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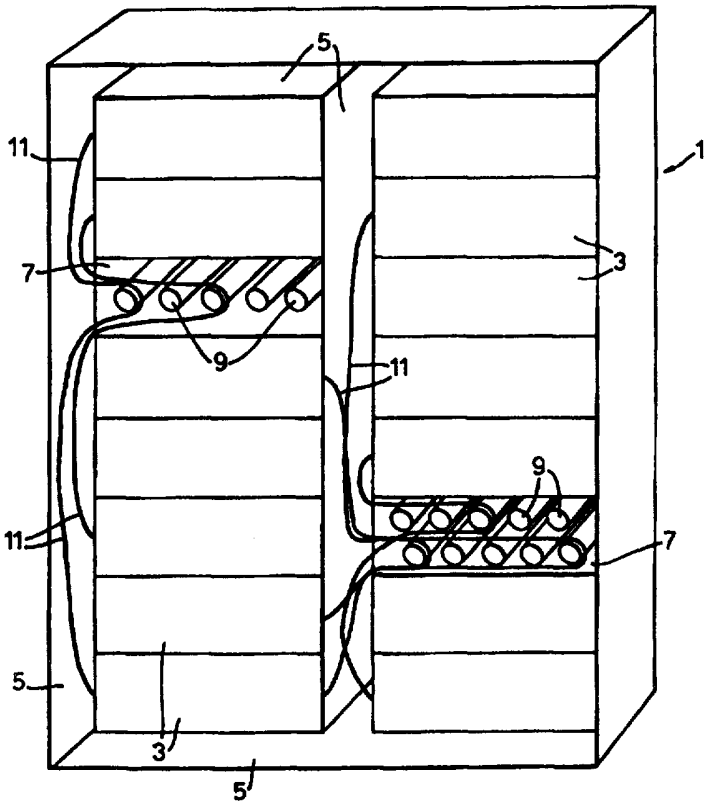
(54) Title: OPTICAL FIBRE DISTRIBUTION SYSTEM

(57) Abstract

An optical fibre distribution system (1), comprising: a) at least one stack of optical fibre interconnection modules (3); and b) at least one optical fibre storage region (7) located in at least one said stack of interconnection modules, which storage region(7), in use, stores spare lengths of one or more optical fibres (11) which extend between respective interconnection modules (3), wherein the or each storage region (7) comprises a plurality of supports (9) which are mutually spaced-apart across at least part of the width of the stack of interconnection modules (3) such that, in use, each spare length of optical fibre (11) may be routed into the storage region (7) and routed around at least one of the supports (9) which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre (11).



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Optical Fibre Distribution System

The present invention relates to an optical fibre distribution system, to a kit of parts for forming such a system, to an optical fibre storage region module for an optical fibre distribution system, and to a method of connecting an optical fibre and storing a spare length thereof in an optical fibre distribution system.

Several types of optical fibre distribution systems, which are commonly known as frames or racks, are used today. For example, one type of system is disclosed in United States Patent No. 5402515 (3M). This patent discloses a system which comprises a frame having several bays for receiving connector modules, associated jumper organizers for storing spare lengths of jumpers (which may also be called pigtails or patch cords and comprise ruggedized optical fibres which are connected to the connector modules), and upper and lower troughs for conveying jumper fibres between adjacent bays. Spare lengths of jumpers are stored in vertical raceways between the bays of connector modules, with each vertical raceway containing several spools which support the jumpers in such a manner that there are never more than two continuous bends of more than 90°.

A different system of storing spare lengths (sometimes referred to as slack or excess) of optical fibres in a distribution system is disclosed in United States Patent No. 5013121. In this system, the spare optical fibre lengths are stored in a cabinet or module which may form part of a stack of connector cabinets or modules in a distribution frame. The cabinet which stores the spare fibre contains a plurality of trays which are slidably received within the cabinet. A take up spool is provided on each tray, and the slack of a patch cord fibre is stored on each tray by winding the take up spool on that tray.

There are disadvantages with each of these systems. While the spare jumper length storage system disclosed in US 5402515 has the advantage of simplicity, it has the disadvantage of providing only poor organization of the spare jumper lengths, and

tangling of jumpers is therefore possible, and even likely. This tangling leads to the disturbance of other jumpers when attempting to access one particular jumper, which can cause losses in optical signal transmission. Furthermore, the tangling of jumpers is exacerbated by the fact that the vertical raceways (where the spare jumper lengths are stored) are also used to route jumpers between the bays of the distribution system, and so these raceways are normally very crowded with jumpers. This also makes the provision of wide vertical raceways between the bays a necessity, which is disadvantageous in situations where there is insufficient space available for such wide vertical raceways.

The system disclosed in US 5013121 provides a much greater degree of organization of spare optical fibre lengths (e.g. spare jumper or patch cord lengths), but this improved organization is achieved at the cost of greatly increased installation complexity (and consequently installation time). Spare lengths of fibre must be stored individually on the trays in the cabinet in a time-consuming and laborious installation procedure, and a correspondingly time-consuming and laborious procedure is also required in order to gain access to the fibre once stored. Furthermore, the cabinet is a complex and intricate construction which can store a maximum of only 48 patch cords or jumpers, and it is thus a costly and space-consuming design despite its superficially compact appearance.

There is thus a need for an optical fibre distribution system in which spare lengths of fibre are stored in an organized yet compact manner, and which provides quick and easy installation and access of such stored fibre in a manner which reduces the risk of disturbance of other stored fibres. The purpose of the present invention is to provide such a system.

Accordingly, a first aspect of the present invention provides an optical fibre distribution system, comprising:

(a) at least one stack of optical fibre interconnection modules; and

(b) at least one optical fibre storage region located in at least one said stack of interconnection modules, which storage region, in use, stores spare lengths of one or more optical fibres which extend between respective interconnection modules, wherein the or each storage region comprises a plurality of supports which are mutually spaced-apart across at least part of the width of the stack of interconnection modules such that, in use, each spare length of optical fibre may be routed into the storage region and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre.

A second aspect of the invention provides a kit of parts for forming an optical fibre distribution system, comprising:

(a) a plurality of optical fibre interconnection modules which, in use, are arranged in a stack; and

(b) at least one optical fibre storage region module which, in use, is located in at least one said stack of interconnection modules, which storage region, in use, stores spare lengths of one or more optical fibres which extend between respective interconnection modules, wherein the or each storage region comprises a plurality of supports which are mutually spaced-apart across at least part of the width of the stack of interconnection modules such that, in use, each spare length of optical fibre may be routed into the storage region and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre.

A third aspect of the invention provides an optical fibre storage region module for an optical fibre distribution system, which module, in use, stores spare lengths of one or more optical fibres which are connected in the distribution system, the module comprising a plurality of supports which are mutually spaced-apart across at least part of the width thereof such that, in use, each spare length of optical fibre may be routed into the module and routed around at least one of the supports which may be selected

to provide at least approximately the correct storage length required for that spare length of optical fibre.

A fourth aspect of the invention provides a method of connecting an optical fibre and storing a spare length thereof in an optical fibre distribution system according to the first aspect of the invention, comprising:

(a) connecting opposite ends of the optical fibre in respective interconnection modules;

(b) routing a said spare length of said connected optical fibre into the storage region;

(c) selecting at least one of the supports to provide at least approximately the correct storage length required for that spare length of optical fibre; and

(d) routing the spare length of optical fibre around the selected support(s).

Preferably, the step of routing the spare length of optical fibre around the selected support(s) comprises hooking a bend in that optical fibre around the selected support(s), e.g. by passing the bend around an end (e.g. a front end) of the support or through a gap in the support.

The invention has the advantage that it provides a simple, organized and compact system of storing spare lengths of optical fibre (which will normally be ruggedized fibre, e.g. pigtails, patch cords or jumpers) because the storage region comprises a plurality of supports which are mutually spaced-apart across at least part of the width of the stack of modules such that each spare length of optical fibre may be routed into the storage region and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length for that spare length of optical fibre.

This manner of spare fibre length storage is compact because it does not require the use of trays for storing individual (ruggedized) fibres; also, because the storage is carried out within the stack of modules, it does not require wide vertical

raceways between such stacks or bays. It furthermore provides good organization since the spare fibre lengths are organized according to their length by virtue of the fact that the support or supports around which they are routed is/are selected according to the length of spare fibre which needs to be accommodated. This means that the spare lengths of fibre routed into the storage region are each organized into one of a plurality of different possible routes, thus aiding subsequent accessibility. Ordinarily, of course, there will be more than one (ruggedized) fibre following each route. It has been found that this system of spare fibre length storage can provide adequately organized storage of up to 300 or more ruggedized fibres in the same volume and shape as the module disclosed in US 5013121 (which typically has dimensions of: height 8" (20.3cm); depth 12" (30.5cm); width 21" (53.3cm)).

The optical fibre storage region preferably comprises a module which may be included in a stack of interconnection modules (or the like) as and where required. Advantageously, the or each storage region module may have substantially the same size and shape as the, or at least one of the, interconnection modules. Alternatively, however, at least in some embodiments, the storage region may be a part of, or attachable to, a frame (or the like) of the distribution system, other than as a module. For example, the supports may be part of, or attachable directly to, such a frame.

The interconnection modules preferably includes means for connecting the optical fibres (spare lengths of which are stored in the storage region(s)) to other optical fibres and/or devices (e.g. optical devices). They may, for example, include optical connectors, splices, splitters or the like. They most preferably include a patch panel or other patching means.

The plurality of supports in the optical fibre storage region preferably comprise at least one series of supports (e.g. threee or four or more) which are mutually spaced-apart across at least part of the region, i.e. across at least part of the module or stack of interconnection modules. Advantageously, each support may comprise at least one elongate member which extends in a direction which is transverse, and preferably

substantially perpendicular, to the width of the stack of interconnection modules. Each support is preferably shaped so that the radius of curvature of an optical fibre routed around it in use cannot be less than the normal operational minimum bend radius of the fibre (in order to avoid damage of the fibre and/or optical transmission losses).

Preferably, spare lengths of optical fibre are routed into the optical fibre storage region through at least one side thereof (i.e. through at least one extreme end of its width). The fibres may, for example, be routed into the storage region from one side only, e.g. to avoid tangling of the stored lengths. Ordinarily, when the fibres enter the storage region from only one side, they may subsequently be removed without the need to remove any of the other stored fibres. Alternatively, optical fibres may be routed through the storage region from one side to the other across its width.

In some preferred embodiments of the invention, the or each optical fibre storage region has at least one support located at the point of entry/exit of an optical fibre into the storage region, the support being arranged so that an optical fibre entering/exiting the storage region may be routed around it.

In certain preferred embodiments, the supports (e.g. elongate support members) increase in length from one side to the other side of the stack of interconnection modules. This has the advantage that it may improve the ease of installation and/or removal of stored optical fibre lengths into or out of the storage region. The supports preferably decrease in length away from a side of the region from which the fibres enter the region (see, for example, Figure 2 of the drawings).

The or each stack of interconnection modules preferably has a front and a back which are each transverse to its width (the stack is preferably substantially rectangular or square in plan view), for example with the front arranged to be readily accessible, and the back arranged to be less readily accessible, in use. The supports of the or each storage region are preferably mounted on a structural member of the distribution

system located at or near the back of the stack of interconnection modules. In embodiments in which the or each storage region comprise(s) a module, the structural member preferably comprises part of the module, e.g. a back plate or frame of the module. Otherwise, the structural member may, for example, comprise a frame or the like) of the distribution system, e.g. upon which the interconnection modules are mounted. In preferred embodiments, the support members (e.g. elongate members) extend closer to the front of the stack of interconnection modules as their length increases from one side to the other side of the stack.

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

Figure 1 illustrates, schematically, an optical fibre distribution system according to the invention;

Figure 2 illustrates, schematically, an optical fibre storage region according to the invention; and

Figure 3 illustrates, schematically, how a spare length of optical fibre is stored in a storage region of a distribution system according to the invention; and

Figure 4 illustrates, schematically, an alternative way of storing a length of optical fibre in another storage region of a distribution system according to the invention.

Figure 1 illustrates, schematically, an optical fibre distribution system 1 according to the invention. The system comprises two stacks (other numbers of stacks are, of course, possible) of optical fibre interconnection modules 3, and ducting 5 around the stacks through which cables and/or fibres may be routed. In each stack is an optical fibre storage region 7. Illustrated schematically in each storage region 7 are

a plurality of supports 9 which are mutually spaced-apart across the width of their respective stack. The storage region 7 illustrated in the left-hand stack (as drawn) has a single series of supports, whereas the storage region 7 illustrated in the right-hand stack has two series of supports. Ruggedized optical fibres 11 (e.g. pigtails) which extend between respective interconnection modules 3 are routed through the side ducts and into their respective storage region 7 through the closest side thereof. The optical fibres 3 are hooked around the appropriate support(s) 9 so that the spare or slack fibre is taken up.

Figure 2 illustrates, schematically, an optical fibre storage region 7. The storage region 7 includes a series of elongate support members 9 extending from the back of the region in a direction substantially perpendicular to the width of the stack. The support members 9 are mutually spaced-apart across the width of the storage region, and each one is curved in cross-section so that an optical fibre 9 hooked around it is not bent at a radius below its normal operation minimum bend radius. The elongate support members decrease in length from the side of the storage region through which the fibres enter. This facilitates installation and removal of the fibres, particularly those fibres for which the greatest spare length is stored in the storage region.

Figure 3 illustrates three steps in the connection of an optical fibre and the storage of a spare length thereof, in an optical fibre distribution system according to the invention. In step 1, opposite ends of an optical fibre 11 (e.g. a ruggedized optical fibre) are connected in two different interconnection modules (although they could be connected in the same interconnection module). This leaves a spare (slack) length 13 of the optical fibre which needs to be stored. In step 2 a middle portion of the optical fibre is bent and this bend 15 is inserted into an optical fibre storage region 7 which is situated in a stack of interconnection modules 3. In step 3 the bend 15 in the middle portion of the optical fibre is hooked over the front end of an appropriate support 9 which is selected from the series of available supports to provide the correct storage length required to take up that spare (slack) length of optical fibre.

Figure 4 illustrates, schematically, another storage region 7 of a distribution system according to the invention. In this storage region, there are supports 9 located in (some or all of) its corners. These corner supports may guide optical fibres 11 where they extend into the storage region. As shown in a dashed line, optical fibres may extend through the storage region from one side to the other, i.e. across the entire width of the storage region.

Claims

1. An optical fibre distribution system, comprising:

(a) at least one stack of optical fibre interconnection modules; and

(b) at least one optical fibre storage region located in at least one said stack of interconnection modules, which storage region, in use, stores spare lengths of one or more optical fibres which extend between respective interconnection modules, wherein the or each storage region comprises a plurality of supports which are mutually spaced-apart across at least part of the width of the stack of interconnection modules such that, in use, each spare length of optical fibre may be routed into the storage region and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre.

2. A kit of parts for forming an optical fibre distribution system, comprising:

(a) a plurality of optical fibre interconnection modules which, in use, are arranged in a stack; and

(b) at least one optical fibre storage region module which, in use, is located in at least one said stack of interconnection modules, which storage region, in use, stores spare lengths of one or more optical fibres which extend between respective interconnection modules, wherein the or each storage region comprises a plurality of supports which are mutually spaced-apart across at least part of the width of the stack of interconnection modules such that, in use, each spare length of optical fibre may be routed into the storage region and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre.

3. A system or kit according to Claim 1 or Claim 2, in which said plurality of supports comprises at least one series of supports which are mutually spaced-apart across at least part of the width of the stack of interconnection modules.

4. A system or kit according to any preceding claim, in which each support comprises at least one elongate member which extends in a direction which is transverse, and preferably substantially perpendicular, to the width of the stack of interconnection modules.

5. A system or kit according to Claim 4, in which the elongate support members increase in length from one side to the other side of the stack of interconnection modules.

6. A system or kit according to any preceding claim, in which the or each stack of interconnection modules has a front and a back which are each transverse to its width, the front arranged to be readily accessible, and the back arranged to be less readily accessible, in use, and wherein the supports are mounted on a structural member of the system located at or near the back of the stack of interconnection modules.

7. A system or kit according to Claim 6 when dependent upon Claim 5, in which the elongate support members extend closer to the front of the stack of interconnection modules as their length increases from one side to the other side of the stack.

8. A system or kit according to any preceding claim, in which the or each optical fibre storage region comprises a module which may be included in a said stack of interconnection modules as and where required.

9. A system or kit according to Claim 8, in which the or each storage region module each has substantially the same size and shape as the, or at least one of the, interconnection modules.

10. A system or kit according to Claim 8 or Claim 9 when dependent upon Claim 6 or Claim 7, in which the structural member is part of the optical fibre storage region module.

11. A system or kit according to any one of claims 6 to 9, in which the structural member is a frame upon which the interconnection modules are mounted in use.

12. A system or kit according to any preceding claim, in which each support is shaped so that the radius of curvature of an optical fibre routed around it in use cannot be less than the normal operational minimum bend radius of the fibre.

13. A system or kit according to any preceding claim, in which the or each optical fibre storage region is arranged such that, in use, optical fibres are routed into it through at least one extreme end of its width.

14. A system or kit according to any preceding claim, in which the or each optical fibre storage region has at least one support located at the point of entry/exit of an optical fibre into the storage region, the support being arranged so that an optical fibre entering/exiting the storage region may be routed around it.

15. A system or kit according to any preceding claim, further comprising one or more optical fibres, spare lengths of which are stored in at least one said optical fibre storage region.

16. A system or kit according to any preceding claim, in which the or each said optical fibre comprises a ruggedized optical fibre or group of fibres, e.g. a pigtail, a patch cord or a jumper.

17. An optical fibre storage region module for an optical fibre distribution system, which module, in use, stores spare lengths of one or more optical fibres which are connected in the distribution system, the module comprising a plurality of supports which are mutually spaced-apart across at least part of the width thereof such that, in use, each spare length of optical fibre may be routed into the module and routed around at least one of the supports which may be selected to provide at least approximately the correct storage length required for that spare length of optical fibre.

18. A module according to Claim 17, in which said plurality of supports comprises at least one series of supports which are mutually spaced-apart across at least part of the width of the module.

19. A method of connecting an optical fibre and storing a spare length thereof in an optical fibre distribution system according to any preceding claim, comprising:

(a) connecting opposite ends of the optical fibre in respective interconnection modules;

(b) routing a said spare length of said connected optical fibre into the storage region;

(c) selecting at least one of the supports to provide at least approximately the correct storage length required for that spare length of optical fibre; and

(d) routing the spare length of optical fibre around the selected support(s).

20. A method according to Claim 19, in which the step of routing the spare length of optical fibre around the selected support(s) comprises hooking a bend in that optical fibre around the selected support(s).

Fig.1.

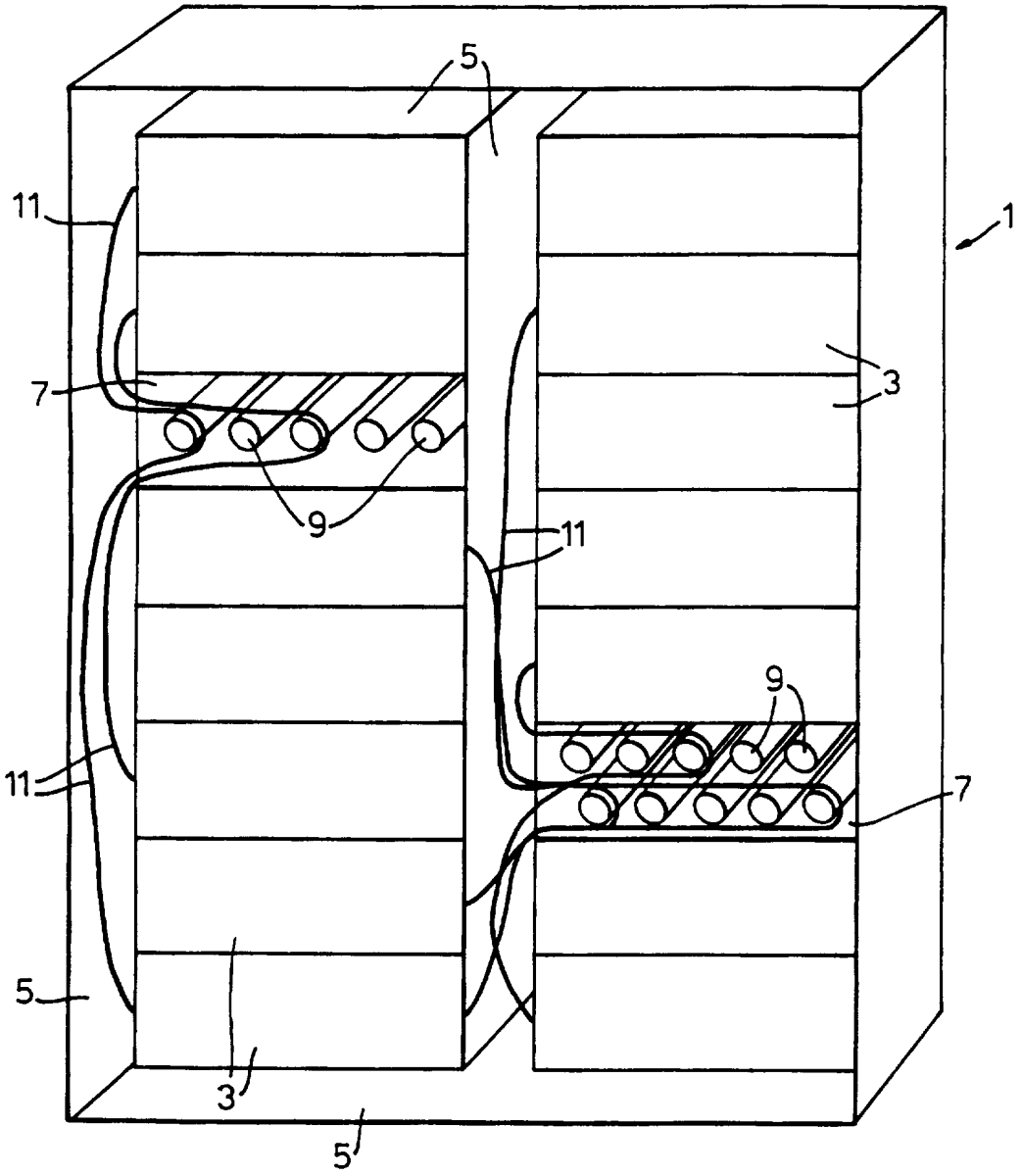


Fig.2.

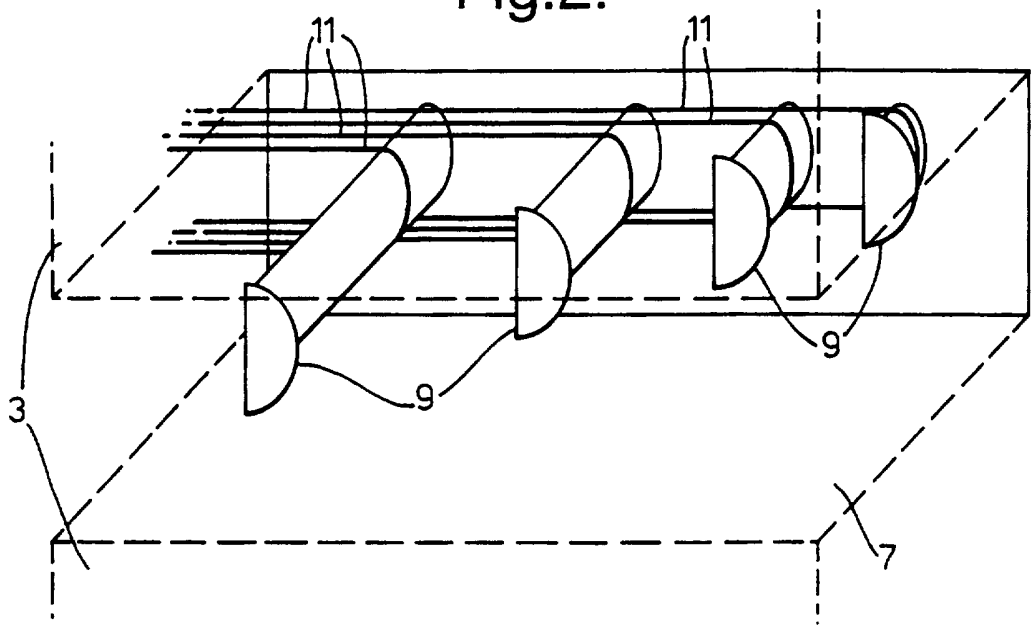


Fig.4.

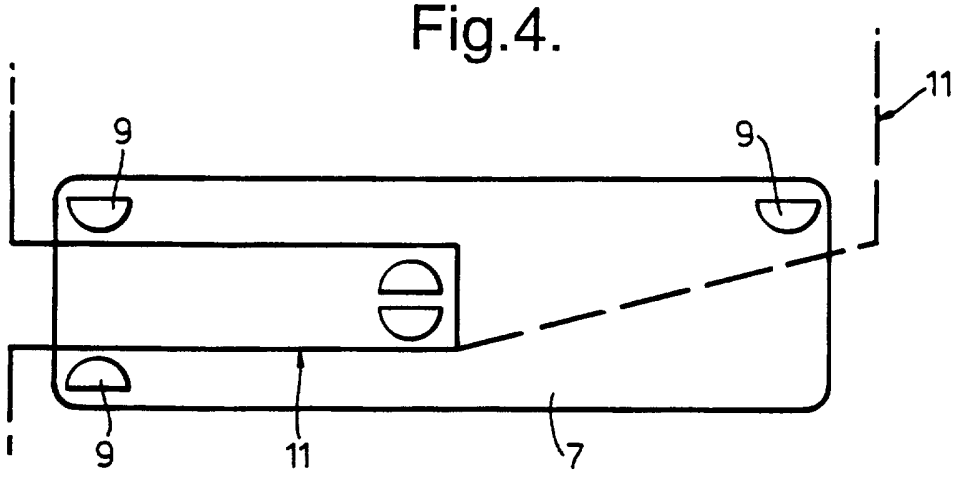
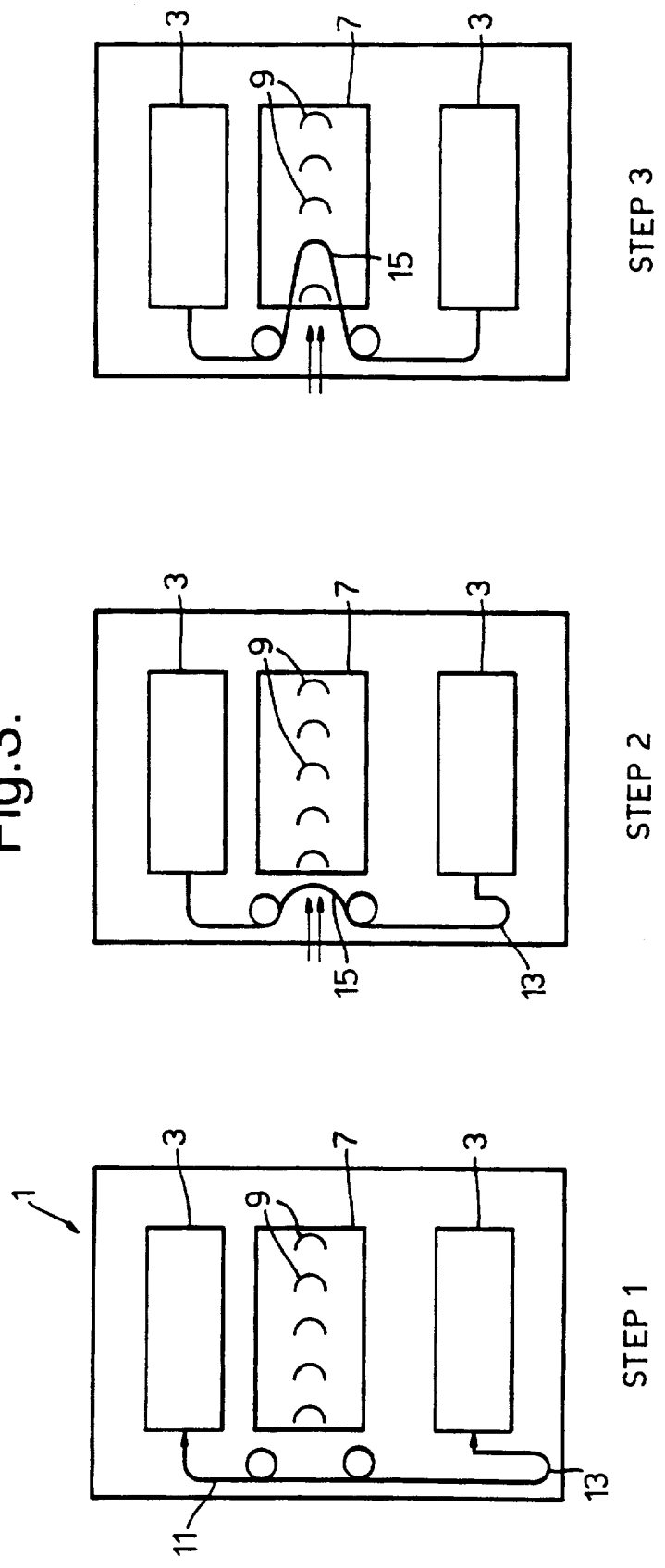


Fig.3.



INTERNATIONAL SEARCH REPORT

Inte tional Application No
PCT/GB 97/00394

A. CLASSIFICATION OF SUBJECT MATTER

G 02 B 6/46,G 02 B 6/44

According to International Patent Classification (IPC) or to both national classification and IPC6

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G 02 B

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.
X	FR, A, 2 678 076 (ALCATEL) 24 December 1992 (24.12.92), page 1, line 4 - page 2, line 16; page 3, line 19 - page 7, line 5.	1,2,8, 12,13, 15,17
Y		3,9, 11,18
A		6,19, 20
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Y	US, A, 5 339 379 (KUTSCH et al.) 16 August 1994 (16.08.94), column 2, line 50 - column 5, line 65.	3,9, 11,18
A		1,2, 6,12, 15-17,

[X] Further documents are listed in the continuation of box C.

[X] 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
22 April 1997	14.05.97

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	--	19,20
A	US, A, 5 013 121 (ANTON et al.) 07 May 1991 (07.05.91), column 2, line 35 - column 5, line 68 (cited in the application).	1,2,8, 17,19, 20
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A	US, A, 4 832 436 (GOTO et al.) 23 May 1989 (23.05.89), abstract; fig. 1-3.	1-3,6, 12,15, 17,19, 20

ANHANG

zum internationalen Recherchenbericht über die internationale Patentanmeldung Nr.

ANNEX

to the International Search Report to the International Patent Application No.

ANNEXE

au rapport de recherche international relatif à la demande de brevet international n°

PCT/GB 97/00394 SAE 152484

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