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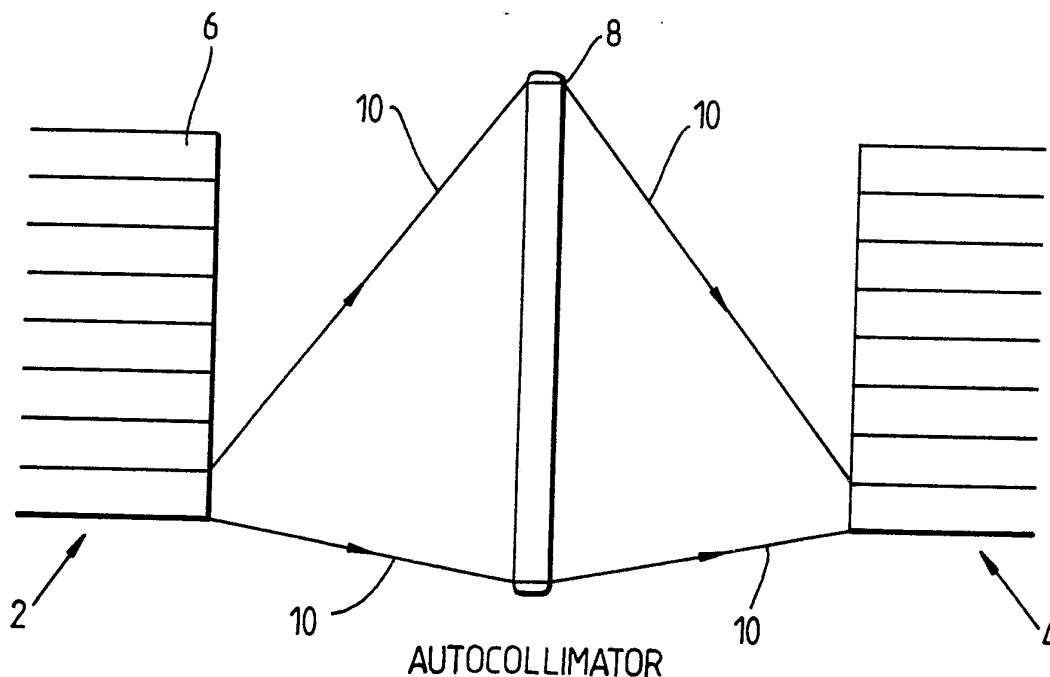
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(54) Title: INTERCONNECTION



(57) Abstract

An interconnection between an array (2) of optical fibres (6) transmits optical radiation to an array (4) of like fibres provided by an auto-collimating screen (8). This provides one-to-one interconnection in a particularly compact manner.

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INTERCONNECTION

This invention relates to interconnections and in particular, but not exclusively, to optical interconnections.

There is frequently a requirement for interconnecting high densities of connection points. One approach is to use electromagnetic radiation waveguides between an electromagnetic transmitter and a receiver, for example planar optical waveguides in opto-electronic integrated circuits. Electrical signals can be used to modulate an electromagnetic radiation source, for example a laser, which can be received by the receiver and the electrical signals subsequently recovered. However, such waveguide systems do not allow the ready replacement of elements to be interconnected.

According to the present invention an interconnection comprises a plurality of transmitters of electromagnetic radiation, a plurality of receivers, and an autocollimating screen coupling each transmitter to a respective receiver.

The autocollimator screen causes the electromagnetic radiation, for example optical signal, transmitted by the transmitters at given points to be imaged at their conjugate points. By placing the respective receivers at these points, one-to-one interconnection links are made between the transmitters and receivers. Because the interconnection is a free-space interconnection the transmitters and receivers can be readily made interchangeable with others.

The use of an autocollimating screen provides a compact interconnect without the need for large, relatively expensive lenses.

The autocollimator screen may comprise a matched pair of arrays of microlenses. Preferably a finely structured diffuser screen is positioned between the arrays to increase the efficiency of the autocollimating in known manner.

If the transmitters and receivers are arranged in linear arrays, the microlenses may be cylindrical.

The transmitters and receivers may be the ends of optical fibres or, where integrated circuits are to be interconnected, they might be lasers and optical detectors respectively. The invention is envisaged to encompass all types of transmitters and receivers capable of launching and collecting, respectively, electromagnetic radiation. They may be active, eg. a laser or LED source, or passive, eg. a fibre couplable to a light source or optical detector.

The invention will now be described by way of example only with reference to the accompanying drawings in which

Figure 1 is a schematic end view of a fibre-to-fibre interconnect according to the present invention;

Figure 2 is a schematic perspective view of an integrated circuit interconnect according to the present invention; and

Figures 3 and 4 are schematic end views of prior art sheet autocollimators either of which may be used as the autocollimator of the Figures 1 and 2 embodiments.

In Figure 1 an optical interconnect comprises two linear arrays 2 and 4 of eight optical fibres 6.

A sheet autocollimator 8 positioned between the fibre arrays images the light exiting the end of each fibre of one array with a corresponding end of a fibre in the other array - as illustrated for one exemplary pair of fibres by optical rays 10. In this instance the array of fibres 2 constitutes an array of optical transmitters and the array of fibres 4 an array of optical receivers.

Referring now to Figure 2 integrated circuits 20 and 22 are interconnected via a screen autocollimator 24. The integrated circuit 20 has lasers (not shown) which transmit in a generally downward direction in the orientation of Figure 2 towards the

autocollimator screen 24 which images the transmitted signals on respective optical detectors 26 so interconnecting the two circuits 20 and 22.

Alternative sources may be used for example light emitting diodes, multiple quantum well modulators or other compact sources of electromagnetic radiation.

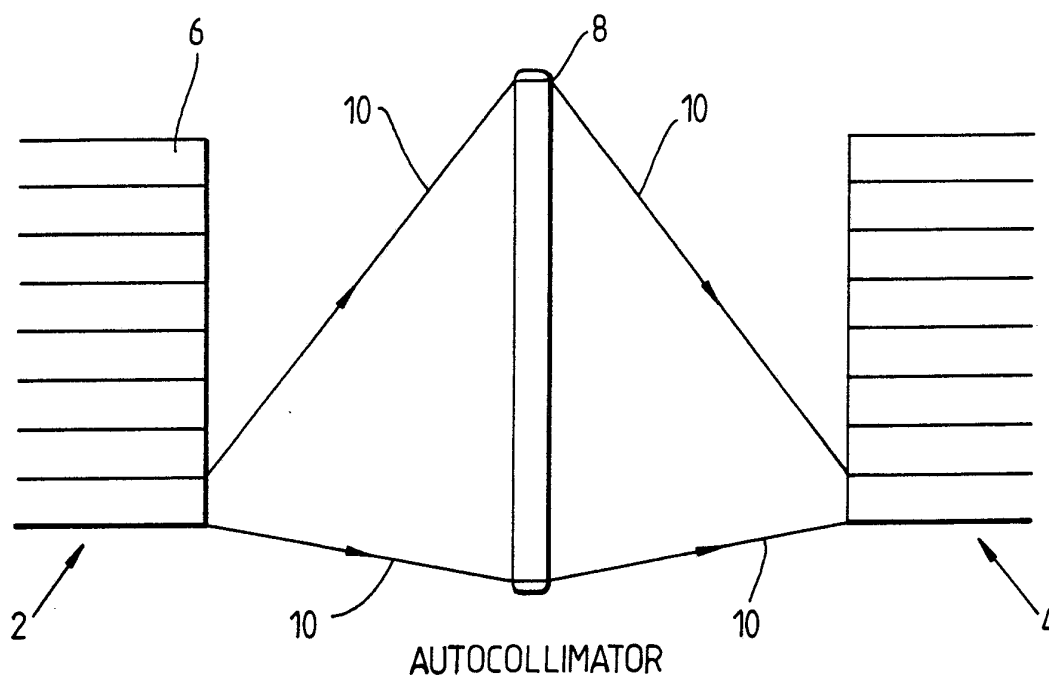
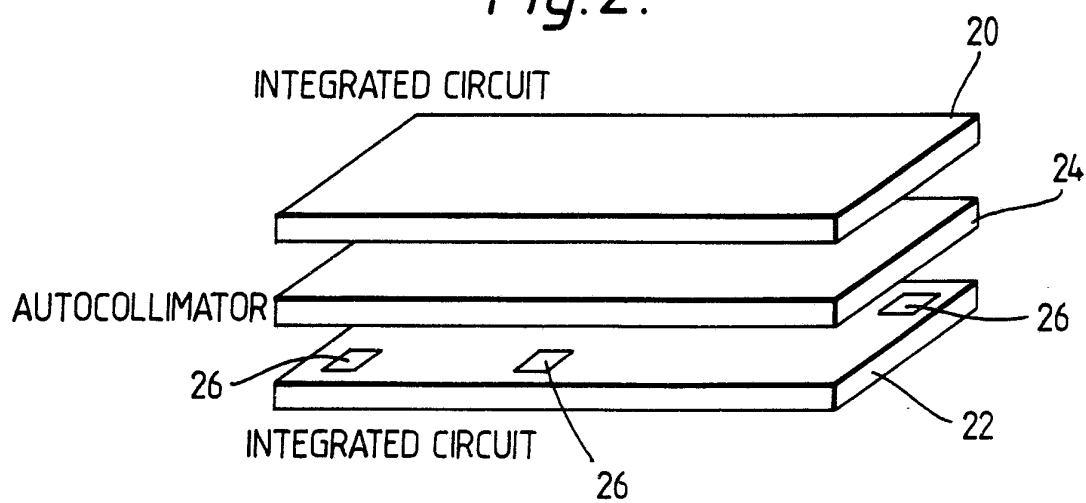
Referring now to Figures 3 and 4 there are shown cross-sections of exemplary screen autocollimators that may be used with the embodiments of Figures 1 and 2. In Figure 3 the autocollimator 30 is formed from two matched rectangular arrays 32 and 34 of hemispherical microlenses 36 supported on transparent backing sheets 38 and 40 respectively. Other microlenses having non-spherical cross-sections may also be used.

The autocollimator of Figure 4 is as in Figure 3 with the addition of a finely structured diffuser 40.

CLAIMS

1. An interconnection comprising a plurality transmitters of electromagnetic radiation, a plurality of receivers, and an autocollimating screen coupling each transmitter to a respective receiver.
2. An interconnection as claimed in claim 1 in which the autocollimator screen comprises a matched pair of arrays of microlenses.
3. An interconnection as claimed in claim 2 in which the microlenses are hemispherical.
4. An interconnection as claimed in either of claims 2 and 3 including a finely structured diffusing screen between the arrays of microlenses.
5. An interconnection as claimed any preceding claim in which the transmitters or the receivers comprise arrays of ends of single mode optical fibres.
6. An interconnection as claimed in any one of claims 1 to 4 in which the receivers or the transmitters are formed on an integrated circuit.
7. An interconnection as claimed in claim 6 in which the receivers comprise optical dectectors and the transmitters comprise sources of optical radiation.
8. An interconnection as claimed in claim 7 in which the transmitters comprise lasers.

1/2

Fig.1.*Fig.2.*

$\frac{2}{2}$
Fig.3.

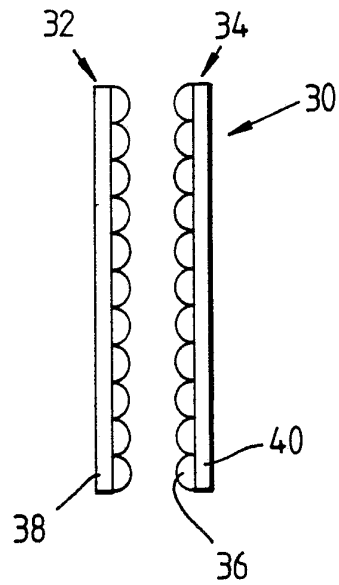
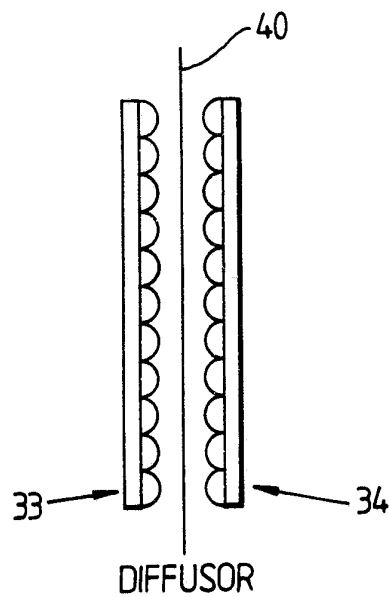


Fig.4.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00099

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 ⁵ : G 02 B 6/42, 6/32																							
II. FIELDS SEARCHED <div style="text-align: center; margin-top: 10px;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border: none;"> <tr> <td style="width: 25%; border: none;">Classification System</td> <td style="border: none;">Classification Symbols</td> </tr> <tr> <td style="border: none; padding-top: 10px;">IPC⁵</td> <td style="border: none; padding-top: 10px;">G 02 B 6/00, H 01 L 31/00, H 04 B 10/00</td> </tr> </table> <div style="text-align: center; margin-top: 10px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	IPC ⁵	G 02 B 6/00, H 01 L 31/00, H 04 B 10/00																	
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IPC ⁵	G 02 B 6/00, H 01 L 31/00, H 04 B 10/00																						
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category ⁹</th> <th style="width: 70%;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%;">Relevant to Claim No. ¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;">WO, A, 8400822 (WESTERN ELECTRIC) 1 March 1984 see the whole document</td> <td style="text-align: center; vertical-align: top;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">6,7</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td style="vertical-align: top;">IBM Technical Disclosure Bulletin, vol. 18, no. 7, December 1975, (New York, US), H.E. Korth: "Optical multichannel connection of integrated modules", page 2187 see the whole article</td> <td style="text-align: center; vertical-align: top;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">2,6,7</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">FR, A, 2520883 (NIPPON SHEET GLASS) 5 August 1983 see figure 8; page 12, lines 18-35; page 13, lines 1-14; claims</td> <td style="text-align: center; vertical-align: top;">1,2,3</td> </tr> <tr> <td colspan="3" style="text-align: center; padding-top: 20px;">./.</td> </tr> </tbody> </table>			Category ⁹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	WO, A, 8400822 (WESTERN ELECTRIC) 1 March 1984 see the whole document	1	A	--	6,7	X	IBM Technical Disclosure Bulletin, vol. 18, no. 7, December 1975, (New York, US), H.E. Korth: "Optical multichannel connection of integrated modules", page 2187 see the whole article	1	A	--	2,6,7	A	FR, A, 2520883 (NIPPON SHEET GLASS) 5 August 1983 see figure 8; page 12, lines 18-35; page 13, lines 1-14; claims	1,2,3	./.		
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<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>[*] Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Z" document member of the same patent family</p> </div> </div>																							
IV. CERTIFICATION <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; padding-bottom: 10px;"> Date of the Actual Completion of the International Search <div style="text-align: center; margin-top: 10px;">14th May 1991</div> </td> <td style="width: 50%; border: none; padding-bottom: 10px;"> Date of Mailing of this International Search Report <div style="text-align: center; margin-top: 10px;">17 JUN 1991</div> </td> </tr> <tr> <td style="width: 50%; border: none; padding-top: 10px;"> International Searching Authority <div style="text-align: center; margin-top: 10px;">EUROPEAN PATENT OFFICE</div> </td> <td style="width: 50%; border: none; padding-top: 10px;"> Signature of Authorized Officer <div style="text-align: center; margin-top: 10px;"> MISS T. TAZELAAR </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <div style="text-align: center; margin-top: 10px;">14th May 1991</div>	Date of Mailing of this International Search Report <div style="text-align: center; margin-top: 10px;">17 JUN 1991</div>	International Searching Authority <div style="text-align: center; margin-top: 10px;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer <div style="text-align: center; margin-top: 10px;"> MISS T. TAZELAAR </div>																	
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages	Relevant to Claim No.
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A	GB, A, 2220501 (THE PLESSEY) 10 January 1990 see figures 10a,10b; page 8, lines 5-27 -----	1,5,8

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

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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 11/06/91
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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