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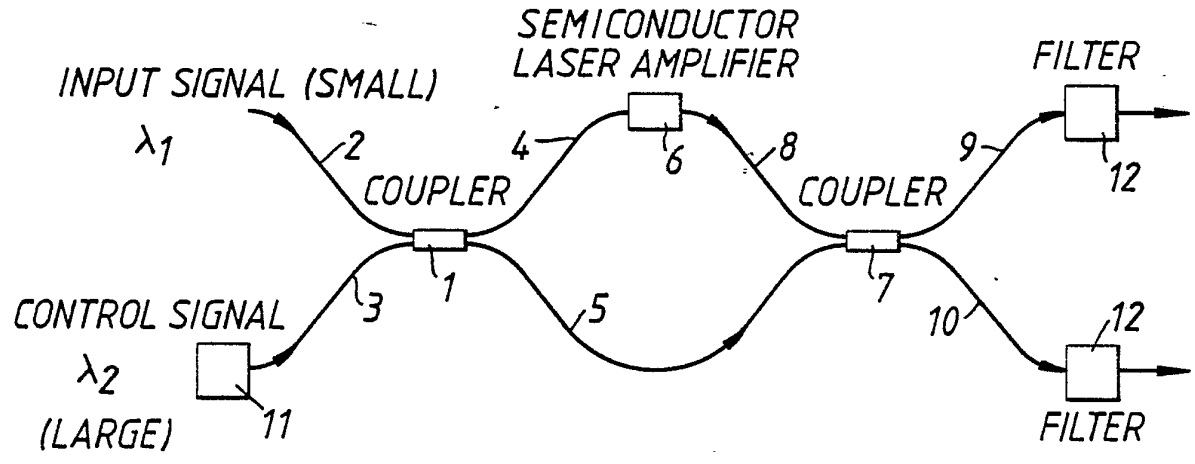

(57) Abstract

An optical coupling assembly which comprises a semiconductor laser amplifier (6) to which an optical control signal and an input signal are fed. The semiconductor laser amplifier (6) is responsive to changes in amplitude of the control signal to produce corresponding phase shifts in the input signal. Optical couplers (1, 7) are positioned upstream and downstream of the laser amplifier (6) so that a proportion of the input signal and control signal are fed along an optical fiber (5) directly from the optical coupler (1) to the coupler (7). The remaining portions of the input signal and control signal are fed to the amplifier (6) where the input signal is phase shifted and then fed to the coupler (7). The arrangement is such that the proportion of the input signal output from each output port (9, 10) of the coupler (7) is selectable by controlling the amplitude of the control signal.

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OPTICAL COUPLING ASSEMBY

The invention relates to an optical coupling assembly for controlling the coupling of an input optical signal between an input port and a pair of output ports.

In accordance with one aspect of the present invention, an optical coupling assembly comprises a conversion device to which an optical control signal and an input signal are fed, the conversion device being responsive to changes in amplitude of the control signal to produce corresponding phase shifts in the input signal; and optical coupling means having two input ports and two output ports for coupling the phase shifted input signal from the conversion device with the input signal the arrangement being such that the proportion of the input signal output from each output port of the optical coupling means is selectable by controlling the amplitude of the control signal.

The invention provides a neat way in which to couple an optical input signal selectively with one of two output ports.

In one arrangement the control signal component could be separated from the phase shifted signal prior to the one coupling means by the insertion of suitable separation means in the signal path.

Preferably, the assembly includes additional optical coupling means having two input ports and two output ports, the two output ports being connected respectively with the conversion device and an input port of the one optical coupling means and the two input ports receiving, in use, the control signal and the input signal respectively.

In this case proportions of both the control signal and non-phase shifted input signal will be fed to the one coupling means. To deal with this, separation means could be inserted between the coupling means or

downstream of the one coupling means to remove the control signal component if desired.

The conversion device is preferably provided by an optical device which has a refractive index which varies in accordance with the optical power of the optical control signal. This variation causes changes in the optical path length through the device. An example of a suitable conversion device is a semiconductor laser amplifier.

In accordance with a second aspect of the present invention, a method of operating an optical coupling assembly according to the one aspect of the invention comprises generating a control signal having one of two amplitudes, the power of the control signal being such that the input signal is substantially completely coupled with one of the two output ports of the one coupling means, the output port being selected in accordance with the amplitude of the control signal.

In this way, the optical coupling assembly is used as an optical switch.

Preferably, the control signal has a different wavelength from the input signal. This simplifies the filtering out of the control signal downstream of the optical coupling means which is necessary in certain applications.

In this specification, the term optical is intended to refer to that part of the electromagnetic spectrum which is generally known as the visible region together with those parts of the infra-red and ultra-violet regions at each end of the visible region which are capable of being transmitted by dielectric optical waveguides such as optical fibres.

Some examples of optical switches in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 illustrates a first example;

Figure 2 illustrates a second example; and,

Figure 3 illustrates a third example.

The switch shown in Figure 1 comprises a first optical fibre coupler 1 having two input ports defined by optical fibres 2, 3 and two output ports defined by optical fibres 4, 5. The optical fibre 4 is connected to a semiconductor laser amplifier 6. A second optical coupler 7 has a pair of input ports defined by the optical fibre 5 and an optical fibre 8 and a pair of output ports defined by optical fibres 9, 10. This arrangement constitutes a modified Mach-Zender interferometer.

The semiconductor laser amplifier exhibits certain optical non-linearities with incident light power. These include the fact that both the gain and the refractive index of the laser varies with incident light power. This latter non-linearity leads to changes in the optical path length through the laser amplifier, and hence changes in the signal transit time. These changes result in phase shifts of signals passing through the amplifier.

In use, an input signal which may be for example amplitude or phase modulated in accordance with information is fed along the optical fibre 2 to the coupler 1. In addition, a laser 11 generates a constant power control signal which has a large amplitude relatively to the input signal. This control signal is fed to the coupler 1 along the optical fibre 3. At the coupler 1, the two incoming optical signals are combined and proportions of each signal are fed along the optical fibres 4, 5.

The laser amplifier 6 is responsive to the large amplitude control signal to cause corresponding phase shifts in the input signal. The amplitude of the control signal is controlled to take up one of two values which

causes the laser amplifier 6 to impart one of two different phase shifts to the input signal output by the laser amplifier 6. This phase shifted signal combined with the control signal is fed along the optical fibre 8 to the coupler 7. In addition, a combination of the input signal and control signal is fed directly to the coupler 7 along the optical fibre 5.

If the two components input to the optical coupler 7 have powers in the correct ratio, then the original input signal on the optical fibres 2, 5 can be substantially completely coupled with either the optical fibre 9 or the optical fibre 10 depending upon which of the two amplitudes the original control signal has.

It will be appreciated that the optical coupler 7 will couple a proportion of the control signal into each of the optical fibres 9, 10. It is preferable therefore for filtering means 12 to be provided to remove the control signal component. This is most simply achieved if the control signal has a different wavelength from the input signal in which case the separation means 12 can comprise wavelength filters.

In the example shown in Figure 1, the control signal is injected into the semiconductor laser amplifier 6 in the same direction as the input signal. Figure 2 illustrates an alternative arrangement in which the control signal is fed to a third optical fibre coupler 13 which couples the control signal into the optical fibre 10 leading to the coupler 7. In this way, the control signal is injected into the semiconductor laser amplifier 6 in a direction opposite to the input signal. The use of the extra optical coupler 13 is important where the input signal may be desired on either of the optical fibre 9 or the optical fibre 10.

In a simpler arrangement shown in Figure 3, the control signal is injected directly into the optical

fibre 10 but in this case access is not required to the switched, input signal along the optical fibre 10.

The advantage of inserting the control signal in a direction opposite to the input signal is a reduction in the power of the amplified control signal emerging from the system with the switched signal, possibly making the use of filters unnecessary.

CLAIMS

1. An optical coupling assembly comprising a conversion device to which an optical control signal and an input signal are fed, the conversion device being responsive to changes in amplitude of the control signal to produce corresponding phase shifts in the input signal; and optical coupling means having two input ports and two output ports for coupling the phase shifted input signal from the conversion device with the input signal the arrangement being such that the proportion of the input signal output from each output port of the optical coupling means is selectable by controlling the amplitude of the control signal.

2. An assembly according to claim 1, further including additional optical coupling means having two input ports and two output ports, the two output ports being connected respectively with the conversion device and an input port of the one optical coupling means and the two input ports receiving, in use, the control signal and the input signal respectively.

3. An assembly according to claim 1 or claim 2, further comprising control signal separation means positioned downstream of each output port of the one optical coupling means to remove the control signal component.

4. An assembly according to any of the preceding claims, wherein the conversion device is provided by an optical device which has a refractive index which varies in accordance with the optical power of the optical control signal.

5. A method of operating an optical coupling assembly according to any of the preceding claims,

the method generating a control signal having one of two amplitudes, the power of the control signal being such that the input signal is substantially completely coupled with one of the two output ports of the one coupling means, the output port being selected in accordance with the amplitude of the control signal.

6. A method according to claim 5, wherein the control signal has a different wavelength from the input signal.

FIG. 1.

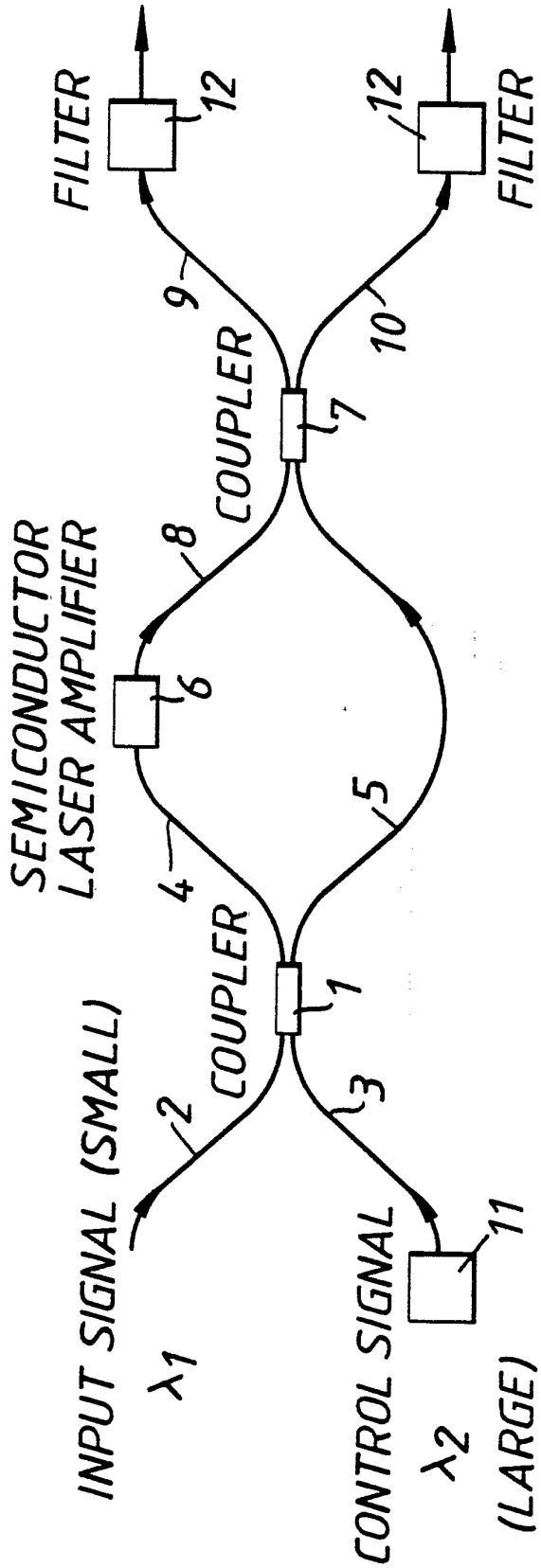
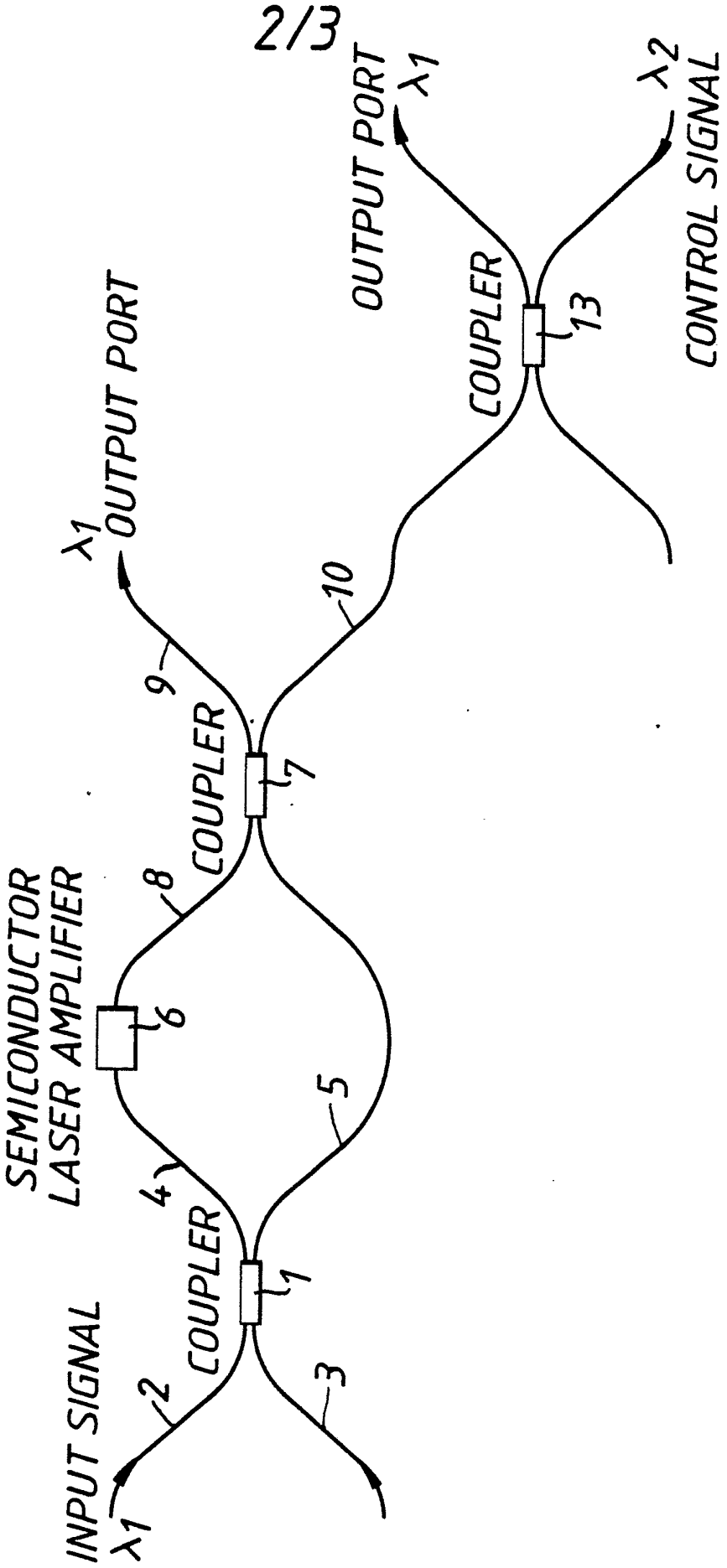

FILTER
12
12
FILTER
9
10
COUPLER
7
8
SEMICONDUCTOR
LASER AMPLIFIER
6
4
5
COUPLER
1
2
3
INPUT SIGNAL (SMALL)
λ1
CONTROL SIGNAL
λ2
(LARGE)
11

FIG. 2.


INPUT SIGNAL
λ1
2
COUPLER
4
1
3
SEMICONDUCTOR
LASER AMPLIFIER
6
5
8
COUPLER
7
9
λ1
OUTPUT PORT
10
OUTPUT PORT
λ1
COUPLER
13
λ2
CONTROL SIGNAL

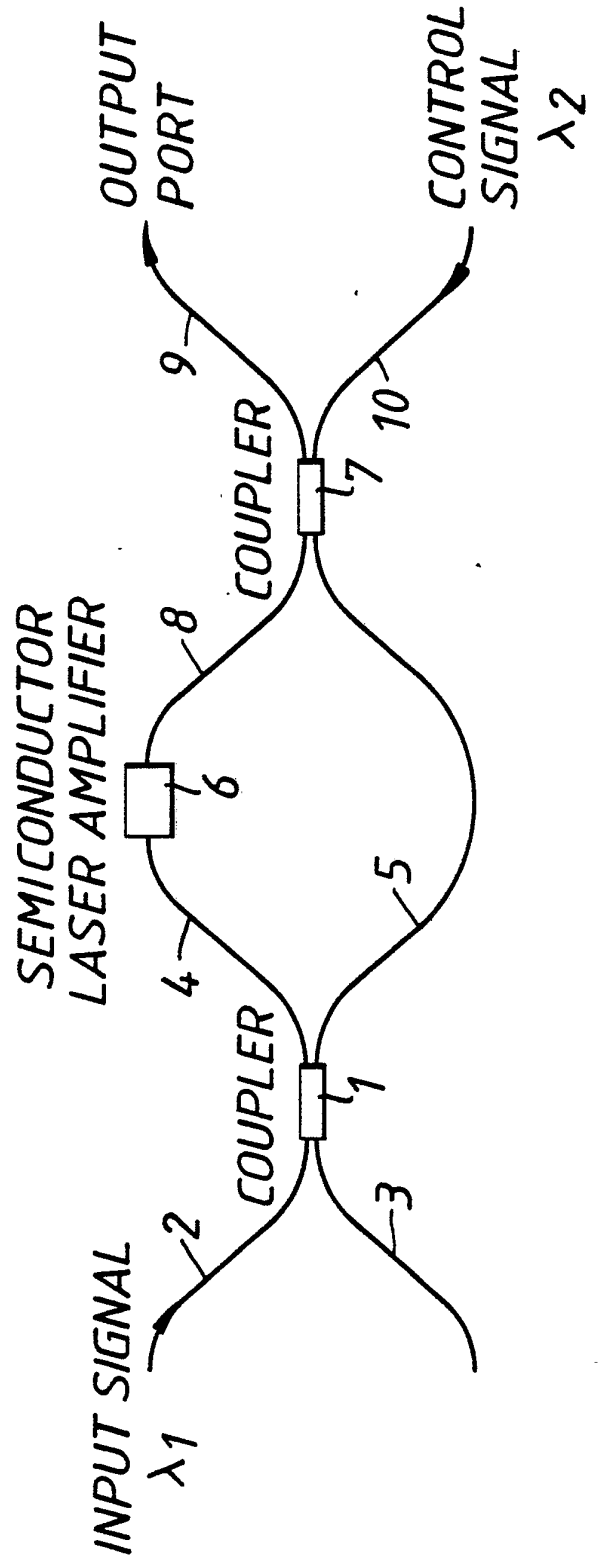

INPUT SIGNAL
λ1
2
COUPLER
1
3
4
SEMICONDUCTOR
LASER AMPLIFIER
6
8
COUPLER
7
9
10
OUTPUT
PORT
CONTROL
SIGNAL
λ2
5

FIG. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00352

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: G 02 F 1/21; H 01 S 3/06; H 04 B 9/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	G 02 F 1/21; H 01 S 3/06; H 04 B 9/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 3691387 (DE LANGE) 12 September 1972 see column 3, lines 46-49; figure 1	1-6
A	Electronics Letters, vol. 19, no. 14, 7 July 1983 (London, GB) R. Wyatt et al.: "1,52μm PSK heterodyne experiment featuring an external cavity diode laser local oscillator", pages 550-552, see especially figure 1	1-6
A	EP, A, 0143561 (THE BOARD OF TRUSTEES OF THE LELAND STANFORD JUNIOR UNIVERSITY) 5 June 1985 see figures 9,12 and 13	1,2,6
A	US, A, 3908121 (RISEBERG et al.) 23 September 1975 see abstract and figures	1
A	Electronics Letters, vol. 18, no. 5, 4 March 1982 (New York, US) S. Kobayashi et al.: "Optical phase modulation	./.

* Special categories of cited documents: [10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24th September 1986	29 OCT 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	in an injection locked AlGaAs semi-conductor laser", pages 210-211, see especially figure 1	1
	--	
A	Laser and Optoelektronik, vol. 16, no. 1, February 1984 (Stuttgart, DE) R. Kist et al.: "Faser- und integriert-optische Monomode-Sensoren: eine Ubersicht", pages 17-30, see especially figures 1,5-6	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00352 (SA 13680)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 07/10/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3691387	12/09/72	None	
EP-A- 0143561	05/06/85	AU-A- 3345284	30/05/85
US-A- 3908121	23/09/75	None	