

CPC**COOPERATIVE PATENT CLASSIFICATION****H01S****DEVICES USING STIMULATED EMISSION****NOTE**

This subclass covers:

- devices for the generation or amplification, by using stimulated emission, of coherent electromagnetic waves or other forms of wave energy;
- such functions as modulating, demodulating, controlling, or stabilising such waves.

WARNING

The following IPC groups are not used in the CPC scheme.

Subject matter covered by these groups is classified in the following CPC groups:

- [H01S 3/098](#) covered by [H01S 3/08018](#), [H01S 3/11](#) and s.gr.

H01S 1/00

Lasers, i.e. devices for generation, amplification, modulation, demodulation, or frequency-changing, using stimulated emission, of electromagnetic waves of wavelength longer than that of infra-red waves

H01S 1/005

- . {using a relativistic beam of charged particles, e.g. electron cyclotron maser, gyrotron}

H01S 1/02

- . solid

H01S 1/04

- . liquid

H01S 1/06

- . gaseous, {i.e. beam masers (atomic clocks [G04F 5/14](#); circuits using beam masers as a reference frequency for regulating frequency of oscillators [H03L 7/26](#); molecular or atomic beam generation [H05H 3/02](#))}

H01S 3/00

Lasers, i.e. devices for generation, amplification, modulation, demodulation, or frequency-changing, using stimulated emission, of infra-red, visible, or ultra-violet waves ({stimulated Brillouin or Raman effects [H01S 3/30](#)}; semiconductor lasers [H01S 5/00](#))

H01S 3/0007

- . {Applications not otherwise provided for (working metals or other materials by laser beam [B23K 26/00](#); using photons to produce a reactive propulsive thrust [F03H 3/00](#); optical recording of measured values in general [G01D 15/14](#); optics in general [G02B](#); holographic processes or apparatus [G03H](#); optical marking or sensing of data record carriers [G06K 7/10](#) to [G06K 7/14](#), [G06K 15/12](#); injection heating of plasma by laser [H05H 1/22](#); acceleration of neutral particles by electromagnetic wave pressure [H05H 3/04](#))}

H01S 3/0014

- . {Monitoring arrangements not otherwise provided for (photometry [G01J 1/00](#), e.g. [G01J 1/4257](#); radiation pyrometry [G01J 5/00](#); measuring coherence of light [G01J 9/00](#); measuring wavelength of light [G01J 9/00](#), e.g. [G01J 9/0246](#); measuring optical pulses [G01J 11/00](#); calorimetrically measuring power of laser beams [G01K 17/003](#))}

H01S 3/005

- . {Optical devices external to the laser cavity, specially adapted for lasers, e.g. for homogenisation of the beam or for manipulating laser pulses, e.g. pulse shaping (shaping laser beam for working metal or other materials [B23K 26/06](#); optical elements, systems or apparatus in general [G02B](#))}

- H01S 3/0057 .. {Temporal shaping, e.g. pulse compression, frequency chirping ([soliton generation and propagation G02F 1/3513](#), [H01S 3/063](#) and [H01S 3/108](#))}
- H01S 3/0064 .. {Anti-reflection devices, e.g. optical isolators ([absorbing layers for marking or protecting purposes in laser working B23K 26/0054](#); [magneto-optical non-reciprocal devices G02F 1/093](#), [G02F 1/0955](#))}
- H01S 3/0071 .. {Beam steering, e.g. whereby a mirror outside the cavity is present to change the beam direction}
- H01S 3/0078 .. {Frequency filtering}
- H01S 3/0085 .. {Modulating the output, i.e. the laser beam is modulated outside the laser cavity}
- H01S 3/0092 .. {Nonlinear frequency conversion, e.g. second harmonic generation [SHG] or sum- or difference-frequency generation outside the laser cavity ([nonlinear frequency conversion per se G02F 1/35](#))}
- H01S 3/02 . Constructional details {([housings or packages of fibre lasers H01S 3/06704](#))}
- H01S 3/022 .. {of liquid lasers}
- H01S 3/025 .. {of solid state lasers, e.g. housings or mountings}
- H01S 3/027 ... {comprising a special atmosphere inside the housing}
- H01S 3/03 .. of gas laser discharge tubes {([gas discharge tubes in general H01J 17/00](#), [H01J 61/00](#))}
- H01S 3/0305 ... {Selection of materials for the tube or the coatings thereon}
- H01S 3/031 ... {Metal vapour lasers, e.g. metal vapour generation}
- H01S 3/0315 ... {Waveguide lasers}
- H01S 3/032 ... for confinement of the discharge, e.g. by special features of the discharge constricting tube
 - H01S 3/0323 {by special features of the discharge constricting tube, e.g. capillary}
 - H01S 3/0326 {by an electromagnetic field}
- H01S 3/034 ... Optical devices within, or forming part of, the tube, e.g. windows, mirrors ([reflectors having variable properties or position for initial adjustment of the resonator H01S 3/086](#))
 - H01S 3/0343 {Aerodynamic windows}
 - H01S 3/0346 {Protection of windows or mirrors against deleterious effects ([cooling arrangements H01S 3/0401](#))}
- H01S 3/036 ... Means for obtaining or maintaining the desired gas pressure within the tube, e.g. by gettering, replenishing; Means for circulating the gas, e.g. for equalising the pressure within the tube {([H01S 3/031 takes precedence](#); [cooling arrangements for gas lasers H01S 3/041](#); [gas dynamic lasers H01S 3/0979](#); in general [H01J 17/22](#), [H01J 61/24](#))}
- H01S 3/038 ... Electrodes, e.g. special shape, configuration or composition
 - H01S 3/0381 {Anodes or particular adaptations thereof}
 - H01S 3/0382 {Cathodes or particular adaptations thereof}
 - H01S 3/0384 {Auxiliary electrodes, e.g. for pre-ionisation or triggering, or particular adaptations therefor}
 - H01S 3/0385 {Shape}
 - H01S 3/0387 {Helical shape}
 - H01S 3/0388 {Compositions, materials or coatings}
- H01S 3/04 .. Cooling arrangements

H01S 3/0401	...	{of optical elements being part of laser resonator, e.g. windows, mirrors, lenses}
H01S 3/0402	...	{for liquid lasers}
H01S 3/0404	...	{Air- or gas cooling, e.g. by dry nitrogen}
H01S 3/0405	...	{Conductive cooling, e.g. by heat sinks or thermo-electric elements}
H01S 3/0407	...	{Liquid cooling, e.g. by water}
H01S 3/0408	...	{Radiative cooling, e.g. by anti-Stokes scattering in the active medium}
H01S 3/041	...	for gas lasers {(H01S 3/0401 takes precedence)}
H01S 3/042	...	for solid state lasers {(H01S 3/0401 takes precedence)}
H01S 3/05	.	Construction or shape of optical resonators; Accomodation of active medium therein; Shape of active medium
H01S 3/06	..	Construction or shape of active medium
H01S 3/0602	...	{Crystal lasers or glass lasers (H01S 3/063 takes precedence)}
H01S 3/0604	....	{in the form of a plate or disc}
H01S 3/0606	....	{with polygonal cross-section, e.g. slab, prism (H01S 3/0604 takes precedence)}
H01S 3/0608	....	{Laser crystal with a hole, e.g. a hole or bore for housing a flashlamp or a mirror}
H01S 3/061	....	{with elliptical or circular cross-section and elongated shape, e.g. rod}
H01S 3/0612	....	{Non-homogeneous structure (H01S 3/07 takes precedence)}
H01S 3/0615	....	{Shape of end-face}
H01S 3/0617	....	{having a varying composition or cross-section in a specific direction}
H01S 3/0619	...	{Coatings, e.g. AR, HR, passivation layer}
H01S 3/0621	....	{Coatings on the end-faces, e.g. input/output surfaces of the laser light}
H01S 3/0623	.....	{Antireflective [AR]}
H01S 3/0625	....	{Coatings on surfaces other than the end-faces}
H01S 3/0627	...	{the resonator being monolithic, e.g. microlaser}
H01S 3/063	...	Waveguide lasers, {i.e. whereby the dimensions of the waveguide are of the order of the light wavelength (waveguide gas lasers H01S 3/0315)}
H01S 3/0632	....	{Thin film lasers in which light propagates in the plane of the thin film}
H01S 3/0635	.....	{provided with a periodic structure, e.g. using distributed feed-back, grating couplers (controlling, e.g. modulating distributed feed-back lasers H01S 3/102)}
H01S 3/0637	.....	{Integrated lateral waveguide, e.g. the active waveguide is integrated on a substrate made by Si on insulator technology (Si/SiO ₂)}
H01S 3/067	....	Fibre lasers {(optical pumping thereof H01S 3/094003; controlling the output parameters H01S 3/10; stabilisation of the output parameters H01S 3/13; characterised by scattering effects, i.e. stimulated Brillouin or Raman effects, H01S 3/302)}
H01S 3/06704	.....	{Housings; Packages}
H01S 3/06708	.....	{Constructional details of the fibre, e.g. compositions, cross-section, shape or tapering (optical fibres as passive waveguides G02B 6/02)}
H01S 3/06712	.....	{Polarising fibre; Polariser}

H01S 3/06716	.....	{Fibre compositions (per se C03C 13/04) or doping with active elements (lasing materials in general H01S 3/14)}
H01S 3/0672	.....	{Non-uniform radial doping}
H01S 3/06725	.....	{Fibre characterized by a specific dispersion, e.g. for pulse shaping in soliton lasers or for dispersion compensating [DCF]}
H01S 3/06729	.....	{Peculiar transverse fibre profile}
H01S 3/06733	.....	{Fibre having more than one cladding}
H01S 3/06737	.....	{Fibre having multiple non-coaxial cores, e.g. multiple active cores or separate cores for pump and gain}
H01S 3/06741	.....	{Photonic crystal fibre, i.e. the fibre having a photonic bandgap}
H01S 3/06745	.....	{Tapering of the fibre, core or active region}
H01S 3/0675	.....	{Resonators including a grating structure, e.g. distributed Bragg reflectors [DBR] or distributed feedback [DFB] fibre lasers}
H01S 3/06754	.....	{Fibre amplifiers (H01S 3/06708 takes precedence)}
H01S 3/06758	.....	{Tandem amplifiers}
H01S 3/06762	.....	{having a specific amplification band}
H01S 3/06766	.....	{C-band amplifiers, i.e. amplification in the range of about 1530 nm to 1560 nm}
H01S 3/0677	.....	{L-band amplifiers, i.e. amplification in the range of about 1560 nm to 1610 nm}
H01S 3/06775	.....	{S-band amplifiers, i.e. amplification in the range of about 1450 nm to 1530 nm}
H01S 3/06779	.....	{with optical power limiting}
H01S 3/06783	.....	{Amplifying coupler}
H01S 3/06787	.....	{Bidirectional amplifier}
H01S 3/06791	.....	{Fibre ring lasers (fibre laser gyrometers G01C 19/72)}
H01S 3/06795	.....	{with superfluorescent emission, e.g. amplified spontaneous emission sources for fibre laser gyrometers (fibre laser gyrometers per se G01C 19/72)}
H01S 3/07	...	consisting of a plurality of parts, e.g. segments (H01S 3/067 takes precedence)
H01S 3/073	....	{Gas lasers comprising separate discharge sections in one cavity, e.g. hybrid lasers (tandem arrangements of separate gas lasers H01S 3/2366)}
H01S 3/076	.....	{Folded-path lasers}
H01S 3/08	..	Construction or shape of optical resonators or components thereof {(waveguide lasers H01S 3/063 ; controlling the laser output H01S 3/10 ; stabilising H01S 3/13)}
H01S 3/08004	...	{incorporating a dispersive element, e.g. a prism for wavelength selection (H01S 3/0811 , H01S 3/08022 take precedence)}
H01S 3/08009	....	{using a diffraction grating}
H01S 3/08013	...	{Resonator comprising a fibre, e.g. for modifying dispersion or repetition rate (the active medium being a fibre H01S 3/067)}
H01S 3/08018	...	{Mode suppression}
H01S 3/08022	....	{Longitudinal mode control, e.g. specifically multimode}
H01S 3/08027	.....	{by a filter, e.g. a Fabry-Perot filter is used for wavelength setting}
H01S 3/08031	.....	{Single-mode emission}

H01S 3/08036	.....	{by a dispersive, polarising or birefringent element placed in the cavity, e.g. a Fabry-Perot etalon, tilted plate}
H01S 3/0804	....	{Transverse or lateral mode control, e.g. specifically multimode}
H01S 3/08045	.....	{Single-mode emission}
H01S 3/0805	.....	{by apertures, e.g. pinholes, knife-edges, apodizers}
H01S 3/08054	...	{Passive cavity elements acting on the polarization, e.g. a polarizer for branching or walk-off compensation (quarter-wave plates in a Q-switch laser H01S 3/1124 , H01S 3/115)}
H01S 3/08059	...	{Constructional details of the reflector, e.g. shape (mirrors in general G02B 5/08 ; mountings for mirrors G02B 7/18)}
H01S 3/08063	....	{Graded reflectivity, e.g. variable reflectivity mirror}
H01S 3/08068	....	{Holes; Stepped surface; Special cross-section}
H01S 3/08072	...	{Thermal lensing or thermally induced birefringence; Compensation thereof}
H01S 3/08077	....	{Pump induced waveguiding, i.e. the pump induces refractive index change in the laser medium to guide the amplified light, e.g. gain- or loss- guiding or thermally induced refractive index change}
H01S 3/08081	...	{Unstable resonators}
H01S 3/08086	...	{Multiple-wavelength emission}
H01S 3/0809	....	{Two-wavelength emission}
H01S 3/08095	...	{Zig-zag travelling beam through the active medium}
H01S 3/081	...	comprising more than two reflectors ({ folded-path gas lasers H01S 3/076 })
H01S 3/0811	....	{incorporating a dispersive element, e.g. a prism for wavelength selection}
H01S 3/0812	.....	{using a diffraction grating}
H01S 3/0813	....	{Configuration of resonator}
H01S 3/0815	.....	{having 3 reflectors, i.e. V-shaped resonators}
H01S 3/0816	.....	{having 4 reflectors, i.e. Z-shaped resonators}
H01S 3/0817	.....	{having 5 reflectors, i.e. W-shaped resonators}
H01S 3/0818	....	{Unstable resonators}
H01S 3/082	....	defining a plurality of resonators, e.g. for mode selection ({ single longitudinal mode control H01S 3/08022 })
H01S 3/0823	.....	{incorporating a dispersive element, e.g. a prism for wavelength selection}
H01S 3/0826	.....	{using a diffraction grating}
H01S 3/083	....	Ring lasers (ring laser gyrometers G01C 19/66 ; fibre ring lasers H01S 3/06791)
H01S 3/0835	.....	{Gas ring lasers}
H01S 3/086	...	One or more reflectors having variable properties or positions for initial adjustment of the resonator (varying a parameter of the laser output during operation H01S 3/10 ; stabilisation of the laser output H01S 3/13)
H01S 3/09	.	Processes or apparatus for excitation, e.g. pumping
H01S 3/0903	..	{Free-electron laser}
H01S 3/0906	..	{Electrical, electrochemical, or electron-beam pumping of a dye laser}
H01S 3/091	..	using optical pumping

H01S 3/0912	...	{Electronics or drivers for the pump source, i.e. details of drivers or circuitry specific for laser pumping (laser diode drivers H01S 5/042)}
H01S 3/0915	...	by incoherent light
H01S 3/09155	....	{by cathodo-luminescence}
H01S 3/092	....	of flash lamp (H01S 3/0937 takes precedence; {flash lamps per se H01J 61/80 ; circuit arrangements for operating flash lamps in general H05B 41/30 })
H01S 3/093	.....	focusing or directing the excitation energy into the active medium
H01S 3/0931	.....	{Imaging pump cavity, e.g. elliptical}
H01S 3/0933	....	of a semiconductor, e.g. light emitting diode
H01S 3/0937	....	produced by exploding or combustible material
H01S 3/094	...	by coherent light

NOTE

Groups [H01S 3/094003](#) to [H01S 3/094088](#) take precedence over groups [H01S 3/0941](#) to [H01S 3/0947](#)

H01S 3/094003	....	{the pumped medium being a fibre}
H01S 3/094007	.....	{Cladding pumping, i.e. pump light propagating in a clad surrounding the active core}
H01S 3/094011	.....	{with bidirectional pumping, i.e. with injection of the pump light from both two ends of the fibre}
H01S 3/094015	.....	{with pump light recycling, i.e. with reinjection of the unused pump light back into the fiber, e.g. by reflectors or circulators}
H01S 3/094019	.....	{Side pumped fibre, whereby pump light is coupled laterally into the fibre via an optical component like a prism, or a grating , or via V-groove coupling}
H01S 3/094023	.....	{with ASE light recycling, with reinjection of the ASE light back into the fiber, e.g. by reflectors or circulators}
H01S 3/094026	....	{for synchronously pumping, e.g. for mode-locking}
H01S 3/09403	....	{Cross-pumping, e.g. Förster process involving intermediate medium for excitation transfer}
H01S 3/094034	....	{the pumped medium being a dye}
H01S 3/094038	....	{End pumping}
H01S 3/094042	....	{of a fibre laser}
H01S 3/094046	.....	{of a Raman fibre laser}
H01S 3/094049	....	{Guiding of the pump light}
H01S 3/094053	.....	{Fibre coupled pump, e.g. delivering pump light using a fibre or a fibre bundle}
H01S 3/094057	.....	{by tapered duct or homogenized light pipe, e.g. for concentrating pump light}
H01S 3/094061	....	{Shared pump, i.e. pump light of a single pump source is used to pump plural gain media in parallel}
H01S 3/094065	....	{Single-mode pumping}
H01S 3/094069	....	{Multi-mode pumping}

H01S 3/094073	....	{Non-polarized pump, e.g. depolarizing the pump light for Raman lasers}
H01S 3/094076	....	{Pulsed or modulated pumping (H01S 3/1024 takes precedence)}
H01S 3/09408	....	{Pump redundancy}
H01S 3/094084	....	{with pump light recycling, i.e. with reinjection of the unused pump light, e.g. by reflectors or circulators}
H01S 3/094088	....	{with ASE light recycling, i.e. with reinjection of the ASE light, e.g. by reflectors or circulators}
H01S 3/094092	....	{Upconversion pumping}
H01S 3/094096	....	{Multi-wavelength pumping}
H01S 3/0941	....	of a laser diode
H01S 3/09415	.....	{the pumping beam being parallel to the lasing mode of the pumped medium, e.g. end-pumping}
H01S 3/0943	....	of a gas laser
H01S 3/0947	....	of an organic dye laser
H01S 3/095	..	using chemical or thermal pumping {(generating plasma, e.g. by combustion H02K 44/00 , H05H 1/24)}
H01S 3/09505	...	{involving photochemical reactions, e.g. photodissociation (Iodine lasers H01S 3/2215)}
H01S 3/0951	...	by increasing the pressure in the laser gas medium
H01S 3/0953	....	Gas dynamic laser, i.e. with expansion of the laser gas medium to supersonic flow speeds
H01S 3/0955	..	using pumping by high energy particles {(H01S 3/0903 , H01S 3/0906 , H01S 3/09707 take precedence)}
H01S 3/0957	...	by high energy nuclear particles
H01S 3/0959	...	by an electron beam
H01S 3/097	..	by gas discharge of a gas laser
H01S 3/09702	...	{Details of the driver electronics and electric discharge circuits}
H01S 3/09705	...	{with particular means for stabilising the discharge}
H01S 3/09707	...	{using an electron or ion beam (free-electron laser H01S 3/0903)}
H01S 3/0971	...	transversely excited (H01S 3/0975 takes precedence)
H01S 3/09713	....	{with auxiliary ionisation, e.g. double discharge excitation}
H01S 3/09716	.....	{by ionising radiation}
H01S 3/0973	....	having a travelling wave passing through the active medium
H01S 3/0975	...	using inductive or capacitive excitation
H01S 3/0977	...	having auxiliary ionisation means {(H01S 3/09713 takes precedence)}
H01S 3/09775	....	{by ionising radiation}
H01S 3/0979	...	Gas dynamic lasers, i.e. with expansion of the laser gas medium to supersonic flow speeds

- H01S 3/10
- Controlling the intensity, frequency, phase, polarisation or direction of the emitted radiation, e.g. switching, gating, modulating or demodulating ([mode locking](#) [{H01S 3/1106}](#); [controlling of light beams](#), [frequency-changing](#), [non-linear optics](#), [optical logic elements](#), in general [G02F](#))

NOTE

Group [H01S 3/10007](#) takes precedence over groups [H01S 3/102](#) to [H01S 3/104](#)

- H01S 3/10007 .. {in optical amplifiers}
- H01S 3/10015 ... {by monitoring or controlling, e.g. attenuating, the input signal}
- H01S 3/10023 ... {by functional association of additional optical elements, e.g. filters, gratings, reflectors}
- H01S 3/1003 {turnable optical elements, e.g. acousto-optic filters, tunable gratings}
- H01S 3/10038 .. {Amplitude control}
- H01S 3/10046 ... {Pulse repetition rate control ([H01S 3/11](#) takes precedence)}
- H01S 3/10053 .. {Phase control}
- H01S 3/10061 .. {Polarization control}
- H01S 3/10069 .. {Memorized or pre-programmed characteristics, e.g. look-up table [LUT]}
- H01S 3/10076 .. {using optical phase conjugation, e.g. phase conjugate reflection}
- H01S 3/10084 .. {Frequency control by seeding}
- H01S 3/10092 ... {Coherent seed, e.g. injection locking}
- H01S 3/101 .. Lasers provided with means to change the location from which, or the direction in which, laser radiation is emitted ([optical-mechanical scanning systems in general G02B 26/10](#); [electro-, magneto- or acousto-optical deflection G02F 1/29](#); {control of position or direction of light beam generating device in general [G05D 3/00](#)})
- H01S 3/102 .. by controlling the active medium, e.g. by controlling the processes or apparatus for excitation ([H01S 3/13](#) takes precedence)
- H01S 3/1022 ... {by controlling the optical pumping}
- H01S 3/1024 {for pulse generation}
- H01S 3/1026 ... {Controlling the active medium by translation or rotation, e.g. to remove heat from that part of the active medium that is situated on the resonator axis}
- H01S 3/1028 ... {by controlling the temperature}
- H01S 3/104 ... in gas lasers
- H01S 3/105 .. by controlling the mutual position or the reflecting properties of the reflectors of the cavity {e.g. by controlling the cavity length} ([{H01S 3/10076}](#) , [H01S 3/13](#) take precedence)
- H01S 3/1051 ... {one of the reflectors being of the type using frustrated reflection}
- H01S 3/1053 ... {Control by pressure or deformation}
- H01S 3/1055 ... one of the reflectors being constituted by a diffraction grating
- H01S 3/106 .. by controlling a device placed within the cavity ([{H01S 3/10076}](#) , [H01S 3/13](#) take precedence)
- H01S 3/1061 ... {using a variable absorption device}
- H01S 3/1062 ... {using a controlled passive interferometer, e.g. a Fabry-Perot etalon}
- H01S 3/1063 ... {using a solid state device provided with at least one potential jump barrier}

H01S 3/1065	...	{using liquid crystals}
H01S 3/1066	...	{using a magneto-optical device}
H01S 3/1067	...	{using pressure or deformation}
H01S 3/1068	...	{using an acousto-optical device}
H01S 3/107	...	using an electro-optical device, e.g. exhibiting Pockels- or Kerr-effect {(H01S 3/1061, H01S 3/1063, H01S 3/1065 take precedence)}
H01S 3/1075	....	{for optical deflection}
H01S 3/108	...	using a non-linear optical device, e.g. exhibiting Brillouin- or Raman-scattering {(mode locking using a non-linear element H01S 3/1112)}
H01S 3/1083	....	{using parametric generation}
H01S 3/1086	....	{using scattering effects, e.g. Raman or Brillouin effect}
H01S 3/109	....	Frequency multiplying, e.g. harmonic generation
H01S 3/1095	.....	{self doubling, e.g. lasing and frequency doubling by the same active medium}
H01S 3/11	..	{Pulse generation, e.g. Q-switching, mode locking}
H01S 3/1103	...	{Cavity dumping}
H01S 3/1106	...	{Mode locking}
H01S 3/1109	....	{Active mode locking}
H01S 3/1112	....	{Passive mode locking}
H01S 3/1115	.....	{using a saturable absorber (Q-switching by saturable absorbers H01S 3/113)}
H01S 3/1118	.....	{Solid state absorber, e.g. SESAM}
H01S 3/1121	....	{Harmonically mode-locked lasers, e.g. modulation frequency equals multiple integers or a fraction of the resonator roundtrip time}
H01S 3/1124	...	{Q-switching using magneto-optical devices}
H01S 3/1127	...	{Q-switching using pulse transmission mode [PTM]}
H01S 3/113	...	{Q-switching} using bleachable or solarising media
H01S 3/115	...	{Q-switching} using electro-optical devices
H01S 3/117	...	{Q-switching} using acousto-optical devices
H01S 3/121	...	{Q-switching} using mechanical devices
H01S 3/123	....	Rotating mirror
H01S 3/125	....	Rotating prism
H01S 3/127	...	Plural Q-switches
H01S 3/13	..	Stabilisation of laser output parameters, e.g. frequency, amplitude

NOTE

Group [H01S 3/1301](#) takes precedence over groups [H01S 3/131](#) to [H01S 3/134](#)

H01S 3/1301	...	{in optical amplifiers}
H01S 3/1302	....	{by all-optical means, e.g. gain-clamping}
H01S 3/1303	...	{by using a passive reference, e.g. absorption cell (H01S 3/139 takes precedence)}

H01S 3/1304	...	{by using an active reference, e.g. second laser, klystron or other standard frequency source (H01S 3/139 takes precedence; automatic control of electronic generators H03L 7/00)}
H01S 3/1305	...	{Feedback control systems}
H01S 3/1306	...	{Stabilisation of the amplitude}
H01S 3/1307	...	{Stabilisation of the phase}
H01S 3/1308	...	{Stabilisation of the polarisation}
H01S 3/131	...	by controlling the active medium, e.g. by controlling the processes or apparatus for excitation
H01S 3/1312	....	{by controlling the optical pumping}
H01S 3/1315	....	{by gain saturation}
H01S 3/1317	....	{by controlling the temperature}
H01S 3/134	....	in gas lasers
H01S 3/136	...	by controlling a device placed within the cavity
H01S 3/137	....	for stabilising of frequency
H01S 3/139	...	by controlling the mutual position or the reflecting properties of the reflectors of the cavity {e.g. by controlling the cavity length}
H01S 3/1392	....	{by using a passive reference, e.g. absorption cell (H01S 3/1396 , H01S 3/1398 take precedence)}
H01S 3/1394	....	{by using an active reference, e.g. second laser, klystron or other standard frequency source}
H01S 3/1396	....	{by using two modes present, e.g. Zeeman splitting (H01S 3/1398 takes precedence)}
H01S 3/1398	....	{by using a supplementary modulation of the output}
H01S 3/14	.	characterised by the material used as the active medium
H01S 3/16	..	Solid materials
H01S 3/1601	...	{characterised by an active (lasing) ion}
H01S 3/1603	....	{rare earth}
H01S 3/1605	.....	{terbium}
H01S 3/1606	.....	{dysprosium}
H01S 3/1608	.....	{erbium}
H01S 3/161	.....	{holmium}
H01S 3/1611	.....	{neodymium}
H01S 3/1613	.....	{praseodymium}
H01S 3/1615	.....	{samarium}
H01S 3/1616	.....	{thulium}
H01S 3/1618	.....	{ytterbium}
H01S 3/162	....	{transition metal}
H01S 3/1621	.....	{cobalt}
H01S 3/1623	.....	{chromium, e.g. Alexandrite}
H01S 3/1625	.....	{titanium}
H01S 3/1626	....	{uranium}

H01S 3/1628	...	{characterised by a semiconducting matrix}
H01S 3/163	...	{characterised by a crystal matrix}
H01S 3/1631	....	{aluminate}
H01S 3/1633	.....	{BeAl ₂ O ₄ i.e. Chrysoberyl}
H01S 3/1635	.....	{LaMgAl ₁₁ O ₁₉ (LNA, Lanthanum Magnesium Hexaluminate)}
H01S 3/1636	.....	{Al ₂ O ₃ (Sapphire)}
H01S 3/1638	.....	{YAlO ₃ (YALO or YAP, Yttrium Aluminium Perovskite)}
H01S 3/164	....	{garnet}
H01S 3/1641	.....	{GGG}
H01S 3/1643	.....	{YAG}
H01S 3/1645	....	{halide}
H01S 3/1646	.....	{BaY ₂ F ₈ }
H01S 3/1648	.....	{with the formula XYZF ₆ (Colquiriite structure), wherein X is Li, Na, K or Rb, Y is Mg, Ca, Sr, Cd or Ba and Z is Al, Sc or Ga}
H01S 3/165	.....	{with the formula MF ₂ , wherein M is Ca, Sr or Ba}
H01S 3/1651	.....	{SrAlF ₅ }
H01S 3/1653	.....	{YLiF ₄ (YLF, LYF)}
H01S 3/1655	....	{silicate}
H01S 3/1656	.....	{BeAl ₂ (SiO ₃) ₆ }
H01S 3/1658	.....	{Mg ₂ SiO ₄ (Forsterite)}
H01S 3/166	.....	{La ₃ Ga ₅ SiO ₁₄ [LGS]}
H01S 3/1661	.....	{Y ₂ SiO ₅ [YSO]}
H01S 3/1663	....	{beryllate}
H01S 3/1665	.....	{La ₂ Be ₂ O ₅ [BEL]}
H01S 3/1666	....	{borate, carbonate, arsenide}
H01S 3/1668	....	{scandate}
H01S 3/167	.....	{Sc ₂ O ₃ }
H01S 3/1671	....	{vanadate, niobate, tantalate}
H01S 3/1673	.....	{YVO ₄ [YVO]}
H01S 3/1675	....	{titanate, germanate, molybdate, tungstate}
H01S 3/1676	.....	{Li ₄ Ge ₅ O ₁₂ }
H01S 3/1678	.....	{LaBGeO ₅ }
H01S 3/168	...	{using an organic dye dispersed in a solid matrix}
H01S 3/1681	...	{using colour centres}
H01S 3/1683	...	{using superconductivity e.g. provided with Josephson junctions}
H01S 3/1685	...	{Ceramics}
H01S 3/1686	...	{Liquid crystal active layer}
H01S 3/1688	...	{Stoichiometric laser compounds, i.e. in which the active element forms one component of a stoichiometric formula rather than being merely a dopant}
H01S 3/169	...	{Nanoparticles, e.g. doped nanoparticles acting as a gain material}

H01S 3/1691	...	{characterised by additives / sensitisers / promoters as further dopants}
H01S 3/1693	....	{aluminium}
H01S 3/1695	....	{germanium}
H01S 3/1696	....	{transition metal}
H01S 3/1698	....	{rare earth}
H01S 3/17	...	amorphous, e.g. glass {(glass manufacture, shaping or supplementary processes C03B ; compositions for laserable glass C03C 4/0071)}
H01S 3/171	....	{chalcogenide glass}
H01S 3/172	....	{selenide glass}
H01S 3/173	....	{fluoride glass, e.g. fluorozirconate or ZBLAN [$\text{ZrF}_4\text{-BaF}_2\text{-LaF}_3\text{-AlF}_3\text{-NaF}$]}
H01S 3/175	....	{phosphate glass}
H01S 3/176	....	{silica or silicate glass}
H01S 3/177	....	{telluride glass}
H01S 3/178	....	{plastic}
H01S 3/20	..	Liquids
H01S 3/207	...	including a chelate {e.g. including atoms or ions, e.g. Nd}
H01S 3/213	...	including an organic dye
H01S 3/22	..	Gases
H01S 3/2207	...	{Noble gas ions, e.g. $\text{Ar}^{+>}$, $\text{Kr}^{+>}$ }
H01S 3/2215	...	{Iodine compounds or atomic iodine}
H01S 3/2222	...	{Neon, e.g. in helium-neon (He-Ne) systems}
H01S 3/223	...	the active gas being polyatomic, i.e. containing more than one atom (H01S 3/227 takes precedence)
H01S 3/2232	....	{Carbon dioxide (CO_2) or monoxide [CO]}
H01S 3/2235	....	{Dye vapour}
H01S 3/2237	....	{Molecular nitrogen (N_2), e.g. in noble gas- N_2 systems}
H01S 3/225	....	comprising an excimer or exciplex
H01S 3/2251	.....	{ArF, i.e. argon fluoride is comprised for lasing around 193 nm}
H01S 3/2253	.....	{XeCl, i.e. xenon chloride is comprised for lasing around 308 nm}
H01S 3/2255	.....	{XeF, i.e. xenon fluoride is comprised for lasing around 351 nm}
H01S 3/2256	.....	{KrF, i.e. krypton fluoride is comprised for lasing around 248 nm}
H01S 3/2258	.....	{F ₂ , i.e. molecular fluoride is comprised for lasing around 157 nm}
H01S 3/227	...	Metal vapour
H01S 3/23	.	Arrangements of two or more lasers not provided for in groups H01S 3/02 to H01S 3/22 , e.g. tandem arrangements of separate active media
H01S 3/2308	..	{Amplifier arrangements, e.g. MOPA}
H01S 3/2316	...	{Cascaded amplifiers}
H01S 3/2325	...	{Multi-pass amplifiers, e.g. regenerative amplifiers}
H01S 3/2333	....	{Double-pass amplifiers}
H01S 3/2341	....	{Four pass amplifiers}
H01S 3/235	....	{Regenerative amplifiers}

- H01S 3/2358 .. {comprising dyes as the active medium}
- H01S 3/2366 .. {comprising a gas as the active medium ([H01S 3/10092](#), [H01S 3/2383](#) take precedence)}
- H01S 3/2375 .. {Hybrid lasers ([H01S 3/07](#) takes precedence)}
- H01S 3/2383 .. {Parallel arrangements}
- H01S 3/2391 ... {emitting at different wavelengths}
- H01S 3/30 . using scattering effects, e.g. stimulated Brillouin or Raman effects
- H01S 3/302 .. {in an optical fibre}
- H01S 3/305 .. {in a gas}
- H01S 3/307 .. {in a liquid}

- H01S 4/00** **Devices using stimulated emission or wave energy other than those covered by groups [H01S 1/00](#) or [H01S 3/00](#), e.g. phonon maser, gamma maser**

- H01S 5/00** **Semiconductor lasers {(superluminescent diodes [H01L 33/0045](#))}**
- H01S 5/0014 . {Measuring characteristics or properties thereof (measuring techniques per se [G01J](#), [G01K](#), [G01N](#), [G01R](#))}
- H01S 5/0021 .. {Degradation or life time measurements}
- H01S 5/0028 .. {Laser diodes used as detectors}
- H01S 5/0035 .. {Simulations of laser characteristics}
- H01S 5/0042 .. {On wafer testing, e.g. lasers are tested before separating wafer into chips}
- H01S 5/005 . {Optical devices external to the laser cavity, specially adapted therefor, e.g. for homogenisation or merging of the beams or for manipulating laser pulses, e.g. pulse shaping ([H01S 5/026](#), [H01S 5/18388](#) take precedence)}
- H01S 5/0057 .. {Temporal shaping, e.g. pulse compression, frequency chirping}
- H01S 5/0064 .. {Anti-reflection devices, e.g. optical isolators}
- H01S 5/0071 .. {Beam steering, e.g. whereby a mirror outside the cavity is present to change the beam direction}
- H01S 5/0078 .. {Frequency filtering}
- H01S 5/0085 .. {Modulating the output, i.e. the laser beam is modulated outside the laser cavity}
- H01S 5/0092 .. {Nonlinear frequency conversion, e.g. second harmonic generation [SHG] or sum- or difference-frequency generation outside the laser cavity (nonlinear frequency conversion per se [G02F 1/35](#))}
- H01S 5/02 . Structural details or components not essential to laser action
- H01S 5/0201 .. {Separation of the wafer into individual elements, e.g. by dicing, cleaving, etching or directly during growth}
- H01S 5/0202 ... {Cleaving}
- H01S 5/0203 ... {Etching}
- H01S 5/0205 ... {during growth of the semiconductor body}
- H01S 5/0206 .. {Substrates, e.g. growth, shape, material, removal or bonding; (specific crystal orientation [H01S 5/3202](#))}
- H01S 5/0207 ... {Substrates having a special shape}
- H01S 5/0208 ... {Semi-insulating substrates}
- H01S 5/021 ... {Silicon based substrates}

H01S 5/0211	...	{Substrates made of ternary or quaternary compounds}
H01S 5/0212	....	{with a graded composition}
H01S 5/0213	...	{Sapphire, quartz or diamond based substrates}
H01S 5/0215	...	{Bonding to the substrate}
H01S 5/0216	....	{using an intermediate compound, e.g. a glue or solder}
H01S 5/0217	...	{Removal of the substrate}
H01S 5/0218	...	{Substrates comprising semiconducting materials from different groups of the periodic system than the active layer}
H01S 5/022	..	{Mountings; Housings (packaging and electrical lead-through per se H01L 23/00)}
H01S 5/02204	...	{including a getter material to absorb contaminations}
H01S 5/02208	...	{Shape of the housing}
H01S 5/02212	....	{Can-type, e.g. TO-9 housing with emission along or parallel to symmetry axis}
H01S 5/02216	....	{Butterfly-type, i.e. the housing is generally flat}
H01S 5/0222	...	{filled with special gases}
H01S 5/02224	....	{Oxygen is contained in the housing, e.g. to avoid contamination of the light emitting facet}
H01S 5/02228	...	{filled with a resin, or the complete housing being made of resin}
H01S 5/02232	...	{filled with a liquid (H01S 5/0243 takes precedence)}
H01S 5/02236	...	{Mounts or sub-mounts (H01S 5/02476 takes precedence)}
H01S 5/0224	....	{Up-side down mounting, e.g. flip-chip or epi-side down mounted laser}
H01S 5/02244	....	{Lead-frames, e.g. the laser is mounted on a lead frame or on a stem}
H01S 5/02248	....	{Mechanically integrated components on a mount or an optical micro-bench, e.g. optical components, detectors, etc.}
H01S 5/02252	.....	{Relative positioning of laser diode and optical components, e.g. grooves in the mount to fix an optical fibre or a lens}
H01S 5/02256	....	{Details of fixing the laser diode on the mount}
H01S 5/0226	.....	{using an adhesive}
H01S 5/02264	.....	{by clamping}
H01S 5/02268	.....	{Positioning, e.g. using marks for positioning of the laser diode}
H01S 5/02272	.....	{using soldering}
H01S 5/02276	....	{Wire-bonding details}
H01S 5/0228	...	{Out-coupling light}
H01S 5/02284	....	{with an optical fibre}
H01S 5/02288	....	{with a lens}
H01S 5/02292	....	{with a beam deflecting element}
H01S 5/02296	....	{Details of a window, e.g. special materials or special orientation for back-reflecting light to a detector inside the housing}
H01S 5/024	..	Cooling arrangements {(cooling solid state junction devices H01L 23/34 ; Heating arrangements ; H01S 5/0261 takes precedence)}
H01S 5/02407	...	{Active cooling, e.g. the laser temperature is controlled by a thermo-electric cooler or water cooling}

H01S 5/02415	....	{by using a thermo-electric cooler [TEC], e.g. Peltier element}
H01S 5/02423	....	{Liquid cooling, e.g. a liquid cools a mount of the laser}
H01S 5/0243	.....	{Laser is immersed in the coolant, i.e. the whole laser chip is immersed in the liquid for cooling}
H01S 5/02438	...	{Characterized by cooling of elements other than the laser, e.g. an optical element being part of an external cavity or a collimating lens}
H01S 5/02446	....	{Cooling being separate from the laser cooling}
H01S 5/02453	...	{Heating, e.g. the laser is heated for stabilisation against temperature fluctuations of the environment (H01S 5/0612 takes precedence, for monolithically integrated heaters see also H01S 5/0261)}
H01S 5/02461	...	{Structure or details of the laser chip to manipulate the heat flow, e.g. passive layers in the chip with a low heat conductivity}
H01S 5/02469	...	{Passive cooling, e.g. where heat is removed by the housing as a whole or by a heat pipe without any active cooling element like a TEC}
H01S 5/02476	...	{Heat spreaders, i.e. improving heat flow between laser chip and heat dissipating elements}
H01S 5/02484	....	{Sapphire or diamond heat spreaders}
H01S 5/02492	....	{CuW heat spreaders}
H01S 5/026	..	Monolithically integrated components, e.g. waveguides, monitoring photo-detectors, drivers (stabilisation of output H01S 5/06; coupling light guides with opto-electronic elements G02B 6/42; devices consisting of a plurality of semiconductor or other solid state components formed in or on a common substrate, adapted for light emission H01L 27/15)
H01S 5/0261	...	{Non-optical elements, e.g. laser driver components, heaters (H01S 5/0265 takes precedence)}
H01S 5/0262	...	{Photo-diodes, e.g. transceiver devices, bidirectional devices (H01S 5/0265 takes precedence)}
H01S 5/0264	....	{for monitoring the laser-output}
H01S 5/0265	...	{Intensity modulators (intracavity modulators H01S 5/0625)}
H01S 5/0267	...	{Integrated focusing lens (H01S 5/18388 takes precedence)}
H01S 5/0268	...	{Integrated waveguide grating router, e.g. emission of a multi-wavelength laser array is combined by a "dragon router"}
H01S 5/028	..	Coatings; {Treatment of the laser facets, e.g. etching, passivation layers or reflecting layers}
H01S 5/0281	...	{Coatings made of semiconductor materials}
H01S 5/0282	...	{Passivation layers or treatments}
H01S 5/0283	....	{Optically inactive coating on the facet, e.g. half-wave coating}
H01S 5/0284	...	{Coatings with a temperature dependent reflectivity}
H01S 5/0285	...	{Coatings with a controllable reflectivity}
H01S 5/0286	...	{Coatings with a reflectivity that is not constant over the facets, e.g. apertures}
H01S 5/0287	...	{Facet reflectivity}
H01S 5/0288	....	{Detuned facet reflectivity, i.e. reflectivity peak is different from gain maximum}
H01S 5/04	.	Processes or apparatus for excitation, e.g. pumping, {e.g. by electron beams} (H01S 5/06 takes precedence)

- H01S 5/041 .. {Optical pumping}
- H01S 5/042 .. Electrical excitation; {Circuits therefor (discrete or monolithically integrated laser drive components on mountings [H01S 5/0261](#))}
- H01S 5/0421 ... {characterised by the semiconducting contacting layers (electrodes [H01S 5/0425](#))}
- H01S 5/0422 {with n- and p-contacts on the same side of the active layer}
- H01S 5/0424 {lateral current injection}
- H01S 5/0425 ... {Electrodes, e.g. materials, shape, configuration, structure}
- H01S 5/0427 ... {for applying modulation to the laser}
- H01S 5/0428 ... {for applying pulses to the laser}
- H01S 5/06 . Arrangements for controlling the laser output parameters, e.g. by operating on the active medium ([transmission systems employing light H04B 10/00](#))
- H01S 5/0601 .. {comprising an absorbing region ([H01S 5/0604](#), [H01S 5/0607](#), [H01S 5/0615](#) and [H01S 5/065](#) take precedence; bistable laser devices in general [G02F 3/026](#))}
- H01S 5/0602 ... {which is an unpumped part of the active layer}
- H01S 5/0604 .. {comprising a non-linear region, e.g. generating harmonics of the laser frequency}
- H01S 5/0605 ... {Self doubling, e.g. lasing and frequency doubling by the same active medium}
- H01S 5/0607 .. {by varying physical parameters other than the potential of the electrodes, e.g. by an electric or magnetic field, mechanical deformation, pressure, light, temperature}
- H01S 5/0608 ... {controlled by light, e.g. optical switch}
- H01S 5/0609 {acting on an absorbing region, e.g. wavelength convertors}
- H01S 5/0611 {wavelength convectors}
- H01S 5/0612 ... {controlled by temperature}
- H01S 5/0614 ... {controlled by electric field, i.e. whereby an additional electric field is used to tune the bandgap, e.g. using the Stark-effect}
- H01S 5/0615 .. {Q-switching, i.e. in which the quality factor of the optical resonator is rapidly changed}
- H01S 5/0617 .. {using memorised or pre-programmed laser characteristics}
- H01S 5/0618 .. {Details on the linewidth enhancement parameter alpha}
- H01S 5/062 .. by varying the potential of the electrodes ([H01S 5/065](#) takes precedence)
- H01S 5/06203 ... {Transistor-type lasers ([H01S 5/0608](#) takes precedence)}
- H01S 5/06206 {Controlling the frequency of the radiation, e.g. tunable twin-guide lasers [TTG]}
- H01S 5/06209 ... {in single-section lasers ([H01S 5/0608](#) takes precedence)}
- H01S 5/06213 {Amplitude modulation}
- H01S 5/06216 {Pulse modulation or generation}
- H01S 5/0622 {Controlling the frequency of the radiation}
- H01S 5/06223 ... {using delayed or positive feedback}
- H01S 5/06226 ... {Modulation at ultra-high frequencies}
- H01S 5/0623 {using the beating between two closely spaced optical frequencies, i.e. heterodyne mixing}
- H01S 5/06233 ... {Controlling other output parameters than intensity or frequency}

H01S 5/06236	....	{controlling the polarisation, e.g. TM/TE polarisation switching}
H01S 5/0624	....	{controlling the near- or far field}
H01S 5/06243	....	{controlling the position or direction of the emitted beam}
H01S 5/06246	....	{controlling the phase}
H01S 5/0625	...	in multi-section lasers
H01S 5/06251	....	{Amplitude modulation}
H01S 5/06253	....	{Pulse modulation}
H01S 5/06255	....	{Controlling the frequency of the radiation}
H01S 5/06256	.....	{with DBR-structure}
H01S 5/06258	.....	{with DFB-structure}
H01S 5/065	..	Mode locking; Mode suppression; Mode selection; {Self pulsating}
H01S 5/0651	...	{Mode control}
H01S 5/0652	....	{Coherence lowering or collapse, e.g. multimode emission by additional input or modulation}
H01S 5/0653	....	{Mode suppression, e.g. specific multimode}
H01S 5/0654	.....	{Single longitudinal mode emission}
H01S 5/0655	.....	{Single transverse or lateral mode emission}
H01S 5/0656	...	{Seeding, i.e. an additional light input is provided for controlling the laser modes, for example by back-reflecting light from an external optical component (H01S 5/14 , H01S 5/4062 and H01S 5/4006 take precedence)}
H01S 5/0657	...	{Mode-locking, i.e. generation of pulses at a frequency corresponding to a roundtrip in the cavity}
H01S 5/0658	...	{Self-pulsating}
H01S 5/068	..	Stabilisation of laser output parameters (H01S 5/0625 takes precedence)
H01S 5/06804	...	{by monitoring an external parameter, e.g. temperature}
H01S 5/06808	...	{by monitoring the electrical laser parameters, e.g. voltage or current}
H01S 5/06812	...	{by monitoring or fixing the threshold current or other specific points of the L-I or V-I characteristics}
H01S 5/06817	...	{Noise reduction}
H01S 5/06821	...	{Stabilising other output parameters than intensity or frequency, e.g. phase, polarisation or far-fields}
H01S 5/06825	...	{Protecting the laser, e.g. during switch-on/off, detection of malfunctioning or degradation}
H01S 5/0683	...	{by monitoring the optical output parameters}
H01S 5/06832	....	{Stabilising during amplitude modulation}
H01S 5/06835	....	{Stabilising during pulse modulation or generation}
H01S 5/06837	....	{Stabilising otherwise than by an applied electric field or current, e.g. by controlling the temperature}
H01S 5/0687	....	Stabilising the frequency of the laser
H01S 5/10	.	Construction or shape of the optical resonator, {e.g. extended or external cavity, coupled cavities, bent-guide, varying width, thickness or composition of the active region (H01S 5/20 takes precedence)}

- H01S 5/1003 .. {Waveguide having a modified shape along the axis, e.g. branched, curved, tapered, voids}
- H01S 5/1007 ... {Branched waveguides}
- H01S 5/101 ... {Curved waveguide ([H01S 5/1243](#) takes precedence)}
- H01S 5/1014 ... {Tapered waveguide, e.g. spotsize converter ([H01S 5/1064](#) takes precedence)}
- H01S 5/1017 ... {Waveguide having a void for insertion of materials to change optical properties}
- H01S 5/1021 .. {Coupled cavities ([H01S 5/14](#) takes precedence)}
- H01S 5/1025 .. {Extended cavities}
- H01S 5/1028 .. {Coupling to elements in the cavity, e.g. coupling to waveguides adjacent the active region, e.g. forward coupled [DFC] structures}
- H01S 5/1032 ... {Coupling to elements comprising an optical axis that is not aligned with the optical axis of the active region}
- H01S 5/1035 {Forward coupled structures [DFC]}
- H01S 5/1039 .. {Details on the cavity length}
- H01S 5/1042 .. {Optical microcavities, e.g. cavity dimensions comparable to the wavelength}
- H01S 5/1046 .. {Comprising interactions between photons and plasmons, e.g. by a corrugated surface}
- H01S 5/105 .. {Comprising a photonic bandgap structure}
- H01S 5/1053 .. {Comprising an active region having a varying composition or cross section in a specific direction}
- H01S 5/1057 ... {varying composition along the optical axis}
- H01S 5/106 ... {varying thickness along the optical axis}
- H01S 5/1064 ... {varying width along the optical axis}
- H01S 5/1067 ... {comprising nanoparticles}
- H01S 5/1071 .. {Ring-lasers}
- H01S 5/1075 ... {Disk lasers with special modes, e.g. whispering gallery lasers}
- H01S 5/1078 .. {with means to control the spontaneous emission, e.g. reducing or reinjection}
- H01S 5/1082 .. {with a special facet structure, e.g. structured, non planar, oblique}
- H01S 5/1085 ... {Oblique facets}
- H01S 5/1089 .. {Unstable resonators}
- H01S 5/1092 .. {Multi-wavelength lasing}
- H01S 5/1096 ... {in a single cavity}
- H01S 5/12 the resonator having a periodic structure, e.g. in distributed feed-back lasers (DFB-lasers) ([H01S 5/18](#) takes precedence) { ([forward coupled structures](#), i.e. [DFC lasers](#), [H01S 5/1028](#))}
- H01S 5/1203 ... {over only a part of the length of the active region}
- H01S 5/1206 ... {having a non constant or multiplicity of periods}
- H01S 5/1209 {Sampled grating}
- H01S 5/1212 {Chirped grating}
- H01S 5/1215 {Multiplicity of periods}
- H01S 5/1218 {in superstructured configuration, e.g. more than one period in an alternate sequence}

H01S 5/1221	...	{Detuning between Bragg wavelength and gain maximum}
H01S 5/1225	...	{with a varying coupling constant along the optical axis}
H01S 5/1228	...	{DFB lasers with a complex coupled grating, e.g. gain or loss coupling}
H01S 5/1231	...	{Grating growth or overgrowth details}
H01S 5/1234	...	{Actively induced grating, e.g. acoustically or electrically induced}
H01S 5/1237	...	{Lateral grating, i.e. grating only adjacent ridge or mesa}
H01S 5/124	...	{incorporating phase shifts}
H01S 5/1243	....	{by other means than a jump in the grating period, e.g. bent waveguides}
H01S 5/1246	....	{plurality of phase shifts}
H01S 5/125	...	Distributed Bragg reflector lasers (DBR-lasers)
H01S 5/14	..	External cavity lasers {(external cavity elements, their control or stabilisation H01S 3/08 , H01S 3/10 and H01S 3/13)}

NOTE

in this group external cavity elements correspond to elements inside the laser cavity but outside the monolithic semiconductor body. These elements correspond to intra cavity elements in [H01S 3/00](#)

H01S 5/141	...	{using a wavelength selective device, e.g. a grating or etalon (H01S 5/146 takes precedence)}
H01S 5/142	....	{which comprises an additional resonator}
H01S 5/143	....	{Littman-Metcalf configuration, e.g. laser - grating - mirror}
H01S 5/145	...	{Phase conjugate mirrors}
H01S 5/146	...	{using a fiber as external cavity}
H01S 5/147	....	{having specially shaped fibre, e.g. lensed or tapered end portion}
H01S 5/148	...	{using a Talbot cavity}
H01S 5/16	..	Window-type lasers, i.e. with a region of non-absorbing material between the active region and the reflecting surface
H01S 5/162	...	{with window regions made by diffusion or disordering of the active layer}
H01S 5/164	...	{with window regions comprising semiconductor material with a wider bandgap than the active layer}
H01S 5/166	...	{with window regions comprising non-semiconducting materials}
H01S 5/168	...	{with window regions comprising current blocking layers}
H01S 5/18	..	Surface-emitting lasers (SE-lasers)
H01S 5/183	...	having a vertical cavity (VCSE-lasers)
H01S 5/18302	....	{comprising an integrated optical modulator}
H01S 5/18305	....	{with emission through the substrate, i.e. bottom emission}
H01S 5/18308	....	{having a special structure for lateral current or light confinement}
H01S 5/18311	.....	{using selective oxidation}
H01S 5/18313	.....	{by oxidizing at least one of the DBR layers}
H01S 5/18316	.....	{Airgap confined}
H01S 5/18319	.....	{comprising a periodical structure in lateral directions (photonic crystals in semiconductor laser structures per se H01S 5/105)}

H01S 5/18322	.....	{Position of the structure}
H01S 5/18325	.....	{Between active layer and substrate}
H01S 5/18327	.....	{Structure being part of a DBR (H01S 5/18391 takes precedence)}
H01S 5/1833	.....	{with more than one structure}
H01S 5/18333	.....	{only above the active layer}
H01S 5/18336	.....	{only below the active layer}
H01S 5/18338	.....	{Non-circular shape of the structure}
H01S 5/18341	....	{Intra-cavity contacts}
H01S 5/18344	....	{characterized by the mesa, e.g. dimensions or shape of the mesa}
H01S 5/18347	.....	{Mesa comprising active layer}
H01S 5/1835	.....	{Non-circular mesa}
H01S 5/18352	.....	{Mesa with inclined sidewall}
H01S 5/18355	....	{having a defined polarisation}
H01S 5/18358	....	{containing spacer layers to adjust the phase of the light wave in the cavity}
H01S 5/18361	....	{Structure of the reflectors, e.g. hybrid mirrors}
H01S 5/18363	.....	{comprising air layers}
H01S 5/18366	.....	{Membrane DBR, i.e. a movable DBR on top of the VCSEL}
H01S 5/18369	.....	{based on dielectric materials}
H01S 5/18372	.....	{by native oxidation}
H01S 5/18375	.....	{based on metal reflectors}
H01S 5/18377	.....	{comprising layers of different kind of materials, e.g. combinations of semiconducting with dielectric or metallic layers}
H01S 5/1838	.....	{Reflector bonded by wafer fusion or by an intermediate compound}
H01S 5/18383	....	{with periodic active regions at nodes or maxima of light intensity}
H01S 5/18386	....	{Details of the emission surface for influencing the near- or far-field, e.g. a grating on the surface}
H01S 5/18388	.....	{Lenses}
H01S 5/18391	.....	{Aperiodic structuring to influence the near- or far-field distribution}
H01S 5/18394	.....	{Apertures, e.g. defined by the shape of the upper electrode}
H01S 5/18397	....	{Plurality of active layers vertically stacked in a cavity for multi-wavelength emission}
H01S 5/187	...	using a distributed Bragg reflector (SE-DBR-lasers)
H01S 5/20	.	Structure or shape of the semi-conductor body to guide the optical wave; {Confining structures perpendicular to the optical axis, e.g. index- or gain-guiding, stripe geometry, broad area lasers, gain tailoring, transverse or lateral reflectors, special cladding structures, MQW barrier reflection layers}
H01S 5/2004	..	{Confining in the direction perpendicular to the layer structure}
H01S 5/2009	...	{electron barrier layers}
H01S 5/2013	....	{MQW barrier reflection layers}
H01S 5/2018	...	{Optical confinement, e.g. absorbing-, reflecting- or waveguide-layers}
H01S 5/2022	....	{Absorbing region or layer parallel to the active layer, e.g. to influence transverse modes}

H01S 5/2027	....	{Reflecting region or layer, parallel to the active layer, e.g. to modify propagation of the mode in the laser or to influence transverse modes}
H01S 5/2031	....	{characterized by special waveguide layers, e.g. asymmetric waveguide layers or defined band-gap discontinuities}
H01S 5/2036	..	{Broad area laserse}
H01S 5/204	..	{Strongly index guided structures}
H01S 5/2045	...	{employing free standing waveguides or air gap confinement}
H01S 5/205	..	{Antiguide structures}
H01S 5/2054	..	{Methods of obtaining the confinement}
H01S 5/2059	...	{by means of particular conductivity zones, e.g. obtained by particle bombardment or diffusion}
H01S 5/2063	....	{obtained by particle bombardment}
H01S 5/2068	....	{obtained by radiation treatment or annealing}
H01S 5/2072	....	{obtained by vacancy induced diffusion}
H01S 5/2077	...	{using lateral bandgap control during growth, e.g. selective growth, mask induced}
H01S 5/2081	...	{using special etching techniques}
H01S 5/2086	....	{lateral etch control, e.g. mask induced}
H01S 5/209	....	{special etch stop layers}
H01S 5/2095	...	{using melting or mass transport}
H01S 5/22	..	having a ridge or stripe structure
H01S 5/2201	...	{in a specific crystallographic orientation}
H01S 5/2202	...	{by making a groove in the upper laser structure}
H01S 5/2203	...	{with a transverse junction stripe [TJS] structure}
H01S 5/2205	...	{comprising special burying or current confinement layers}
H01S 5/2206	....	{based on III-V materials}
H01S 5/2207	.....	{GaAsP based}
H01S 5/2209	.....	{GaInP based}
H01S 5/221	.....	{containing aluminium}
H01S 5/2211	....	{based on II-VI materials}
H01S 5/2213	....	{based on polyimide or resin}
H01S 5/2214	....	{based on oxides or nitrides}
H01S 5/2215	.....	{using native oxidation of semiconductor layers}
H01S 5/2216	.....	{nitrides}
H01S 5/2218	....	{having special optical properties}
H01S 5/2219	.....	{absorbing}
H01S 5/222	.....	{having a refractive index lower than that of the cladding layers or outer guiding layers}
H01S 5/2222	....	{having special electric properties}
H01S 5/2223	.....	{hetero barrier blocking layers, e.g. P-P or N-N}
H01S 5/2224	.....	{semi-insulating semiconductors}

H01S 5/2226	.....	{semiconductors with a specific doping}
H01S 5/2227	.....	{special thin layer sequence}
H01S 5/2228	.....	{quantum wells}
H01S 5/223	...	Buried stripe structure {(H01S 5/227 takes precedence)}
H01S 5/2231	....	{with inner confining structure only between the active layer and the upper electrode}
H01S 5/2232	....	{with inner confining structure between the active layer and the lower electrode}
H01S 5/2234	.....	{having a structured substrate surface}
H01S 5/2235	.....	{with a protrusion}
H01S 5/2237	....	{with a non-planar active layer}
H01S 5/2238	....	{with a terraced structure}
H01S 5/227	...	Buried mesa structure; {Striped active layer}
H01S 5/2272	....	{grown by a mask induced selective growth}
H01S 5/2275	....	{mesa created by etching}
H01S 5/2277	.....	{double channel planar buried heterostructure [DCPBH] laser}
H01S 5/24	..	having a grooved structure, e.g. V-grooved, {crescent active layer in groove, VSIS laser}
H01S 5/30	.	Structure or shape of the active region; Materials used for the active region
H01S 5/3004	..	{employing a field effect structure for inducing charge-carriers, e.g. FET}
H01S 5/3009	...	{MIS or MOS configurations}
H01S 5/3013	..	{A(III)-B(V) compounds}
H01S 5/3018	..	{A(II)-B(VI) compounds}
H01S 5/3022	..	{A(IV)-B(VI) compounds}
H01S 5/3027	..	{IV compounds}
H01S 5/3031	...	{Si}
H01S 5/3036	....	{SiC}
H01S 5/304	....	{porous Si}
H01S 5/3045	...	{diamond}
H01S 5/305	..	{characterised by the doping materials used in the laser structure}
H01S 5/3054	...	{p-doping}
H01S 5/3059	....	{in II-VI materials}
H01S 5/3063	....	{using Mg}
H01S 5/3068	...	{deep levels}
H01S 5/3072	...	{Diffusion blocking layer, i.e. a special layer blocking diffusion of dopants}
H01S 5/3077	...	{plane dependent doping}
H01S 5/3081	.....	{using amphoteric doping}
H01S 5/3086	...	{doping of the active layer}
H01S 5/309	....	{doping of barrier layers that confine charge carriers in the laser structure, e.g. the barriers in a quantum well structure (Barriers in quantum wells per se H01S 5/3407)}

H01S 5/3095	...	{Tunnel junction}
H01S 5/32	..	comprising PN junctions, e.g. hetero- or double- heterostructures (H01S 5/34 , H01S 5/36 take precedence)
H01S 5/3201	...	{incorporating bulkstrain effects, e.g. strain compensation, strain related to polarisation}
H01S 5/3202	...	{grown on specifically orientated substrates, or using orientation dependent growth}
H01S 5/3203	....	{on non-planar substrates to create thickness or compositional variations}
H01S 5/3205	...	{with an active layer having a graded composition in the growth direction}
H01S 5/3206	...	{ordering or disordering the natural superlattice in ternary or quaternary materials}
H01S 5/3207	....	{ordered active layer}
H01S 5/3209	....	{disordered active layer}
H01S 5/321	...	{having intermediate bandgap layers}
H01S 5/3211	...	{characterised by special cladding layers, e.g. details on band-discontinuities}
H01S 5/3213	....	{asymmetric cladding layers}
H01S 5/3214	....	{comprising materials from other groups of the periodic system than the materials of the active layer, e.g. ZnSe claddings and GaAs active layer}
H01S 5/3215	....	{graded composition cladding layers}
H01S 5/3216	....	{quantum well or superlattice cladding layers}
H01S 5/3218	....	{specially strained cladding layers, other than for strain compensation}
H01S 5/3219	....	{explicitly Al-free cladding layers}
H01S 5/322	...	{type-II junctions}
H01S 5/3222	...	{in A(IV)-B(VI) compounds, e.g. PbSSe-laser}
H01S 5/3223	...	{IV compounds}
H01S 5/3224	....	{Si}
H01S 5/3226	.....	{SiC}
H01S 5/3227	.....	{porous Si}
H01S 5/3228	....	{diamond}
H01S 5/323	...	in A(III)-B(V) compounds, e.g. alGaAs-laser, {InP-based laser}
H01S 5/32308	....	{emitting light at a wavelength less than 900 nm}
H01S 5/32316	.....	{comprising only (Al)GaAs}
H01S 5/32325	.....	{red laser based on InGaP}
H01S 5/32333	.....	{based on InGaAsP}
H01S 5/32341	.....	{blue laser based on GaN or GaP}
H01S 5/3235	....	{emitting light at a wavelength longer than 1000 nm, e.g. InP-based 1300 nm and 1500 nm lasers}
H01S 5/32358	.....	{containing very small amounts, usually less than 1%, of an additional III or V compound to decrease the band-gap strongly in a non-linear way by the bowing effect}
H01S 5/32366	.....	{(In)GaAs with small amount of N}
H01S 5/32375	.....	{In(As)N with small amount of P, or In(As)P with small amount of N}

H01S 5/32383	.....	{small amount of Thallium (Tl) e.g. GaTlP}
H01S 5/32391	.....	{based on In(Ga)(As)P}
H01S 5/327	...	in A(II)-B(VI) compounds, e.g. ZnCdSe-laser
H01S 5/34	..	comprising quantum well, or superlattice structures, e.g. single quantum well lasers (SQW lasers), multiple quantum well lasers (MQW lasers), graded index separate confinement heterostructure lasers (GRINSCH lasers) (H01S 5/36 takes precedence)
H01S 5/3401	...	{having no PN junction, e.g. unipolar lasers, intersubband lasers, quantum cascade lasers}
H01S 5/3402	....	{intersubband lasers, e.g. transitions within the conduction or valence bands}
H01S 5/3403	...	{having a strained layer structure in which the strain performs a special function, e.g. general strain effects, strain versus polarisation}
H01S 5/3404	....	{influencing the polarisation}
H01S 5/3406	....	{including strain compensation}
H01S 5/3407	...	{characterised by special barrier layers}
H01S 5/3408	...	{characterised by specially shaped wells, e.g. triangular}
H01S 5/3409	...	{special GRINSCH structures}
H01S 5/341	...	{Structures having reduced dimensionality, e.g. quantum wires}
H01S 5/3412	....	{quantum box or quantum dash}
H01S 5/3413	...	{comprising partially disordered wells or barriers}
H01S 5/3414	....	{by vacancy induced interdiffusion}
H01S 5/3415	...	{containing details related to carrier capture times into wells or barriers}
H01S 5/3416	....	{tunneling through barriers}
H01S 5/3418	...	{using transitions from higher quantum levels}
H01S 5/3419	....	{intersubband lasers, e.g. laser transitions within the conduction or valence bands in non unipolar structures}
H01S 5/342	...	{containing short period superlattices [SPS]}
H01S 5/3421	...	{layer structure of quantum wells to influence the near/far field}
H01S 5/3422	...	{comprising type-II quantum wells or superlattices}
H01S 5/3424	...	{comprising freestanding wells}
H01S 5/3425	...	{comprising coupled wells or superlattices}
H01S 5/3426	...	{in A(IV)-B(VI) compounds, e.g. PbSSe-laser}
H01S 5/3427	...	{in IV compounds}
H01S 5/3428	...	{layer orientation perpendicular to the substrate}
H01S 5/343	...	in A(III)-B(V) compounds, e.g. AlGaAs-laser, {InP-based laser}
H01S 5/34306	....	{emitting light at a wavelength longer than 1000nm, e.g. InP based 1300 and 1500nm lasers}
H01S 5/34313	....	{with a well layer having only As as V-compound, e.g. AlGaAs, InGaAs}
H01S 5/3432	.....	{the whole junction comprising only (Al)GaAs}
H01S 5/34326	....	{with a well layer based on InGa(Al)P, e.g. red laser}
H01S 5/34333	....	{with a well layer based on Ga(In)N or Ga(In)P, e.g. blue laser}
H01S 5/3434	....	{with a well layer comprising at least both As and P as V-compounds}

- H01S 5/34346 {characterised by the materials of the barrier layers}
- H01S 5/34353 {based on (Al)GaAs}
- H01S 5/3436 {based on InGa(Al)P}
- H01S 5/34366 {based on InGa(Al)As}
- H01S 5/34373 {based on InGa(Al)AsP}
- H01S 5/3438 {based on In(Al)P}
- H01S 5/34386 {explicitly Al-free}
- H01S 5/34393 {not only based on A(III)-B(V) compounds}
- H01S 5/347 in A(II)-B(VI) compounds, e.g. ZnCdSe- laser
- H01S 5/36 . . . comprising organic materials ([dye lasers H01S 3/213](#))
- H01S 5/40 . . . Arrangement of two or more semiconductor lasers, not provided for in groups [H01S 5/02](#) to [H01S 5/30](#) ([H01S 5/50](#) takes precedence)
- H01S 5/4006 . . . {Injection locking}
- H01S 5/4012 . . . {Beam combining, e.g. by the use of fibres, gratings, polarisers, prisms}
- H01S 5/4018 . . . {Lasers electrically in series}
- H01S 5/4025 . . . {Array arrangements, e.g. constituted by discrete laser diodes or laser bar ([H01S 5/42](#) takes precedence)}
- H01S 5/4031 . . . {Edge-emitting structures}
- H01S 5/4037 {with active layers in more than one orientation}
- H01S 5/4043 {with vertically stacked active layers}
- H01S 5/405 {Two-dimensional arrays}
- H01S 5/4056 {emitting light in more than one direction}
- H01S 5/4062 {with an external cavity or using internal filters, e.g. Talbot filters}
- H01S 5/4068 {with lateral coupling by axially offset or by merging waveguides, e.g. Y-couplers}
- H01S 5/4075 . . . {Beam steering}
- H01S 5/4081 . . . {Near-or far field control}
- H01S 5/4087 . . . {emitting more than one wavelength}
- H01S 5/4093 {Red, green and blue [RGB] generated directly by laser action or by a combination of laser action with nonlinear frequency conversion}
- H01S 5/42 . . . Arrays of surface emitting lasers
- H01S 5/423 . . . {having a vertical cavity}
- H01S 5/426 {Vertically stacked cavities}
- H01S 5/50 . . . Amplifier structures not provided for in groups [H01S 5/02](#) to [H01S 5/30](#) (as repeaters in transmission systems [H04B 10/291](#))
- H01S 5/5009 . . . {the arrangement being polarisation-insensitive}
- H01S 5/5018 . . . {using two or more amplifiers or multiple passes through the same amplifier}
- H01S 5/5027 . . . {Concatenated amplifiers, i.e. amplifiers in series or cascaded}
- H01S 5/5036 . . . {the arrangement being polarisation-selective}
- H01S 5/5045 . . . {the arrangement having a frequency filtering function}
- H01S 5/5054 . . . {in which the wavelength is transformed by non-linear properties of the active medium, e.g. four wave mixing}

- H01S 5/5063 . . {operating above threshold}
- H01S 5/5072 . . . {Gain clamping, i.e. stabilisation by saturation using a further mode or frequency}
- H01S 5/5081 . . {specifically standing wave amplifiers}
- H01S 5/509 . . {Wavelength converting amplifier, e.g. signal gating with a second beam using gain saturation}

H01S 2301/00**Functional characteristics**

- H01S 2301/02 . ASE (amplified spontaneous emission), noise; Reduction thereof
- H01S 2301/03 . Suppression of nonlinear conversion, e.g. specific design to suppress for example stimulated brillouin scattering [SBS], mainly in optical fibres in combination with multimode pumping
- H01S 2301/04 . Gain spectral shaping, flattening
- H01S 2301/06 . Gain non-linearity, distortion; Compensation thereof
- H01S 2301/08 . Generation of pulses with special temporal shape or frequency spectrum
- H01S 2301/085 . . solitons
- H01S 2301/14 . Semiconductor lasers with special structural design for lasing in a specific polarisation mode
- H01S 2301/145 . . TM polarisation
- H01S 2301/16 . Semiconductor lasers with special structural design to influence the modes, e.g. specific multimode
- H01S 2301/163 . . Single longitudinal mode
- H01S 2301/166 . . Single transverse or lateral mode
- H01S 2301/17 . Semiconductor lasers comprising special layers
- H01S 2301/173 . . The laser chip comprising special buffer layers, e.g. dislocation prevention or reduction
- H01S 2301/176 . . Specific passivation layers on surfaces other than the emission facet
- H01S 2301/18 . Semiconductor lasers with special structural design for influencing the near- or far-field
- H01S 2301/185 . . for reduction of Astigmatism
- H01S 2301/20 . Lasers with a special output beam profile or cross section, e.g. non-Gaussian
- H01S 2301/203 . . with at least one hole in the intensity distribution, e.g. annular or doughnut mode
- H01S 2301/206 . . Top hat profile

H01S 2302/00**Amplification / lasing wavelength****NOTE**

In group [H01S 2302/00](#) and separated therefrom by a + sign the wavelength in nanometers (nnnn) is indicated.

- H01S 2302/02 . THz - lasers, i.e. lasers with emission in the wavelength range of typically 0.1 mm to 1 mm

H01S 2303/00**Pumping wavelength****NOTE**

H01S 2303/00

(continued)

In group [H01S 2303/00](#) and separated therefrom by a + sign the wavelength in nanometers (nnnn) is indicated.

H01S 2304/00

Special growth methods for semiconductor lasers

H01S 2304/02

. MBE

H01S 2304/025

. . MOMBE

H01S 2304/04

. MOCVD or MOVPE

H01S 2304/06

. LPE

H01S 2304/10

. CBE

H01S 2304/12

. Pendeo epitaxial lateral overgrowth [ELOG], e.g. for growing GaN based blue laser diodes