul optical fibre systems, for example submarine systems.

An optical pre-amplifier can be used to enhance the sensitivity of a conventional receiver. Sensitivities at least as low as -39.5 dBm have been achieved by the applicants at 2.5 Gbit/s, and lower still have been reported elsewhere, which are similar to those being achieved using coherent receivers.

A significant drawback to optically pre-amplified receivers is that when operated in the constant gain mode the dynamic range of the combination is reduced, compared to that of the receiver alone. This is because, to operate at maximum sensitivity, the optical amplifier has to be the dominant noise source in the system, and therefore is operated at high gain.

The situation is depicted in Figure 1(a) and 1(b). Here sensitivity of the pre-amplifier/receiver combination is plotted vs amplifier gain and, as seen to achieve maximum sensitivity, gains of 30 dB may be required. Figure 1(b) shows the received light level at the receiver photodiode itself, and it is observed that levels as high as -15 dBm may be required to achieve maximum sensitivity.

In a real system, it would be normal practice to install the receiver/pre-amplifier optimised for maximum sensitivity.

However, in this case, because allowances for repair and ageing have not been used up, the signal level at the receiver itself could be 10 dB higher than that end of life, and as a consequence the receiver would overload (Figure 2).

According to the present invention there is provided an optical pre-amplifier/receiver arrangement for an optical fibre telecommunications system wherein the pre-amplifier is an optical amplifier having an automatic gain control whereby the optical output of the pre-amplifier applied to the receiver input is maintained constant.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figures 1(a) and 1(b) respectively illustrate sensitivity of pre-amplifier/receiver vs amplifier gain and signal level at receiver input vs sensitivity of pre-amplifier/receiver;

Figure 2 illustrates operating signal level at an optical receiver photodetector at the start of system life;

Figure 3 illustrates schematically an optical pre-amplifier/receiver arrangement, and

Figure 4 illustrates sensitivity of optical pre-amplifier/receiver combination vs amplifier gain with effective input level tracked by automatic gain control.

The invention seeks to provide an optical pre-amplifier/receiver arrangement which adjusts amplifier gains so as to maintain adequate sensitivity for the system lifetime. The preferred arrangement is shown in Figure 3. An incoming optical fibre 10 is coupled to an optical amplifier 11 the output of which is applied, via an optical bandpass filter 12, to a receiver 13. Between the filter 12 and the receiver 13 there is incorporated an optical coupler 14 which taps off a small portion of the optical

signal applied to the receiver. Typically the coupler may be a 10:1 skew coupler. The tapped off signal is fed to a monitor photodiode 15 to provide a feedback signal to an automatic gain control (AGC) circuit 16 which controls the gain of the amplifier 11. For longhaul optical fibre systems such as submarine systems it is convenient to use optical amplifiers in which a length of amplifying fibre is pumped by a local laser. Typically the amplifying fibre is an erbium doped fibre. Provision of AGC for an erbium doped optical amplifier is already known from our copending application No. 89 09222.5 (Serial No. 2230912).

The mean power at the monitor photodiode 15 will be a measure of the signal level at the output of the pre-amplifier. The gain of the pre-amplifier is adjusted during the life of the system to maintain a constant level at the monitor photodiode, and thereby a wide dynamic range can be realised from the pre-amplifier/receiver combination as a whole.

The AGC loop is set up to deliver the required sensitivity at minimum input level. At higher input levels the gain is reduced by the AGC. Whilst this does degrade the sensitivity of the receiver/pre-amplifier combination, this is more than offset by the higher signal level at the pre-amplifier input. Indication of the safety margin associated with AGC is shown in Figure 4. A dynamic range in excess of 20 dB can be achieved by this technique.

CLAIMS:-

1. An optical pre-amplifier/receiver arrangement for an optical fibre telecommunications system wherein the pre-amplifier is an optical amplifier having an automatic gain control whereby the optical output of the pre-amplifier applied to the receiver input is maintained constant.
2. An optical pre-amplifier/receiver arrangement according to claim 1 wherein the optical amplifier comprises a pumped erbium fibre amplifier with feedback AGC.
3. An optical pre-amplifier/receiver arrangement according to claim 2 wherein the feedback AGC controls the pump power applied to the erbium amplifier.
4. An optical pre-amplifier/receiver arrangement substantially as described with reference to the drawings.
5. A method of optimising sensitivity of an optical pre-amplifier/receiver arrangement including providing feedback automatic gain control for the optical pre-amplifier.
6. A method according to claim 5 wherein the optical pre-amplifier is a pumped erbium fibre amplifier, the feedback AGC being effective to adjust the pump power applied to the erbium fibre to maintain the amplifier output constant.

Relevant Technical fields

(i) UK Cl (Edition K) H1C (CEA, CEX) H3X

(ii) Int CL (Edition 5) H01S

Search Examiner

G M PITCHMAN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI, CLAIMS

Date of Search

29 APRIL 1992

Documents considered relevant following a search in respect of claims

1 TO 6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2244595 A (BRITISH TELECOMMUNICATIONS) See Figure 1, page 3 line 8 to page 4 line 15, page 4 lines 21 to 23	1-6
X	GB 2230912 A (STC) See Figure 3, page 2 lines 31 to page 3 line 17 and page 3 lines 24 to 37	1-6
X	US 5050949 (DIGIOVANNI) See column 2 lines 52 to 55	1-6
X	US 4954786 (YAMAKAWA) See abstract	1,5
X	US 4886334 (AOKI) See abstract	1,5

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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.

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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.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).