Patent RU2564517C2

Passively mode-locked fibre pulsed linear laser (versions)

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Priority: 2014-01-10 | **Filing**: 2014-01-10 | **Grant**: 2015-10-10 | **Publication**: 2015-10-10

***Abstract**: passively mode-locked fibre pulsed linear laser comprises a pumping radiation source, a radiation polarisation supporting fibre linear resonator, comprising series-arranged spectrally selective reflecting element, a collimator, a fibre end which does not reflect laser radiation back to said fibre, an amplifying fibre, at least one fibre spectral information module for inputting pumping radiation into the resonator, at least one polarisation-dependent splitter for outputting radiation from the resonator, a fibre end which does not reflect laser radiation back to said fibre, a collimator, a radiation focusing optical element and a resonator mirror. The resonator mirror is placed on the flat surface of laser radiation-transparent optical element with Kerr-type nonlinearity and thickness greater than 0.5 mm, the second flat surface of which is located between the mirror and the radiation focusing optical element and has an inclination angle greater than 1 degree to the axis of the laser resonator. EFFECT: enabling generation of short-pulse radiation in a wide spectral range without limitations on the service life of the laser.*
35 cl, 7 dwg

Description

The present invention relates to lasers - gears for generation of coherent of electromagnetic waves and is industrially applicable in devices and systems using laser radiation.

From the existing level of technics is known for fiber pulse a linear laser is with passive mode locking of radiation (WO 2004/059806 the A2, Optical pulse lasers), in which the functions device the synchronization radiation modes performs a saturable absorber based on carbon nanotubes, deposited on the reflecting mirror of the resonator laser. The main disadvantage of saturating absorbers, in including on the basis of carbon nanotubes, is a their susceptibility degradation when working in the conditions of high-density power of the incident of laser radiation, required to achieve absorption saturation. In connection with this characteristic term work saturable absorbers makes from several honeycombs up to several thousand hours. In addition, cooking homogeneous of the matrix with carbon nanotubes and applying her on the mirror laser is a complex of technological process, not always realizable even in laboratory conditions.

Known also Jog laser with synchronization modes radiation with via Kerr lenses in the optical member, located in the resonator laser in beam waist laser radiation (WO 2,013,050,054 A1, Laser device with kerr effect based mode-locking and operation thereof). Disadvantage of this solutions is that it stipulated only for lasers with disc active medium and does not envisage use to the proposed synchronization device radiation modes in a fiber laser.

The most closest to the claimed technical solution is a fiber laser with passive mode locking radiation behind expense of application of a semiconductor saturable absorber (US patent 6,097,741, Passively mode-locked fiber lasers). The disadvantage of this solutions is a susceptibility to of semiconductor saturable absorbers degradation when working in the conditions of high-density power of the incident of laser radiation, the maximum time service a semiconductor saturable absorber does not exceed the several thousand hours. In addition, manufacturing of a semiconductor saturable absorber and alignment of his with a mirror of the resonator is a complex technological task requiring special expensive equipment, special expensive materials and high qualification of.

The task to be the solution of which is directed the claimed invention, is the creation of of a fiber pulsed linear laser with a passive synchronizer radiation modes, not requiring of application of complex

expensive technologies and materials for of its manufacturing, having a unlimited service life and having the the opportunity to of the spectral of perestroika of the emission line in a wide spectral the range.

This task is solved at the expense of addition, that in the known a fiber pulsed a linear laser with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation into the resonator, At least one poljarizatsionno-dependent coupler for the the emission output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation optical element, mirror resonator, according invention mirror resonator located on audio surface of the transparent for radiation laser optical element with Kerr nonlinearity and thickness exceeding 0.5 mm, other surface whose located between the mirror and the focusing radiation optic element and the has an inclination angle more than one degrees to the axis of of the resonator laser.

In particular, the other surface of the optical element with the Kerr nonlinearity can have antireflection coating.

In particular, spectrally-selective reflection member may be a prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

In particular, spectrally-selective reflective element of may be a fiber Bragg grating or volumetric a diffraction grating.

In particular, spectrally-selective reflection member may be a mirror with prescribed spectral stripe reflection.

In particular, collimators and the focusing radiation optical element might have the antireflection coatings.

In particular, between the focusing radiation optic element and the closest thereto collimator may be disposed polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

In particular, source pump radiation fiber laser may be a Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical element Si, N, Ga, Al, Fe , F, Ti, In, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser may be formed two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and reflective radiation first Stokes components the Raman laser.

In particular, resonator the Raman laser may be formed four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components the Raman laser.

This task is solved at the expense of addition, that in the known a fiber pulsed a linear laser with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation into the resonator, At least one poljarizatsionno-dependent coupler for the the emission

output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation optical element, mirror resonator, according invention between the mirror resonator and the focusing radiation optical element located optical element with Kerr nonlinearity and thickness exceeding 0.5 mm with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

In particular, both surface of the optical element with the Kerr nonlinearity have the antireflection coating.

In particular, distance between the mirror resonator and nearest thereto surface of the optical element with Kerr nonlinearity not exceeds 1 mm.

In particular, spectrally-selective reflection member may be a prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

In particular, spectrally-selective reflective element of may be a fiber Bragg grating or volumetric a diffraction grating.

In particular, spectrally-selective reflection member may be a mirror with prescribed spectral stripe reflection.

In particular, collimators and the focusing radiation of optical element have the antireflection coatings.

In particular, between the focusing radiation optic element and the closest thereto collimator may be disposed polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

In particular, source pump radiation fiber laser may be a Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical element Si, N, Ga, Al, Fe , F, Ti, In, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser may be formed two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and reflective radiation first Stokes components the Raman laser.

In particular, that the resonator the Raman laser may be formed four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components the Raman laser.

This task is solved at the expense of addition, that in the known a fiber pulsed a linear laser with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation into the resonator, At least one poljarizatsionno-dependent coupler for the the emission output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation optical element, mirror resonator, according invention mirror resonator is spherical, between spherical mirror resonator and the focusing radiation optical element at the beam waist radiation located optical element with Kerr nonlinearity and thickness exceeding 0.5 mm with bushing for radiation laser surfaces having angle tilt adjustment to the resonator axis laser does not less than one degree.

In particular, both surface of the optical element with the Kerr nonlinearity have the antireflection coating.

In particular, both surface of the optical element with the Kerr nonlinearity are Brewster.

In particular, spectrally-selective reflection member may be a prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

In particular, spectrally-selective reflective element of may be a fiber Bragg grating or volumetric a diffraction grating.

In particular, spectrally-selective reflection member may be a mirror with prescribed spectral stripe reflection.

In particular, collimators and the focusing radiation of optical element have the antireflection coatings.

In particular, between the focusing radiation optic element and the closest thereto collimator may be disposed polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

In particular, source pump radiation fiber laser may be a Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical element Si, N, Ga, Al, Fe , F, Ti, B, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser may be formed two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and reflective radiation first Stokes components the Raman laser.

In particular, that the resonator the Raman laser may be formed four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components the Raman laser.

The technical result of, provided by the reduced totality of signs of, is the achievement of of small duration pulses the output radiation fiber laser with the possibility of of perestroika spectrum of radiation and ensuring the stability of obtained parameters radiation in the for an unlimited time. Malaya duration of the pulses is achieved due to realization of the timing mode radiation modes with the use of of the Kerr effect (quadratic electro-optical effect), providing a fast non-linear response of the medium with a characteristic time response of the order of 10-14-10-15 with. Effect Kerr leads to a change values refractive index optical material proportionally square of tensions applied electric field which took in case axisymmetric Gaussian beam radiation or the like having transverse distribution radiation intensity, "decaying" to the edges beam, leads to the formation in a medium of induced so-called "Kerr lens "- distribution of values the refractive index, to the current on the beam the transmitted radiation as a lens. For the majority of of optical materials, possessing the Kerr nonlinearity (quartz, polycomponent glass-class FFs, sapphire, calcite and other) this lens is a positive. Formation of the quick the Kerr lens in the resonator laser allows you to create a configuration of the resonator, at which the high-intensity pulse of laser radiation has small optical losses, as well long pulse or continuous radiation have large optical losses. Shareable action Kerr lenses in the optical member with Kerr nonlinearity and spatial filtration fashion (when entering radiation into fiber) corresponding radiation pulses with the greatest peak power, leads to breeding generation regime short pulses radiation with high peak power.

Should be noted that audio one separately details commitment made device does not gives such effect what gives totality stated features. Prior to the of filing this application was unpredictably, that the totality of of stated features will allow to solve the task of creating of a fiber pulsed linear laser with a passive synchronizer radiation modes, not requiring of application of complex expensive technologies and materials for of its manufacturing, having a unlimited service life and having the the opportunity to of the spectral of perestroika line radiation in a wide spectral range.

The invention is illustrated by the following drawings.

FIG. 1 is represented scheme of of a fiber pulsed linear laser with passive synchronization radiation modes: 1 - a source of the pump radiation, 2 - spectrally-selective reflecting element, 3 - a collimator, 4 - the fiber end linear of the resonator, 5 - supportive the polarization of radiation potentiating fiber, 6 - fiber module spectral information for the introduction of the pump radiation into the resonator, 7 - poljarizatsionno-dependent coupler for the the emission output from the resonator, 8 - fiber for O the output radiation, 9 - the fiber end linear of the resonator, 10 - a collimator, 11 - a focusing radiation of optical element, 12 - an optical element of with the Kerr nonlinearity, 13 - a mirror of the resonator, 14 - the other surface of the optical element with the Kerr nonlinearity.

FIG. 2 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein spectrally-selective reflection member 2 is prism in combination with a reflective mirror.

FIG. 3 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein spectrally-selective reflection member 2 is prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

FIG. 4 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein between the mirror resonator and the focusing optical element located optical element with Kerr nonlinearity, whose surface the have an angle of inclination to resonator axis laser does not less than one degree.

FIG. 5 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein mirror resonator is spherical, between spherical mirror resonator and focusing element at the beam waist radiation located optical element with Kerr nonlinearity, whose surface the have an angle of inclination to resonator axis laser does not less than one degrees.

FIG. 6 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein source pump radiation fiber laser is Raman laser, when this resonator the Raman laser formed by two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and reflective radiation first Stokes components the Raman laser.

FIG. 7 is represented diagram fiber pulsed linear laser with passive synchronization radiation modes, wherein between the focusing radiation optic element and the closest thereto collimator located polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

The device operates as follows.

The pump radiation, generated a source of 1 of optical radiation the pumping, through the fiber module spectral information 6 adjudged to be in reinforcing fiber 5, translating an amplifying medium laser in active state; lasing laser is carried in the linear resonator, mirrors in whose are: spectrally-selective reflecting element 2 and reflecting surface 13 which is flat when her's location in on audio side optical element with Kerr nonlinearity or spherical when her's location in on a spherical mirror. The surface of

(or the surface of) 14 of the optical element with the Kerr nonlinearity has a (or have the) antireflection coating. Butts fiber 4 and 9 have inclined surface (skoly), not reflecting radiation laser ago at this fiber. Collimating exiting from end faces fiber radiation produced collimators 3 and 10. Focusing radiation on element with Kerr nonlinear is carried focusing element 11. As the collimators and focusing element can be used as lenses, so and lenses. The output radiation laser 8 is deduced from of the resonator laser through poljarizatsionno-dependent coupler 7. Use of coupler 7 with the polarization Discrimination in conjunction with fellow the polarization of radiation reinforcing fiber allows to carry out inside the resonator laser the generation of linearly-polarized radiation and eliminate the effect of the nonlinear evolution of polarization of the radiation, which could manifest itself when generating laser unpolarized radiation. Polarization discrimination radiation inside resonator of laser can be strengthened with via polarizer 16 (FIG. 7). Eliminating the effect of nonlinear of evolution polarization of the radiation (the parasitic in this case) is necessary to for the realization of the synchronization radiation modes only on the basis of the Kerr effect, Modifies the value of the refractive index optical material proportional to the square of tension the applied electric field. Effect the Kerr provides quick non-linear response of the medium with a characteristic time response of the order of 10-14-10-15 with, that the allows you to with the use of of this effect to generate extremely short pulses of radiation, the duration of which can be up of all one period oscillations of the electromagnetic of the field. Kerr lens can degrade the or improve setting the laser resonator due to change of focusing of radiation. For example, if focus radiation beam on FIG. 1 is located behind the surface 13 (away The between focusing element 11 and the reflecting surface 13 less than the focal distances focusing element 11), then Kerr lens in the optical member 12 will allow migrate focus radiation on the surface 13. In this case without Kerr lenses radiation losses in the resonator more so as focus radiation located not on reflective surface 13, and behind her. Accordingly, a short high-intensity pulse of laser radiation will have smaller optical losses in such a resonator, than a long impulse or continuous radiation. That is why in such a originally slightly mistuned the resonator laser (focus radiation lies not on the the reflecting surface, and behind it) preferred is a synchronization mode radiation modes at the expense of of the Kerr effect, so-as the pulsed radiation laser in this mode has smaller optical losses.

Such synchronization radiation modes may be implemented as in case of location optical element with Kerr nonlinearity near the focus radiation (FIG. 1), so and in case of location optical element with Kerr nonlinearity in Focus radiation (FIG. 5). In this case, originally slightly detuned the laser resonator (the surface of radiation things being equal phases does not coincide with a spherical reflecting surface 13) at the expense of the Kerr effect in the optical element 12 improves the setting - the surface of of radiation things being equal phases coincides with a spherical reflecting surface 13.

For increase your degree radiation polarization laser between the collimator 10 and focusing element 11 may be located polarizer 16 (FIG. 7) with bushing for the radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

Placed on the between the reflectors of the resonator laser 2 and 13 all reflective surfaces elements of the resonator laser does not should reflect the radiation of ago into the resonator, otherwise reflected from the of these surfaces radiation can to initiate the parasitic the generation of, incapable to solve the task of the claimed invention. Butts fiber 4 and 9 do not reflect radiation laser ago at this fiber at the expense addition, that have or cleave angle not less than 8-mi degrees, or butt terminates fiber without a core (coreless fiber). Reflective surface polarizer (FIG. 7) are inclined to the resonator axis laser on angle is not less than one degree and might have the antireflective Floor. Antireflection Floor might have the also collimators 3 and 10, focusing element 11, one (FIG. 1-3) or two (FIG. 4, 5) surface optical element with Kerr nonlinearity.

Synchronization mod radiation on the basis the Kerr lens favorably differs from the synchronization modes at the the basis of saturable absorbers by the fact that Kerr lens has a unlimited service life,

works in a wide the spectral range, the threshold of its use on density the radiation power is limited only by threshold of destruction of the material itself.

There is a lot of optical materials, possessing the Kerr nonlinearity and transparent in a wide spectral the range - quartz, polycomponent glass-class FFs, sapphire, calcite and others. Kerr lens can be formed in the elements of from these materials in a wide range of the spectrum, that allows to use such elements both for the of tunable along the length of a wave of radiation lasers, so-and for lasers with different wavelengths radiation. Since the effect Kerr is nonlinear optical effect, the calling changes values refractive index optical material proportionally second degree tensions applied electric field, then most strongly he manifested at high density radiation power that in the claimed invention ensured located hotel optical element with Kerr nonlinearity near the focus radiation or in focus radiation. Acute focusing is of laser radiation relatively Short Throw element of with a focus of 30-50 mm allows to generate an appreciable the Kerr lens in the optical elements, possessing the Kerr nonlinearity, thickness of more than 0.5 mm.

The claimed invention may be implemented with using a wide series augmentative fibers - fibers doped with rare earth ions such as erbium (Er^{3+}), neodymium (Nd^{3+}), itterbij (Yb^{3+}), thulium (Tm^{3+}), holmium (Ho^{3+}), bismuth (Bi^{3+}) and others, and also Raman fibers.

When using Raman laser as a source of the pump radiation fiber laser spectrum of the gain band fiber laser corresponds either to spectrum of the first Stokes component Raman laser (without the use of additional of Bragg gratings), either spectrum of second Stokes component Raman laser (when using two of Bragg gratings, "of locking" radiation first Stokes components), either spectrum third Stokes components the Raman laser (when using four Bragg gratings, two of which "locked" radiation first Stokes components the Raman laser, while two other "locked" radiation second Stokes components the Raman laser). The described schemes correspond to the one-stage, two-stage and three-stage Raman the laser to. Using the Raman laser as a radiation source pumping fiber laser allows implement generation the claimed laser in wide spectral range, including in those portions spectrum, in which not provide a gain fiber, doped with rare earth ions.

Number cascades the Raman laser, used as the source pump radiation fiber laser, may be greater three, however EFFICIENCY radiation conversion the Raman laser decreases with the number cascades, therefore usually length pump wave the Raman laser is chosen as easy as possible closer to the required spectral range A of generation for order to minimize the number cascades the Raman laser and ensure greater efficiency laser system.

Possibility of use as a amplifying medium fibers, doped rare-earth ions, as well as Raman fibers, in conjunction with the possibility of of smooth tuning of spectrum of radiation and Kerr "all-wave" element of the synchronization radiation modes allows to carry out the generation of of short pulses of the claimed laser in the ultra a wide spectral range corresponding to to the intersection of of areas transparency used in a laser optical materials.

Claims (35)

1: Fibre pulse a linear laser is with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation in the amplifying fiber, At least one poljarizatsionno-dependent coupler for the the emission output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation of optical element, mirror of the resonator, characterized fact that mirror resonator located on audio surface of

the transparent for radiation laser optical element with Kerr nonlinearity and thickness exceeding 0.5 mm, other surface whose located between the mirror and the focusing radiation optic element and the has an inclination angle not less than one degree to the resonator axis laser .

2: The laser is according to claim. 1, characterized in that the the other surface of the optical element with the Kerr nonlinearity has a antireflection coating.

3: Laser according to claim. 1, characterized fact that spectrally-selective reflective element is the prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

4: Laser according to claim. 1, characterized fact that spectrally-selective reflective element is the fiber Bragg grating or volumetric diffraction grating.

5: Laser according to claim. 1, characterized fact that spectrally-selective reflective element is the mirror with prescribed spectral stripe reflection.

6: Laser according to claim. 1, characterized in that between the focusing radiation optic element and the closest thereto collimator located polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

7: Laser according to claim. 6, characterized fact that and communicating for radiation laser surface polarizer have antireflective Floor.

8: Laser according to claim. 1, characterized fact that and communicating for radiation laser surface collimators and a focusing radiation optical element have antireflective Floor.

9: Laser according to claim. 1, characterized fact that in as reinforcing fiber applied as glass optical fiber, so and glass optical fiber, doped by rare earth elements or doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical element Si, N, Ga, Al, Fe, F, Ti, B, Sn, Ba, Ta, Zr, Bi.

10: Laser according to claim. 1, characterized fact that source pump radiation fiber laser is Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical Si element of , N, Ga, Al, Fe, F, Ti, B, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser formed by two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and are reflective for radiation first Stokes components the Raman laser.

11: Laser according to claim. 10, characterized fact that resonator the Raman laser is formed by four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components of Raman laser.

12: Fibre pulse a linear laser is with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation in the amplifying fiber, At least one poljarizatsionno-dependent coupler for the the emission output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation of optical element, mirror of the resonator, characterized fact that between the mirror resonator and the focusing

optical element located optical element with Kerr nonlinearity and thickness exceeding 0.5 mm with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

13: Laser according to claim. 12, characterized fact that both surfaces optical element with Kerr nonlinearity have antireflective Floor.

14: Laser according to claim. 12, characterized fact that away The between the mirror resonator and nearest thereto surface of the optical element with Kerr nonlinearity not exceeds 1 mm.

15: Laser according to claim. 12, characterized fact that spectrally-selective reflective element is the prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

16: Laser according to claim. 12, characterized fact that spectrally-selective reflective element is the fiber Bragg grating or volumetric diffraction grating.

17: Laser according to claim. 12, characterized fact that spectrally-selective reflective element is the mirror with prescribed spectral stripe reflection.

18: Laser according to claim. 12, characterized in that between the focusing radiation optic element and the closest thereto collimator located polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

19: Laser according to claim. 18, characterized fact that and communicating for radiation laser surface polarizer have antireflective Floor.

20: Laser according to claim. 12, characterized fact that and communicating for radiation laser surface collimators and a focusing radiation optical element have antireflective Floor.

21: Laser according to claim. 12, characterized fact that in as reinforcing fiber applied as glass optical fiber, so and glass optical fiber, doped by rare earth elements or doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical element Si, N, Ga, Al, Fe, F, Ti, B, Sn, Ba, Ta, Zr, Bi.

22: Laser according to claim. 12, characterized fact that source pump radiation fiber laser is Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical Si element of , N, Ga, Al, Fe, F, Ti, B, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser formed by two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and are reflective for radiation first Stokes components the Raman laser.

23: Laser according to claim. 22, characterized fact that resonator the Raman laser is formed by four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components of Raman laser.

24: Fibre pulse a linear laser is with passive mode locking of radiation, containing an optically related the pumping radiation source, which supports the polarization of radiation fiber a linear the resonator, containing sequentially located spectrally-selective reflecting element, a collimator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, potentiating fiber, At least one fiber module spectral information for the introduction of the pump radiation in the amplifying fiber, At least one

poljarizatsionno-dependent coupler for the the emission output from the resonator, the fiber end, do not reflecting the radiation of the laser ago at this fiber, a collimator, a focusing radiation of optical element, mirror of the resonator, characterized fact that mirror resonator is spherical, between spherical mirror resonator and the focusing radiation optical element at the beam waist radiation located optical element with Kerr nonlinearity and thickness exceeding 0.5 mm with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

25: Laser according to claim. 24, characterized fact that both surfaces optical element with Kerr nonlinearity have antireflective Floor.

26: Laser according to claim. 24, characterized fact that both surfaces optical element with Kerr nonlinearity are Brewster.

27: Laser according to claim. 24, characterized fact that spectrally-selective reflective element is the prism in the combination with reflecting mirror or prism Littrow with a reflective coating on a surface on which normally falls sheaf laser radiation after refraction on the input a Brewster-surface prism.

28: Laser according to claim. 24, characterized fact that spectrally-selective reflective element is the fiber Bragg grating or volumetric diffraction grating.

29: Laser according to claim. 24, characterized fact that spectrally-selective reflective element is the mirror with prescribed spectral stripe reflection.

30: Laser according to claim. 24, characterized in that between the focusing radiation optic element and the closest thereto collimator located polarizer with bushing for radiation laser surfaces having angle of inclination to resonator axis laser does not less than one degree.

31: Laser according to claim. 24, characterized fact that and communicating for radiation laser surface polarizer have antireflective Floor.

32: Laser according to claim. 24, characterized fact that and communicating for radiation laser surface collimators and a focusing radiation optical element have antireflective Floor.

33: Laser according to claim. 24, characterized fact that in as reinforcing fiber applied as glass optical fiber, so and glass optical fiber, doped by rare earth elements or doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in Connect of chemical element Si, N, Ga, Al, Fe, F, Ti, B, Sn, Ba, Ta, Zr, Bi.

34: Laser according to claim. 24, characterized fact that source pump radiation fiber laser is Raman laser when used as amplifying fiber fiberglass, doped oxides germanium, phosphorus, and also their combination, thus in oxide matrix may go in compound chemical Si element of , N, Ga, Al, Fe, F, Ti, In, Sn, Ba, Ta, Zr, Bi, when this resonator the Raman laser formed by two fiber Bragg gratings, to Have perpendicular the ray or sloping strokes and are reflective for radiation first Stokes components the Raman laser.

35: Laser according to claim. 34, characterized fact that resonator the Raman laser is formed by four fiber Bragg gratings, to Have perpendicular the ray or sloping strokes, two of which are reflective for radiation first Stokes components the Raman laser, and two others are reflective for radiation second Stokes components of Raman laser.