Patent Abstracts

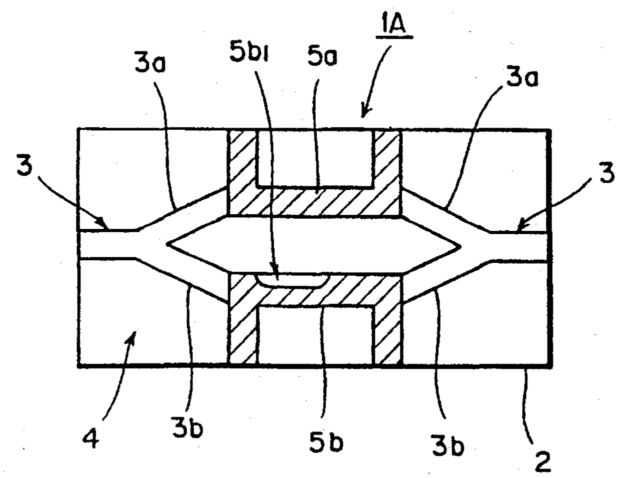
5,283,842 Feb. 1, 1994

Operating Point Trimming Method for Optical Waveguide Modulator and Switch

Inventors: Hironao Hakogi and Hisashi Takamatsu.
Assignee: Fujitsu Limited.
Filed: Mar. 7, 1991.

Abstract—Operating point trimming methods for an optical waveguide modulator and an optical waveguide switch are disclosed. One operating point trimming method for an optical waveguide modulator comprises, for example, the step of removing, while monitoring the waveform of an intensity modulated light beam, a portion of either one of a first and a second electrode such that the intensity modulated waveform takes on a desired waveform. One operating point trimming method for an optical waveguide switch comprises the step of removing a portion of either one of a first and a second electrode while monitoring output light beams.

12 Claims, 7 Drawing Sheets



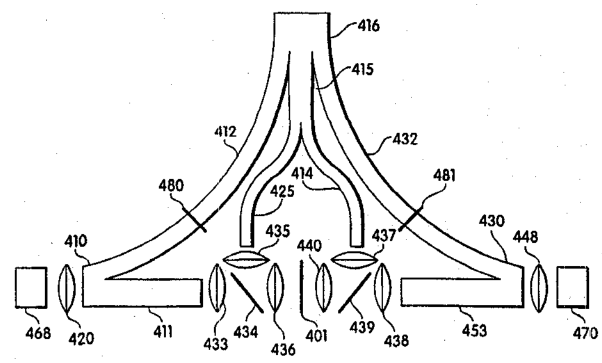
5,283,843 Feb. 1, 1994

Optical Switches

Inventor: Charles H. Olmstead.
Assignee: Digital Optical Corporation.
Filed: Feb. 2, 1993.

Abstract—In a first feature of the invention, an optical switching element is a semi-transparent, metallic film having variable absorption and transmission depending upon whether one or two optical signals are present. The metallic film can be illuminated from opposite sides in a direction perpendicular to its plane by two optical signals or can be illuminated obliquely at the same angle of incidence from opposite sides by two optical signals. In another embodiment, the metallic film is located between two optical waveguides. In a second feature of the invention, an optical switching element is an optically active material that rotates the plane of polarization of an optical input signal in the absence of an optical control signal and rotates the plane of polarization of the optical input signal to a lesser degree in response to an optical control signal. The optical input signal and the optical control signal have π radians phase difference in the optical waveguide and have the same plane of polarization.

18 Claims, 7 Drawing Sheets



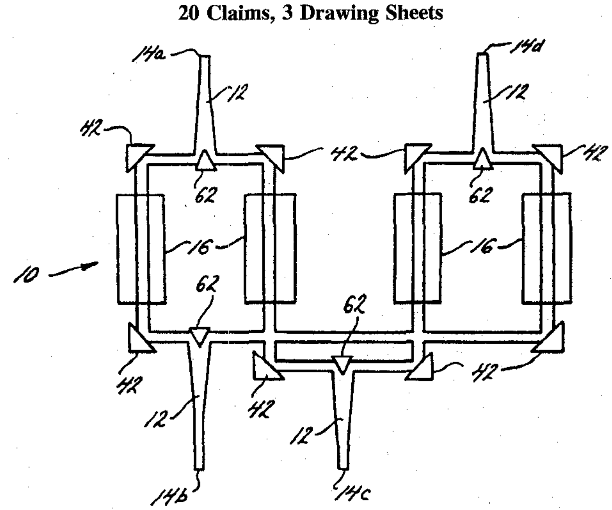
5,283,844 Feb. 1, 1994

Monolithic Active Waveguide Optical Crossbar Switch

Inventors: Robert R. Rice, Mark S. Zediker, Chester L. Balestra, Allen Priest.
Assignee: McDonnell Douglas Corporation.
Filed: Mar. 5, 1992.

Abstract—A semiconductor active waveguide optical crossbar switch to allow optical signals to be routed to any number of ports with no net attenuation of signal strength. The optical crossbar switch is comprised of a network of optical waveguides wherein both lateral and transverse carrier confinement is provided. Redirection of the optical waveguide is accomplished by means of total internal reflectance turning mirrors. Furthermore, the optical waveguides are formed such that electrical current may be applied to the semiconductor structure to amplify the optical signal travelling therein. Electroabsorption switches formed from distinct metallic contacts overlying portions of the optical waveguides amplify the optical signal travelling through the waveguide underneath the switch if sufficient electrical stimulation is applied to the switch. Additionally, if no stimulation is applied to the electro-absorption switch, the optical signal travelling in the portion of the optical waveguide beneath the electro-absorption switches is attenuated to a level below that of the noise in the optical system such that no signal will be received by the output. Thus, by appropriately patterning the optical waveguide network in conjunction with turning mirrors and metallization contacts to provide attenuation or amplification, an input optical signal applied to this semiconductor active waveguide optical crossbar switch may be directed to any number of output ports. By utilizing optical signals throughout the design with no conversion to electrical signals, the transmission bandwidth of the switch is very large and the switching network is impervious to EMI.

20 Claims, 3 Drawing Sheets



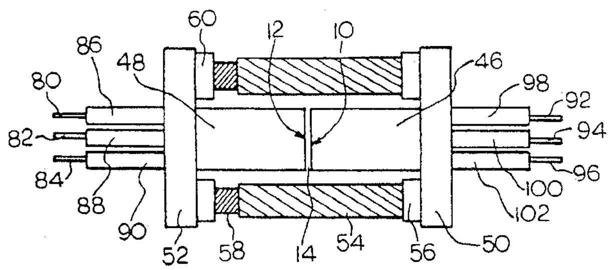
5,283,845 Feb. 1, 1994

Multi-Port Tunable Fiber-Optic Filter

Inventor: Joseph W. Ip.
Assignee: JDS Fitel Inc.
Filed: July 20, 1992.

Abstract—A multiport tunable fiberoptic etalon filter (MTFET) having two spaced partially reflective mirrors, has three or more ports, with at least two on one side and at least one on the other side of the etalon. A single signal can be filtered with the reflected signal being received, forming a wavelength division multiplexor, or a plurality of signals can be filtered, with or without the reflected signals being received. A series of filters can be arranged in a cascade for sequential filtering a series of wave bands. A signal can be processed in two directions sequentially for a higher filter efficiency. A first signal can be monitored and controlled by a second signal. Various other arrangements can be provided. Integral optical processing functions can be incorporated, for example a blocking filter.

13 Claims, 3 Drawing Sheets



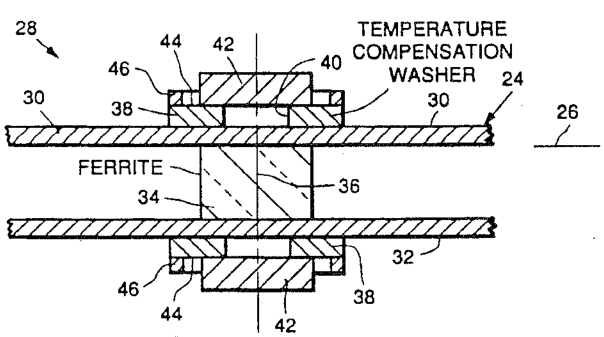
5,285,174 Feb. 8, 1994

Temperature-Compensated Waveguide Isolator

Inventors: Omar M. Al-Bundak and Antonio Luna.
Assignee: Hughes Aircraft Company.
Filed: Dec. 23, 1992.

Abstract—A temperature-compensated junction isolator (28) is used with a waveguide junction (20) in a hollow microwave waveguide system (22). The junction isolator (28) includes a ferrite cylinder (34) within the waveguide walls (30 and 32) at the junction with its cylinder axis (36) perpendicular to the waveguide walls (30 and 32). A pair of temperature-compensation washers (38) are aligned with the cylinder axis (36) of the ferrite cylinder (34) and are positioned external to the waveguide walls (30 and 32). Each washer (38) has a central opening (40) smaller in diameter than the diameter of the ferrite cylinder (34) and is made of a material whose permeability decreases with increasing temperature, preferably a nickel-iron alloy with about 30 percent iron. A pair of magnets (42) are aligned with the cylinder axis (36) of the ferrite cylinder (34), one of the magnets (42) being located exterior to each of the temperature-compensation washers (38). The waveguide junction isolator (28) produces a circulator function with relatively uniform properties over a range of operating temperatures.

18 Claims, 2 Drawing Sheets



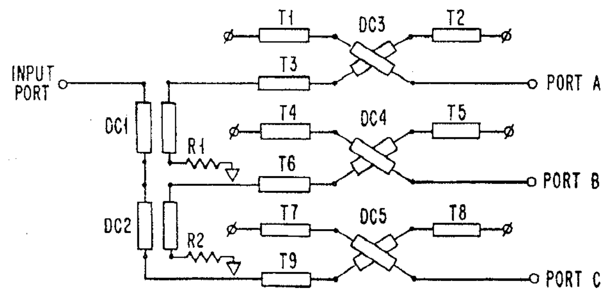
5,285,175 Feb. 8, 1994

Tri-Phase Combiner/Splitter System

Inventor: Richard C. Edwards.
Assignee: Rockwell International.
Filed: Sept. 3, 1992.

Abstract—A tri-phase combiner/splitter system that has similar advantages to presently available binary combiner/splitter systems which uses quadrature couplers. Notably, the combiner input Voltage Standing Wave Ratio ("VSWR") remains at 1:1 for identical mismatch impedance at the output ports. There is also a complete cancellation of back-door intermodulation components for identical output device nonlinearities. An innovative wideband, 0° three way combiner/splitter is the basic building block of the present invention. To achieve equal port impedances, a new wideband transmission line transformer is used. By using 60° or 120° phase equalization networks at the three, 0° output ports, this device is converted to a wideband tri-phase combiner. For moderate bandwidths, a coupled transmission line version is possible using meandering strip lines in the same fashion used in quadrature coupler design. A new transmission line phase compensating technique is also accomplished using meandering strip lines.

4 Claims, 6 Drawing Sheets



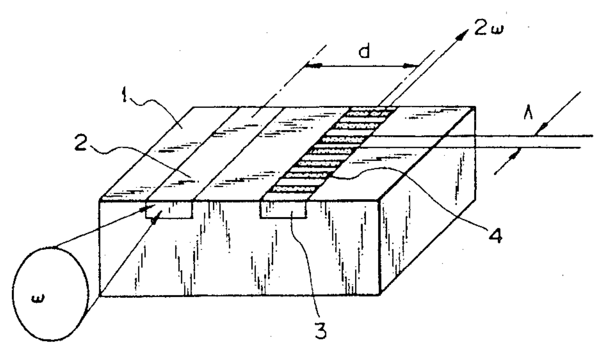
5,285,508 Feb. 8, 1994

Optical Wavelength Converter

Inventor: Kiyofumi Chikuma.
Assignee: Pioneer Electronic Corporation.
Filed: Jan. 14, 1993.

Abstract—An optical wavelength converter comprises a substrate, a first waveguide formed in the substrate and allowing a fundamental wave to enter therein, and a second waveguide extending parallel to the first waveguide and disposed on the substrate at a predetermined distance spaced from the first waveguide, wherein the second waveguide has refractive index gratings formed and arranged periodically in the extending direction thereof, each refractive index grating having an equivalent refractive index different from that of the second waveguide. The optical wavelength converter is of high conversion efficiency.

7 Claims, 4 Drawing Sheets



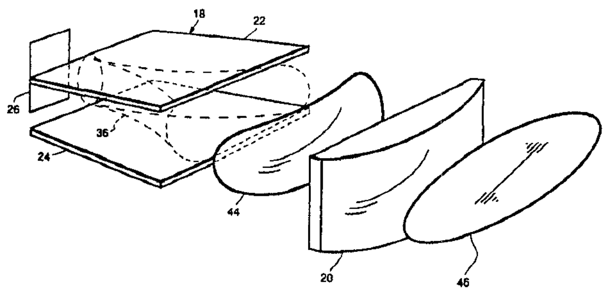
5,285,509 Feb. 8, 1994

Coupler for Waveguides of Differing Cross-Section

Inventors: Robin A. Reeder and Gregory R. Sasaki.
Assignee: Hughes Aircraft Company.
Filed: Dec. 18, 1992.

Abstract—A waveguide coupler for coupling electromagnetic power between a first rectangular waveguide and a second rectangular waveguide includes a one-dimensional intermediate waveguide formed of two plates spaced apart by a distance equal to a common height of the two waveguides. This enables a wave emanating from the first waveguide to spread apart traversely so as to equal the width of the second waveguide, the width of the second waveguide being greater than the width of the first waveguide. A cylindrical lens is located between the intermediate waveguide and the second waveguide to provide for a conversion between a cylindrical wavefront and a planar wavefront. The coupler is operative in reciprocal fashion such that a wave emanating from the first waveguide spreads out in width and is then converted to a planar waveguide prior to entering the second waveguide; and a wave emanating from the second waveguide is converted to a wave of contracting width for entry into the first waveguide. In each of the first and the second waveguides, the waveguide has an open end which serves as a port by which electromagnetic power is coupled between the waveguide and the intermediate waveguide. In an alternative embodiment, the intermediate waveguide may be fabricated as a block of solid electromagnetic-wave propagating material.

10 Claims, 2 Drawing Sheets



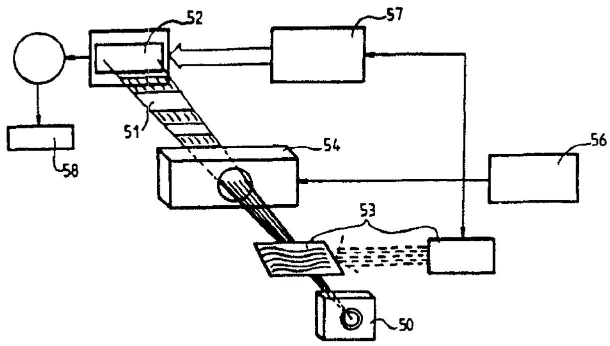
5,286,968 Feb. 15, 1994

Method and Device for Multichannel Analog Detection

Inventors: Danièle Fournier, François Charbonnier, Philippe Gleyzes, Albert-Claude Boccara.
Assignee: Centre National de la Recherche Scientifique (NRS).
Filed: June 27, 1991.

Abstract—The invention relates to a device for multichannel analog detection of a signal to be detected as having a very good signal/noise ratio. It incorporates a modulator (53) producing a modulated signal S(P); means of synchronous attenuation (54) of variable phase Φ producing an attenuated modulated signal; a multipoint receiver (52) receiving the modulated-attenuated signal and producing for each point a primary analog signal; an integrator producing for each point a value $V(P, \Phi)$ resulting from the integration over N periods of the primary analog signal; means of reading, of digitizing and of sorting the values $V(P, \Phi)$ for a given Φ value; a phase sequencer giving Φ the values $\Phi_0 + i2\pi/n$ successively where i is an integer varying from 1 to n; a digital processing unit making it possible to obtain data representative of $S(P)$ from values $V(P, \Phi)$. It is particularly well adapted to the detection of a luminous flux with an array of photodiodes.

13 Claims, 5 Drawing Sheets



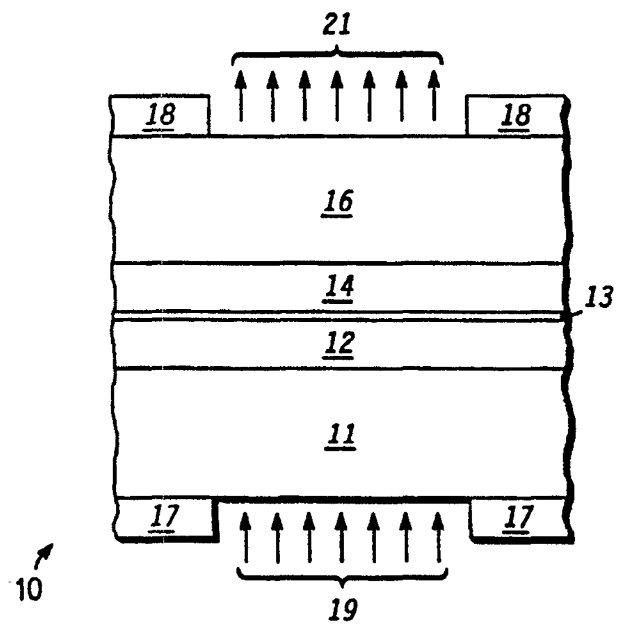
5,286,982 Feb. 15, 1994

High Contrast Ratio Optical Modulator

Inventors: Donald E. Ackley, Herbert Goronkin, Michael S. Lebby.
Assignee: Motorola, Inc.
Filed: Nov. 22, 1991.

Abstract—A thin transition layer (13) is employed to provide alignment between an electron wave function (29) and a hole wave function (37) of an optical modulator (10) for a wide range of applied voltage values that are less than a predetermined value. Over this range of voltages, the modulator (10) is in an off state and substantially absorbs incident light (19). For applied voltages in excess of the predetermined value, the electron (29) and hole wave (37) function alignment is diminished thereby allowing light (19) to be transmitted through the modulator (10).

10 Claims, 2 Drawing Sheets



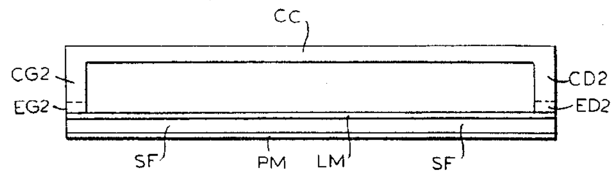
5,287,075 Feb. 15, 1994

Microwave Phase Shifter

Inventors: Francois Regnaudin and Michel Cauterman.
Assignee: Electronique Serge Dassault.
Filed: Apr. 7, 1988.

Abstract—In a reciprocal microwave phase shifter of microstrip technology, a Ferrite substrate carries, on one side, a ground plane (PM) and, on the other, a microstrip line (LM). The lateral branches (CG2 and CD2) cooperating with a base (CC) to define a magnetic circuit come into direct contact with the Ferrite substrate (SF), be being, for example, equipped with a recess (ED2) in line with the passage of the microstrip line (LM).

18 Claims, 4 Drawing Sheets



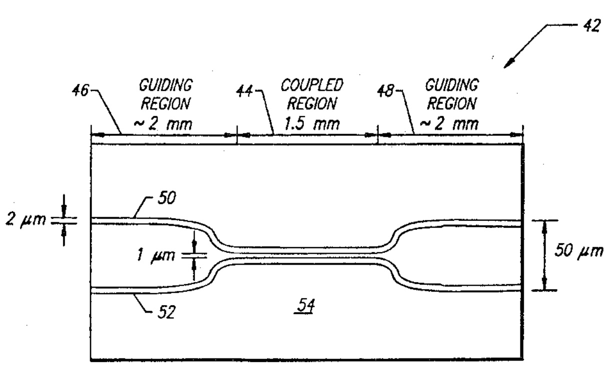
5,287,421 Feb. 15, 1994

All-Optical Modulation in Crystalline Organic Semiconductor Waveguides

Inventors: Stephen R. Forrest and De Yu Zang.
Assignee: University of Southern California.
Filed: Jan. 11, 1993.

Abstract—All-optical modulation occurs in crystalline organic semiconductor waveguides (10*a*) grown by the ultra-high vacuum process of organic molecular-beam deposition onto substrates (10*b*). Two light beams with wavelengths of 1.06 and 0.514 μm from a first source (12) and a second source (34), respectively, may be used as the guided and the pump light sources, respectively. A resonant non-linear coefficient at room temperature of 5.4×10^{-5} cm^2/W at 1.06 μ occurs at a pump intensity of 1.0 W/cm^2. This large non-linear effect is attributed to free electron-hole pairs produced by the dissociation of excitons generated by the short wavelength beam. A carrier lifetime of (17 ± 1) us, which determines the modular switching time, is in good agreement with theoretical predictions. This appears to be the first observation of free-carrier-induced index modulation in crystalline organic waveguides.

17 Claims, 4 Drawing Sheets



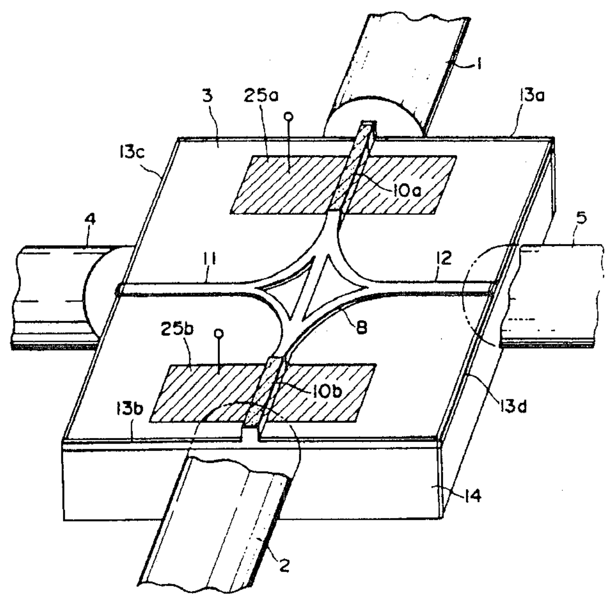
5,287,422 Feb. 15, 1994

Integrated Type Optical Node and Optical Information System Using the Same

Inventors: Uuichi Handa, Hidetoshi Nojiri, Hajime Sakata.
Assignee: Canon Kabushiki Kaisha.
Filed: Mar. 22, 1993.

Abstract—This specification discloses an integrated type optical node comprising a substrate, a channel light waveguide formed on the substrate for connecting the transmission lines of an optical information system, an amplifying portion provided on the light waveguide for amplifying a light propagated through the waveguide, and a light branching-off portion provided on the light waveguide for coupling a light transmitter and/or a light receiver to the transmission lines. The specification also discloses an optical information system using such optical node.

34 Claims, 8 Drawing Sheets



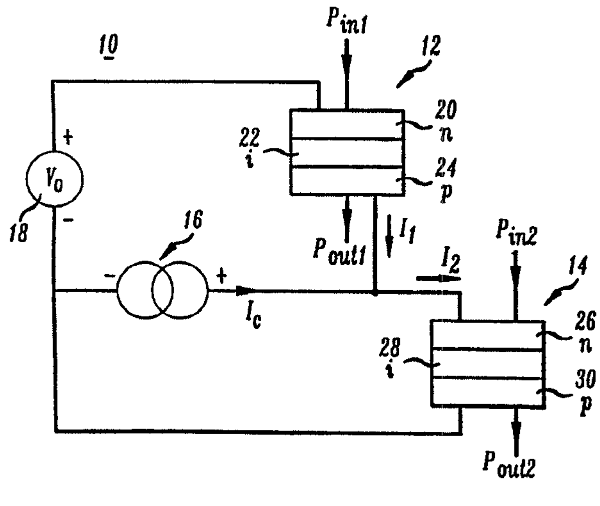
5,288,990 Feb. 22, 1994

Differential Self-Electrooptic Effect Device

Inventor: David A. B. Miller.
Assignee: AT&T Bell Laboratories.
Filed: Dec. 28, 1992.

Abstract—Optical analog information processing capability is achieved by providing a SEED device configured to operate in a differential mode. This "differential SEED" utilizes pairs of input signal beams to represent bipolar analog data and to process those data in a linear fashion. The difference in the optical powers of the input signal beams is used to modulate the absorption of power supply beams in quantum well diodes, such that the difference in the absorbed powers in the quantum well diodes is proportional to the difference in the powers of the input signal beams. The differential SEED can be configured to perform various image processing operations on bipolar analog data, including, for example, image addition and subtraction, optical multiplication, and evaluating spatial derivatives.

18 Claims, 9 Drawing Sheets



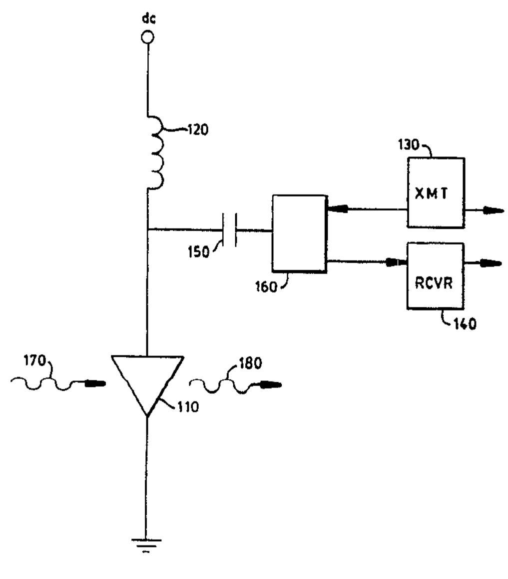
5,289,480 Feb. 22, 1994

Triple-Function Semiconductor Laser Amplifier

Inventors: Kwang-Tsai Koai and Robert Olshansky.
Assignee: GTE Laboratories Incorporated.
Filed: Feb. 3, 1993.

Abstract—An optoelectronic device is disclosed utilizing a semiconductor laser amplifier that provides for simultaneous detection, amplification, and modulation of an input optical signal. In one embodiment, an electronic transmitter and receiver are coupled to the semiconductor laser amplifier through an RF circulator. In an alternative embodiment, the electronic transmitter and receiver are coupled to the semiconductor laser amplifier through an RF power splitter with frequency or phase discriminating circuitry.

5 Claims, 2 Drawing Sheets



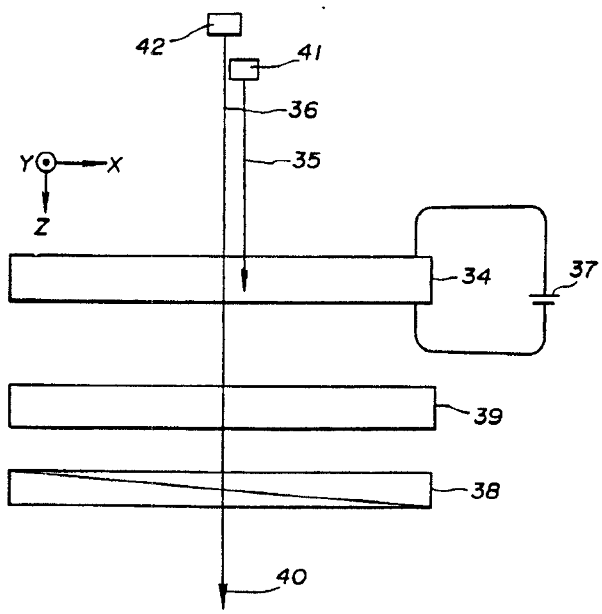
5,289,489 Feb. 22, 1994

All-Optical Light Modulating Apparatus and All-Optical Process for Modulating Light

Inventors: Johan Bergquist and Yasuo Tomita.
Assignee: Canon Kabushiki Kaisha.
Filed: Feb. 20, 1992.

Abstract—A light modulating apparatus includes a semiconductor device having a quantum well structure and a device for applying an electric field to the quantum well structure of the semiconductor device. Both of pump and probe light beams or a pump and probe light beam is input into the semiconductor device. The pump light beam or pump and probe light beam received by the semiconductor device causes a real charge excitation in the quantum well structure, and the real charge excitation screens the electric field applied to the quantum well structure. The polarization state of the probe light beam or pump and probe light beam emerging from the semiconductor device is changed by an electrooptical effect in the quantum well structure induced by the real charge excitation. A polarizer may be disposed for converting a change in polarization state of the light emerging from the semiconductor device into a change in intensity of the light.

18 Claims, 3 Drawing Sheets



5,291,146 Mar. 1, 1994

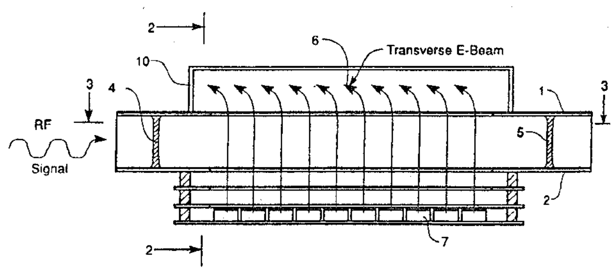
Transverse Traveling Wave Amplifier

Inventor: Walter Friz.
Assignee: The United States of America as represented by the Secretary of the Air Force.
Filed: Oct. 7, 1992.

Abstract—The RF amplifier has a single waveguiding structure extending logitudinally in a direction of propagation of electromagnetic waves, in which density of an injected current flow is not RF modulated, and a transverse E-field component vector of the electromagnetic waves interacts with the electron flow by electron transit time effects. The waveguiding structure comprises a metallic top strip 1 and a metallic ground strip 2 held apart by two ceramic supports 3 which integrate the two strips into a vacuum tight enclosure together with two RF transparent dielectric windows 4 and 5 which represent

the amplifier input and output respectively. Electron flow is generated in a linear current injection system by electronic emitters providing a cathodic source of electron flow which is injected into the waveguiding structure, with a flow vector orientation transverse to the direction of propagation of said electromagnetic waves. The electron flow enters the stripline interior space through an extended slot along the middle of the ground strip, after interaction with the wavefield leaves the waveguiding structure through a longitudinal slot in the metallic top strip, and is then collected by a collector 10 which straddles the slot over its entire length.

7 Claims, 2 Drawing Sheets



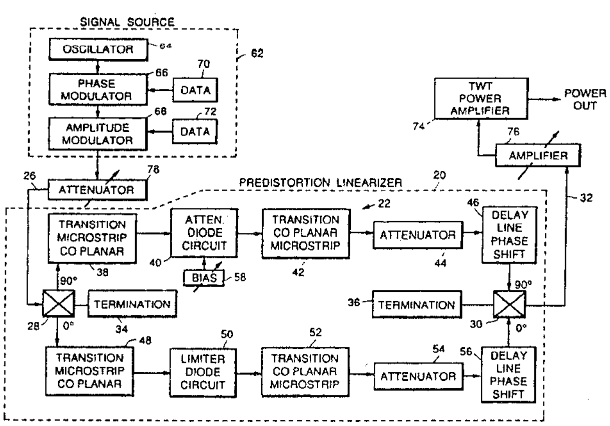
5,291,148 Mar. 1, 1994

Gain Linearization with Coplanar Waveguide

Inventors: Russ A. Reisner, Wilbert Copeland, Arnold Berman, Charles C. Curello.
Assignee: Hughes Aircraft Company.
Filed: Dec. 22, 1992.

Abstract—A predistortion linearizer (20) is operative with a microwave signal, as may be provided by signal source (62) to linearize the gain of a power amplifier, such as a traveling-wave-tube power amplifier (74), by induction of an amplitude and/or a phase distortion to the microwave signal wherein the distortion in inverse to a distortion introduced by the power amplifier, thereby to compensate for the distortion of the power amplifier. The linearizer is constructed of two channels (22, 24) which are operated in parallel but approximately 180 degrees out of phase, with an additional phase increment provided by delay lines (46, 56) to offset one channel from the other channel by a phase difference in a range of approximately 160–200 degrees. Included within each channel is a diode circuit (40, 50) wherein the diode circuit (40) includes a set of PIN diodes operated in linear fashion in the channel (22), and the diode circuit (50) includes a set of Schottky diodes operated in nonlinear fashion in the channel (24). The limiter diode circuit (50) limits signal amplitude resulting in a gain expansion and a phase advance upon summation of signal vectors of the two channels to provide an output signal. These are adjusted to compensate for the gain compression and phase lag of the power amplifier. In each of the diode circuits, the diodes are mounted on components of a coplanar waveguide for symmetry in construction and avoidance of generation of parasitic reactances.

9 Claims, 3 Drawing Sheets



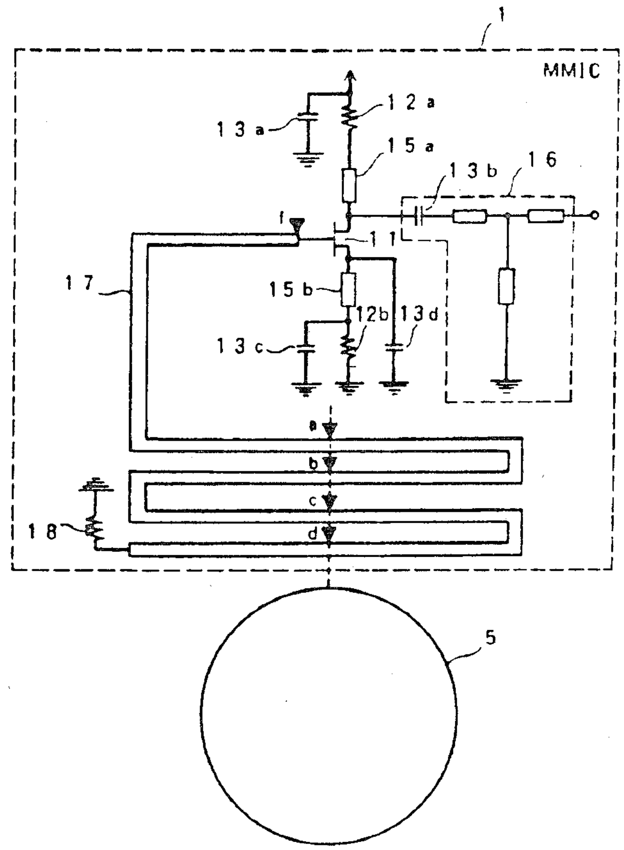
5,291,153 Mar. 1, 1994

Oscillating MMIC Circuit with Dielectric Resonator

Inventor: Nobuo Shiga.
Assignee: Sumitomo Electric Industries, Ltd.
Filed: Apr. 21, 1992.

Abstract—An oscillating circuit includes a substrate, a FET formed on the substrate, a series feedback capacitor connected to the source of the FET, a microstrip line formed on the substrate and connected to the gate of the FET, and a dielectric resonator which is electromagnetically coupled to the microstrip line. The dielectric resonator is located near the microstrip line.

5 Claims, 3 Drawing Sheets



5,291,164 Mar. 1, 1994

Radiating High Frequency Line

Inventor: André Levisse
Assignee: Societe Anonyme Dite Alcatel Cable.
Filed: Dec. 18, 1992.

Abstract—The present invention concerns a high frequency radiating line for radiating electromagnetic energy in a frequency band and comprising at least one tubular conductor (23) surrounding a longitudinal axis (X) and having a plurality of apertures formed into a series of identical patterns (M1) repeated periodically with a period P along said line, characterized in that, when the operating frequency band is of the type $[f_r, (N+1)f_r]$, where f_r is a given frequency and N is a positive integer greater than 1, each of said patterns (M1)

comprises N apertures 0 to $N-1$ and satisfying the following equations:

$$z_k = \frac{P \cdot p_k}{N+2}$$

$$a_k = \frac{\sin\left(\frac{(p'-p_k)\pi}{N+2}\right)\sin\left(\frac{(p''-p_k)\pi}{N+2}\right)}{\sin\left(\frac{p'\pi}{N+2}\right)\sin\left(\frac{p''\pi}{N+2}\right)} a_0$$

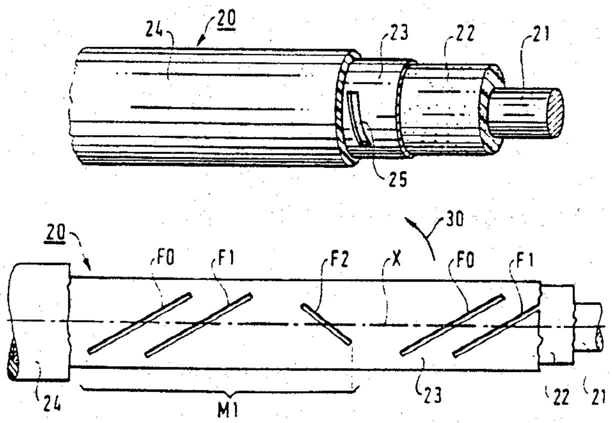
where:
the index k is an integer such that $1 \leq k \leq N-1$ and refers to the kth aperture of one of said patterns (M1).
z_k is the distance between said kth aperture and first aperture (F0) of the pattern.
a_k is the polaribility of the kth aperture,
a_0 is the polarizability of the first aperture,

$$-p' = E\left(\frac{N+2}{4}\right) \quad \text{or} \quad p' = E\left(\frac{N+2}{4}\right)+1$$

$$-p'' = E\left(\frac{3(N+2)}{4}\right) \quad \text{or} \quad p'' = E\left(\frac{3(N+2)}{4}\right)+1$$

where
$E(x)$ designates the integer part of x,
p_k is an integer such that $1 \leq p_k \leq N+1$, said integers p_k being pairwise distinct, such that $p_k < p_{k+1}$, and different from p' and p''.

10 Claims, 7 Drawing Sheets



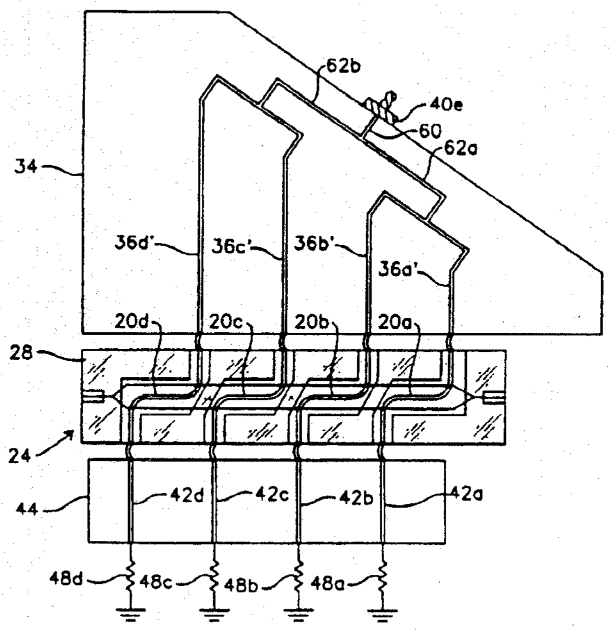
5,291,565 Mar. 1, 1994

Broad Band, Low-Power Electro-Optic Modulator Apparatus and Method with Segmented Electrodes

Inventors: James H. Schaffner and William B. Bridges.
Assignee: Hughes Aircraft Company.
Filed: June 30, 1992.

Abstract—An electrooptic modulator such as Mach-Zehnder interferometer has a segmented optical transmission network with a series of discrete electrodes for successive segments of the network. Respective modulating signals are supplied to the electrodes along transmission lines whose lengths differ from each other, so that modulating signals applied to the inputs of the transmission lines arrive at their respective electrodes in synchronism with the propagation of an optical signal through the optical transmission network. The modulating transmission lines are disposed lateral to and generally coplanar with the optical transmission network, preferably on a separate substrate. The desired differential in transmission line lengths can be achieved by positioning the input ends of the transmission lines along an edge of the input substrate that is at a desired angle to the optical transmission network.

23 Claims, 4 Drawing Sheets



5,291,566 Mar. 1, 1994

Total Internal Reflection Electro-Optic Modulator for Multiple Axis and Asymmetric Beam Profile Modulation

Inventor: Ellis D. Harris.
Assignee: Xerox Corporation.
Filed: Apr. 3, 1992.

Abstract—The total internal reflection modulator has an electrode array distributed across an area of the reflecting surface of the electro-optic material. The electrode array has multiple sets of electrodes forming an outer rectangle interdigitated with at least one reference set of electrodes forming a inner diamond. A diamond-shaped area with no electrodes is preferably symmetrically within the inner electrodes of the electrode array on the reflecting surface. The uniform voltage difference between the electrodes and the varying lengths of the electrodes creates a fringe electrical field in the electro-optical material and an optical phase grating to diffract the incident light on the reflecting surface. The zero order nondiffracted light becomes the output beam. The optical phase grating will control the incident beam's optical profile at the modulator (near field) and hence the imaged spot size at a focus at the image plane (far field).

Alternatively, the total internal reflection modulator can have a diamond-shaped interdigitated electrode pattern within a rectangular shaped area with no electrodes. Using Schlieren optics, the non-zero order diffracted beam becomes the output beam with a modulated optical beam profile.

9 Claims, 3 Drawing Sheets