Patent Abstracts

These Patent Abstracts of recently issued patents are intended to provide the minimum information necessary for readers to determine if they are interested in examining the patent in more detail. Complete copies of patents are available for a small fee by writing: U.S. Patent and Trademark Office, Box 9, Washington, D.C. 20231.

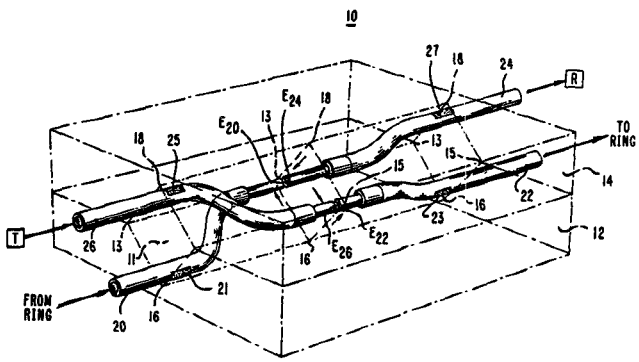
4,946,236 Aug. 7, 1990

Movable Fiber Optical Switch

Inventors: Mindaugas, F. Dautartas, Yinon Degani, Richard T. Kraetsch, Richard J. Pimpinella, and King L. Tai.
Assignee: AT&T Bell Laboratories.
Filed: May 30, 1989.

Abstract—An m-input/n-output (e.g., 2×2) optical fiber switch is disclosed that alters the location of the fibers by the application of an external force. Illustratively, the switch uses a housing with a diamond-shaped opening extending therethrough, with pairs of optical fibers positioned in orthogonally located V-grooves. Upon the application of an external force, the fibers are moved into the remaining, vacant V-grooves formed by the diamond-shaped opening. In a preferred embodiment, a (2×2) switch is magnetically activated.

34 Claims, 5 Drawing Sheets



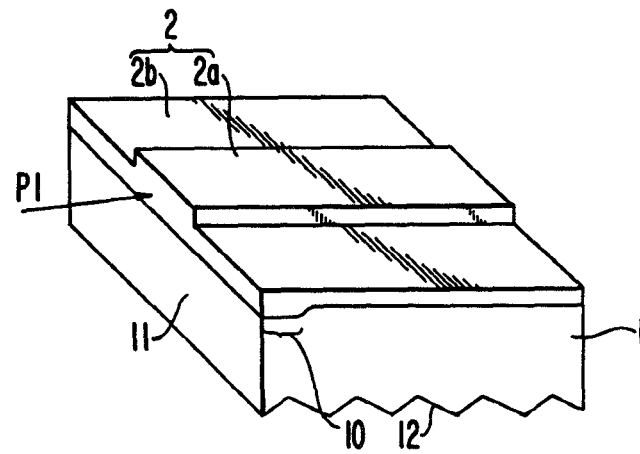
4,946,240 Aug. 7, 1990

Optical Harmonic Generation Device

Inventors: Kazuhisa Yamamoto and Tetsuo Taniuchi.
Assignee: Matsushita Electric Industrial Co.
Filed: Apr. 1, 1988.

Abstract—An optical harmonic generating device having a proton-exchanged optical waveguide possessing an upward covex shape and a structure capable of propagating in a single mode, an input part for receiving an optical wave having a fundamental frequency and an output part for outputting a harmonic wave, disposed on a substrate of $LiNb_xTa_{1-x}O_3 (O \leq x \leq 1)$. The device is an optical harmonic wave generating device with excellent confinement of light, optimum structure and high efficiency.

8 Claims, 9 Drawing Sheets



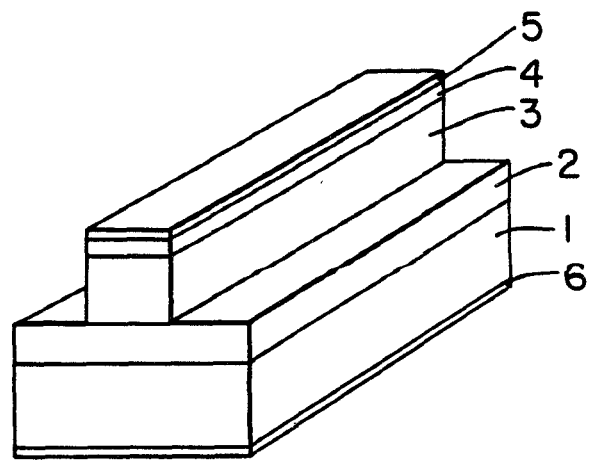
4,946,243 Aug. 7, 1990

Optical Modulation Element

Inventors: Masatoshi Suzuki, Shigeyuki Akiba, Hideaki Tanaka, and Katsuyuki Utaka.
Assignee: Kokusai Denshin Denwa Kabushiki Kaisha.
Filed: July 28, 1989.

Abstract—An optical modulation element is disclosed which has, on a substrate directly or through a lower clad layer, an optical waveguide layer of a low impurity concentration, an upper clad layer of a refractive index smaller than that of the optical waveguide layer, and electrodes, and in which light of a constant intensity incident on a light incident end face of the optical waveguide layer is intensity-modulated by changing the absorption coefficient of the optical waveguide layer by means of an electric field applied thereto across the electrodes so that the thus modulated light is emitted from a light emitting end face of the optical waveguide layer. In accordance with the present invention, a plurality of low impurity concentration regions and a plurality of high impurity concentration regions are disposed alternately with each other in contact with at least one of the lower and upper clad layers in the direction of travel of light in such a manner that the distribution density of the plurality of high impurity concentration regions increases in the direction of travel of light.

3 Claims, 2 Drawing Sheets



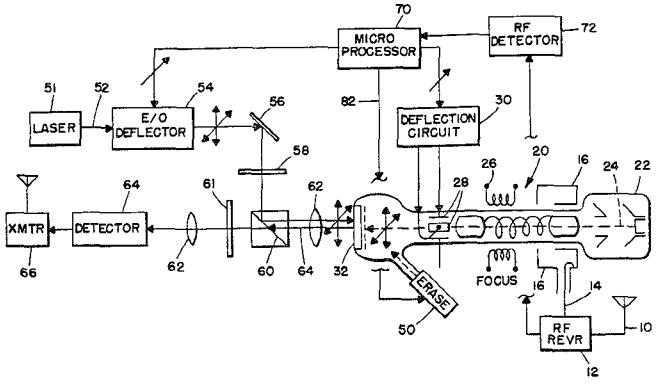
4,946,264 Aug. 7, 1990

Electrooptic Signal Processing Apparatus

Inventor: Dennis W. Davis.
Assignee: United Technologies, Inc.
Filed: Dec. 6, 1988.

Abstract—An input, high frequency signal is applied as a modulating input to a cavity positioned about the electron beam source of a traveling wave tube (TWT) amplifier. The TWT's electron beam is appropriately deflected, in a raster manner, over pixel areas of a KDP crystal plate. This action deposits, in each pixel area, charge which represents analog samples of the microwave waveform. The KDP crystal plate, together with an optical analyzer system, forms a Kerr cell modulator array. The charge deposited at the pixel sites causes associated variations in the index of refraction in the KDP crystal. When a reading beam of collimated, polarized light is raster scanned over the KDP plate, the angle of polarization of the beam is modified at each pixel site. The modified beam is reflected, passes through an analyzer section to a detector and then to a transmitter. By varying the rate of deflection of the reading beam and/or otherwise modifying the waveform produced by the beam, the characteristic of the received signal is modified for subsequent broadcast.

8 Claims, 2 Drawing Sheets



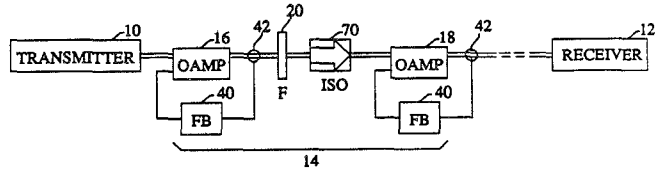
4,947,134 Aug. 7, 1990

Lightwave Systems Using Optical Amplifiers

Inventor: Nils A. Olsson.
Assignee: American Telephone and Telegraph Company.
Filed: Oct. 30, 1987.

Abstract—A single frequency lightwave system employs semiconductor, optical amplifiers arranged in tandem with suitable noise filtering and isolation between amplifier stages. Feedback control maintains overlap between the signal frequency and one of the passbands of the amplifiers. Either direct detection or coherent detection can be used. Also described is a receiver front end that includes such an amplifier between the incoming signal and a photodetector. Both transmission systems and switching systems are described.

19 Claims, 5 Drawing Sheets



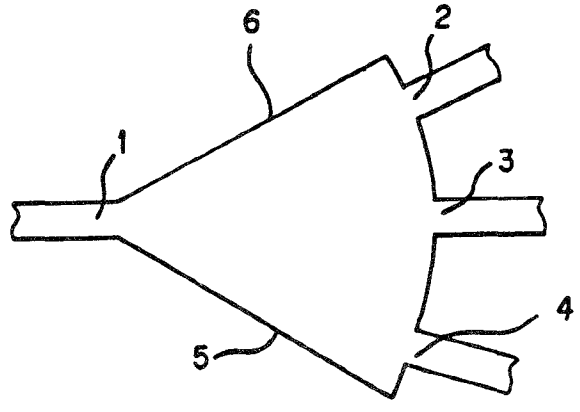
4,947,143 Aug. 7, 1990

Multiport Power Divider-Combiner

Inventors: Mohamed D. Abouzabra and Kuldip C. Gupta.
Assignee: Massachusetts Institute of Technology.
Filed: May 23, 1989.

Abstract—An electrical energy transport arrangement has an arcuate boundary region of substantially constant radius. A first port is disposed substantially at the center of the curvature of the arcurate boundary region and lies at the boundary of the transport arrangement and in electrical communication with it. A plurality of second ports are disposed around the arcuate boundary region and in electrical communication with it. A preferred embodiment provides a purely planar configuration, which may optionally provide balanced phase and amplitude outputs. In other preferred embodiments, there are provided unequal amplitude outputs.

9 Claims, 13 Drawing Sheets



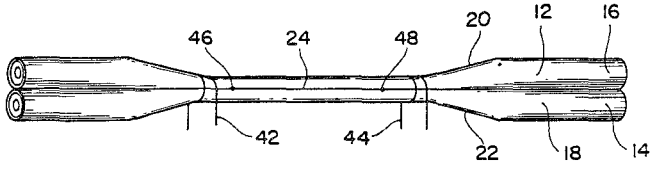
Re. 33,296 Aug. 14, 1990

Method of Making a Polarization-Insensitive, Evanescent-Wave, Fused Coupler with Minimal Environmental Sensitivity

Inventors: David W. Stowe and Paul M. Kopera.
Assignee: Gould, Inc.
Filed: July 2, 1988.

Abstract—An optical coupler and method of making same is described. The coupling ratio of the coupler is polarization-insensitive. The optical coupler described here is made from single-mode optical fibers. Each optical fiber has a length of nearly exposed core which is fused to the exposed core of the other optical fiber while the fibers are maintained in parallel juxtaposition with one another without twisting. By creating a fused core coupler from single-mode optical fibers in which the cores are in parallel juxtaposition with one another, the coupling ratio of the subject invention does not change with changes in polarization of light passing through each single-mode fiber and, thus, is polarization insensitive.

35 Claims, 1 Drawing Sheet



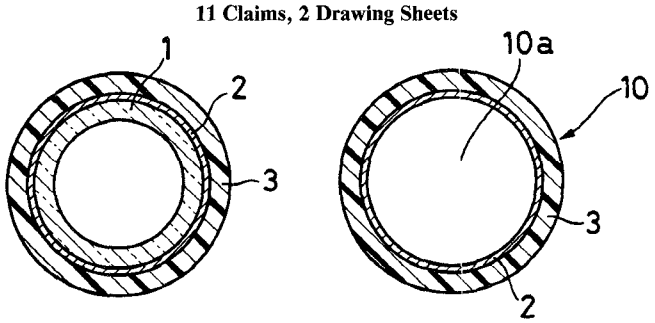
4,947,540 Aug. 14, 1990

Method of Producing Waveguide

Inventor: Yuichi Komachi.
Assignee: Kabushiki Kaisha Machida Seisakusho.
Filed: July 20, 1989.

Abstract—In the production of a waveguide, a pipe of a glass which is soluble in an acid or an alkali is used in order to obtain a smooth inner peripheral surface of a reflecting layer of the waveguide. After the reflecting layer is formed on the outer periphery of the pipe, the glass pipe is dipped in an etchant to be dissolved and removed. A reinforcement layer can be applied to the waveguide, and the reinforcement layer is made of a resin in order to keep the flexibility of the waveguide. In this case, the reinforcement layer of a resin is formed on the outer periphery of the reflecting layer on the pipe, and thereafter the pipe is dipped in the etchant and is removed. The waveguide of a circular cross-section can be flatted. In this case, the reinforcement layer made of a thermoplastic resin is heated to be softened, and then a compressive force is applied to the waveguide radially thereof to flatten the waveguide.

11 Claims, 2 Drawing Sheets



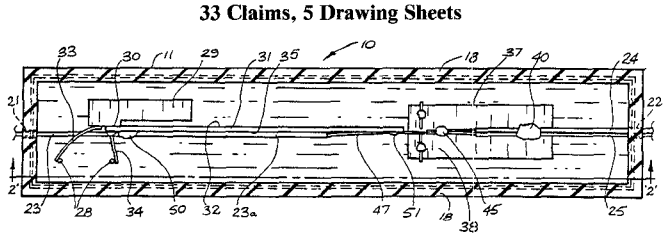
4,948,223 Aug. 14, 1990

Fiberoptic Switch

Inventors: John C. Anderson and John C. Goodwin.
Assignee: Northern Telecon Limited.
Filed: June 16, 1989.

Abstract—A fiberoptic switch of the moving fiber type and a method of making such switches. The switch has at least one stationary fiber and a mobile fiber carried by an actuator, preferably a bimorph, the end of the movable fiber being movable between a transmitting position in which the core of the mobile fiber is alinged with the core of the one stationary fiber and a position in which there is no aligment of the core of the mobile fiber with the core of the same stationary fiber. The stationary-fiber is affixed to a smooth substrate surface with a slight flex downwardly between the point at which it is affixed to substrate surface and the end of the fiber that engages the substrate surface. The actuator is mounted to move in a plane substantially parallel to and above the substrate surface, and the mobile fiber is affixed to the actuator and with a downward flex between the point at which it is affixed to the actuator and the very end thereof that engages the substrate surface. The mobile fiber thus slides over the substrate on movement of the actuator. The flexed engagement of both fibers with the smooth substrate accomplishes accurate alignment of the cores of the fibers in the vertical direction, and the production of the switch with the fibers flexed as described above does not require the provision of any highly machined components.

33 Claims, 5 Drawing Sheets



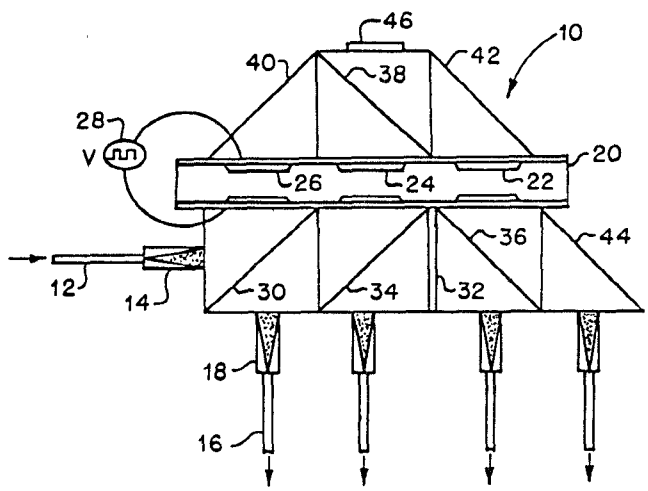
4,948,229 Aug. 14, 1990

Optical Switches Using Ferroelectric Liquid Crystals

Inventor: Richard A. Soref.
Assignee: The United States of America as represented by the Secretary of the Air Force.
Filed: Feb. 15, 1989.

Abstract—This invention comprises a new group of fiber optic switching devices that use layers of surface-established ferroelectric liquid crystals (FLC's) as the switching media. In each of the devices light impinges upon the foerroelectric liquid crystal a an angle of 90 degrees (normal incidence) with the surface plane. Each FLC gives 0 degrees or 90 degree optical rotation, depending upon the polarity of the electric voltage applied. A series of polarizing beam splitters are used to separate unpolarized light into its *s* and *P* polarization components. After ferroelectric liquid crystal switching, other polarizing beam splitters are used to direct the *s* and *p* light to output optical paths. The switches discussed include voltage controlled 2×2, 1×4, 1×6, 1×8, 4×4 and dual plane devices that use one or more layers of surface stabilized ferroelectric liquid crystals to direct optical signals.

11 Claims, 8 Drawing Sheets



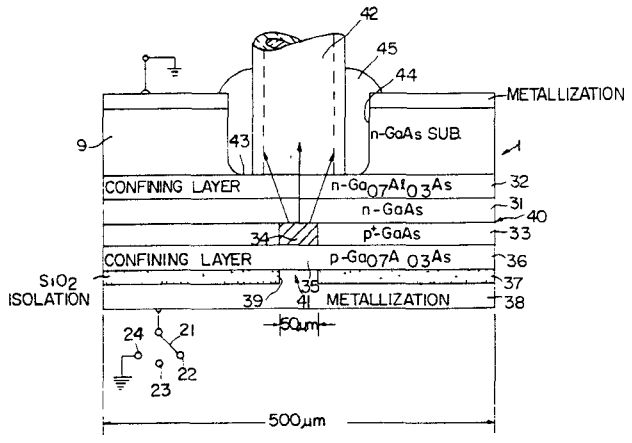
4,948,960 Aug. 14, 1990

Dual Mode Light Emitting Diode/Detector Diode for Optical Fiber Transmission Lines

Inventors: Garfield Simms and Robert G. Hunsperger.
Assignee: The University of Delaware.
Filed: Sept. 20, 1988.

Abstract—The invention relates to a double heterostructure diode and photodiode that is selectively switchable between an emission mode and receiving mode. A light emitting active region is localized and restricted by limitation of the area of contact to a window in a silicon dioxide layer and an optical fiber is coupled to the diode at a lateral surface to provide substantially greater light emission from the lateral surface than from side emission.

8 Claims, 2 Drawing Sheets



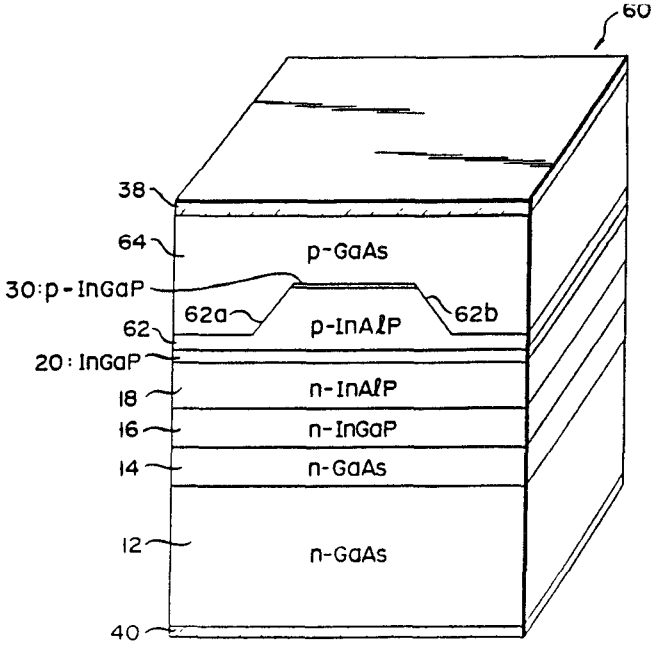
4,949,349 Aug. 14, 1990

Double-Heterostructure Semiconductor with Mesa Stripe Waveguide

Inventors: Yasuo Ohba, Niyoko Watanabe, Hideto Sugawara, Masayuki Ishikawa, Yukio Watanabe, and Motoyuki Yamamoto.
Assignee: Kabushiki Kaisha Toshiba.
Filed: Dec. 5, 1988.

Abstract—A double-heterostructure semiconductor laser is disclosed which has a semiconductive substrate of a first conductivity type made of III-V compound semiconductor material, a first semiconductive cladding layer of the first conductivity type disposed above the substrate, an active layer made of a semiconductor film provided on said cladding layer to serve as a light emission layer, and a second semiconductive cladding layer of a second conductivity type provided on the active layer to define a light waveguide channel of the laser. The second cladding layer is made of a compound semiconductor containing indium, phosphorus, and aluminum. A contact layer section is provided on the second cladding layer to cover the light waveguide channel. The contact layer is made of a compound semiconductor material containing gallium and arsenic, and has a band gap discontinuity at a boundary region of the light waveguide channel to form a barrier that serves to effectively seal current carriers in the waveguide channel, while the laser is emitting a laser light. This contact layer may also serve as a current-blocking layer.

17 Claims, 5 Drawing Sheets



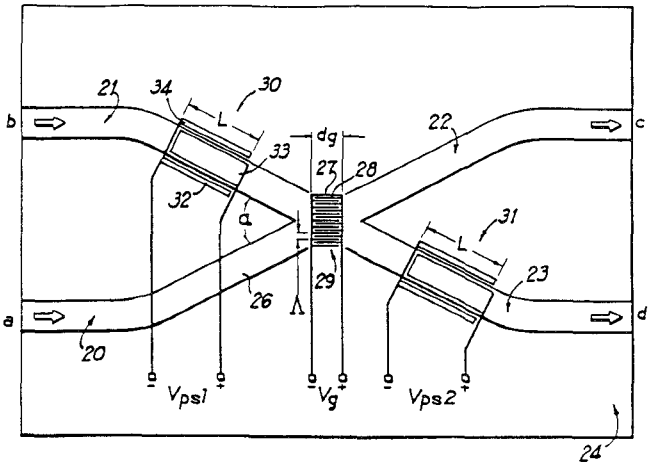
4,950,042 Aug. 21, 1990

Integrated Optical Givens Rotation Device

Inventors: Thomas K. Gaylor, Erik I. Verriest, Mir M. Mirsalehi.
Assignee: Georgia Tech Research Corporation.
Filed: Aug. 16, 1988.

Abstract—An elementary optical Givens rotation device is disclosed comprising a monolithic integrated optical circuit including crossed waveguides, interdigitated electrode means associated with the cross waveguides at their crossing point, and electrooptic phase shifter means lying upstream and downstream of the interdigitated electrode means with respect to one of the waveguides. Two mutually coherent, transverse magnetic input light signals are guided simultaneously into each waveguide. A voltage applied to the interdigitated electrode means induces a diffraction grating thereby forming transmitted and diffracted light waves in output sections of the respective waveguides. Phase shifter means include means for applying voltages to each phase shifter that are equal in magnitude but opposite in sign so that the transmitted and diffracted waves combine in phase in one waveguide and combine 180° out of phase in the other waveguide The device is useful for matrix triangularization by arranging arrays of these devices in a parallel or pipelined architecture on a substrate.

16 Claims, 5 Drawing Sheets



4,950,044 Aug. 21, 1990

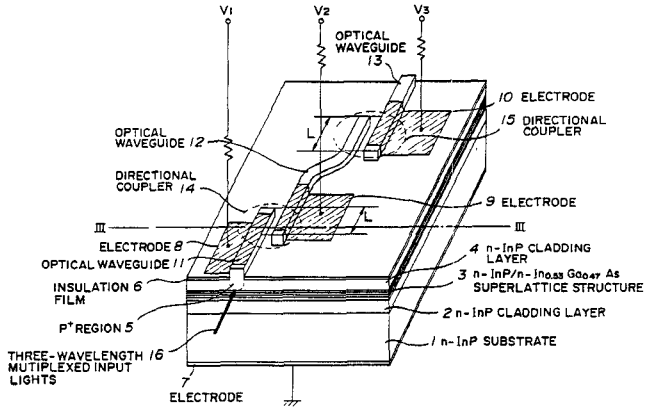
Optical Semiconductor Device for Demultiplexing Wavelength Multiplexed Lights

Inventor: Kiko Makita.
Assignee: NEC Corporation.
Filed: Sept. 19, 1988.

Abstract—An optical semiconductor device for demultiplexing wavelength multiplexed lights utilizes a plurality of waveguides including a superlattice structure, a plurality of directional couplers for coupling two neighboring waveguides among the plurality of waveguides, and a plurality of electrodes for applying different voltages to the plurality of waveguides. When the different voltages are applied to the plurality of waveguides, light having a first wavelength is absorbed in a first waveguide among the plurality of waveguides, while the other remaining lights are waveguided through the first waveguide and transferred through a first directional coupler among the plurality of directional couplers to a second waveguide among the plurality of waveguides. In the second waveguide, light having a second

wavelength is absorbed and the other remaining lights are waveguided therethrough. Thus, the wavelength multiplexed lights are demultiplexed and detected therein.

4 Claims, 4 Drawing Sheets



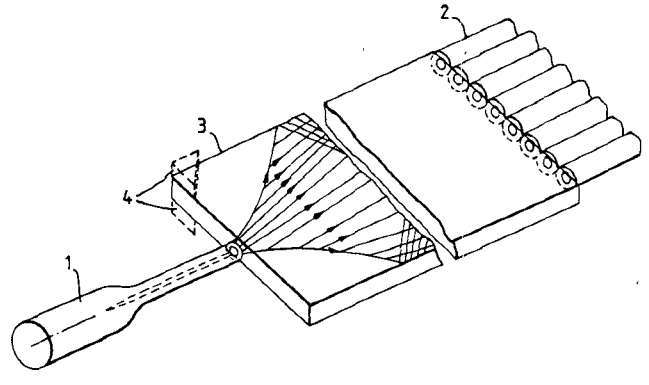
4,950,045 Aug. 21, 1990

Single Mode Couplers

Inventors: Terry Bricheno, Alan Fielding, and Stephen Day.
Assignee: STC PLC.
Filed: July 10, 1989.

Abstract—A $1 \times N$ single mode optical waveguide coupler comprises a single input optical fiber (1), a slab-like mixer waveguide (3) and a plurality (N) of output optical fibers (2). As a result of interference effects light introduced into the mixer waveguide (3) via the centrally located input fiber (1) produces a linear array of output spots at various intervals along the length of the mixer waveguide. The length of the mixer waveguide is chosen such that the output optical fibers are aligned with one such array of output spots. The fibers may be adiabatically tapered to a smaller diameter in order to increase their modal spot size.

10 Claims, 1 Drawing Sheet



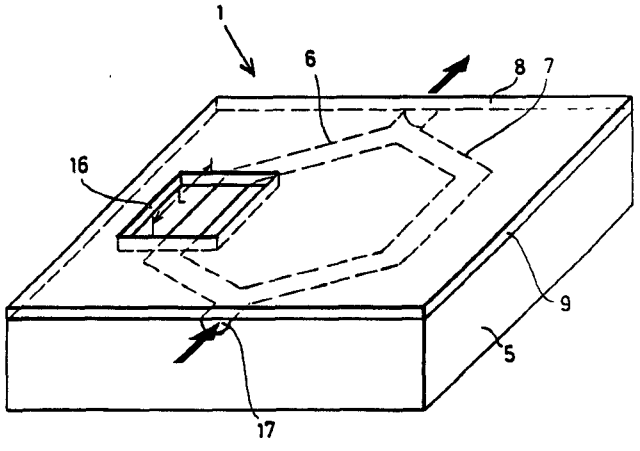
4,950,074 Aug. 21, 1990

Method of Determining the Refractive Index of a Substance and Apparatus Thereof

Inventors: Norbert Fabricius, Helga Götz, Helmut Oeste, Ludwig Roβ, Hans-Jügen Kluge, Jörg Baumgart, and Charitos Efstathiou.
Assignee: IOT Entwicklungsgesellshaft fú Integrierte Optik-Technologie mbH.
Filed: May 2, 1989.

Abstract—The invention is directed to a method for determining the refractive index (n) of a substance wherein monochromatic light is conducted to a single-mode wave guide integrated into a substrate. The wave guide is brought into contact with the substance to be measured along a segment of predetermined length. In this way, the effective refractive index in this segment of the wave guide is changed. This effect is utilized for measuring the refractive index of the measured substance. The change of the effective refractive index causes a phase displacement of the light travelling through this measuring segment. This phase displacement is measured as a phase difference to a light component not influenced by the measuring substance. This measurement is preferably made interferometrically.

13 Claims, 3 Drawing Sheets



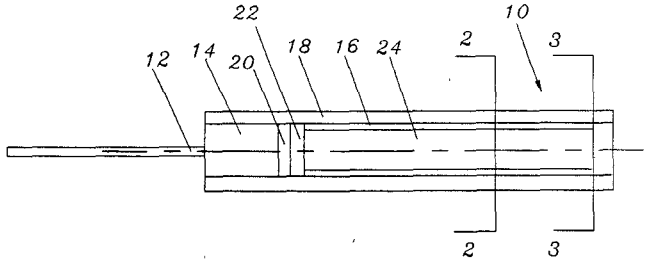
4,950,884 Aug. 21, 1990

Electrooptic Modulator and Modulation Method

Inventor: Frank J. Banks.
Assignee: Moog, Inc.
Filed: Aug. 18, 1989.

Abstract—A device and method for modulating light intensity in response to a varying electrical signal which is particularly useful with optical fiber information sensing systems. The device includes a number of components positioned in seriatim in an elongated cavity in an insulating body. Means for receiving a light signal, such as from an optical fiber, is positioned at one end of the cavity. A lens receives the light and collimates it into a narrow collimated beam directed through the cavity. The beam is polarized, retarded by a wave plate to circular polarization and passed through a modulator material which is capable of rotating beam polarization in response to varying voltage signals imposed on the modulator through electrodes thereon. A mirror at the end of the modulator reflects the beam back through the system. The beam is further rotated by electrooptic material as a function of applied voltage, then further retarded by said wave plate and then attenuated by said polarizer as a function of the applied voltage. The returning attenuated beam is then focused into the optical fiber.

9 Claims, 1 Drawing Sheet



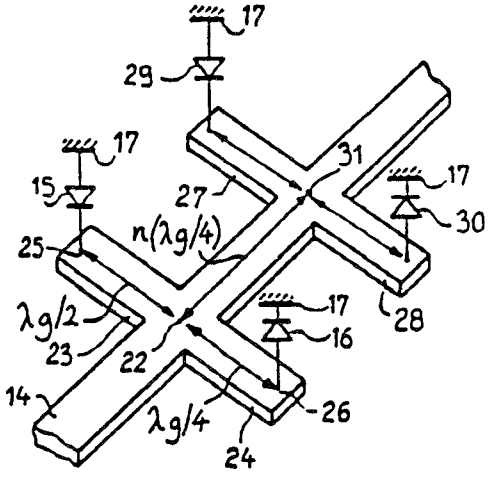
4,951,008 Aug. 21, 1990

Suspended-Line Diode Device Comprising a Triple Plate Line

Inventors: Christian Vedrenne, Patrick Desmarest, and Bernard Guerin.
Assignee: Thomson Hybrides et Microondes.
Filed: Mar. 3, 1988.

Abstract—Disclosed is a hyperfrequency device which includes a triple plate line in which at least two diodes exert their action at the same point on the suspended line. Instead of connecting the two diodes on both sides of the suspended line, they are mounted on the same side, this is possible by providing two subsidiary line sections orthogonal to the main line and in the same hyperfrequency plane. A diode is connected to the end of each subsidiary line at a point distant by $\lambda g/2$ from the central point of the main line. The action of the two diodes is thus brought back to this point.

7 Claims, 2 Drawing Sheets



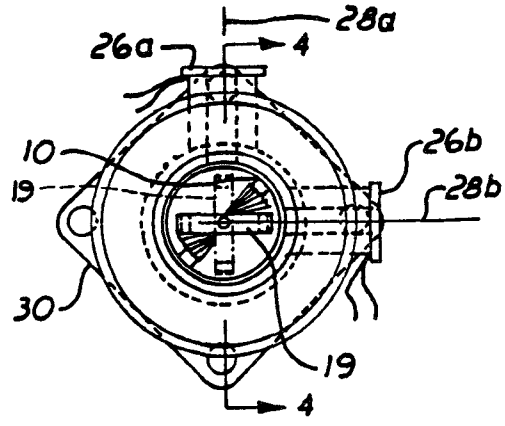
4,951,010 Aug. 21, 1990

Polarization Rotating Apparatus for Microwave Signals

Inventor: Fay Grim.
Assignee: Maxi Rotor, Inc.
Filed: Mar. 15, 1989.

Abstract—Apparatus is disclosed for rotating the polarization of microwave signal received into a circular waveguide. This apparatus includes a septum mounted within a waveguide, with that septum including a plurality of discrete interlinked elements mounted to a shaft supported longitudinally of the axis of the waveguide and includes apparatus for rotating adjacent elements angularly about the shaft along with structure for restricting the relative angular rotation of adjacent such elements about the shaft so that the maximum rotation of each element relative to an adjacent element is limited to a predetermined angle for the element.

10 Claims, 1 Drawing Sheet



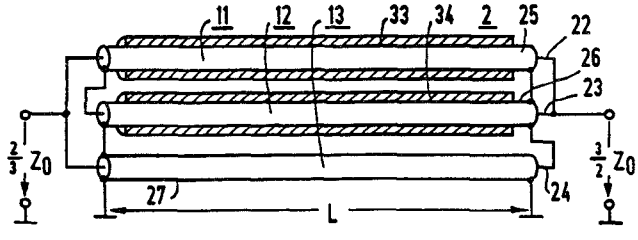
4,951,012 Aug. 21, 1990

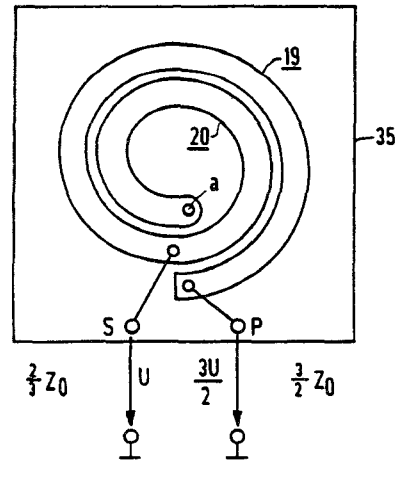
Transformer Arrangement to Accomplish Impedance Transformation

Inventors: Ralph Oppelt and Markus Vester.
Assignee: Siemens Aktiengesellschaft.
Filed: Apr. 5, 1989.

Abstract—An impedance transformation comprising a plurality of elementary transformers that can be used as impedance converters for radio frequency antennas of a nuclear magnetic resonant tomograph system. At least one combination of a parallel circuit and a series circuit using inner conductors and the outer conductors exists at the primary side of the transformer and at the secondary side of the elementary transformers. Nearly all arbitrary transformation ratios can be obtained with the line transformers of the invetion.

10 Claims, 3 Drawing Sheets





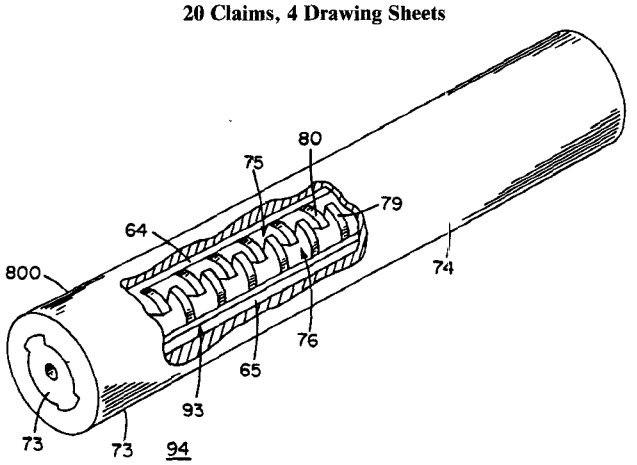
4,951,380 Aug. 28, 1990

Waveguide Structures and Methods of Manufacture for Traveling Wave Tubes

Inventor: Burton H. Smith.
Assignee: Raytheon Company.
Filed: June 30, 1988.

Abstract—Slow-wave structures are formed by the method of this invention in the form of a coupled-cavity structure. The coupled-cavity form of waveguide slow-wave structures is formed by wire electric discharge machining of disks from a solid rod of copper. The disks are supported in their desired position by retained portions of the rod while the disks are brazed inside a cylindrical shell of copper. After brazing, the retained portions may be partially removed to form the completed slowwave structure.

20 Claims, 4 Drawing Sheets



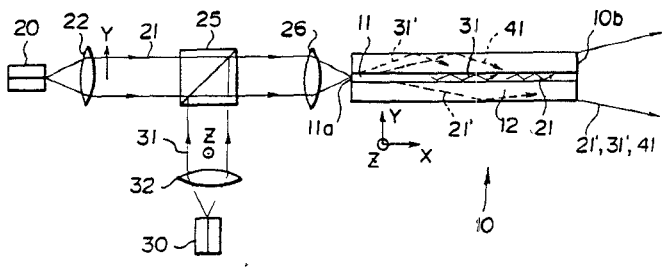
4,952,013 Aug. 28, 1990

Optical Wavelength Converter Device

Inventors: Akinori Harada, Yoji Okazaki, Koji Kamiyama, and Shinsuke Umegaki.
Assignee: Fuji Photo Film Co., Ltd.
Filed: Mar. 24, 1989.

Abstract—An optical wavelength converter device of the optical fiber type comprises a core made of a nonlinear optical material and cladding of an amorphous material and surrounding the core, the cladding having a refractive index lower than the refractive index of the core. An other optical wavelength converter device comprises a two- or three-dimensional optical wavelength converter device produced by growing a nonlinear optical material crystal as an optical waveguide on or in an amorphous substrate having a refractive index lower than the refractive index of the nonlinear optical material crystal. Phase matching is achieved between a radiation mode of a wavelength-converted wave in the cladding or the substrate and a nonlinear polarized wave generated by a waveguide mode of first and second fundamental waves in the core or the optical waveguide.

12 Claims, 4 Drawing Sheets



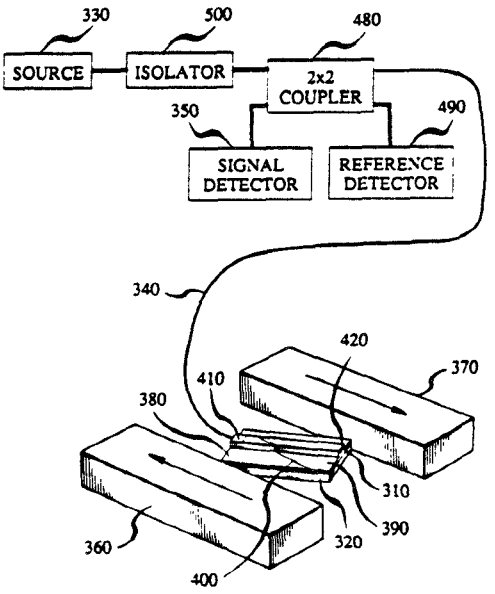
4,952,014 Aug. 28, 1990

Optical Systems with Thin-Film Polarization Rotators and Method for Fabricating such Rotators

Inventors: Robert A. Lieberman and Raymond Wolfe.
Assignee: AT&T Bell Laboratories.
Filed: Apr. 17, 1989.

Abstract—An optical system, useful as a magnetometer and as a polarization controller, is disclosed. The system includes a source of electromagnetic radiation, a detector of electromagnetic radiation, and a magnetizable medium via which the source and detector communicate with one another. The system further includes apparatus for forming at least two adjacent magnetic domains separated by at least one domain wall.

15 Claims, 10 Drawing Sheets



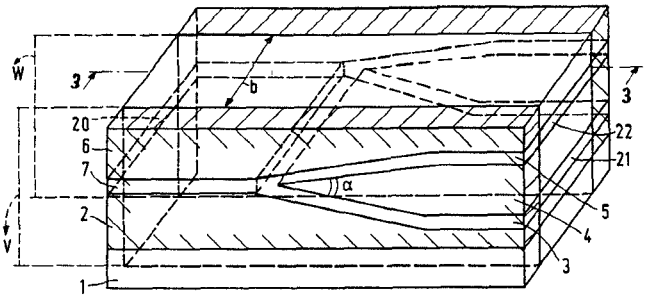
4,952,015 Aug. 28, 1990

Radiation Coupling Device

Inventor: Lodewijk Van Ruyven.
Assignee: U.S. Phillips Corp.
Filed: Apr. 6, 1989.

Abstract—A radiation coupling device comprising at least three radiation guides a first radiation guide of which is divided on at least one end into at least two further radiation guides. According to the invention the radiation guides form part of a semiconductor layer structure having, in a cross-section in the direction of thickness, at least two radiation guiding layers each comprising a further radiation guide. The layers are optically separated by a passive layer that locally shows a stripshaped reduction in thickness or an interruption where the two radiation guiding layers respectively are present within each other's amplification profile or coincide and thus form the first radiation guide.

6 Claims, 5 Drawing Sheets



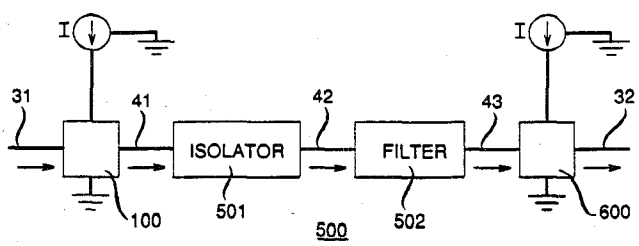
4,952,017 Aug. 28, 1990

Polarization Independent Semiconductor Optical Amplifier

Inventors: Charles H. Henry, Rudolf F. Kazarinov, and Nils A. Olsson.
Assignee: AT&T Bell Laboratories.
Filed: Mar. 14, 1989.

Abstract—In a fiberoptic communication system, a polarization independent semiconductor optical amplifier structure is achieved by tailoring the height-width aspect ratio of its active region to a value at least close to unity and at the same time using a laser cavity structure in which the end mirrors are buried in the semiconductor body in which the optical amplifier structure is built.

10 Claims, 2 Drawing Sheets



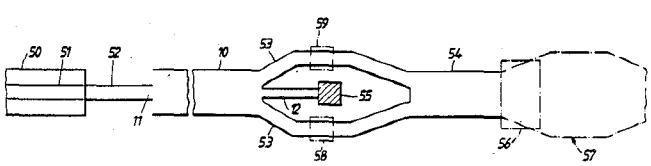
4,952,018 Aug. 28, 1990

Optical in Line Filters

Inventors: Terence P. Young and Ian R. Croston.
Assignee: GEC-Marconi Limited.
Filed: Feb. 23, 1989.

Abstract—An optical in-line filter comprises a first waveguide whose output end is coupled to a second, narrower waveguide such that light from the first waveguide of a predetermined waveband or wavebands only is passed to the second waveguide light of other wavebands emerging elsewhere from the open end of the first waveguide.

14 Claims, 4 Drawing Sheets



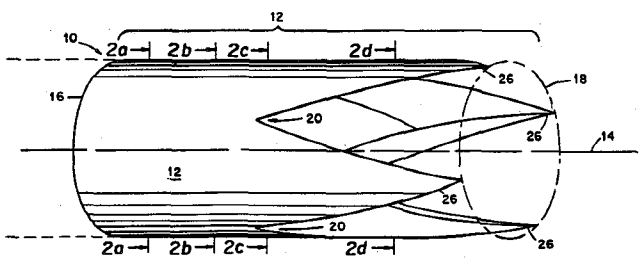
4,952,892 Aug. 28, 1990

Waveguide Impedance Matching Method and Apparatus

Inventor: James W. Kronberg.
Assignee: The United States of America as represented by the United States Department of Energy.
Filed: May 12, 1989.

Abstract—A technique for modifying the end portion of a waveguide, whether hollow or solid, carrying electromagnetic, acoustic or optical energy, to produce a gradual impedance change over the length of the end portion, comprising the cutting of longitudinal. *V*-shaped grooves that increase in width and depth from beginning of the end portion of the waveguide to the end of the guide so that, at the end of the guide, no guide material remains and no surfaces of the guide as modified are perpendicular to the direction of energy flow. For hollow guides, the grooves are cut beginning on the interior surface; for solid guides, the grooves are cut beginning on the exterior surface. One or more resistive, partially conductive or nonconductive sleeves can be placed over the exterior of the guide and through which the grooves are cut to smooth the transition to free space.

26 Claims, 6 Drawing Sheets



4,952,895 Aug. 28, 1990

Planar Airstripline-Stripline Magic-Tee

Inventor: Clifton Quan.
Assignee: Hughes Aircraft Company.
Filed: Sept. 15, 1989.

Abstract—A multilayer, multiconductor stripline magic-tee network is disclosed. The device incorporates a stripline balun that is sandwiched within a double-sided airstripline 3-port reactive-tee power divider to produce a matched 4-port magic-tee that is physically planar and electrically symmetrical. Each port of the device is shielded from the others.

9 Claims, 3 Drawing Sheets