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(54) **PROCEDURE FOR CONTROLLING A RADIATION SOURCE AND CONTROLLABLE RADIATION SOURCE.**

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Description

The present invention relates to a method for controlling a radiation source which comprises a plurality of light-emitting diodes (LEDs); the method comprising a step of selectively driving one of said LEDs for producing output radiation within a selected wavelength range which is associated with the selected one of said LEDs.

The present invention also relates to a controllable radiation source for producing output radiation within a selected wavelength range, comprising: a plurality of light-emitting diodes (LEDs); an output slit or equivalent; an optical dispersing element arranged in an optical path between said plurality of light-emitting diodes and said output slit, the optical dispersing element being adapted for receiving radiation and refracting the received radiation in a direction dependent on the wavelength of the received radiation; and a driver and control means for selectively driving one of said LEDs.

A radiation source of the kind described is used for instance in spectrometers and photometers. In frequent cases the radiation source is the most significant factor limiting the capacity of performance and usability of an instrument. In apparatus meant to be used in industrial conditions, as radiation source have usually been employed thermal radiators, such as sources based on an incandescent filament, for instance. Their problem is, however, poor optical efficiency and consequent high heat dissipation, as well as poor vibration tolerance, short service, life and difficulty of modulation.

In recent years the development of semiconductor technology has introduced on the market efficient lasers based on semiconductor junctions, and light-emitting diodes, or LEDs. They afford several advantages over traditional radiation sources: for instance, small size and low energy consumption, good reliability, long service life (even more than 10^8 hours), high operating speed, easy connection to optic fibres. Furthermore, they can be electrically modulated with ease. Semiconductor radiation sources are nowadays available for the wavelength range about 400 nm to over 10 μm; admittedly, though, for operation at room temperature only up to about 3200 nm. The said range is usable in quantitative and qualitative analysis of most substances.

Semiconductor lasers are nearly ideal radiation sources for spectrometers in view of their narrow spectrum. However, high price and poor stability are their problems. It is also a fact that the selection of standard wavelengths is scanty, particularly in the near IR range. LEDs enable, owing to their wider radiation spectrum, a considerably wider wavelength range to be covered, and they are also lower in price. The spectral radiance of LEDs is on the same order as that of most thermic radiation sources, or higher.

The radiations spectrum of LEDs is mostly too wide to allow them to be used as such in spectroscopic measurements. Moreover, the shape of the radiation spectrum, the peak wavelength and the radiant power change powerfully with changing temperature and driving current, and with time.

In spectrometer designs of prior art based on the use of LED sources, the measuring band is separated from the LEDs, usually, with the aid of separate filters, or the LED is used without filtering, in which case the resolution will also be poor. The variation of radiation intensity has most often been compensated for, either by mere electric compensation or by maintaining constant temperature of the LED, which has lead to a demanding and expensive mechanical design.Owing to the high price and difficult manipulation of the filters (e.g. miniaturizing, cutting), the number of wavelength bands in such pieces of apparatus is usually small (2 to 10).

A method as described in the preamble of claim 1 and a radiation source as described in the preamble of claim 3 are disclosed in European patent application 0 110 201. This prior apparatus, however, comprises quasi-monochromatic radiation elements which must be carefully positioned along a Rowland circle. Each of said quasi-monochromatic radiation elements produces radiation in only one of the selectable wavelength ranges, so that all the radiation elements must be different from each other.

A further drawback of this prior apparatus is that it needs a rather complex configuration wherein the whole of said radiation elements is moved along said Rowland circle and/or the optical dispersing element is rotated.

The object of the present invention is to eliminate, among others, the drawbacks inventioned above and to provide a novel procedure for controlling a radiation source, and a controllable radiation source. This is realized with the aid of the characteristic features of the invention stated un the claims hereto attached.

With the aid of the invention following advantages are gained, among others. On the basis of the procedure of the invention a controllable radiation source can be realized which is simple as to its construction and contains no moving parts. Furthermore, the radiation source can be realized in a design with small external dimensions. Good wavelength resolution can be achieved in spite of small size. The wavelength resolution is determined, in the first place, be the size of the LED elements (typically only 300 μm by 300 μm) and by the angular dispersion and dimensions of the optics which disperse the radiation into a spectrum. The number of measuring channels in the spectrometer in which the procedure of the invention is applied may with ease be increased to be several dozen. The amount of required electronic control and driver apparatus is not necessarily dependent on the number of LEDs. According to the procedure, the intensity of the wavelength bands is also stabilized. The changes of the spectrum of the LEDs and of the total radiant power will then have no influence and the output intensity of the radiation source. According to the procedure, the wavelengths of the radiation source may be electrically selected. The modulation frequency can be made very high if required (e.g. less than 1 µs per LED).It is possible in connection with the controllable radiation source of the invention to use for detector a single-channel radiometer, in which advantageously one single detector element is used. The procedure, and the radiation source applying it, can be used in the visible light and IR radiation ranges.

The invention may be applied in the transmitter part of the spectrometer. In certain applications it is also possible to integrate the whole spectrometer to be one single component, which may be hermetically encapsulated. A reliable and stable spectrometer, and one which is usable in field work, is obtained with the aid of such integration.

Significant advantages are gainable with the aid of the procedure of the invention, and of the radiation source employing it, in reflection or transmission measurements on diffuse objects, compared with the multiple detector technique, which has become commonly used in recent years. In multiple element spectrometers the diffuse radiation has to be collected on small-sized detector elements through a narrow entrance slit, whereby high optical collection losses are incurred. In the controllable radiation source of the invention, the optical collection losses can be minimized by using for detector the single-channel radiometer mentioned above, which has a large-sized detector element and, at the same time, also a wide collection angle.

The invention is described in detail in the following with the aid of the attached drawings, wherein:-

Fig. 1 presents schematically a spectrometer in which the invention is applied;

Fig. 2 presents by way of example the radiation spectrum of a LED and the radiation spectrum achievable with the aid of the invention;

Fig. 3 presents in the form of a block diagram a LED row and its driver and control means;

Fig. 4 presents a radiation source according to the invention in which an optic fibre is utilized; and

Fig. 5 presents schematically a reflection spectrometer in which the invention is applied,

Fig. 6 presents a radiation source row, Fig. 6B, by which a LED row, Fig. 6A, may be replaced.

In the procedure of the invention the radiation source is realized with a LED array composed of semiconductor chips, or LED elements, or equivalent. From the radiation of the LED elements a wavelength range depending on the location of the LED element in said array is separated with an optical means dispersing radiation to a spectrum, and the intensity of this wavelength range, or output radiation, is controlled or maintained constant by observing its intensity and with its aid regulating the current passing through the respective LED element. The desired wavelength range may then be selected electrically by activating the respective element in the LED array.

In the spectrometer of Fig. 1 the procedure of the invention is applied. The radiation source 1 of the spectrometer has been composed of light-emitting diodes, or LEDs. Specifically, the radiation source 1 consists of a row of LEDs 2 which comprises a plurality of side-by-side LED semiconductor chips, or LED elements 21, 22, 23, ..., 26, which are all similar. The radiation source further comprises optical means for separating the desired wavelength range from the radiation produced by the LEDs, and means for maintaining the intensity of the radiation in the wavelength range constant or on desired level. Said optical means consist of optical pieces of equipment, such as lenses, mirrors, gratings, slits and beam dividers, the radiation produced by the LEDs being collected and dispersed to a spectrum with the aid of said means, and the radiation of the desired wavelength range being directed on an output slit or equivalent. The optical means in the spectrometer of Fig. 1 include a radiation-collecting lens 3, a reflecting grating 5 dispersing the radiation to a spectrum, and a stop 6 presenting an output slit 6. It is equally possible to use for radiation-collecting component e.g. a concave mirror, and in place of the reflection grating one may use a transmission grating or a prism. These components may also be combined by using, for instance, a focussing reflector or transmission grating.

The controllable radiation source 1 of the invention further comprises optical means and a detector 7 for observing and/or measuring the intensity of the outgoing radiation. The optical means employed in the spectrometer of Fig. 1 consist of a beam divider 8. The radiation source also comprises a driver and control means 9, to which the detector 7 has been connected. The driver and control means 9 is connected to the LED row 2, to each of its elements 21, 22, ..., 26. With the aid of the driver and control means 9, the desired LED element is selected. Thus from the radiation produced by each LED element the desired wavelength range is directed on the output slit, this wavelength range depending on the location of the LED element 21, 22, ..., 26. From the radiation going out from the radiation source, part is separated with the aid of the optical means to go to the detector 7, the current flowing through the respective LED element and producing the radiation in question being regulated in accordance with the intensity data supplied by the detector and in such manner that the radiation intensity of that wavelength range, and thus the intensity of the output radiation, is constant.

Also other optical means may further be attached to the radiation source 1. In Fig. 1, the output radiation passing through the exit slit 6 is rendered parallel with a lens 10, whereafter it is directed on the object of measurement, 11. After the object of measurement, in the direction of propagation of the radiation, follows a receiver 12, in which capacity in measurements made on diffuse objects advantageously serves a wide-area radiometer. The electric signal from the receiver 12 is amplified in an amplifier 13 and fed to a calculation unit 14, and it is possibly displayed on a display provided in conjunction therewith. With the calculating unit 14, or by controls on a panel provided in conjunction therewith, the driver and control unit 9 of the radiation source 1 may possibly also be controlled.

For reflection and/or transmission measurements, it is advantageous to devise at least the radiation source 1 to be an integral unit. It can be suitably shielded against ambience, for instance enclosed in a hermetically sealed housing, for improved reliability.

The circuitry of the driver and control means 9 is presented in block diagram form in Fig. 3. The LED elements 21, 22, ..., 2(N-1), 2N (N = an integer 1, 2, 3, ...) has been connected over a current control circuit 15 to a voltage source 30. The LED elements are connected to a selector means 16, such as a decoder, and this is connected to the calculating unit 14. The desired LED element, for instance the element 23, and the desired wavelength range of the output radiation from the radiation source are selected with the aid of the selector means 16. Part of the radiation obtained from the LED elements is picked up with the aid of the optical means 8 and carried to the detector 7. The detector 7 is connected with the controller 9a. The current control circuit 15 is governed by the controller 9a with the aid of the signal from the detector 7, in such manner that the output signal of the detector has constantly the desired magnitude, whereby the intensity of the output radiation also maintains the desired level.

Fig. 2 illustrates the spectrum of the output radiation obtained by the procedure of the invention. In the rectangular coordinates, the ordinates represent the radiation intensity I and the abscissae, the wavelength The radiation spectrum of a standard LED has the shape of a broad bell curve, L, Fig. 2A. The spectra of the radiation coming from, a radiation source 1 according to the invention are narrow bands of desired height, or ranges, S, Figs 2B-2E, within the range delimited by the bell curve L.

The spectrometer of Fig. 1 and the radiation source therein employed operate in principle as follows. The driver and control means 9 selects and activates in the LED row 2 the first LED element 21. The radiation of the LED element is collected with the lens 3 and sent as a parallel beam to the reflection grating 4. The lens 3 further produces of the radiation reflected by the grating a spectrum on the stop 5. That part of the radiation (wavelength range $\Delta\lambda_1$) passes through the output slit 6 which is determined by the location of the LED element 21 in the row and by the locations and dimensioning of the other optical means 3,4,6. From the lens 10) a parallel output radiation is obtained, striking the object of measurement 11.

Through the optical means 8, part of the output radiation is directed to strike the detector 7, and the signal representing the intensity that has been obtained is recorded with the driver and control means 9. The driver and control means adjusts the current going to the LED element 21 to have a value such that the signal obtained from the detector 7 rises to desired level, whereby the intensity of the output radiation also assumes the desired value, e.g. I_0. Hereafter the actual measurement takes place in the wavelength range $\Delta\lambda_1$ (Fig. 2B) and the result is recorded in the calculating unit 14. Next, the driver and control means 9 activates the LED element 22 and, after the output intensity has similarly been adjusted to required level, measurement takes place in the wavelength range $\Delta\lambda_2$ (Fig. 2C). The driver and control means 9 activates all LED elements 21 ... 2N in succession and measurements are similarly carried out in the wavelength ranges ..., $\Delta\lambda_N$ (Fig, 2E), whereafter the driver and control means 9 activates again the LED element 21, and so on. The calculating unit 14 is electrically synchronized with the driver and control means 9 so that all results of measurement that have been recorded can be coordinated with the correct wavelength ranges $\Delta\lambda_1$, ... $\Delta\lambda_N$.

In the foregoing in the spectrometer of Fig. 1 the optical means for collecting the radiation from the LED rows, for dispersing it to a spectrum and for directing the desired wavelength range on the output slit 6, comprising a lens 3 and a reflection grating 4 or equivalent. In the radiation source of Fig. 4, said optical means comprise a beam divider cube 17 and on the surface thereof a focussing transmission grating 18. In this case the detector 7 for monitoring the intensity of the output radiation has been disposed in conjunction with the beam divider cube 17. The dividing interface 17a of the beam divider cube reflects to the detector 7 part of the radiation going through the beam divider cube to the output slit. In the capacity of output slit serves an optic fibre connector 19 to which an optic fibre 31 has been connected. The radiation source 1 with its LED row 2 is enclosed in a suitable housing 32.

Fig. 5 depicts a compact spectrometer intended for reflection measurements and comprising both the transmitter of the radiation source and the receiver. The radiation source 1 is equivalent in its design with the radiation source of Fig. 4, and the same reference numerals are employed to indicate equivalent components. In front of the radiation source 1, in the direction of propagation of the radiation, a receiver 33 has been disposed. This receiver consists of a beam divider 34 and a receiver detector 12. The output radiation is carried put from the device through an aperture 35. The object of measurement 36, which is a reflecting surface, is placed in front of the radiation beam coming from the spectrometer. The radiation reflected from the object of measurement 36 returns through the aperture 35 to the beam divider 34 of the receiver 33, from the dividing interface 34a of which the major part of the radiation is reflected to the receiver detector 12 and is detected. Both the radiation source 1 and the receiver 33 have in this case been integrated to constitute a single unit, which may be provided with a hermetically sealed housing 36 if required. In this way the reflection spectrometer can be made into a device usable in the field. The radiation from the spectrometer can be directed to strike the object of measurement 36 without any separate output optics, as has been set forth in the foregoing, or by using e.g. a standard lens optic system or a fibreoptic component.

The LED row may be replaced with another type of radiation source row, as can be seen in Fig. 6. Fig. 6A presents, seen from the side, a LED row 2 comprising consecutively placed LED elements 21, 22, ..., 2N. The alternative radiation source row depicted in Fig. 6B comprises a number of LED elements or separate, encapsulated LEDs 21, 22 27, to each of them connected an optic fibre 41, 42, ..., 47 by its first end 41a, 42a, ..., 47a. The other ends 41b, 42b, ..., 47b of the optic fibres are arranged in a configuration such as is desired. The ends of the optic fibres are then close together and are thus equivalent e.g. to the LED row presented in the foregoing.

It should be noted that although the invention has been presented in the foregoing in the first place only with the aid of one measuring apparatus, it is obvious that the procedure for controlling a radiation source, and the controlled radiation source, can be employed in numerous other applications as well in which a stable, or easy to control, radiation source is needed which produces radiation within a given wavelength range in a plurality of alternatingly active, and if need be narrow, wavelength bands. Moreover, in the embodiment examples of the invention presented in the foregoing a LED row or equivalent is employed, but it is also possible to use in its stead a LED matrix or any other equivalent LED array.

Claims

1. A method for controlling a radiation source (1) which comprises a plurality of light-emitting diodes or LEDs (21, 22, 23, ... 26);
the method comprising a step of selectively driving one of said LEDs for producing output radiation within a selected wavelength range ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...);
characterized by the steps of separating said selected wavelength range from a relatively wide wavelength range of radiation emitted by said one LED, and directing this separated wavelength range to an output slit (6) or equivalent, said separating and directing being performed by means of optical dispersing means (3, 4, 5), wherein said separated wavelength range depends on the position of said LED with respect to the optical dispersing means (3, 4, 5);
measuring the intensity of the radiation in said selected wavelength range or of the output radiation, and regulating the current passing through said one driven LED in response to the measured intensity such that this measured intensity is controlled or maintained constant.

2. Method according to claim 1, characterized in that the wavelength ranges ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...) of the output radiation are selected electrically by activating a suitable LED element (21, 22, 23, ... 26) of said plurality of LED's.

3. A controllable radiation source (1) for producing output radiation within a selected wavelength range ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...), comprising:
a plurality of light-emitting diodes or LEDs (21, 22, 23, ... 26); an output slit (6) or equivalent;
an optical dispersing element (3, 4, 5) arranged in an optical path between said plurality of light-emitting diodes and said output slit, the optical dispersing element being adapted for receiving radiation and refracting the received radiation in a direction dependent on the wavelength of the received radiation; and a driver and control means (9) for selectively driving one of said LEDs;
characterized in:
that the light-emitting diodes are similar to each other and emit radiation in a relatively wide wavelength range from which the selected wave length range is determined by the position of a separately driven LED in respect to the optical dispersing element ;
that optical means (8) are arranged such as to direct part of the output radiation, or of the radiation which is refracted by the optical dispersing element towards the output slit, towards a radiation intensity detector (7) for measuring the intensity of said radiation within said selected wavelength range; and
that the driver and control means (9) is adapted to drive the selected LED in response to the intensity detected by the radiation intensity detector such that the intensity of said radiation within said selected wavelength range as detected by the radiation intensity detector (7) is controlled or maintained at a desired value (I_0).

4. Radiation source according to claim 3, characterized in that the LED elements (21, 22, 23, ..., 26) are arranged in an LED array (2,2′) and are connected together and connected with a current control circuit (15) and a selector means (16) with the aid of which the desired LED element (e.g. 23) and the desired wavelength range ($\Delta\lambda_3$) of the output radiation of the radiation source are selected and which current control circuit (15) is governed by a controller (9a) with the aid of the signal from the detector (7) in such manner that the intensity (I_0) of the output radiation continuously maintains the same value.

5. Radiation source according to claim 3 or 4, characterized in that said optical means for receiving and dispersing the radiation produced by the LEDs and for directing the desired wavelength range on the output slit (6) comprise a focussing reflection or transmission grating.

6. Radiation source according to claim 3 or 4, characterized in that said optical means for receiving and dispersing the radiation produced by the LEDs and for directing the desired wavelength range on the output slit (6) and on the detector (7) comprise a beam divider cube (17) and on the surface thereof a transmission grating (18).

7. Radiation source according to claim 6, characterized in that the detector (7) for observing the intensity of the output radiation has been disposed in conjunction with the beam divider cube (17) so that the beam divider cube also serves as an optical means associated with the detector.

8. Radiation source according to any one of the preceding claims 3-7 for performing reflection and/or transmission measurement, characterized in that the radiation source (1) has been formed to be an integral unit (32).

9. Means according to any one of the preceding claims 3-7 for performing reflection measurements, characterized in that the radiation source (1) is integrated with a receiver (33) to constitute an integrated unit for performing reflection measurements, which unit is advantageously provided with a hermetically sealed housing (37).

10. Radiation source according to any one of the preceding claims 3-7, characterized in that the LED array (2′) consists of a plurality of LED elements or separate encapsulated LEDs (21, 22, ..., 27,Fig. 6B) to each of which is connected an optic fibre (41, 42, ..., 47) by its first end (41a, 42a, ..., 47a) and the second ends (41b, 42b, ..., 47b) have been arranged in a desired configuration.

Patentansprüche

1. Verfahren zum Regeln einer Strahlungsquelle (1) mit einer Merhzahl von Leuchtdioden oder LEDs (21, 22, 23, ... 26);
wobei das Verfahren einen Schritt des wahlweisen Ansteuerns einer der LEDs zum Erzeugen einer Ausgangsstrahlung innerhalb eines ausgewählten Wellenlängenbereichs ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$,...) aufweist;
gekennzeichnet durch die Schritte, nach denen der ausgewählte Wellenlängenbereich aus einem verhältnismässig breiten Wellenlängenbereich der Strahlung separiert wird, die von der einen LED emittiert wird, und dieser separierte Wellenlängenbereich zu einem Ausgangsspalt (6) oder dergleichen hin gerichtet wird, wobei das Separieren und das Richten mit Hilfe optischer Dispersionsmittel (3, 4, 5) durchgeführt werden, und der separierte Wellenlängenbereich von der Position der LED relativ zu den optischen Dispersionsmitteln (3, 4, 5) abhängt; wobei die Intensität der Strahlung in dem ausgewählten Wellenlängenbereich oder der Ausgangsstrahlung gemessen wird, und der durch die eine angesteuerte LED hindurchfliessende Strom in Antwort auf die gemessene Intensität derart gesteuert wird, dass diese gemessene Intensität geregelt oder konstant gehalten wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Wellenlängenbereiche ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...) der Ausgangsstrahlung durch Aktivieren eines geeigneten LED-Elements (21, 22, 23, ... 26) aus der Mehrzahl von LEDs elektrisch ausgewählt werden.

3. Regelbare Strahlungsquelle (1) zum Erzeugen einer Ausgangsstrahlung innerhalb eines ausgewählten Wellenlängenbereichs ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...) mit:
einer Mehrzahl von Leuchtdioden oder LEDs (21, 22, 23, ... 26);
einem Ausgangsspalt (6) oder dergleichen;
optischen Dispersionsmitteln (3, 4, 5), die in dem optischen Weg zwischen der Mehrzahl von Leuchtdioden und dem Ausgangsspalt angeordnet sind, wobei die optischen Dispersionsmittel zum Empfangen der Strahlung und zum Brechen der empfangenen Strahlung in eine Richtung hin ausgelegt sind, die von der Wellenlänge der empfangenen Strahlung abhängt; und einem Ansteuerungs- und Regelungsmittel (9) zum wahlweisen Ansteuern einer der LEDs;
dadurch gekennzeichnet,
dass die Leuchtdioden zueinander gleich sind und eine Strahlung in einem verhältnismässig breiten Wellenlängenbereich emittieren, aus wel-

chem der ausgewählte Wellenlängenbereich durch die Position einer gesondert angesteuerten LED relativ zu dem optischen Dispersionselement bestimmt ist;
dass optische Mittel (8) derart angeordnet sind, dass ein Teil der Ausgangsstrahlung oder der Strahlung, die von dem optischen Dispersionselement zu dem Ausgangsspalt hin gebrochen wird, zu einem Strahlungsintensitätsdetektor (7) hin zum Messen der Intensität der Strahlung innerhalb des ausgewählten Wellenlängenbereichs gerichtet wird; und dass das Ansteuerungs- und Regelungsmittel (9) zum Ansteuern der ausgewählten LED in Antwort auf die von dem Strahlungsintensitätsdetektor detektierte Intensität ausgelegt ist, derart, dass die Intensität der Strahlung innerhalb des ausgewählten Wellenlängenbereichs, wie von dem Strahlungsintensitätsdetektor (7) detektiert, geregelt oder auf einem gewünschten Wert (I_0) gehalten wird.

4. Strahlungsquelle nach Anspruch 3, dadurch gekennzeichnet, dass die LED-Elemente (21, 22, 23, ..., 26) in einer LED-Reihe (2, 2′) angeordnet sind, und zusammengeschaltet sind und mit einer Stromsteuerungsschaltung (15) und einem Auswahlmittel (16) verbunden sind, mit dessen Hilfe das gewünschte LED-Element (z.B. 23) und der gewünschte Wellenlängenbereich ($\Delta\lambda_3$) der Ausgangsstrahlung der Strahlungsquelle ausgewählt werden, und die Stromsteuerungsschaltung (15) von einer Steuereinheit (9a) mit Hilfe des Signals von dem Detektor (7) derart gesteuert wird, dass die Intensität (I_0) der Ausgangsstrahlung kontinuierlich auf demselben Wert gehalten ist.

5. Strahlungsquelle nach Anspruch 3 oder 4, dadurch gekennzeichnet, dass die optischen Mittel zum Empfangen und zum Zerlegen der von den LEDs erzeugten Strahlung und zum Richten des gewünschten Wellenlängenbereichs auf den Ausgangsspalt (6) hin ein fokusierendes Reflexions- oder Transmissionsgitter aufweisen.

6. Strahlungsquelle nach Anspruch 3 oder 4, dadurch gekennzeichnet, dass die optischen Mittel zum Empfangen und zum Zerlegen der von den LEDs erzeugten Strahlung und zum Richten des gewünschten Wellenlängenbereichs auf den Ausgangsspalt (6) und auf den Detektor einen Strahlenteilerwürfel (17) und an dessen Oberfläche ein Transmissionsgitter (18) aufweisen.

7. Strahlungsquelle nach Anspruch 6, dadurch gekennzeichnet, dass der Detektor (7) zum Überwachen der Intensität der Ausgangsstrahlung mit dem Strahlenteilerwürfel (17) verbunden angeordnet ist, so dass der Strahlenteilerwürfel auch als ein dem Detektor zugeordnetes optisches Mittel dient.

8. Strahlungsquelle nach einem der vorangehenden Ansprüche 3 bis 7, zum Durchführen von Reflexions- und/oder Transmissionsmessungen, dadurch gekennzeichnet, dass die Strahlungsquelle (1) als integrierte Einheit (32) ausgebildet ist.

9. Strahlungsquelle nach einem der vorangehenden Ansprüche 3 bis 7, dadurch gekennzeichnet, dass die Strahlungsquelle (1) mit einem Empfänger (33) integriert ist zum Bilden einer integrierten Einheit zum Durchführen von Reflexionsmessungen, welche Einheit vorteilhaft ein hermetisch abgedichtetes Gehäuse (37) umfasst.

10. Strahlungsquelle nach einem der vorangehenden Ansprüche 3 bis 7, dadurch gekennzeichnet, dass die LED-Reihe (2′) aus einer Mehrzahl von LED-Elementen oder gesondert eingekapselten LEDs (21, 22, ..., 27, Fig. 6B) besteht, an jede von denen eine optische Faser (41, 42, ..., 47) mit ihrem einen Ende (41a, 42a, ..., 47a) angeschlossen ist, und die zweiten Enden (41b, 42b, ..., 47b) in einer gewünschten Konfiguration angeordnet sind.

Revendications

1. Procédé pour réguler une source de rayonnement (I) qui comprend une pluralité de diodes électroluminescentes ou DEL (21, 22, 23, ... 26); le procédé comportant une étape de pilotage sélectif de l'une desdites DEL pour produire un rayonnement de sortie dans une gamme de longueurs d'onde sélectionnée ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...);
caractérisé par les étapes de séparation de ladite gamme de longueurs d'onde d'une gamme de longueurs d'onde relativement large de rayonnement émis par ladite DEL, et d'orientation de ladite gamme de longueurs d'onde vers une fente de sortie (6) ou équivalente, lesdites séparation et orientation étant réalisées au moyen de moyens de dispersion optique (3, 4, 5), ladite gamme de longueurs d'onde séparée dépendant de la position de ladite DEL par rapport aux moyens de dispersion optique (3, 4, 5);
de mesure de l'intensité du rayonnement dans ladite gamme de longueurs d'onde ou du rayonnement de sortie, et de régulation du courant passant dans ladite DEL politée, en réponse à l'intensité mesurée, de sorte que cette intensité mesurés est régulée ou maintenue constante.

2. Procédé selon la revendication 1, caractérisé en ce que les gammes de longueurs d'onde ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...) du rayonnement de sortie sont sélectionnées électriquement en activant un élément DEL approprié (21, 22, 23, ... 26) de ladite pluralité de DEL.

3. Source de rayonnement régulable (1) pour produire un rayonnement de sortie dans une gamme de longueurs d'onde sélectionnée ($\Delta\lambda_1$, $\Delta\lambda_2$, $\Delta\lambda_3$, ...), comprenant:
une pluralité de diodes électroluminescentes ou DEL (21, 22, 23, ... 26);
une fente de sortie (6), ou équivalente;
des moyens de dispersion optique (3, 4, 5) disposés dans une trajectoire optique entre ladite pluralité de diodes électroluminescentes et ladite fente de sortie, les moyens de dispersion optique étant adaptés pour recevoir le rayonnement et réfracter le rayonnement reçu dans une direction dépendant de la longueur d'onde du rayonnement reçu; et un moyen pilote de commande (9) pour piloter sélectivement l'une desdites DEL;
caractérisé en ce que:
les diodes électroluminescentes sont similaires les unes aux autres et émettent un rayonnement dans une gamme de longueurs d'onde relativement large, à partir de laquelle la gamme de longueurs d'onde sélectionnée est déterminée par la position d'une DEL pilotée séparément par rapport à l'élément de dispersion optique;
les moyens optiques (8) sont disposés de manière à diriger une partie du rayonnement de sortie, ou du rayonnement qui est réfracté par l'élément de dispersion optique vers la fente de sortie, vers un détecteur d'intensité de rayonnement (7) pour mesurer l'intensité dudit rayonnement dans ladite gamme de longueurs d'onde sélectionnée; et
le moyen pilote de commande (9) est adapté pour piloter la DEL sélectionnée en réponse à l'intensité détectée par le détecteur d'intensité de rayonnement de sorte que l'intensité dudit rayonnement dans ladite gamme de longueurs d'onde sélectionnée, telle que détectée par le détecteur d'intensité de rayonnement (7) est régulée ou maintenue à une valeur désirée (I_0).

4. Source de rayonnement selon la revendication 3, caractérisée en ce que les éléments DEL (21, 22, 23, ..., 26) sont disposés en un ensemble de DEL (2, 2') et sont reliés ensemble à un circuit de régulation de courant (15) et à un moyen de sélection (16), à l'aide duquel l'élément DEL désireé (23, par exemple) et la gamme de longueurs d'onde désirée ($\Delta\lambda_3$) du rayonnement de sortie de la source de rayonnement sont sélectionnés, et duquel le circuit de régulation de courant (15) est piloté par un régulateur (9a) à l'aide du signal émanant du détecteur (7), de manière que l'intensité (I_0) du rayonnement de sortie maintient la même valeur en permanence.

5. Source de rayonnement selon la revendication 3 ou la revendication 4, caractérisée en ce que lesdits moyens optiques de réception et de dispersion du rayonnement produit par les DEL et d'orientation de la gamme de longueurs d'onde désirée sur la fente de sortie (6) comprennent un élément d'émission ou de réflexion de focalisation.

6. Source de rayonnement selon la revendication 3 ou 4, caractérisée en ce que lesdits moyens optiques de réception et de dispersion du rayonnement produit par les DEL et d'orientation de la gamme de longueurs d'onde désirée sur la fente de sortie (6) et sur le détecteur (7) comprennent un cube diviseur de faisceau (17) et sur la surface de celui-ci un élément d'émission (18).

7. Source de rayonnement selon la revendication 6, caractérisée en ce que le détecteur (7) d'observation de l'intensité du rayonnement de sortie a été disposé conjointement au cube diviseur de faisceau (17) de manière que le cube diviseur de faisceau serve également de moyen optique associé au détecteur.

8. Source de rayonnement selon l'une quelconque des revendications précédentes 3 à 7 pour réaliser une mesure de réflexion et/ou d'émission, caractérisée en ce que la source de rayonnement (1) a été constituée pour former une unité intégrale (32).

9. Source de rayonnement selon l'une quelqonque des revendications précédentes 3 à 7, caractérisée en ce que la source de rayonnement (1) est intégrée dans un récepteur (33) pour former une unité intégrale pour réaliser des mesures de réflexion, ladite unité avantageusement comprenant une boîte (37) hermétiquement fermée.

10. Source de rayonnement selon l'une quelconque des revendications précédentes 3 à 7, caractérisée en ce que l'ensemble de DEL (2') comprend une pluralité d'éléments DEL ou de DEL encapsulées séparées (21, 22, ..., 27, Fig. 6B), chacun d'entre eux étant relié à une fibre optique (41, 42, ..., 47) par sa première extrémité (41a, 42a, ..., 47a), les secondes extrémités (41b, 42b, ..., 47b) ayant été disposées selon une configuration désirée.

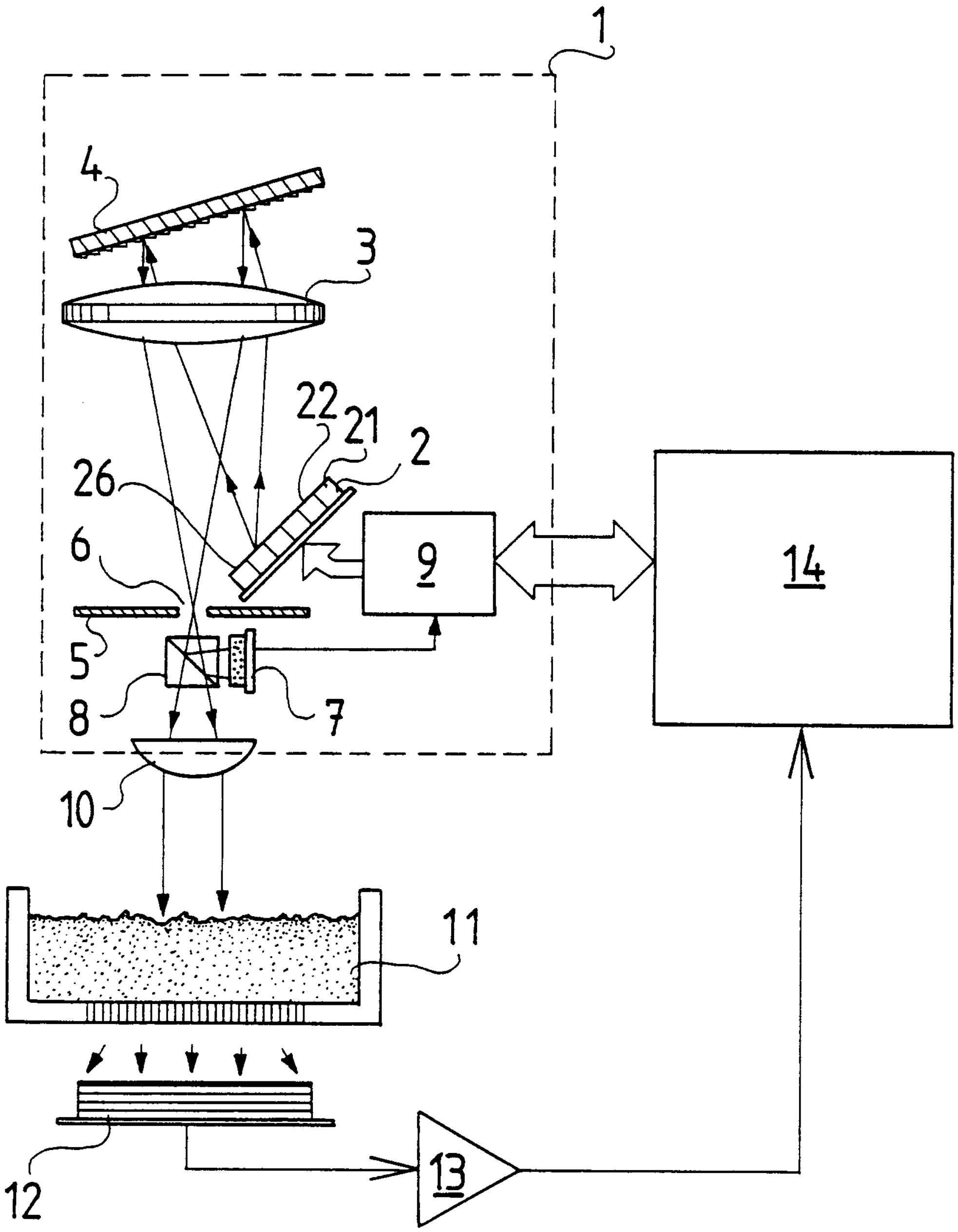

Fig.1

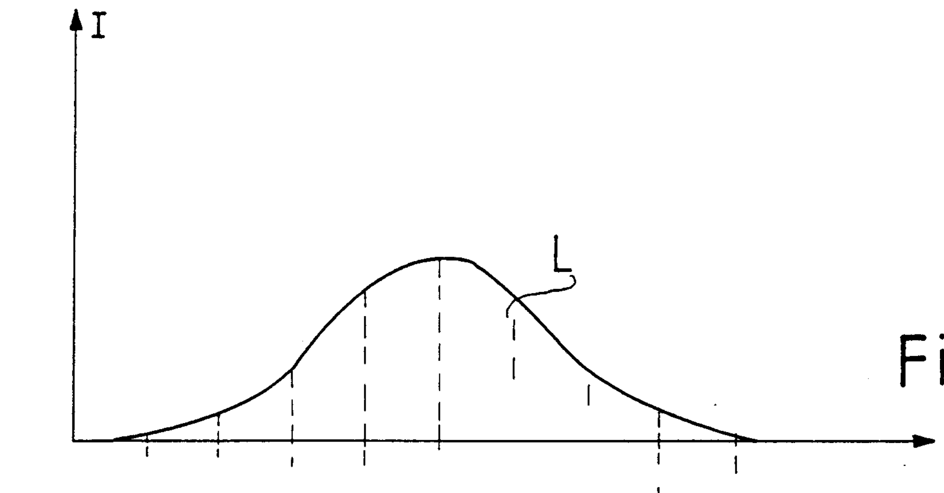

Fig. 2A

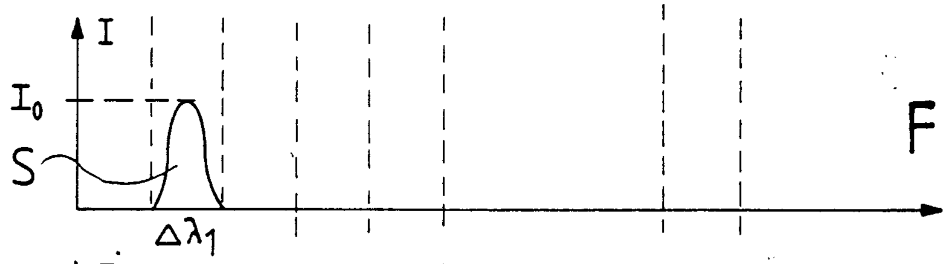

Fig. 2B

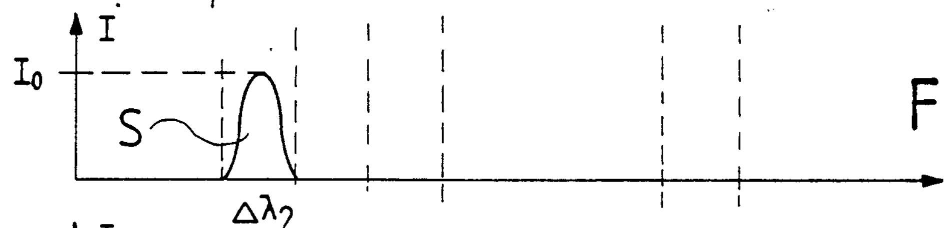

Fig. 2C

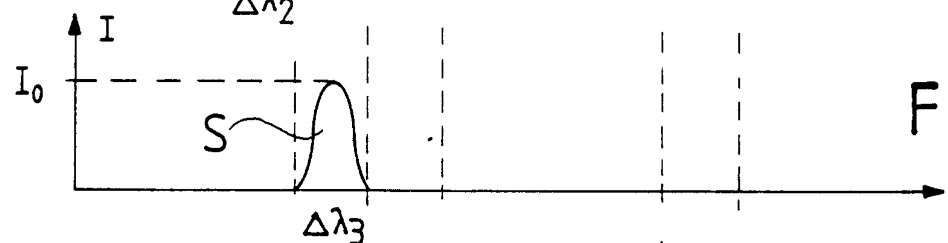

Fig. 2D

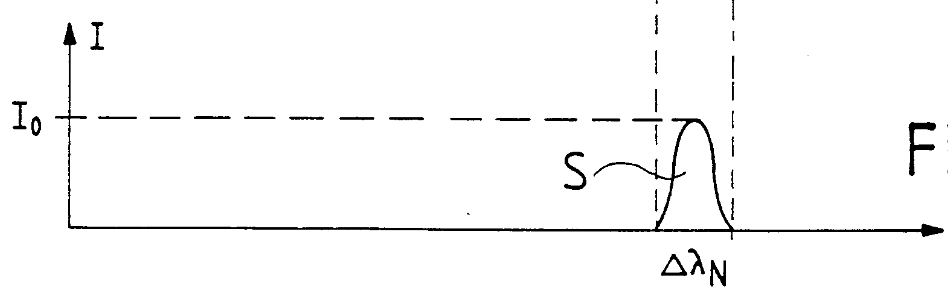

Fig. 2E

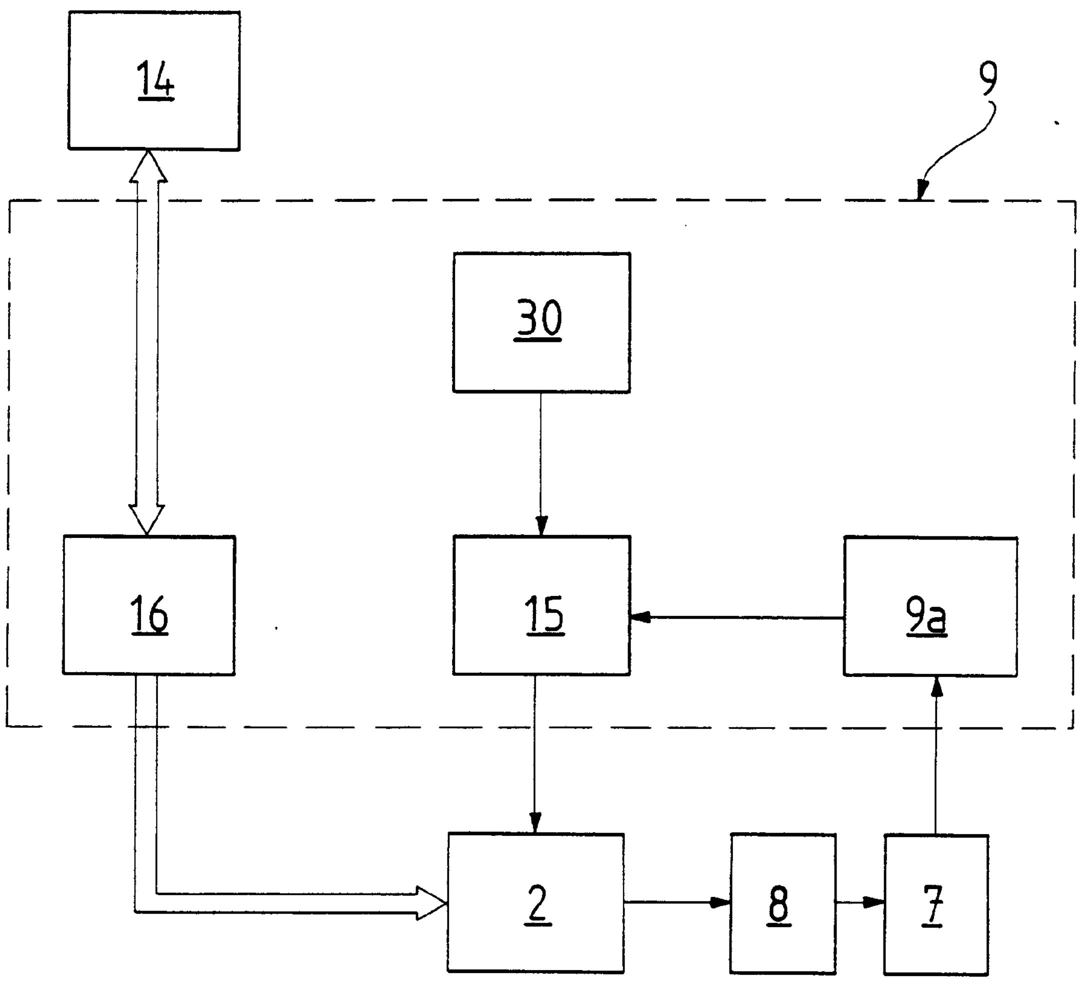

Fig. 3

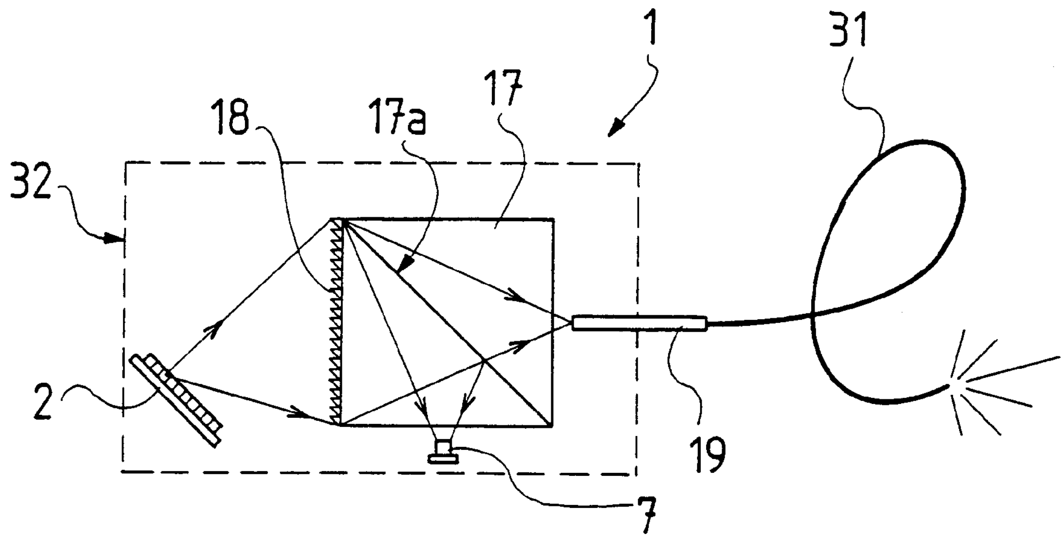

Fig. 4

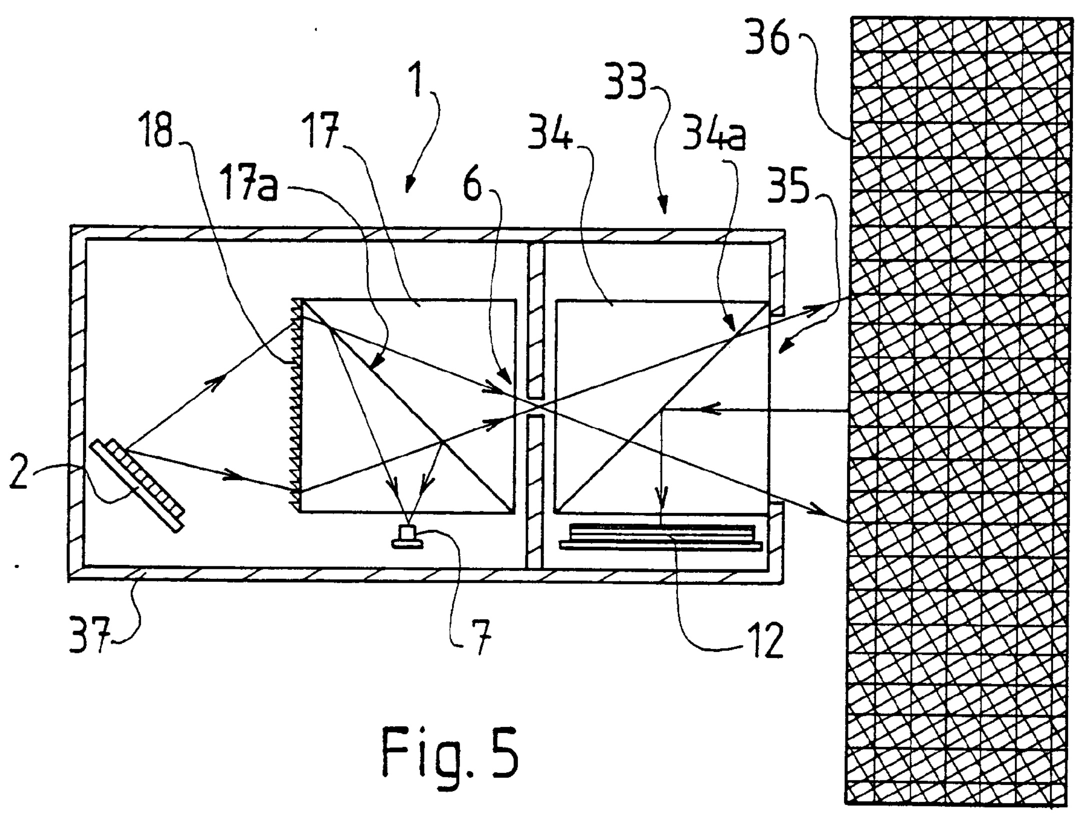

Fig. 5

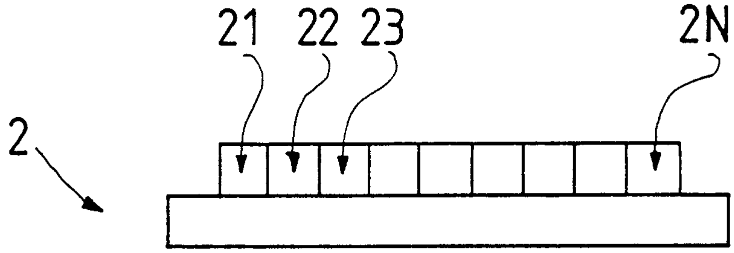
21
22
23
2N
2

Fig. 6A

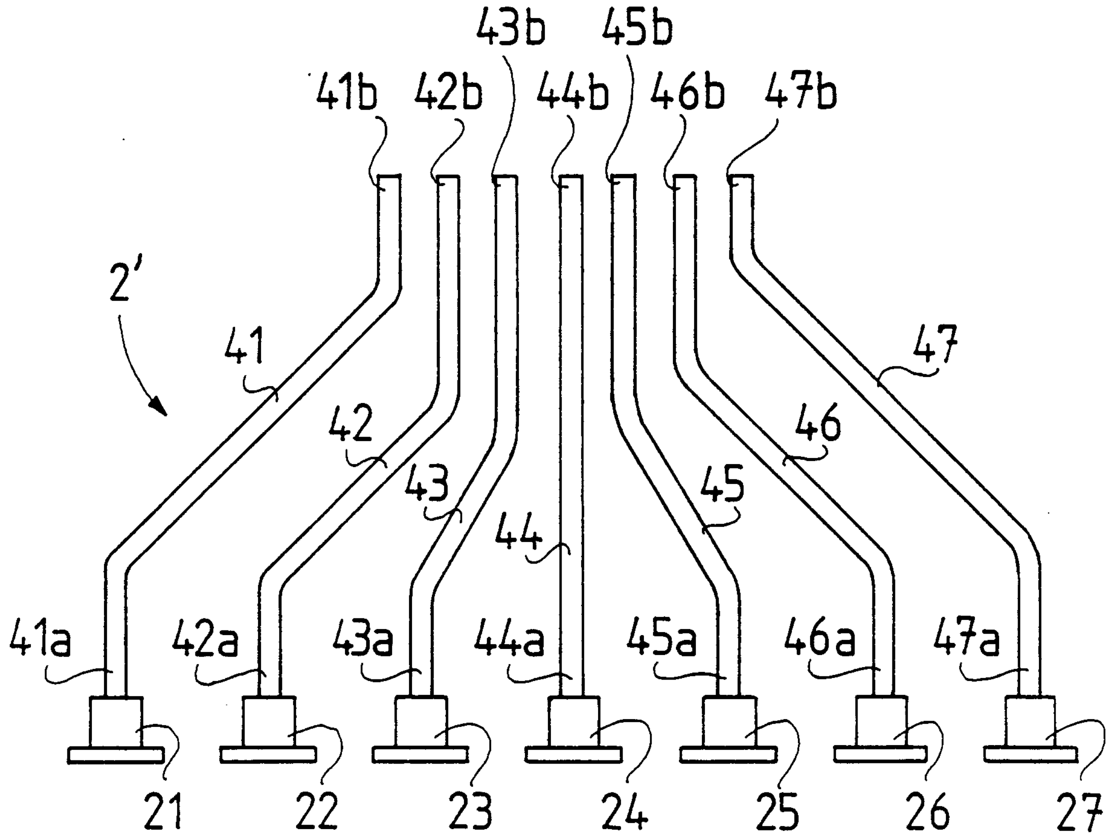
43b
45b
41b
42b
44b
46b
47b
2'
41
42
43
44
45
46
47
41a
42a
43a
44a
45a
46a
47a
21
22
23
24
25
26
27

Fig. 6B