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(54) **CONTINUOUSLY WAVELENGTH-TUNABLE MONOMODE LASER SOURCE**

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(52) **U.S. Cl.** **372/20**; 372/64; 372/32; 372/26; 372/9; 372/102
(58) **Field of Search** 372/20, 102, 92, 372/32, 29, 98, 99, 107, 64, 26, 109

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(57) **ABSTRACT**

The invention relates to an external cavity, continuously tunable monomode laser source, comprising, in a resonant cavity, resonating at the emission wavelength λe, a retrore-flecting wavelength dispersing device, arranged to produce a selectivity curve with a peak 80 s.

According to the invention, additional fine-control means, enable, from the approximate continuous tunability position, to monitor the deviation λe–λs during the variation of the emission wavelength ke while preventing this deviation from reaching one of the limits causing mode hopping.

Such a configuration enables to avoid imperfections usually associated with mechanical adjustment and to guarantee continuity of the wavelength variation and to compensate for the latter as long as its fluctuations remain smaller than approx. Δλe/2 where Δλe is the distance between two successive resonance modes of the cavity.

12 Claims, 7 Drawing Sheets

FIG.1
PRIOR ART

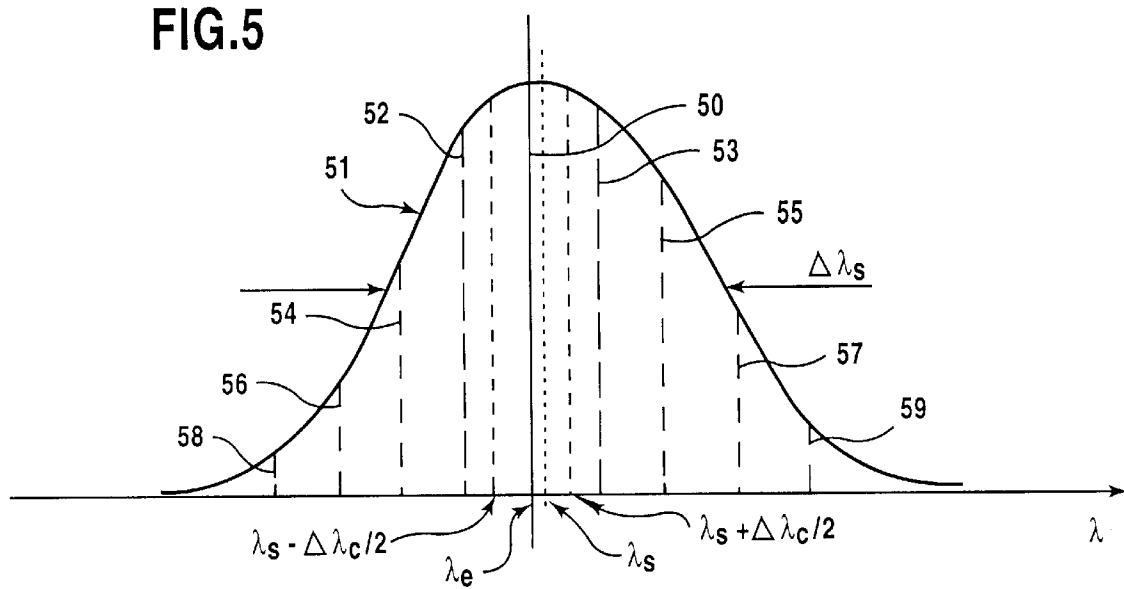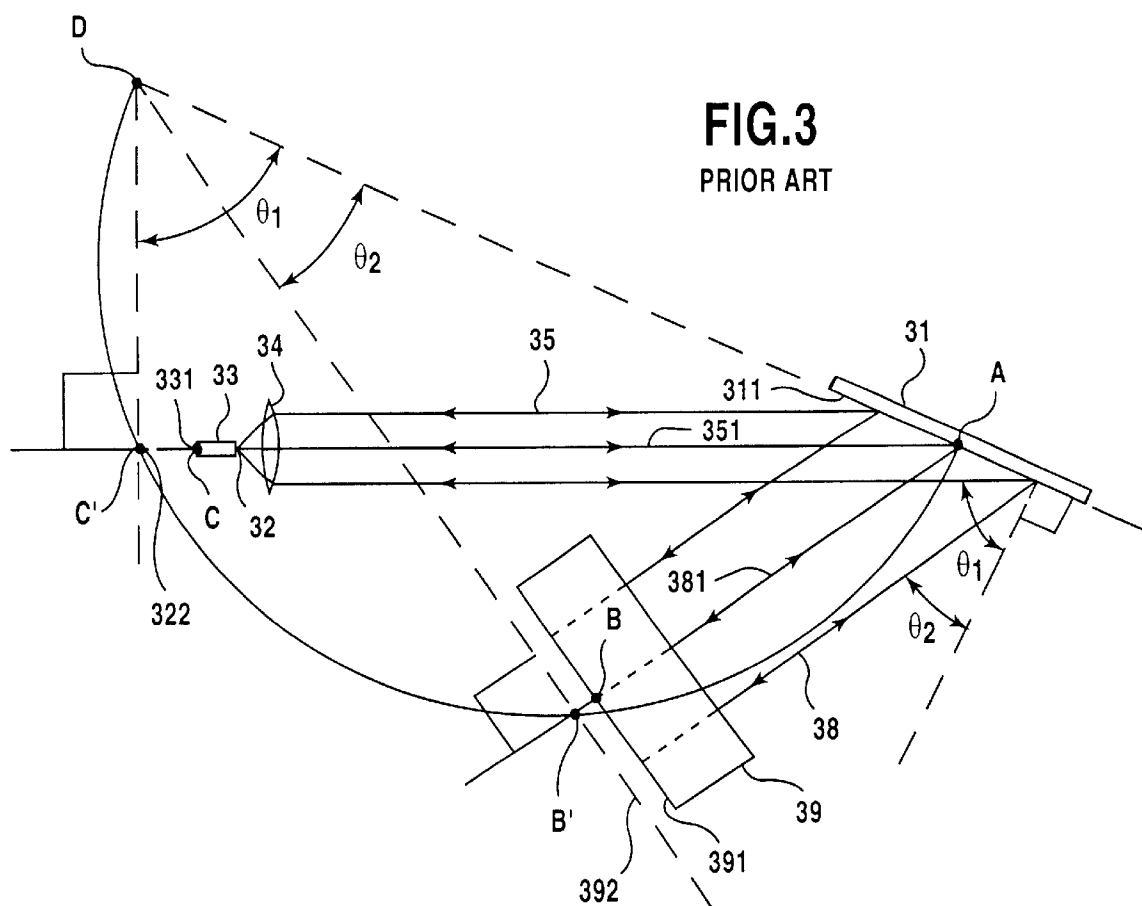**FIG.2A**
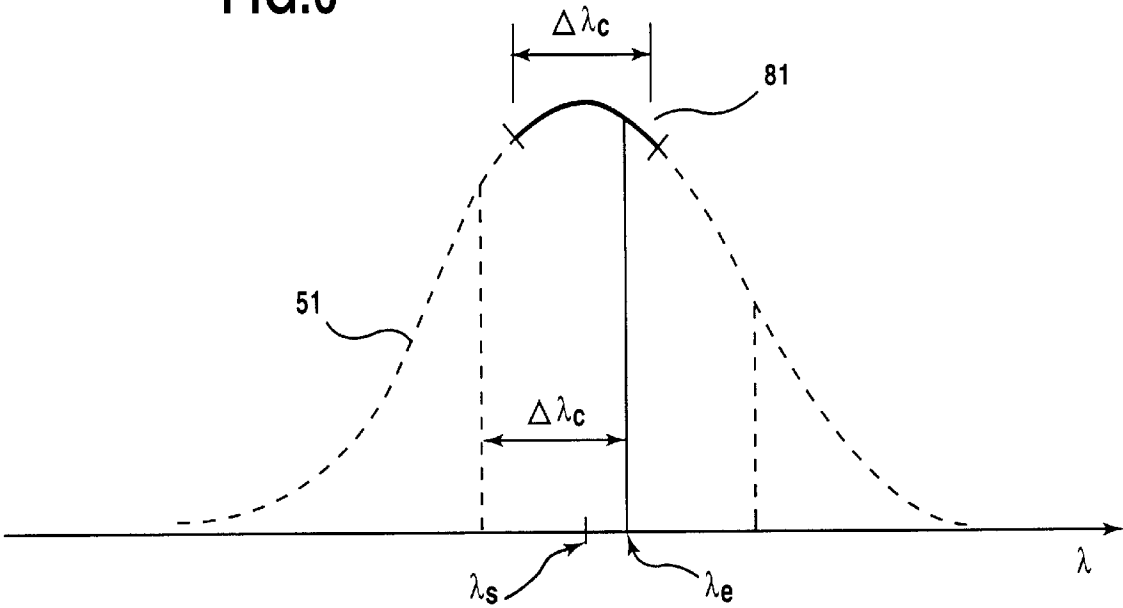PRIOR ART

FIG.2B
PRIOR ART

FIG.3
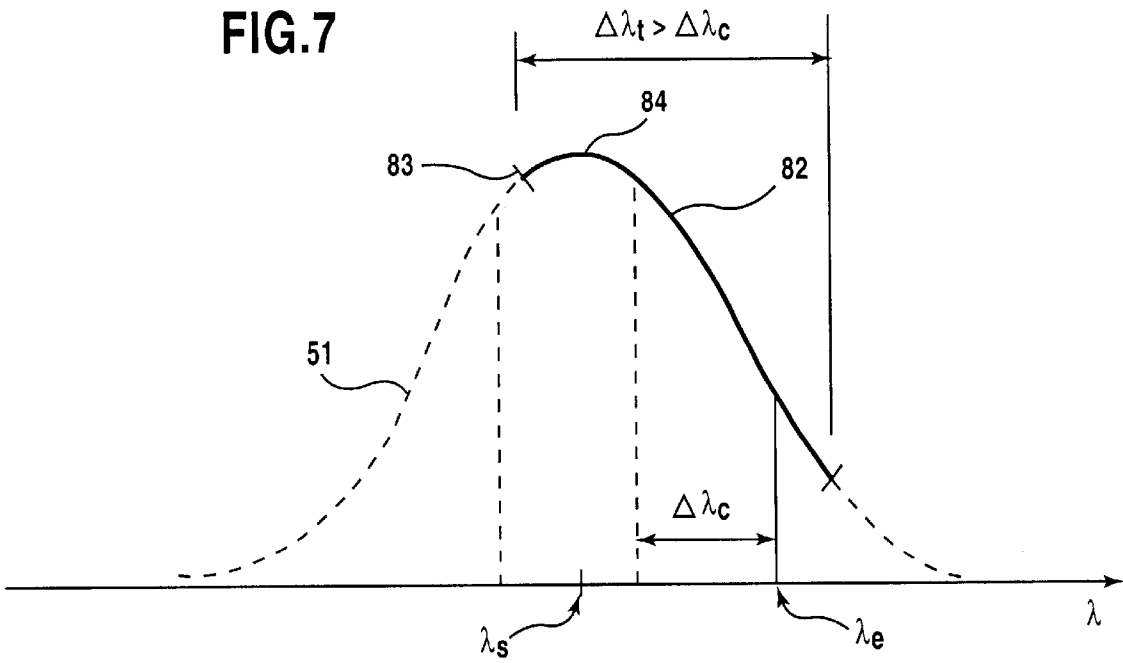PRIOR ART
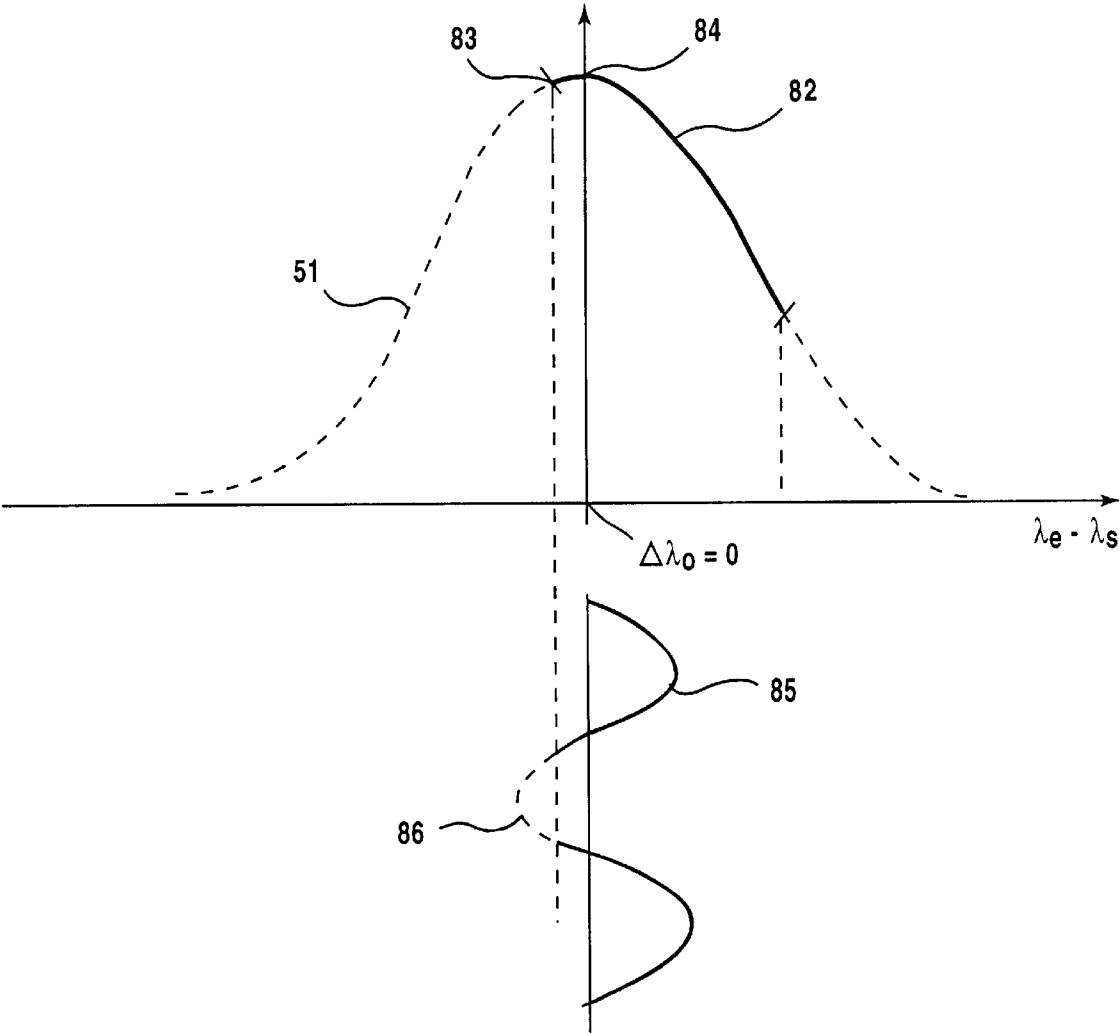
FIG.5
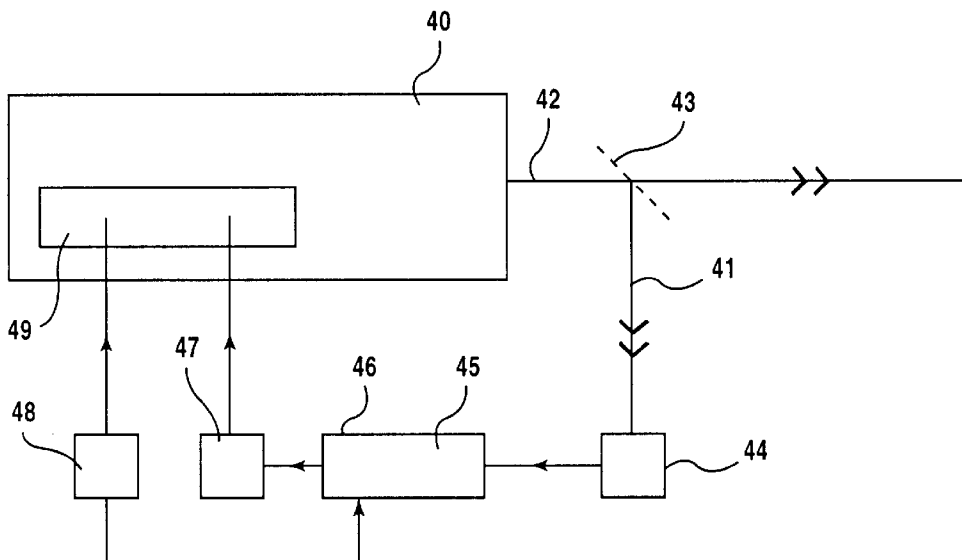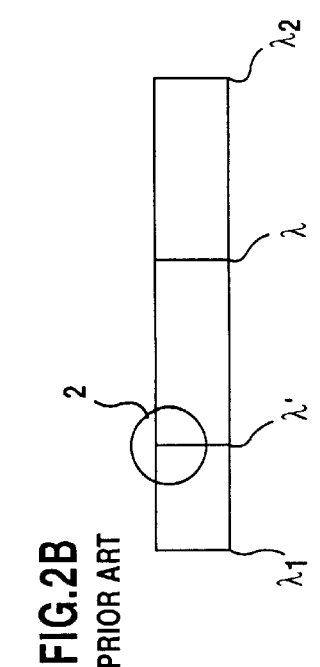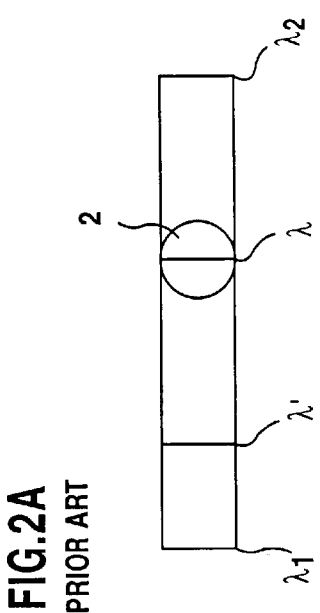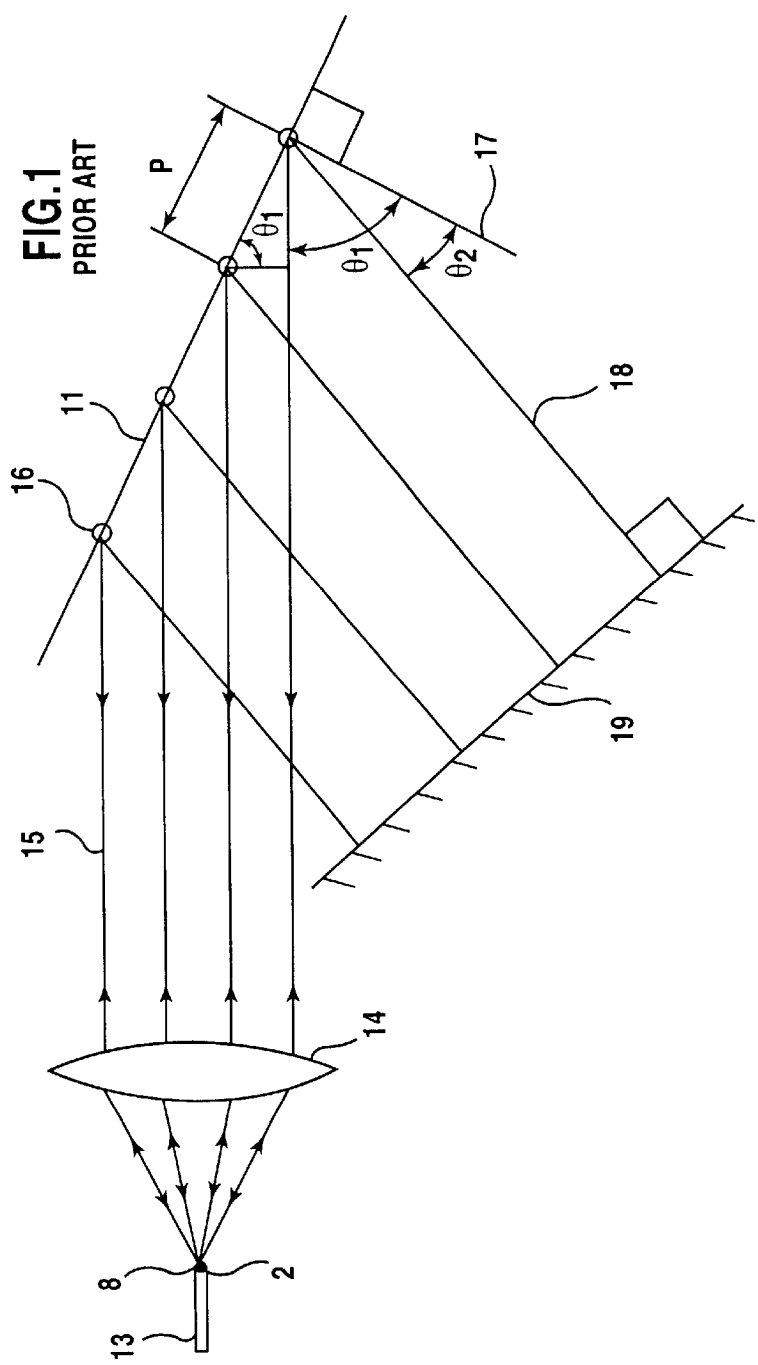
FIG.4
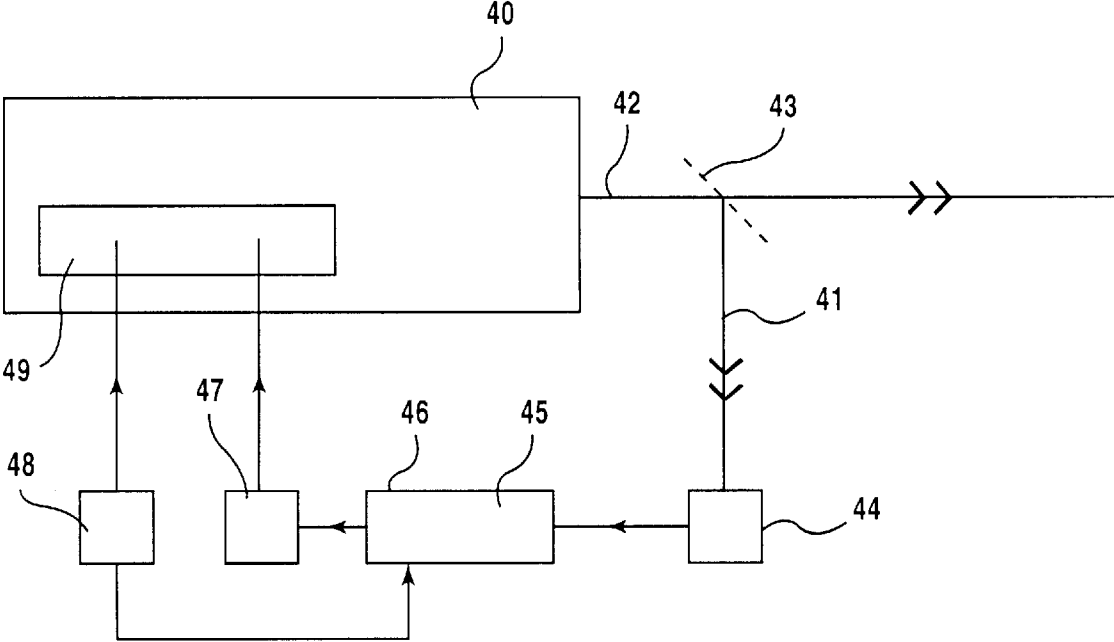
FIG.6

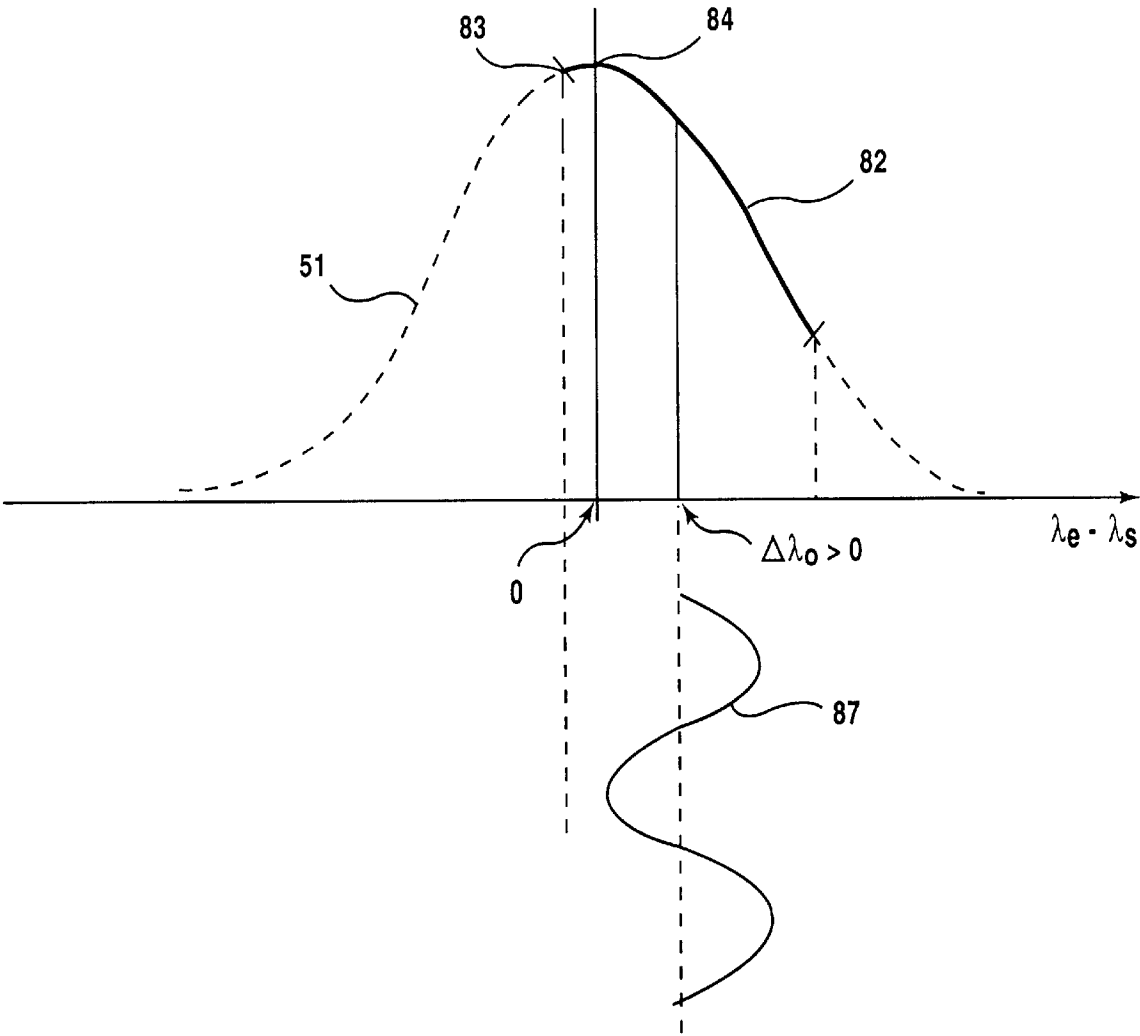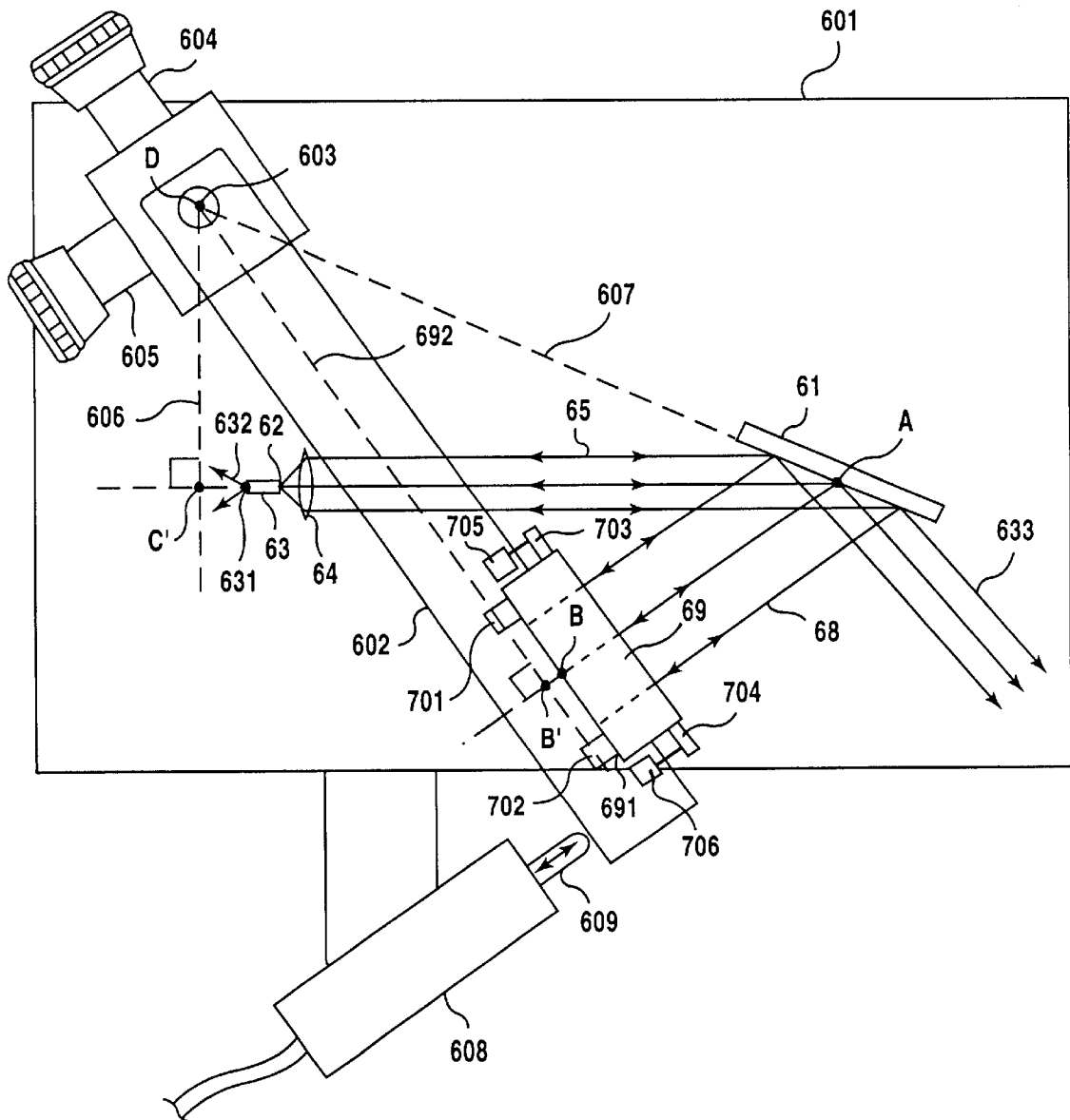

FIG.7

FIG.8

FIG.9

FIG.10

CONTINUOUSLY WAVELENGTH-TUNABLE MONOMODE LASER SOURCE

This invention relates to a wavelength-tunable monomode laser source with external cavity.

We know that the resonant optic cavity of a laser source selects one or several wavelengths emitted by an amplifier laser medium. Most often, the system consists of two mirrors, whereas one of them is partially transparent, forming a so-called Fabry-Perot cavity. Such a Fabry-Perot cavity selects or resonates for semi-wavelengths equal to sub-multiples of the optic length L_{op} of the cavity and hence generally quite close to one another. Several wavelengths can then be amplified by the wide spectrum amplifier medium, to provide a multimode laser.

For certain applications, monomode lasers are preferred. It is then necessary to implement a resonant optic cavity associating a selection means complimentary to the Fabry-Perot cavity, for instance by replacing one of its mirrors by a retroreflecting dispersing device.

Retroreflecting dispersing devices are commonly used in conventional optics. The best known device is probably the pitch p plane grating employed according to the Littrow configuration.

Generally speaking, a pitch p plane grating has a dispersion plane perpendicular to its lines. A collimated light beam of wavelength λ, tilted by an angle $\theta 1$ with respect to the normal axis of the grating which is parallel to the dispersion plane of the grating, generates a collimated beam which is also parallel to the dispersion plane and whose direction is tilted by an angle $\theta 2$ with respect to the normal axis, whereas $\theta 1$ and $\theta 2$ are linked by the following relation:

$$p \sin \theta 1 + p \sin \theta 2 = \lambda$$

In external cavity tunable laser sources operating with a so-called Littman-Metcalf configuration where the incident collimated beam forms an angle $\theta 1$ with the normal axis of the grating, an additional mirror is placed with its normal axis forming an angle $\theta 2$ on the grating. The wavelength λ which respects the equation $\lambda = p \sin \theta 1 + p \sin \theta 2$, is dispersed by the grating at an angle $\theta 2$, then is retroreflected onto the mirror which is then perpendicular, and is finally dispersed again into the grating in return and comes out at the input angle $\theta 1$. This wavelength λ is therefore selected in the cavity. Wavelength tunability is obtained by varying the orientation of the grating/mirror assembly, i.e. while varying $\theta 1$, or while varying solely the orientation of the mirror, i.e. while varying $\theta 2$ or finally while varying solely the orientation of the grating, i.e. while varying $\theta 1$ and $\theta 2$, whereby the relation $\theta 1 - \theta 2$ should remain constant.

FIG. 1 represents a grating 11 implemented according to the Littman-Metcalf assembly in which the extremity 2 of a guided monomode amplifier medium 13 is placed at the focus of collimation optics 14 which generate a main collimated beam 15 of wavelength λ.

This beam is parallel to the dispersion plane of the grating, i.e. to the plane perpendicular to the lines 16 of the grating 11 and forms an angle $\theta 1$ with the normal axis 17 at the surface of the grating 11. By diffraction onto the grating, the beam 15 produces a secondary collimated beam 18, which lies in the dispersion plane and forms an angle $\theta 2$ with the normal axis 17. A plane mirror 19 is placed at right angle to the beam 18 and the beam is retroreflected through the whole system.

We know under these circumstances that, with p as the pitch of the grating, when the relation $p \sin \theta 1 + p \sin \theta 2 = \lambda$ is verified, the beam 15 comes back onto itself after first

diffraction onto the grating 11, retroreflection onto the mirror 19 and second diffraction onto the grating 11. It therefore produces a point-image 8 superimposed with the extremity 2.

The adjustment of such devices calls for accurate positioning of the grating round an axis perpendicular to the selection axis and parallel to the dispersion plane. This latter adjustment and its stability are quite difficult and will determine, in most cases, the quality of the result obtained.

For clarification purposes, FIG. 2A represents a view of the focal plane of the collimation optics 14 in which lies the extremity 2 of a guided amplifier medium and the spectrum generated in return by the assemblies shown on FIG. 1, when the amplifier produces a wide spectrum. We have therefore a spectrum ranging from a wavelength $\lambda 1$ to a wavelength $\lambda 2$ and for which the wavelength λ is retroreflected onto the extremity 2 and is therefore selected in the cavity.

In practice, since the real rotation axis cannot be exactly parallel to the grating lines, displacement of the spectrum in the focal plane is accompanied by a movement perpendicular to the former and leads, when the wavelength λ' is retroreflected, to a configuration such as that represented on FIG. 2B, on which retroreflection is not provided exactly because of the offset of the spectrum, perpendicular to itself, at the same as parallel to itself in the focal plane of the collimation optics.

In the Littman-Metcalf configuration, this problem is raised when the grating 11 or the mirror 19 or both of them, revolve round an axis parallel to the lines 16 of the grating.

Such devices can also generate mode hopping. Indeed, rotation of the grating dispersing device changes the selected wavelength, but this wavelength must also respect the resonance condition of each optic cavity which indicates that the optic length Lop of the cavity (one way) is equal to an integer N of semi-wavelength:

$$L_{op} = N \cdot \lambda / 2$$

If the wavelength selected decreases, the cavity must be shortened at the same time, and vice versa when the wavelength increases, in order to keep the same integer N and prevent any mode hopping.

A continuous tunability device exempt from mode hopping has been suggested with a Littrow configuration, distinct from the Littman-Metcalf configuration (F. Favre and D. Le Guen, <<82 nm of continuous tunability for an external cavity semi-conductor laser>>, Electronics Letters, Vol. 27, 183-184, [1991]), but it involves a complex mechanical assembly using two translation movements and two rotation movements.

In an article of 1981, Liu and Littman (Optics Letters, Vol. 6, N°3, March 1981, pp. 117-118) describe a device comprising a mirror and a variable orientation mirror implemented for the execution of a variable wavelength monomode laser. The geometry suggested enables continuous wavelength scanning.

Besides, reflecting dihedra have been studied for a long time. In particular, the Japanese patent application JP-A-57.099793 of Jun. 21, 1981 suggests to use such a dihedron to build a retroreflecting dispersing device in a wavelength multiplexed optic fibre communication system, whereby the said lengths are fixed.

We also know such continuous tunable monomode laser source as described in the European patent application 0.702.438 which uses a Littman-Metcalf configuration defined with reference to FIG. 3 of this title, comprising a plane grating 31, an orthogonal reflecting dihedron 39 whose edge 391 is parallel to the dispersion plane of the grating 31 comprising the collimation axes.

The point A is the point of intersection of the collimation axes and of the grating, the point B' is the optic extremity of the cavity located on dispersing system side, the point C' is the intersection of the main collimation axis with the optic extremity of the cavity located on the amplifier medium side, the point D is the intersection of the plane containing the diffraction phase of the grating and of the parallel to the edge of the dihedron going through B'.

The angle AC'D is kept equal to 90° and the length AD is kept constant.

Such a device in which these conditions are met thanks to purely mechanical means, is satisfactory to a vast extent. However, it has proven useful to further enhance this device in order to facilitate its adjustment.

The purpose of the invention is therefore to provide an external cavity continuously tunable monomode laser source whose ease of adjustment has improved, which could therefore be executed in the best possible economic conditions and guarantee good stability as soon as the first operation and throughout its lifetime.

To this end, the invention relates therefore to an external cavity, continuously tunable monomode laser source. It comprises a resonant cavity, resonating at the emission wavelength λe, with:

a spatially monomode, amplifying wave guide, located inside the resonant cavity, whereas the said wave guide exhibits an intracavity face treated with an antireflection coat,

collimation optics with a focus, whereby the intracavity face of the wave guide is located at the focus of these optics,

a partially reflecting output face,

a retroreflecting wavelength dispersing device, arranged with respect to the wave guide and to the collimation optics so that they describe wavelength selectivity curve with a peak λs, and

primary mechanical means guaranteeing more or less continuous tunability.

According to the invention, it comprises additional fine-control means, enabling from the approximate continuous tunability position, for automatic control of the position of the retroreflecting dispersing device, in order to monitor the deviation $\lambda e - \lambda s$ during the variation of the emission wavelength λe while preventing this deviation from reaching one of the limits causing mode hopping.

Such a configuration enables to avoid imperfections usually associated with mechanical adjustment and to guarantee continuity of the wavelength variation and to compensate for the latter as long as its fluctuations remain smaller than approx. $\Delta \lambda e / 2$ where $\lambda \Delta e$ is the distance between two successive resonance modes of the cavity.

Advantageously:

the control means comprise:

a generator of modulation $\lambda e - \lambda s$,

an intensity demodulator of the light flux measured which produces a demodulated signal used for automatic control of the position of the retroreflecting dispersing device;

the standard deviation $\langle \lambda e - \lambda \rangle$ is monitored to a value $\Delta \lambda o$ greater than zero;

the deviation $\langle \lambda e - \lambda s \rangle$ is monitored to zero;

control and modulation of $\lambda e - \lambda s$ are provided by controlling and modulating the wavelength λs of the peak of the selectivity curve of the retroreflecting dispersing device;

control and modulation of the wavelength λs are provided by additional rotation of one of the elements of the retroreflecting dispersing device;

control and modulation of the wavelength λs are provided by additional rotation of the reflector;

control and modulation of $\lambda e - \lambda s$ are provided by controlling and modulating the wavelength λe;

control and modulation of the wavelength λe are provided by additional translation of one of the element of the resonant cavity;

the retroreflecting dispersing device comprises a reflector, whereas control and modulation of the wavelength λe are provided out by additional translation of the said reflector.

The invention will be described in more detail with reference to the drawings on which:

FIG. **1** is a schematic representation of a conventional assembly, of the previous art, according to the Littman-Metcalf configuration;

FIGS. **2A** and **2B** are a schematic representation of the spectrum reflected in the plane of the source for two different adjustments of the elements of FIG. **1**;

FIG. **3** is a schematic representation of a continuously tunable and self-aligned laser cavity according to the previous art;

FIG. **4** is a schematic representation of the control and modulation blocks of the source;

FIG. **5** is a representation of the laser beam emitted by the source with respect to the other longitudinal modes of the Fabry-Perot cavity and to the wavelength selectivity curve of the retroreflecting dispersing device;

FIG. **6** is a representation of the operating zone of the source without any mode hopping, at the threshold;

FIG. **7** is a representation of the operating zone of the source without any mode hopping in normal operating conditions;

FIGS. **8** and **9** are schematic representations of the modulation used for automatic control;

FIG. **10** is a concrete embodiment of the source according to the invention.

In order to improve the operation of an external cavity continuously tunable monomode laser source, such as described above with reference to FIG. **3**, the source according to the invention comprises means to control and to modulate the deviation $\lambda e - \lambda s$ when varying the emission wavelength λe. These control and modulation means are represented on FIG. **4**.

A portion **41** of the light flux **42** emitted by the source **40** is sampled by a separation means **43** and measured by a photoelectric detector **44**, providing possibly via a first processing unit **45**, a measurement of the deviation $\lambda e - \lambda s$, which, via the control means **47**, operates the actuator **49** of the source **40** in order to master this deviation $\lambda e - \lambda s$.

Advantageously, a modulator **48** operates the actuator **49** of the source **40** in order to modulate at a frequency f, the deviation $\lambda e - \lambda s$, whereas the deviation $\lambda e - \lambda s$ then becomes the sum of an average deviation $\langle \lambda e - \lambda s \rangle$ and of the modulation. In this case, the processing unit **45** contains a demodulator **46** connected to the modulation generator **48** enabling the said unit to extract from the modulated electric signal supplied by the photodetector **44**, the demodulated component depending on the deviation $\langle \lambda e - \lambda s \rangle$.

This demodulated component serves then as an error signal for a slaving loop where control means **47** operate the actuator **49** in order to control the average deviation $\langle \lambda e - \lambda s \rangle$.

This arrangement, which has proven particularly efficient, seems to apply the following theory. When a purely

mechanical adjustment, such as that incorporated to a source of the previous art, represented above with reference to FIG. 3, fulfils the continuous tunability conditions, assuming that the source has been adjusted correctly, the single emission mode has a peak power at the wavelength λe which coincides with the value λs, the peak wavelength of the selectivity curve. This coincidence is maintained when one of the components of the retroreflecting-dispersing device is caused to rotate in order to modify the emission wavelength. The mechanical adjustment is however not perfect and, in practice, the deviation between the wavelengths λe and λs is not kept at zero, it fluctuates. As long as the amplitude of these fluctuations remains within the range from λs$-\Delta\lambda_c/2$ to λs$+\Delta\lambda_c/2$ (where $\Delta\lambda_c=\lambda^2_e/2L_{op}$ is the spacing of the longitudinal modes of the cavity), the tunable source continues to operate on the same longitudinal mode without any mode hopping. It has been noticed, however, that if the power of the source is changed by modifying the gain in the amplifier wave guide **33**, the said power will modify the index of this guide, thus causing a variation of the optic length L_{op} of the cavity and therefore of λe. Once the mechanical adjustment has been kept constant, the fluctuations of the deviation λe$-\lambda$s remain identical in amplitude, but are not centred on 0 any longer since they have been translated by the index variation of the wave guide. When these fluctuations cause λe to exceed the limits λs$-\Delta\lambda_c/2$ or λs$+\Delta\lambda_c/2$, mode hopping can be noticed, which offsets suddenly the emission wavelength λe by $\Delta\lambda_c$ or $-\Delta\lambda_c$ respectively.

Electromechanical control of the residual deviations λe$-\lambda$s enables to avoid this mode hopping.

FIG. **5** represents the laser beam emitted **50** at the wavelength λe with respect to the wavelength selectivity curve **51** of the retroreflecting dispersing device, a curve centred on the wavelength λs and of width $\Delta\lambda$s halfway up, as well as the other longitudinal modes **52** to **59** of the Fabry-Perot cavity.

As long as the absolute value of the deviation λe$-\lambda$s remains smaller than $\Delta\lambda_c/2$, the emission beam **50** coincides with the mode of the Fabry-Perot cavity subject to he highest amplification. When the absolute value of the deviation λe$-\lambda$s becomes greater than $\Delta\lambda_c/2$, one of the longitudinal modes **52, 53** of the Fabry-Perot cavity placed on either side of λe is liable to be exposed to an amplification ratio greater than that of the wavelength λe and may become the emission wavelength to the detriment of the former emission wavelength. There is therefore, failing any control, a mode hopping that should have been avoided by mastering the deviation λe$-\lambda$s as provided by the invention.

Controlling and/or modulating the deviation λe$-\lambda$s can be carried out by controlling and/or modulating λe or λs. FIG. **6** represents the operating range **81** without any mode hopping. This range **81** centred on λs has a width of $\Delta\lambda$c.

The source of the invention is advantageously provided in accordance with FIG. **10** in which the retroreflecting dispersing device comprises a fixed grating **61** and a dihedron **69** mounted on a mobile bracket **602** which can revolve round the axis perpendicular to the dispersion plane of the grating **61** and going through D.

The grating **61**, the monomode guided amplifier medium **63** comprising an intracavity face **62**, and the collimation lens **64** are fixed on a frame **601**. The dihedron **69** is fixed on a primary mobile bracket **602** revolving round an axis **603** moved out of centre, so that the line **692** parallel to the edge **691** going through the point B' which is the optic extremity of the cavity, also goes through the axis **603**.

This axis **603** is fixed on a set of translation movements **604** and **605** which enable to position the said axis at the

intersection D of the perpendicular **606** to the cavity axis going through C', and of the line **607** going through the face of the grating **61**. A motor **608**, fixed to the frame **601**, actuates a rod **609** which causes the rotation round the axis **603** of the primary bracket **602** and of the dihedron **69** fixed thereon. Thus, the diffracted beam **68** which is selected in the cavity remains perpendicular to the edge **691**.

During rotation of the mobile bracket **602**, the beam **68** moves laterally on the dihedron **69**, as well as B', along the line **692**. This displacement of the beam is a geometric translation of the said beam, which does not imply any translations of mechanical parts.

This arrangement enables approximate, purely mechanical, adjustment of the continuous tunability, which is particularly convenient from the point of view of mechanical layout, since it uses simple mechanical rotation of the primary bracket. We observe that the point B' can be offset with respect to the position indicated above, thus shortening or lengthening the cavity. It is then possible to find the same continuous tunability condition by revolving round D while moving the point C' over the same length, but in reverse direction in order to compensate for this offset, offset caused by the displacement of B'.

This tunable source delivers a diverging beam **632** at the output **631** of the amplifier medium **63**, but it is also possible to use easily the collimated beam **633** which corresponds to the ordinary reflection of the beam **65** onto the grating **61**. This ordinary reflection, also called zero order of the grating, maintains a fixed direction since the grating is fastened to the grating and only the dihedron is mobile during wavelength adjustment.

Controlling and/or modulating the deviation λe$-\lambda$s is advantageously carried out by controlling and/or modulating λs. This can be provided by acting on the position and/or the additional angular orientation of the reflector **69** round an axis perpendicular to the dispersion plane. To this end, the latter is fixed on the arm **602** via articulated fastening means **701** and **702** and it is interconnected to back-up surfaces **703** and **704** which co-operate with piezoelectric actuators **705** and **706** interconnected to the primary bracket **602**. The actuators **705** and **706** can also be simply interposed between the primary bracket **602** and the reflector **69**. The primary bracket **602** enables approximate adjustment and the actuators **705** and **706** enable fine-control.

These piezoelectric actuators **705, 706**, corresponding to the actuator **49** of FIG. **4**, are operated by the control means **47** as regards controlling the average deviation $<\lambda$e$-\lambda$s $>$ and by the generator **48** as regards its modulation.

In a way similar and not represented, this modulation and/or control of λs can be monitored by acting of the angular orientation of the grating **61**.

It is still possible, for controlling and/or modulating the deviation λe$-\lambda$s, to act on λe, i.e. on the optic length L_{op} of the cavity. Varying the length L_{op} of the cavity can be carried out by translating the reflector **69** or the grating **61**. It is also possible to modulate the optic index of an element of the cavity, either of the amplifier guide **63** or of an additional element provided to this end, whose index can be varied in a controlled way. It is thus possible to act on the transversal position parallel to the dispersion plane of the collimation lens **64** with respect to the guided amplifier medium **63** which determines the orientation of the collimated beam **65**.

It is often useful to reduce the average deviation $<\lambda$e$-\lambda$s$>$ to zero, thereby bringing back the wavelength of the emission mode λe to the peak λs of the selectivity curve of the retroreflecting dispersing device. This produces the maximum optic power. In such a case, the slaving loop is designed so that the demodulated error signal is brought back to zero.

In practice, it has been noticed that automatic control of the average deviation <λe−λs> should preferably be set, not to the zero value, but to a positive value Δλo ranging from Δλ$_c$/5 to Δλ$_c$. This is what is represented on FIG. **9**. Indeed, it has been observed that the explanatory theory of the mode hopping presented above does not correspond to the reality any longer when the operation is far from the laser threshold. In practice, when the power emitted by the source increases, complex phenomena crop up, causing hysteresis and asymmetry effects. The source can then operate without mode hopping over a range of width Δλt greater than Δλc, but it has been detected that this operating range **82** without mode hopping was offset towards the long wavelengths with respect to λs (FIG. **7**). Adjustment to the maximum **84** (average deviation <λe−λs>=0) then exhibits important risks of mode hopping since the limit **83** towards the smaller wavelengths of these hops is close to λs and small fluctuation of the deviation λe−λs, possibly caused by modulation, could cause this frontier to be exceeded and provoke mode hopping (FIG. **8**). It is even possible, in the case of very high powers, that this limit **83** towards the smaller wavelengths exceed λs.

The value selected for Δλ=<λe−s> results from a compromise: Δλo must be large enough to keep λe away from the lower limit **83** of the mode hopping, but not too large in order to maintain sufficient power; this power deteriorates when λe moves away from λs which corresponds to the peak **84** of the selectivity curve.

The modulation **85**, **87** of the deviation λe−λs is represented on FIGS. **8** and **9**. On FIG. **8**, Δλ=<λe−λs> is equal to 0 and the modulation **85** leads to exceed, in the zone **86**, the lower limit **83**, which causes mode hopping. On FIG. **9**, selection of a value Δλo=<λe−λs> which is positive and sufficient prevents the modulation **87** from exceeding the lower limit **83**, without departing too much from the peak **84** of the selectivity curve.

In a particularly interesting embodiment, we seek to provide a source operating round a wavelength of approx. 1550 nm.

The length of the cavity can then be advantageously L$_{op}$=30 mm (30 mm one way only), the distance Δλc of the longitudinal modes is approx. 40 pm and the width Δλs halfway up of the selectivity curve is approx. 200 pm.

The deviation λe−λs should be controlled and/or modulated by additional rotation of the reflector **69**.

The modulation amplitude of the deviation λe−λs is typically 10 pm, i.e. Δλ$_c$/4 and the modulation frequency ranges from 5 to 10 kHz. Since the reflector dihedron can be very light, such a movement at such a frequency is obtained quite easily with less modulation voltage on conventional piezoelectric ceramics.

For monitoring and automatic controlling λe−λs on Δλo, which corrects the defects of the primary mechanical system, compensation amplitude is in practice linked with the electric voltage available to drive the actuators. A good order of magnitude consists in compensating for a few Δλ$_c$ (either a few mode hops) with a few tens of volts.

The reference signs inserted after the technical characteristics mentioned in the claims solely aim at facilitating the understanding of the said claims and do not limit their extent in any way.

What is claimed is:

1. An external cavity, continuously wavelength-tunable monomode laser source comprising a resonant cavity, resonating at an emission wavelength λe, with:

a spatially monomode, amplifying wave guide, located inside the resonant cavity, said wave guide having an intracavity face treated with an antireflection coat,

collimation optics with a focus, the intracavity face of the wave guide being located at the focus of said optics,

a partially reflecting output face on said wave guide,

extraction means for extracting a portion of intracavity flux from said wave guide,

a retroreflecting wavelength dispersing device, arranged with respect to the wave guide and to the collimation optics to produce a wavelength selectivity curve with a peak power wavelength λs,

primary mechanical means for interrelating said wave guide and said retroreflecting wavelength dispersing device for substantially continuous tunability of said laser source, and

additional fine-control means, for enabling from an approximate continuous tunability position, monitoring and controlling a deviation λe−λs so that during the variation of the emission wavelength λe, the deviation is prevented from reaching at least one of plural limits which would cause mode hopping of said laser source.

2. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein the fine-control means controls by acting on at least one of a position, and an orientation of the retroreflecting device.

3. A continuously wavelength-tunable monomode laser source according to claim **2**, wherein the fine-control means includes

a generator of modulation for the deviation λe−λs,

an intensity demodulator of the portion of the intracavity flux extracted by the extraction means and measured, said demodulator producing a demodulated signal, and

a control means receiving the demodulated signal and performing said acting for control of the position of the retroreflecting dispersing device.

4. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein an average deviation is monitored and controlled to a value Δλo greater than zero.

5. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein the deviation is monitored and controlled to zero.

6. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein control and modulation of λe−λs are provided by controlling and modulating the wavelength λs of the peak of the selectivity curve of the retroreflecting dispersing device.

7. A continuously wavelength-tunable monomode laser source according to claim **6**, wherein control and modulation of the wavelength λs are provided by rotation of one of plural elements of the retroreflecting dispersing device.

8. A continuously wavelength-tunable monomode laser source according to claim **7**, wherein the retroreflecting wavelength dispersing device comprises a reflector and, control and modulation of the peak power wavelength λs are provided by additional rotation of the reflector.

9. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein control and modulation of λe−λs are provided by controlling and modulating the emission wavelength λe.

10. A continuously wavelength-tunable monomode laser source according to claim **9**, wherein control and modulation of the emission wavelength λe are provided by additional translation of one of the elements of the resonant cavity.

11. A continuously wavelength-tunable monomode laser source according to claim **10**, wherein the retroreflecting wavelength dispersing device comprises a reflector, whereas control and modulation of the emission wavelength λe are provided by additional translation of the reflector.

12. A continuously wavelength-tunable monomode laser source according to claim **1**, wherein control and modulation of λe−λs are obtained by controlling and modulating a transversal position, parallel to the dispersion plane, of the collimation optics.

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