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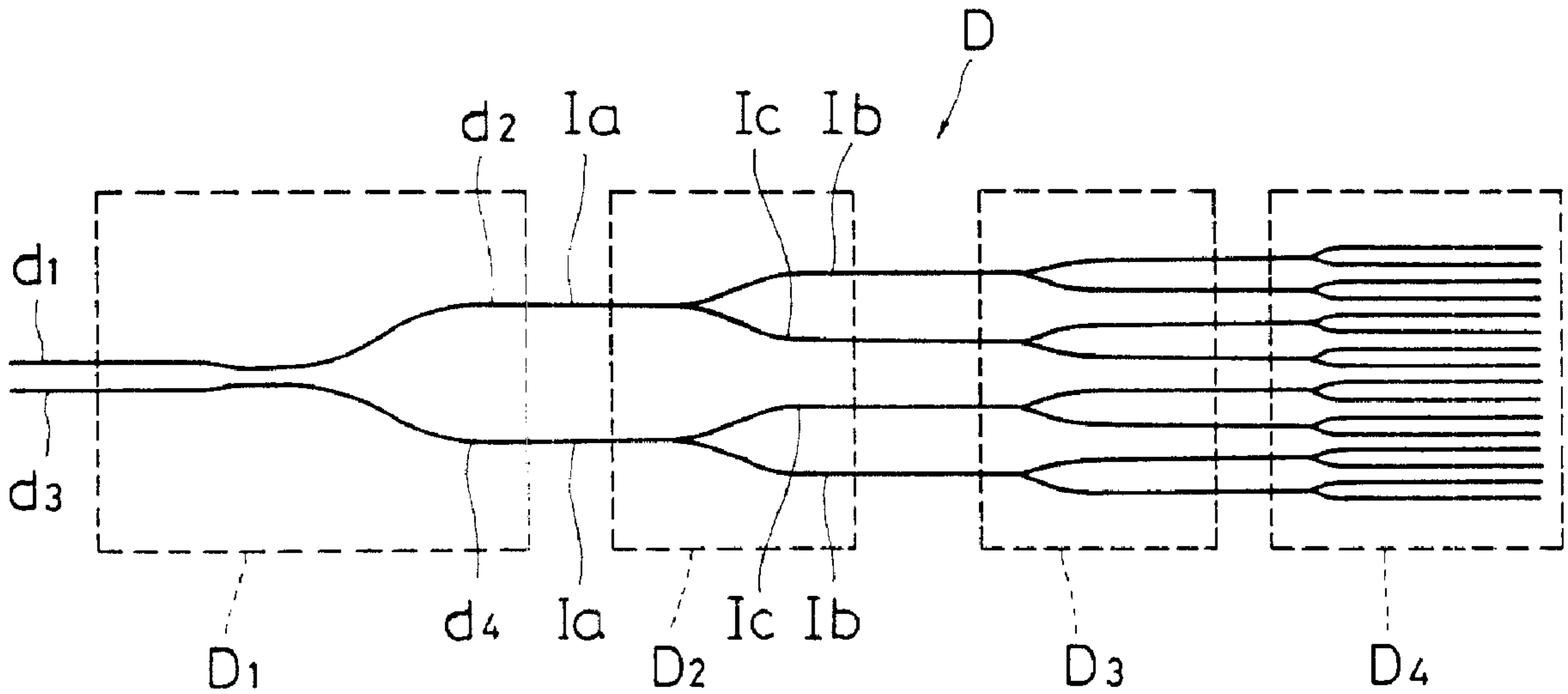
(54) Titre : COUPLEUR-REPARTITEUR A GUIDE DE LUMIERE
(54) Title: WAVEGUIDE-TYPE COUPLER/SPLITTER



(57) Abrégé/Abstract:
A 2-input/2-output directional coupler is arranged as an element coupler/splitter for a first stage, and 1-input/2-output coupler/splitters are used as element coupler/splitters for a second stage and its subsequent stages. Output ports of these element coupler/splitters are concatenated with input ports of other element coupler/splitters to form a 2-input/multi-output coupler/splitter. An optical signal can be inputted through one input port of the first-stage 2-input/2-output directional coupler, and an optical signal for optical line monitoring can be inputted through the other input port. It is unnecessary, therefore, to use an optical wavelength division multiplexer/demultiplexer or other optical part which conventionally is connected at the time of optical line monitoring.

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ABSTRACT OF THE DISCLOSURE

A 2-input/2-output directional coupler is arranged as an element coupler/splitter for a first stage, and 1-input/2-output coupler/splitters are used as element coupler/splitters for a second stage and its subsequent stages. Output ports of these element coupler/splitters are concatenated with input ports of other element coupler/splitters to form a 2-input/multi-output coupler/splitter.

An optical signal can be inputted through one input port of the first-stage 2-input/2-output directional coupler, and an optical signal for optical line monitoring can be inputted through the other input port. It is unnecessary, therefore, to use an optical wavelength division multiplexer/demultiplexer or other optical part which conventionally is connected at the time of optical line monitoring.

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TITLE OF THE INVENTION
WAVEGUIDE-TYPE COUPLER/SPLITTER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to waveguide-type coupler/splitters effectively used in an optical fiber communication system and optical sensor system, and more particularly, to waveguide-type coupler/splitters which need not be connected with any other optical parts, such as an optical wavelength division multiplexer/demultiplexer, at the time of optical line monitoring in these systems.

Description of the Prior Art

In an optical fiber communication system, such as the one shown in Fig. 1, a signal transmitted from one parent station 1 is divided into N number of signals by means of a 1-input/N-output waveguide-type coupler/splitter 2, and the individual signals are distributed to N number of child stations 4_1, 4_2, $\cdots$ 4_N by means of N number of fiber lines 3_1, 3_2, $\cdots$ 3_N, respectively.

Referring now to Figs. 2 to 7, 1-input/16-output versions of the coupler/splitter 2 adapted to be used in this system will be described by way of example.

A coupler/splitter A of the type shown in Fig. 2 uses, as each of its element coupler/splitters, a 1-input/2-output Y-branch waveguide I in which two output ports I_b and I_c are continuous with an input port I_a, as shown in Fig. 3. The input and output ports I_a, I_b and I_c of these individual element coupler/splitters are concatenated to one another in four stages in a tournament-list style.

A coupler/splitter B of the type shown in Fig. 4 uses, as each of its element coupler/splitters, a 1-input/2-output directional connector II formed of a 1-input/2-output Y-branch waveguide and having a junction II_d at which one of two waveguides is continuous and the other is discontinuous, as shown in Fig. 5. Input and output ports II_a, II_b and II_c of these individual element coupler/splitters are concatenated to one another in four stages.

A coupler/splitter C of the type shown in Fig. 6 uses, as each of its element coupler/splitters, a 1-input/2-output directional coupler III formed of a 1-input/3-output Y-branch waveguide and having a junction III_d at which two waveguides are discontinuous with another waveguide, as shown in Fig. 7. Input and output ports III_a, III_b and III_c of these individual element coupler/splitters are concatenated to one another in four stages.

In monitoring the optical fiber lines 3_1, 3_2, · · · 3_N without interrupting communication between the parent station and the child stations 4_1, 4_2, · · · 4_N, in the optical communication system shown in Fig. 1, it is necessary to connect an optical line monitoring device (e.g., OTDR) 5, which uses light with a monitoring wavelength λ_2 different from a communication wavelength λ_1, as shown in Fig. 8, to the arrowed spot (Fig. 1) of an optical path connecting the parent station 1 and the 1-input/N-output coupler/splitter 2, through an optical wavelength division multiplexer/demultiplexer 6 for synthesizing and dividing light waves with the wavelengths λ_1 and λ_2.

Thus, when using the 1-input/N-output coupler/splitter 2 composed of the concatenated 1-input/2-output element coupler/splitters I, II or III of the conventional configuration described above, the interposition of another optical part, such as the optical wavelength division mulitiplexer/demultiplexer ($\lambda_1 \neq \lambda_2$) or an optical coupler ($\lambda_1 = \lambda_2$), is required in connecting the optical line monitoring device 5 between the coupler/splitter 2 and the parent station 1.

OBJECT AND SUMMARY OF THE INVENTION

The object of the present invention is to provide a waveguide-type coupler/splitter capable of optical line monitoring without the interposition of any other optical part, such as an optical wavelength division multiplexer/demultiplexer or optical coupler.

In order to achieve the above object, according to the present invention, there is provided a waveguide-type coupler/splitter comprising: a plurality of element coupler/splitters concatenated to one another, input ports of said individual element coupler/splitters being connected to output ports of other element coupler/splitters, said element coupler/splitter in a first stage being a 2-input/2-output coupler/splitter, wherein said element coupler/splitter in the first stage has a branch coupling ratio which is wavelength-independent for light having a wavelength falling within a predetermined range, and each of said element coupler/splitters in a second stage and in subsequent stages being a 1-input/2-output coupler/splitter.

In the coupler/splitter of the present invention, the first-stage element coupler/splitter is a 2-input/2-output coupler/splitter, and therefore, the input ports thereof can be used separately, one for communication and the other for optical line monitoring. Alternatively, the two input ports may be used individually as a running version and as a stand-by (spare).

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing an example of an optical fiber communication system;

Fig. 2 is a schematic view showing an example of a conventional waveguide-type coupler/splitter;

Fig. 3 is a schematic view showing a 1-input/2-output element coupler/splitter of the Y-branch waveguide type used in the coupler/splitter of Fig. 2;

Fig. 4 is a schematic view showing another example of the conventional waveguide-type coupler/splitter;

Fig. 5 is a schematic view showing a 1-input/2-output element coupler/splitter of the directional connector type used in the coupler/splitter of Fig. 4;

Fig. 6 is a schematic view showing still another example of the conventional waveguide-type coupler/splitter;

Fig. 7 is a schematic view showing a 1-input/2-output element coupler/splitter of the directional connector type used in the coupler/splitter of Fig. 6;

Fig. 8 is a schematic view showing an optical part interposed for optical line monitoring in the optical communication system of Fig. 1;

Fig. 9 is a schematic view showing a 2-input/16-output waveguide-type coupler/splitter according to the present invention; and

Fig. 10 is a schematic view showing a 2-input/2-output element coupler/splitter of the directional connector type arranged in a first stage of the coupler/splitter of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 9 is a schematic view showing a 2-input/16-output coupler/splitter. In this coupler/splitter D, a first-stage element coupler/splitter D_1 is a 2-input/2-output coupler/splitter, as shown in Fig. 10. The input port I_a of the Y-branch waveguide I shown in Fig. 3 is concatenated to each of output ports d_2 and d_4 of the coupler/splitter D_1, thus forming a second-stage element coupler/splitter group D_2 having four output ports. Further, the input port I_a of the Y-branch waveguide I is concatenated to each of the output ports I_b and I_c of each group-D_2 Y-branch waveguide, thus forming a third-stage element coupler/splitter group D_3 having eight output ports. Likewise, the input port I_a of the Y-branch waveguide I is concatenated to each of the output ports I_b and I_c of each group-group D_3 Y-branch waveguide, thus forming a fourth-stage element coupler/splitter group D_4 having sixteen output ports.

After the formation of the group D_4, additional Y-branch waveguides are successively concatenated in the same manner as aforesaid. If the 1-input/2-output element coupler/splitters are connected in (n - 1) stages in all, the resulting coupler/splitter becomes a 2-input/2^n-output coupler/splitter.

The element coupler/splitters concatenated in the second stage and its subsequent stages are not limited to the Y-branch waveguide I shown in Fig. 3, and may be of the type II shown in Fig. 5 or the type III shown in Fig. 7 or suitable combinations of these types I, II and III.

In the waveguide-type coupler/splitter according to the present invention, the coupler/splitter D_1 as an element coupler/splitter in the first stage is arranged so that a signal with a communication wavelength λ_1 is inputted through the one input port d_1 (or d_2), while a light beam for optical line monitoring with a monitoring wavelength λ_2 is inputted through the other input port d_2 (or d_1).

Preferably, the coupler/splitter D_1 should be one whose branch coupling ratio for light having a wavelength intermediate between the communication wavelength λ_1 and the monitoring wavelength λ_2 is wavelength-independent, that is, a coupler/splitter which is wavelength-flattened between the communication and monitoring wavelengths.

As an example of the coupler/splitter of this type, there is an asymmetric Mach-Zehnder interferometer-type optical waveguide coupler with wavelength insensitive coupling ratio by KANAME JINGUJI, et al "Integrated Photonics Research" 1990 Technical Digest Series Volume 5 Conference Edition March 26 to 28 1990, Hilton Head, North Carolina (WINC) Topical Meeting on Integrated Photonic Research.

Preferably, the coupler/splitter D_1 is arranged so that a slit is cut in the one input port d_1, for example, and a filter which transmits light with the communication wavelength λ_1 and reflects light with the monitoring wavelength λ_2 is housed in the slit, and at the same time, another slit is cut in the other input ports d_2, and a filter which reflects light with the communication wavelength λ_1 and transmits light with the monitoring wavelength λ_2.

Thus, according to the present waveguide-type coupler/splitter, the element coupler/splitters used are equal in number to the ones used in the conventional coupler/splitter. Since the first-stage element coupler/splitter is a 2-input/2-output coupler/splitter, however, one of its input ports can be used for optical line monitoring, so that it is unnecessary to use an exclusive optical part for optical line monitoring which conventionally is essential.

CLAIMS:

1. A waveguide-type coupler/splitter comprising:

a plurality of element coupler/splitters concatenated to one another, input ports of said individual element coupler/splitters being connected to output ports of other element coupler/splitters,

said element coupler/splitter in a first stage being a 2-input/2-output coupler/splitter, wherein said element coupler/splitter in the first stage has a branch coupling ratio which is wavelength-independent for light having a wavelength falling within a predetermined range, and

each of said element coupler/splitters in a second stage and in subsequent stages being a 1-input/2-output coupler/splitter.

2. A waveguide-type coupler/splitter according to claim 1, wherein said first-stage element coupler/splitter has a first slit cut in one of the input ports thereof, a filter housed in the first slit for transmitting light with a communication wavelength and reflecting light with a monitoring wavelength, a second slit cut in the other input port thereof and a filter housed in the second slit for reflecting light with the communication wavelength and transmitting light with the monitoring wavelength.

3. A waveguide-type coupler/splitter according to claim 1, wherein each of said element coupler/splitters in the second stage and the subsequent stages is a Y-branch waveguide.

4. A waveguide-type coupler/splitter according to claim 1, wherein each of said element coupler/splitters in the second

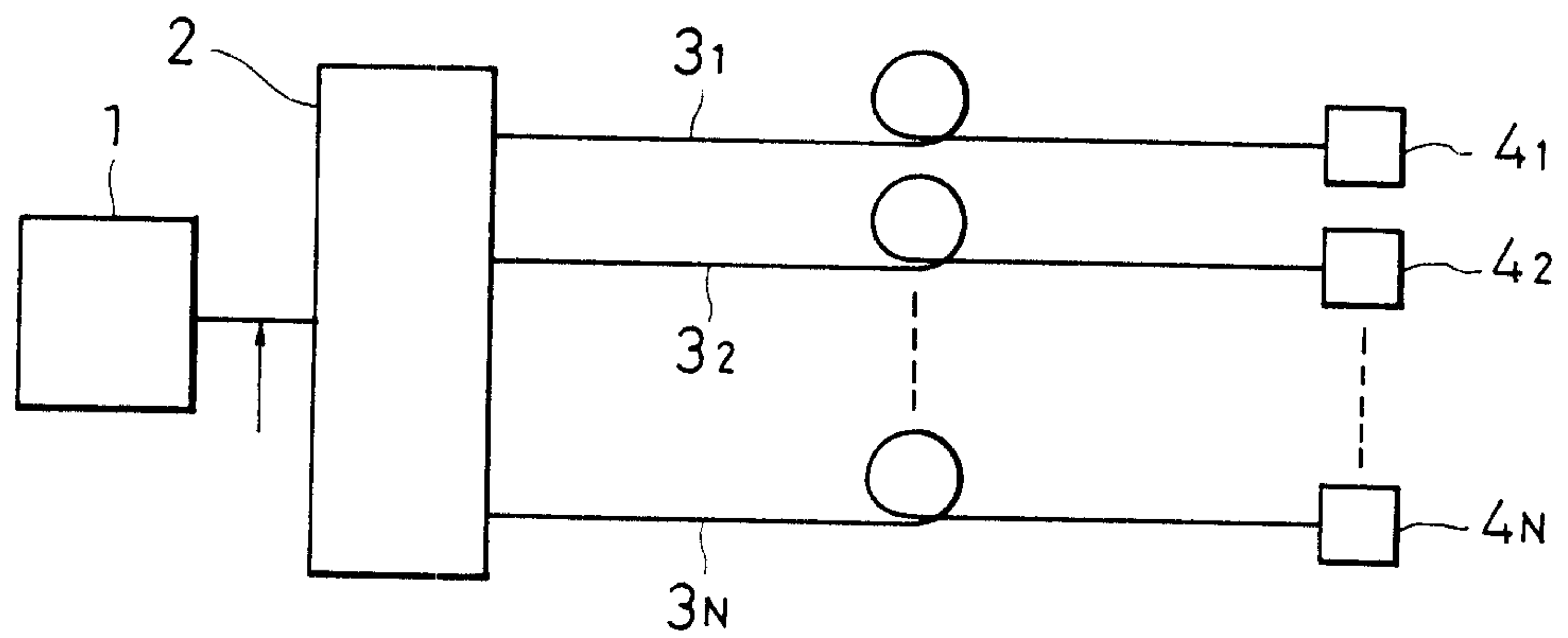
stage and the subsequent stages is a 1-input/2-output directional coupler having a junction at which two waveguides for output are discontinuous with one waveguide for input.

SMART & BIGGAR

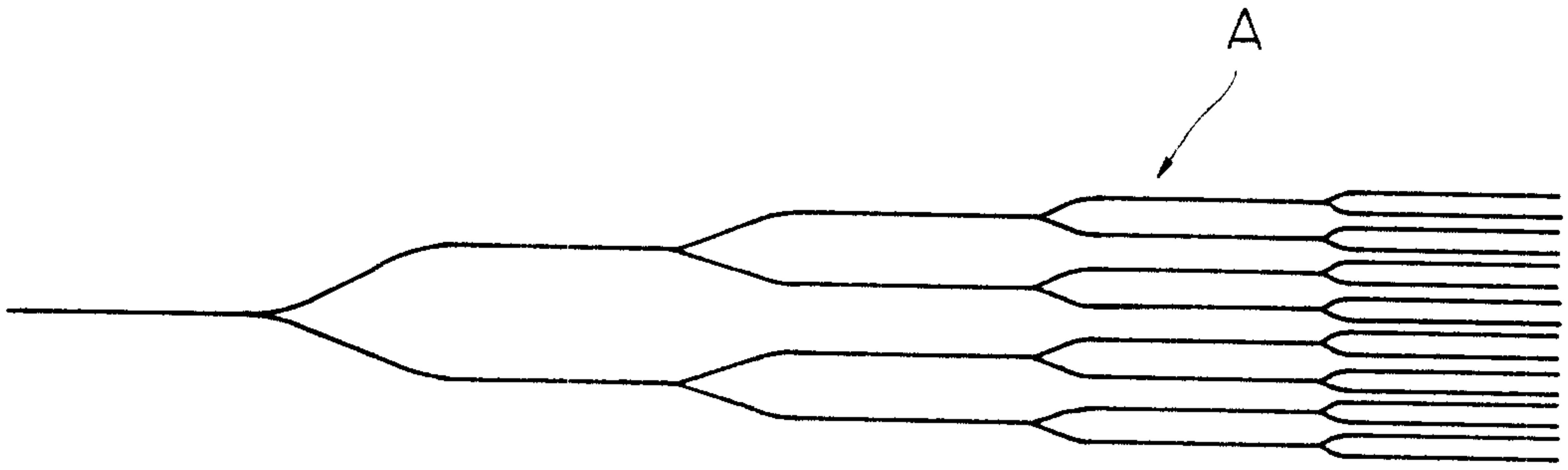
PATENT AGENTS

OTTAWA, CANADA

F I G. 1 PRIOR ART



F I G. 2 PRIOR ART



F I G. 3 PRIOR ART

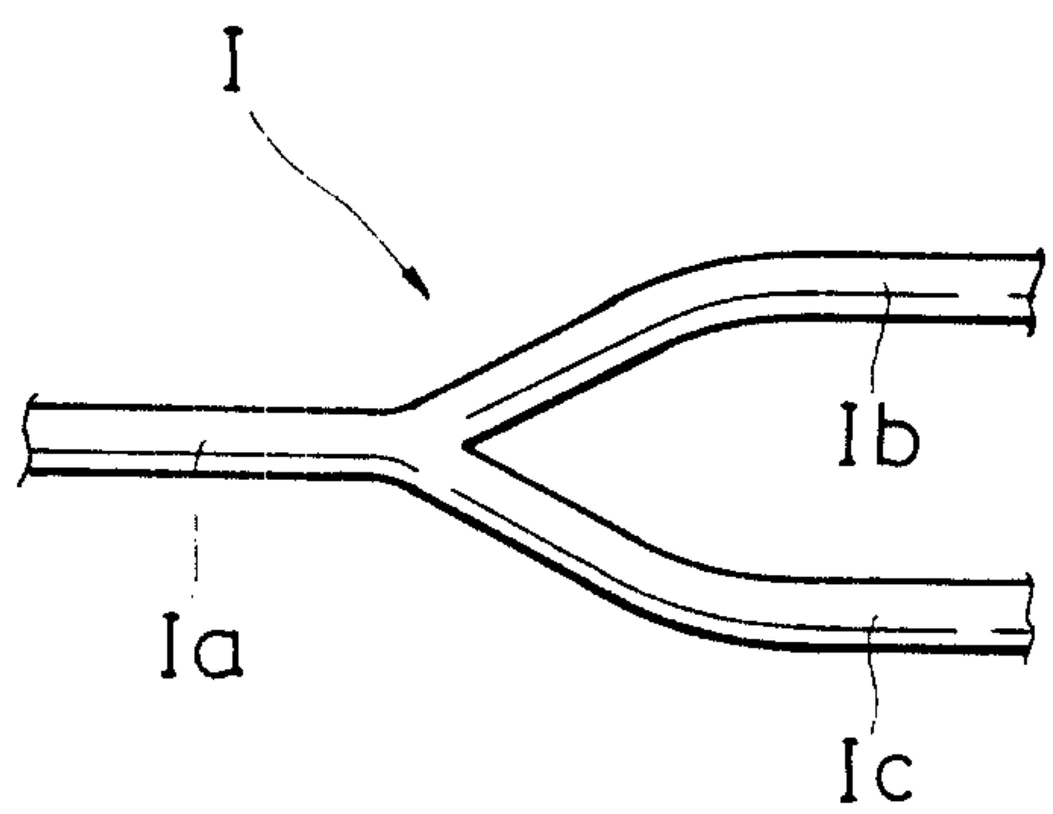


FIG. 4 PRIOR ART

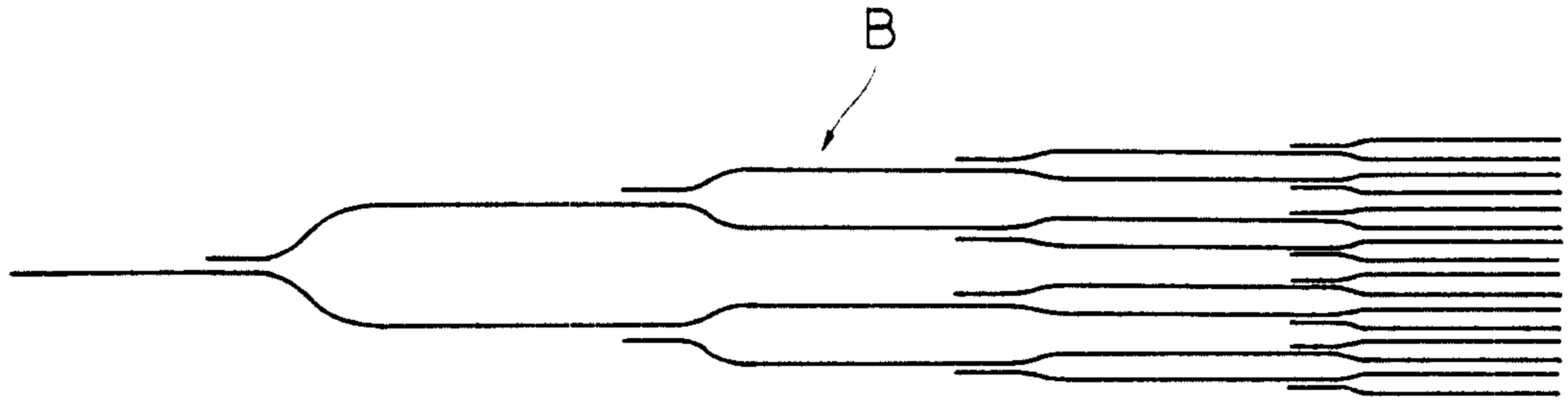


FIG. 5 PRIOR ART

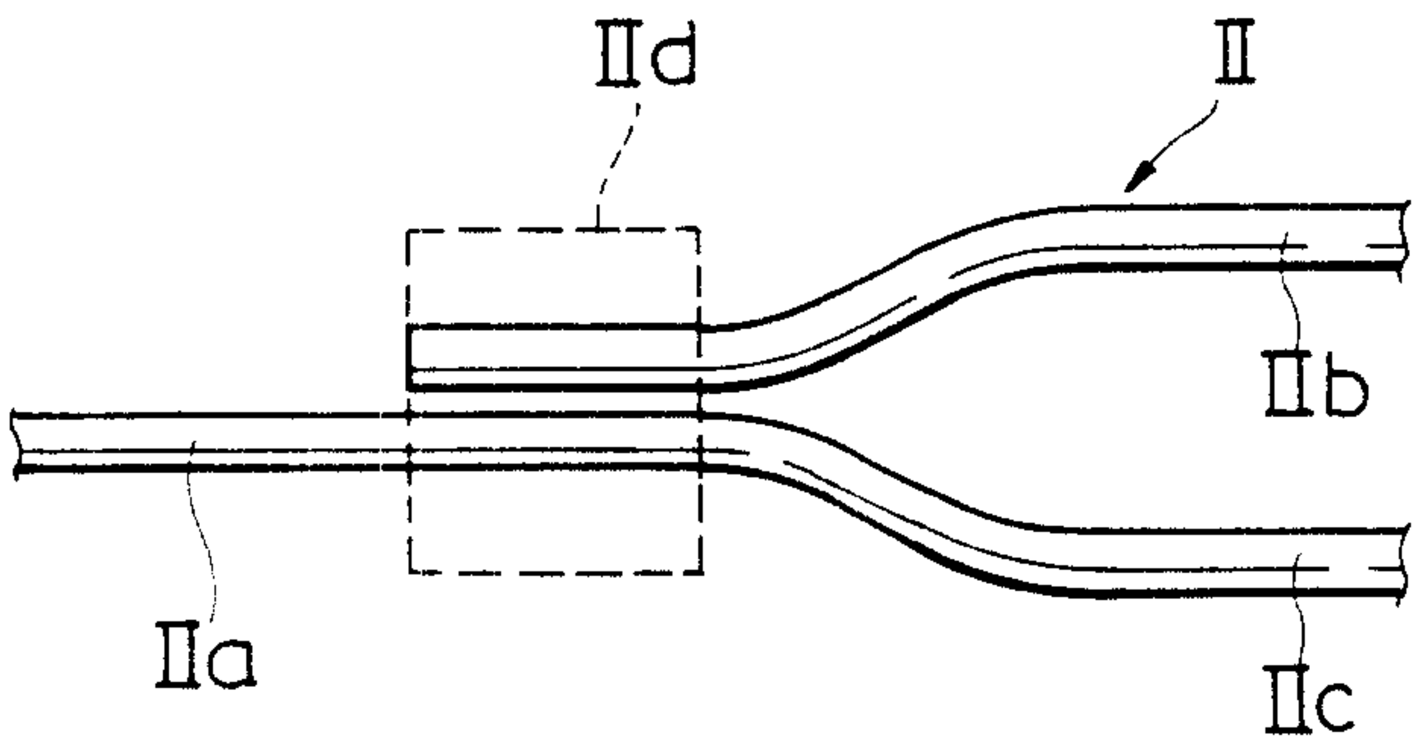


FIG. 6 PRIOR ART

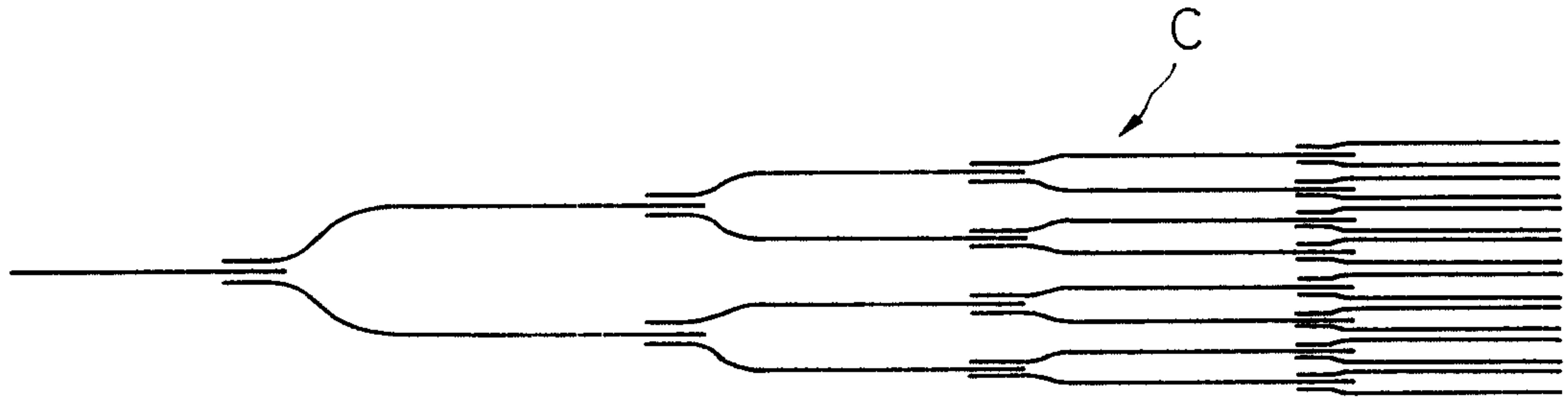


FIG. 7 PRIOR ART

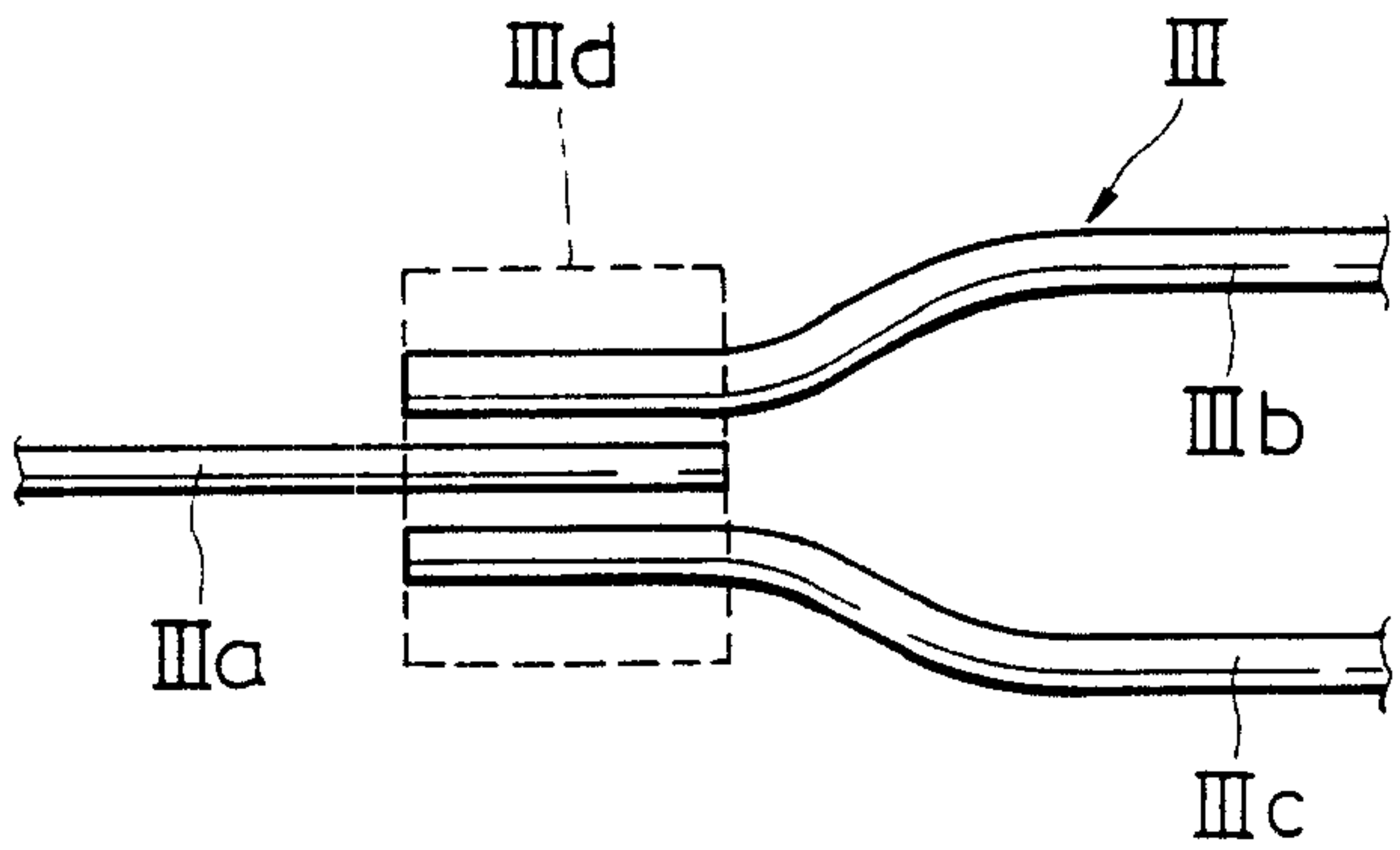


FIG. 8 PRIOR ART

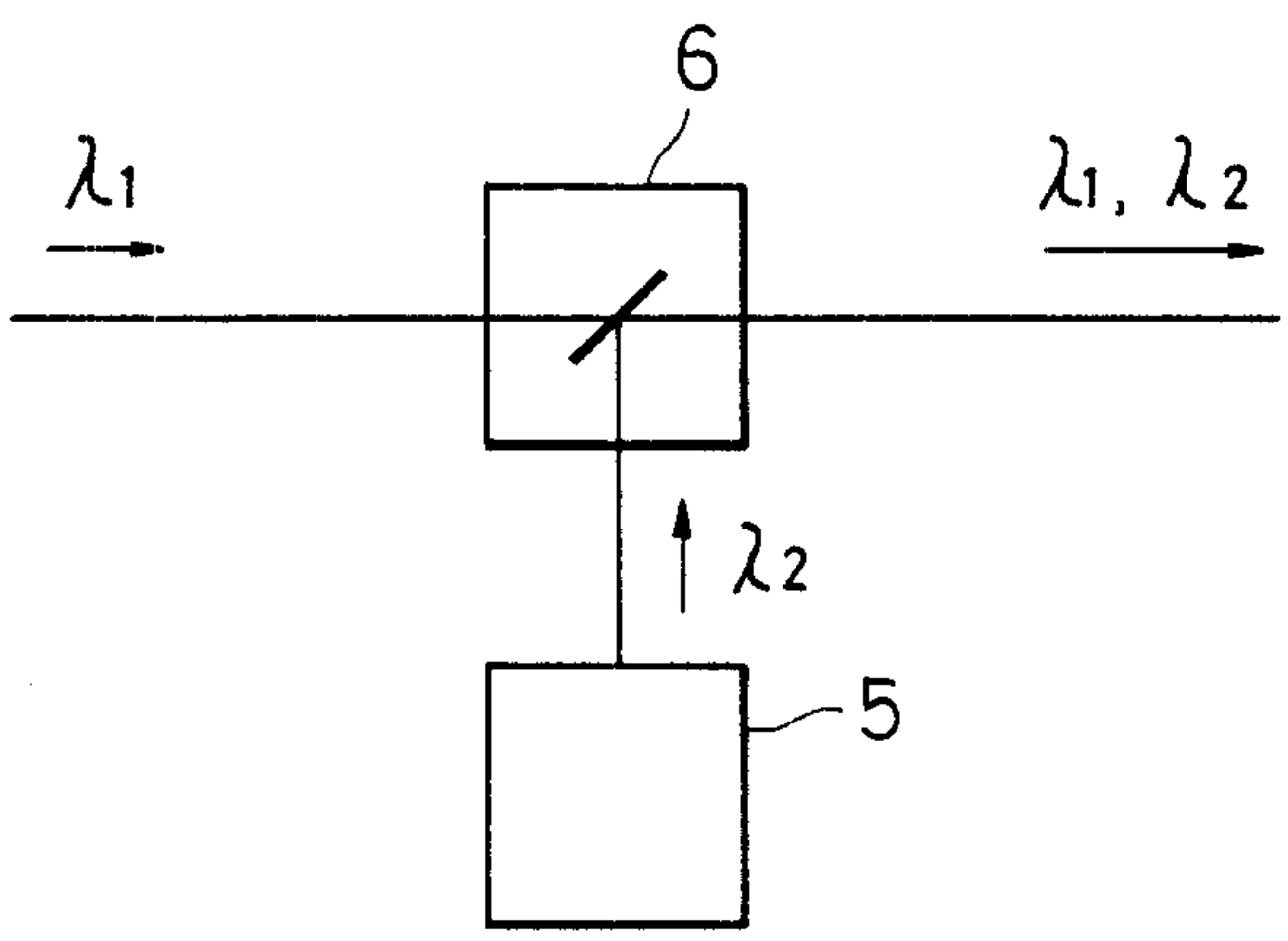


FIG. 9

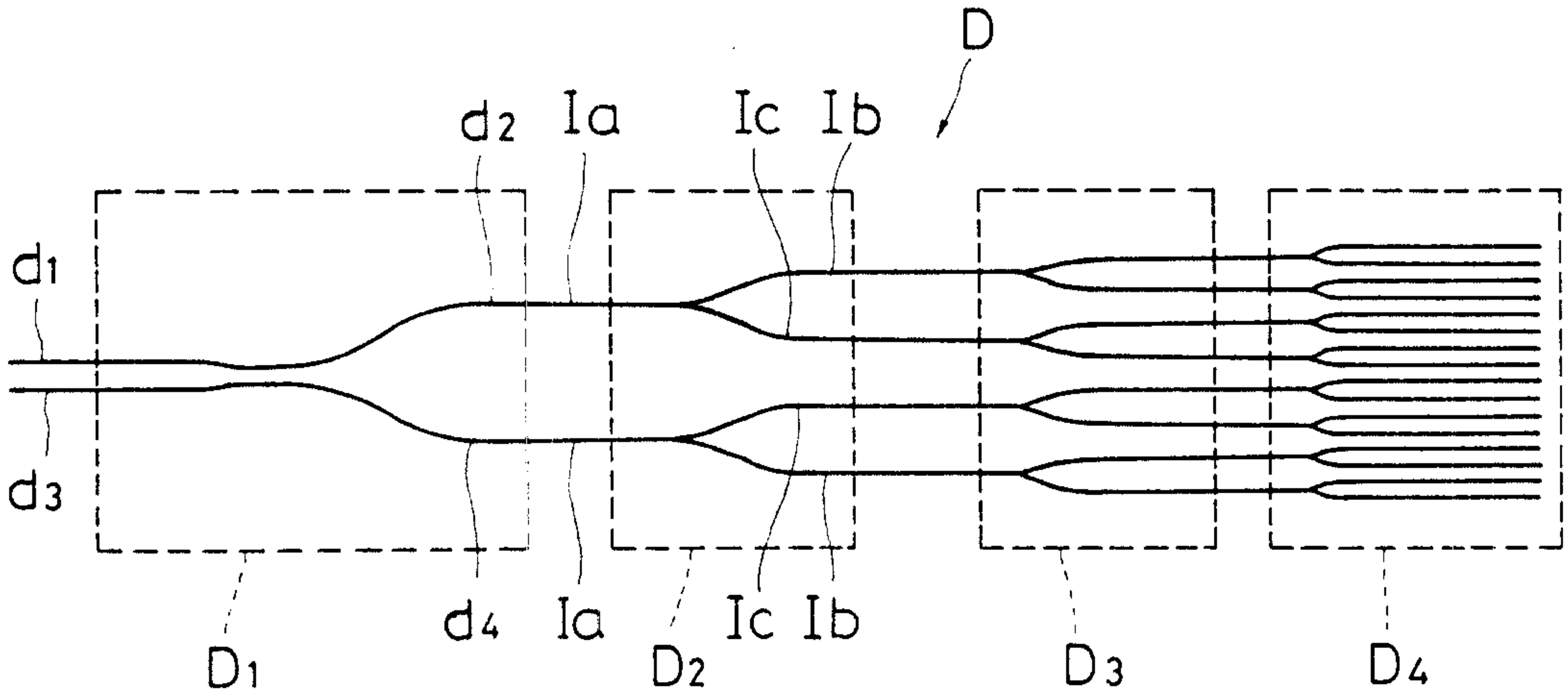
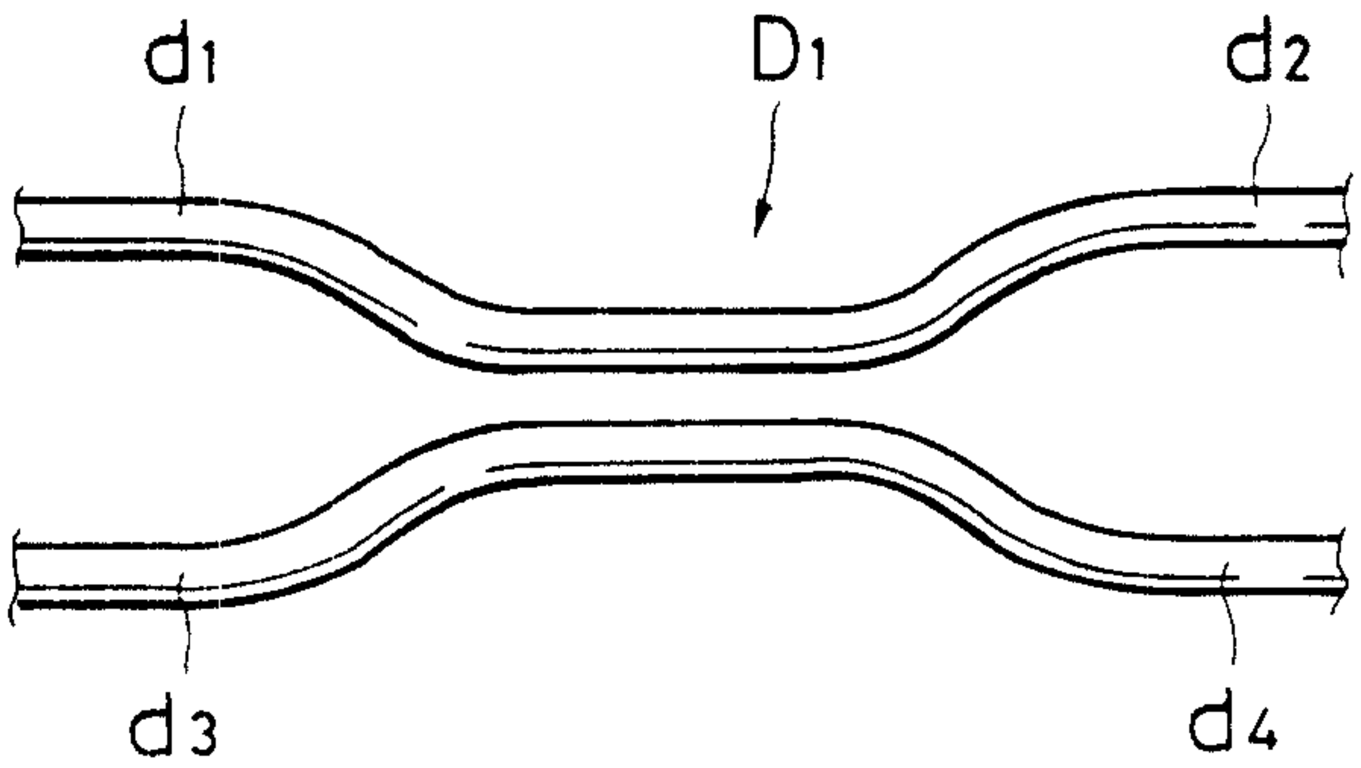
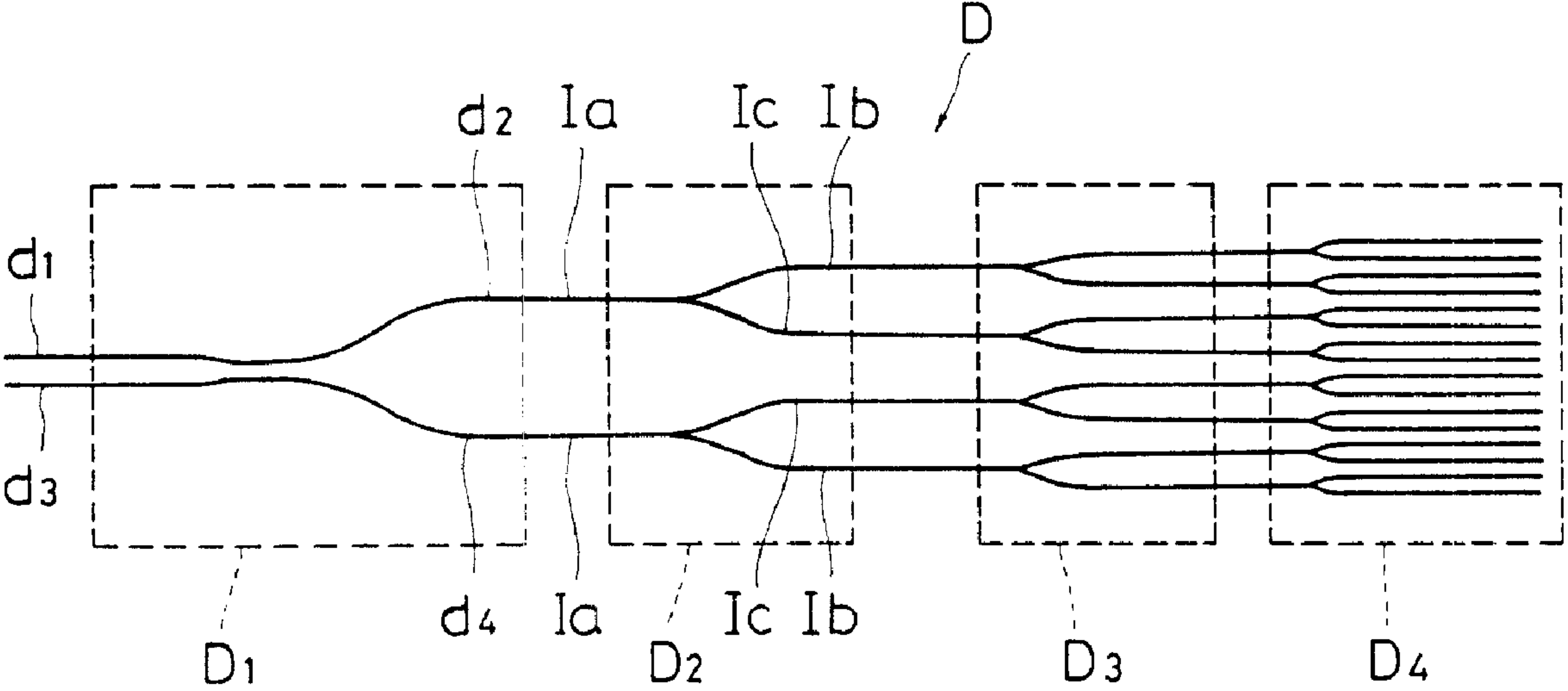


FIG. 10

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