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ADMINISTRATIVE INFORMATION

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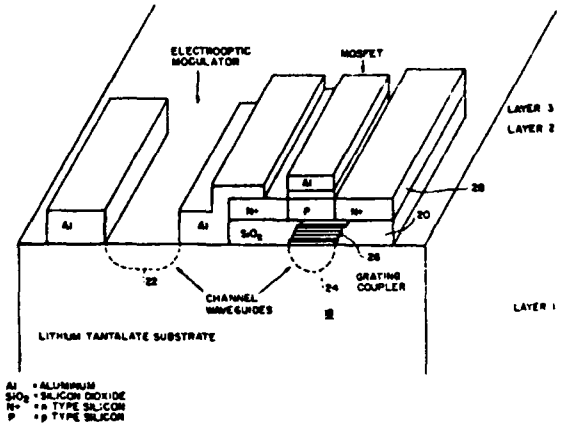
SEMICONDUCTOR TECHNOLOGY

FABRICATION OF SEMICONDUCTOR DEVICES IN RECRYSTALLIZED SEMICONDUCTOR FILMS ON ELECTROOPTIC SUBSTRATES

Inventor: Ronald E. Reedy
Patent Number 4,649,624; dated 17 March 1987

ABSTRACT: This invention relates to a process of manufaturing an integrated structure in which optical signals can be processed in an electrooptic material such as lithium tantalate, and electrical signals can be processed in a semiconductor material such as silicon. Microelectronic semiconductors are fabricated in the semiconductor material and electrooptic devices are fabricated in the electrooptic material. Devices made by the process of the present invention are also disclosed.



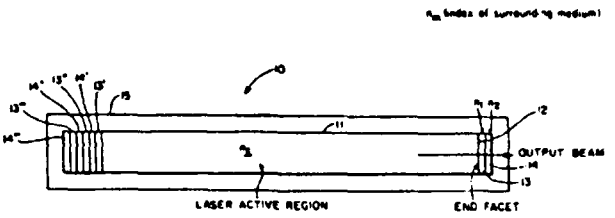
STAGE OF DEVELOPMENT: The invention has been demonstrated with both lithium tantalate and PLZT substrates.

APPLICATIONS: Devices created in accordance with the present invention have the capability of handling both electronic and optical signals in a single substrate structure. Devices fabricated in accordance with the present invention exhibit increased reliability, easier fabrication, potentially increased system speed, and potential new applications and/or functions based on the interaction of electronic and electrooptic devices.

SEMICONDUCTOR LASER END-FACET COATINGS FOR USE IN SOLID OR LIQUID ENVIRONMENTS

Inventors: Graham A. Garcia and Steven J. Cowen
Patent Number 4,510,607; dated 9 April 1985

ABSTRACT: An improvement for a semiconductor laser allows the facet reflectivity to be modified to compensate for the presence of a liquid or transparent solid medium having an index of refraction n_m. A first dielectric coating is disposed on an end facet of the semiconductor laser and has an index of refraction n_1. A second dielectric coating is disposed on the first dielectric coating and has an index of refraction n_2. The materials of the dielectric coatings are selected such that the fraction $n\sqrt{n_2} = \sqrt{n_m}$. Thus, the problems associated with reductions of laser facet reflectivity due to being in contact with a surrounding medium that optically is very different from air are overcome.



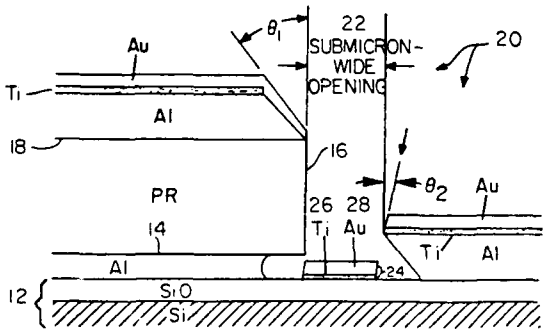
STAGE OF DEVELOPMENT: This technique has been verified mathematically but no attempt was made to confirm the mathematical concept by fabricating a working model.

APPLICATIONS: These end-facet coatings would be used in applications requiring the laser to be immersed in a liquid or potted in a solid material. Such would be the case where the laser must be protected from harsh environments. For underwater applications in communication systems, sensors, or instrumentation, the laser may be packaged in a liquid- or solid-filled enclosure to withstand the elevated pressures encountered at depth.

FABRICATION OF SUBMICRON-WIDE LINES WITH SHADOW DEPOSITIONS

Inventors: Edward C. Jelks and George L. Kerber
Patent Number 4,409,262; dated 11 October 1983

ABSTRACT: A method of fabricating lines of submicron width, comprising the following steps: (1) providing a substrate; (2) depositing a first layer of metal upon the substrate; (3) spinning a photoresist layer on the metal; (4) patterning the photoresist layer; (5) etching the metal to undercut the photoresist edge (e.g., with a mixture for approximately ten minutes at room temperature); (6) depositing a second layer of metal at an angle θ_1 to the photoresist edge, thereby defining a long, submicron-wide opening to the underlying substrate; (7) depositing a chosen material (for example, metallic or semiconductor) for the bridge onto the substrate at an angle of θ_2 through the submicron-wide opening; and (8) removing undesired material surrounding the bridge by dissolving the photoresist in hot acetone followed by stripping the remaining two layers of metal with etchant.



SHADOW DEPOSITION GEOMETRY.

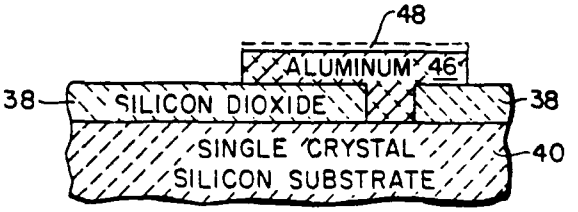
STAGE OF DEVELOPMENT: This method has been experimentally verified.

APPLICATIONS: This method has applications in the area of microelectronic processing.

CHEMICAL ETCHING OF TRANSFORMED STRUCTURES

Inventor: Monti E. Aklufi
Patent Number 4,450,041; dated 22 May 1984

ABSTRACT: A maskless technique is disclosed for shaping semiconductor materials by forming selectively etchable areas with respect to the rest of the structure. In one embodiment of this invention, a body of amorphous material is subjected to radiation by a focused energy beam so as to convert a predetermined region of the amorphous material into a region of crystalline material. The converted region etches at a slower rate than the nonconverted amorphous material. In a second embodiment, a method of selectively etching a metal is disclosed, which includes the step of subjecting a predetermined region of the metal to be impinged upon by a shaped ion beam so as to ion-implant the predetermined region. A chemical etch is applied to the metal and the ion-implanted region of the metal. The ion-implanted region etches at a slower rate than the metal outside the ion-implanted region. In another embodiment of the present invention, a method of selectively etching a dielectric is disclosed that includes subjecting a predetermined region of the dielectric to be impinged upon by a shaped ion beam so as to ion-implant the predetermined region. A chemical etch is applied to the dielectric and to the ion-implanted region of the metal. The ion-implanted region etches faster than the portion of the dielectric outside the ion-implanted region.



STAGE OF DEVELOPMENT: The method has been experimentally verified.

APPLICATIONS: This method has applications in semiconductor technology.

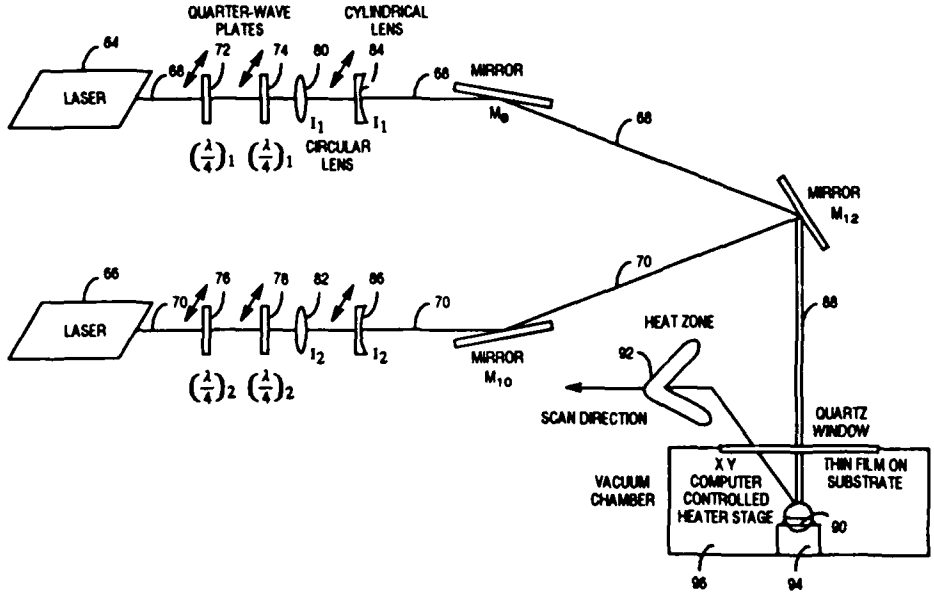
SINGLE CRYSTAL THIN FILMS

Inventor: Monti E. Aklufi
Patent Number 4,707,217; dated 17 November 1987

ABSTRACT: A system and techniques are disclosed for forming single crystal films with the use of energy sources that can create shaped hot zones. The energy may be from any source provided that it can be shaped and directed, and can heat the film to become molten and recrystallized by liquid-phase epitaxy. The hot zone created by the heat source is shaped such that the angle defined by the scanned hot zone's trailing liquid edge is smaller than the angle defined by the intersection of the crystal's slowest growth planes.

STAGE OF DEVELOPMENT: This crystallization method has been verified in a laboratory environment for silicon semiconductors.

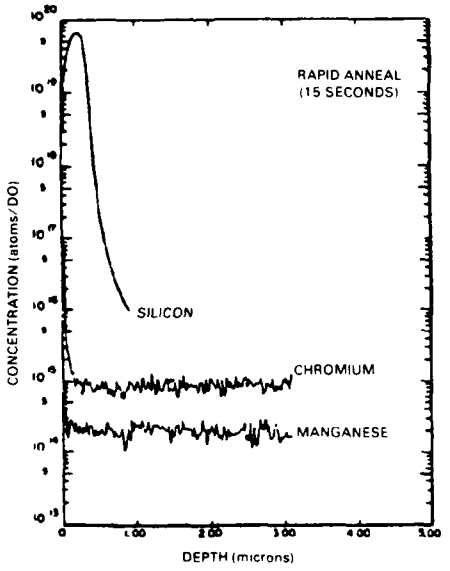
APPLICATIONS: This technique of forming crystallized films on amorphous substrates has been applied to silicon on silicon dioxide whose potential application include low-cost, efficient solar cells, electronic display panels, and integrated circuits.

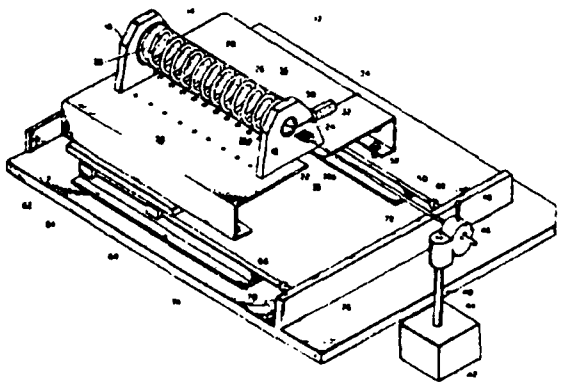


FURNACE TRANSIENT ANNEALING PROCESS

Inventors: David A. Collins, Derek L. Lile, and Carl R. Zeisse
Patent Number 4,555,273; dated 26 Novemb · 1985

ABSTRACT: A method for annealing semiconductor samples, especially following ion-implantation of semiconductor samples, is disclosed. A furnace on a set of rails is passed over the semiconductor sample, which is supported on a stationary wire basket made of low-thermal-mass, fine tungsten wire. The furnace temperature may be about 5° above the desired anneal temperature of the semiconductor sample such that the sample temperature rises to within a few degrees of the furnace temperature within seconds. Utilizing the movable furnace insures uniform heating without elaborate temperature control or expensive beam-generating equipment.





The apparatus and process of the present invention are utilized for rapid annealing of ion-implanted indium phosphide (InP) semiconductors within 10 to 30 seconds and at a temperature of approximately 700° C., thereby eliminating undesired and damaging movement of impurities within the ion-implanted InP.

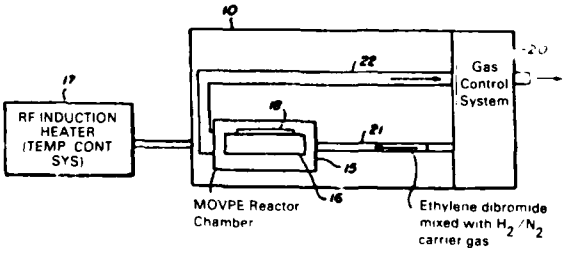
STAGE OF DEVELOPMENT: This method of annealing has been satisfactorily used in annealing InP following silicon ion implantation into both semi insulating and zinc doped "p" type InP.

APPLICATIONS: This method is applicable for annealing various semiconductors and implanted ions within the range of about 650° to 900° C where minimum impurity motion is desired.

THERMALLY ACTIVATED VAPOR ETCHANT FOR INP

Inventor: Arthur R. Clawson
Patent Number 4,671,847; dated 9 June 1987

ABSTRACT: The Thermally Activated Vapor Etchant for InP is a method for *in situ* gas phase etching of InP substrates in Metalorganic Vapor Phase Epitaxy (MOVPE), using bromine byproducts from thermally decomposed ethylene dibromide. This permits introduction of a non-corrosive vapor from a gas distribution manifold that is activated in the thermal environment surrounding the heated substrate in MOVPE.

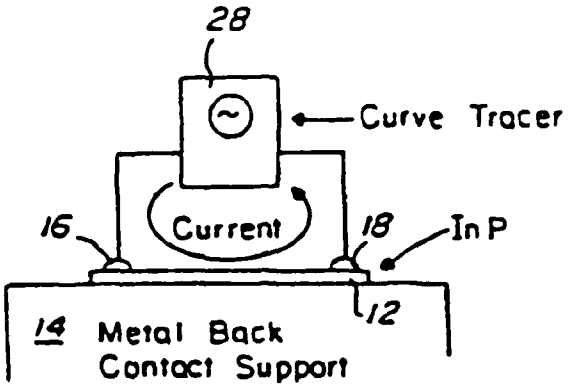


STAGE OF DEVELOPMENT: This method is used in indium phosphide layer growth research and is incorporated in MOVPE hardware at NOSC.

GENERATION OF OHMIC CONTACTS ON INDIUM PHOSPHIDE

Inventors: David A. Collins and Derek L. Lile
Patent Number 4,662,063; dated 5 May 1987

ABSTRACT: A process for forming low-resistance ohmic contacts on InP avoids the usual problem of high-temperature annealing. The method comprises passing a current between two contacts of a suitably chosen metallic conductor that is doped so as to be the same conductivity type as the underlining semiconductor. Passage of the current causes the contacts to combine with the semiconductor via field-assisted thermal diffusion.



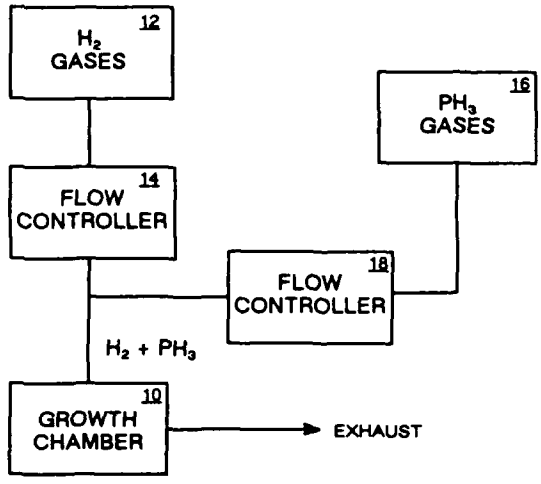
STAGE OF DEVELOPMENT: This process has been routinely used in the fabrication of various charge-coupled devices on indium phosphide.

APPLICATIONS: This process is applicable whenever the deleterious effects of high-temperature annealing must be avoided and is especially useful for fabricating buried-channel charge-coupled devices.

METHOD OF LIQUID PHASE EPITAXIAL GROWTH

Inventors: Arthur R. Clawson, Wing Y. Lum, and Gerald E. McWilliams
Patent Number 4,263,064; dated 21 April 1981

ABSTRACT: An improved method of liquid phase epitaxial growth of III-V compound on an InP substrate by growing the epitaxial layer in an atmosphere of H_2 with 10^{-5} to 10^{-4} mole fraction PH_3.



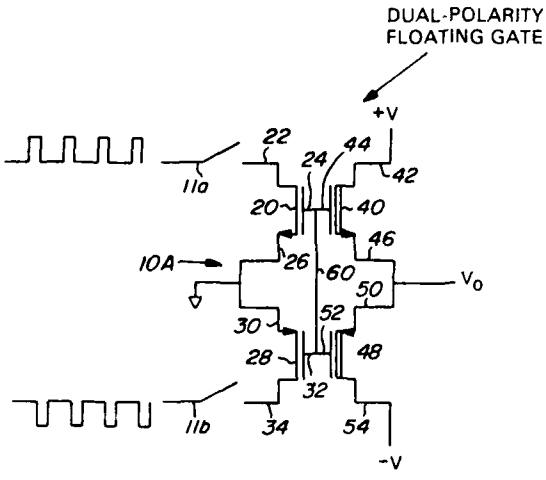
STAGE OF DEVELOPMENT: This method is in current use in various epitaxial reactors at NOSC and elsewhere.

APPLICATIONS: This method has applications in any epitaxial reactor where phosphorus-containing III-V compounds are used.

DUAL-POLARITY FLOATING GATE MOS ANALOG MEMORY DEVICE

Inventors: Ronald E. Reedy, Randy L. Shimabukuro, and Graham A. Garcia
Navy Case Number 71,105

ABSTRACT: A nonvolatile MOS integrated circuit memory element that is capable of storing both positive and negative analog data has been developed. The memory value can be increased or decreased incrementally and has storage times on the order of several years. The device is very compact, using just four MOSFETs, and is, therefore, very well suited for the storage of weight values in integrated-circuit implementations of neural networks.



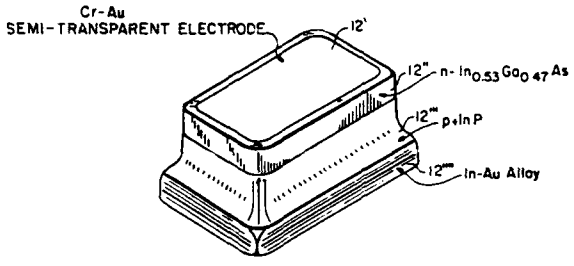
STAGE OF DEVELOPMENT: Discrete devices have been fabricated and tested. Arrays of the devices are currently being developed for use as neural network chips.

APPLICATIONS: The invention can be utilized in any application requiring a variable threshold MOSFET, or a variable resistance.

HETEROJUNCTION-DIODE TRANSISTOR EBS AMPLIFIER

Inventor: Herman H. Wieder
Patent Number 4,410,903; dated 18 October 1983

ABSTRACT: An improved apparatus modulates greater currents at higher frequencies over extended bandwidths. In addition to conventional biasing and modulation, a beam of electrons is directed onto a heterojunction-diode device disposed to receive the modulating electron beam. The heterojunction-diode device is fabricated from two different semiconducting materials having identical crystalline lattice structures, different fundamental energy bandgaps, and different impurity types of different concentrations. This combination of properties assures greater output currents, higher frequency modulation, and increased bandwidths.

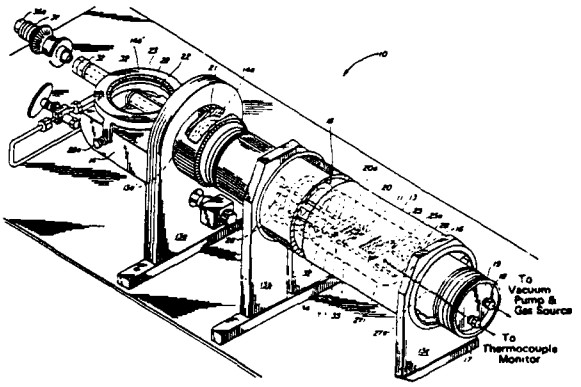


STAGE OF DEVELOPMENT: Although this proposed device needs to be demonstrated, the material technology is here (1989) and similar devices developed for different purposes clearly demonstrate the potential for these devices for EBS technology.

APPARATUS FOR TRANSIENT ANNEALING OF SEMICONDUCTOR SAMPLES IN A CONTROLLED AMBIENT

Inventors: Carl R. Zeisse, and Edward R. Schumacher
Patent Number 4,721,836; dated 26 January 1988

ABSTRACT: An improved apparatus for annealing an ion-implanted semiconductor sample reduces the deleterious side effects otherwise associated with the process. A semiconductor sample, fabricated, for example, from indium phosphide or gallium arsenide, is set upon the fingers of a carrier that is displaced to the interior of an elongate furnace having its internal temperature maintained at the proper annealing temperature. Next, the fingers are rotated and the sample is placed on a number of razor blade-like edges extending up from an internal rack. The carrier is withdrawn and the sample is quickly brought to the annealing temperature for the precise period of time, usually no more than 20 seconds. After the exact annealing period, the carrier is reintroduced and the fingers are rotated to lift and withdraw the sample from the rack. Since only the sample is brought within the furnace and placed on the preheated rack, it is immediately brought to the proper annealing temperature for the precise annealing duration that is ended by the immediate withdrawal of the sample from the furnace on the moveable carrier. Since the furnace, carrier, and rack are in a sealed enclosure, a non-oxidizing gas is provided to prevent oxidation and related degradation of the sample materials.



STAGE OF DEVELOPMENT: This apparatus has been built and works fine for indium phosphide implants and ohmic contacting.

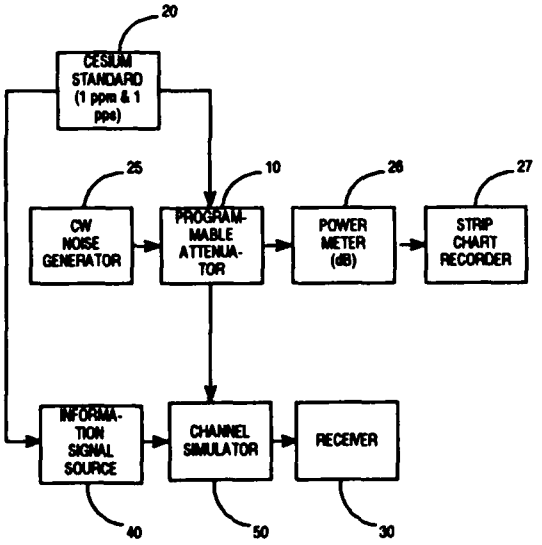
APPLICATIONS: This apparatus is good for semiconductors such as indium phosphide and mercury cadmium telluride, which benefit from processing at and below about 700°C. Because silicon and gallium arsenide require higher temperatures, they cannot be used as the apparatus now stands.

TEST-INSTRUMENT TECHNOLOGY

PROGRAMMABLE TIME VARYING ATTENUATOR

Inventors: Paul A. Singer and James L. Courath
Patent Number 4,625,332; dated 25 November 1986

ABSTRACT: A programmable time-varying attenuator has a reprogrammable digital circuit for impressing an analog attenuation signal on a continuous-wave noise signal. This signal is fed to the input of a receiver and, since the digital circuitry can be reprogrammed with a known sequence to effect a desired analog attenuation, a receiver's performance can be monitored and evaluated when the attenuated signal or error signal is simultaneously received with information signals. A desired time relationship between the information signals and the time varying attenuating test signal or error signal is maintained since both are slaved to a common standard. The programmable time varying attenuator is programmable independent of the information signal source and, therefore, is adaptable with different sources while being a highly reliable and cost-effective device for system testing.



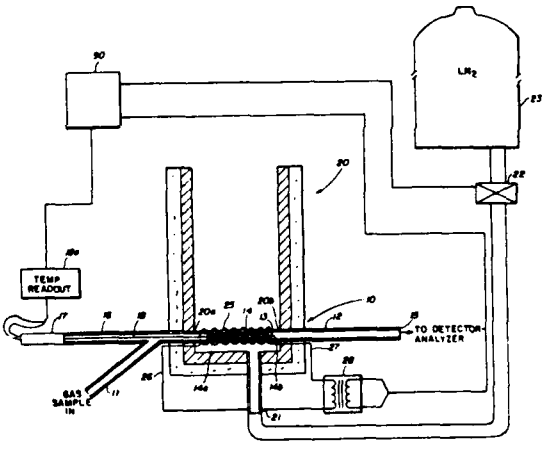
STAGE OF DEVELOPMENT: The device is presently in use as part of a strategic communications system testbed.

APPLICATIONS: This device has application where amplitude of signals needs to be finitely altered at precise and repeatable intervals.

VARIABLE TEMPERATURE TRAP

Inventor: Cesar Clavell, Jr.
Patent Number 4,610,169; dated 9 September 1986

ABSTRACT: Volatile organotin compounds are concentrated and subsequently eluted to a detector that provides an indication of the concentration of the various compounds of interest. An elongated tube, having a longitudinal chamber containing granular absorbent, receives the gas sample. Liquid nitrogen covers the tube and brings the temperature down to about -198°C, at which temperature the organotins of interest are trapped in the chamber. A helical coil about the tube then heats it to discrete temperatures at the organo-tins of interest are eluted to an interconnected detector. Precise control of the temperatures allows precise analysis of the organotin. A later raising of the temperature to an even higher level rids the longitudinal chamber of other compounds and water vapor so that liquid nitrogen can be reintroduced to start another cycle.



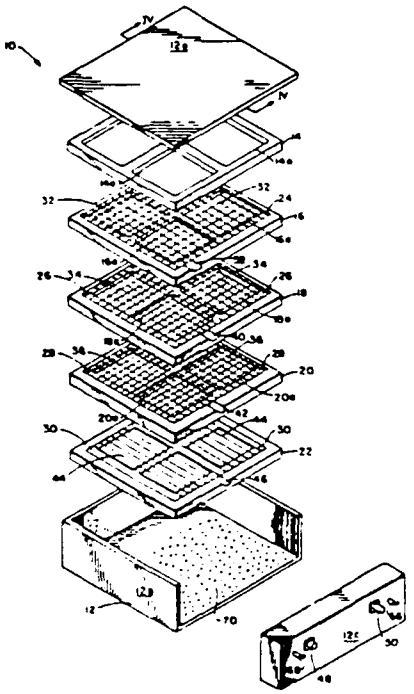
STAGE OF DEVELOPMENT: The trap system has been tested and is currently being used in an automated organometal analyzer.

APPLICATIONS: The trap assembly is applicable to all analytical instrumentation using cryogenic trap and purge techniques to analyze for chemical compounds entrained in a carrier gas. The programmable temperature regulation provides significant adjustment of compound retention times.

LITHIUM-6 COATED WIRE-MESH NEUTRON DETECTOR

Inventors: Charles A. Young and Bruce D. Geelhood
Patent Number 4,481,421; dated 4 November 1984

ABSTRACT: A neutron detection apparatus is provided that includes a selected number of surfaces of lithium-6 coated wire mesh, as well as a gas mixture in contact with each sheet of lithium-6 coated wire mesh for selectively reacting to charged particles emitted or radiated by the lithium-6 coated mesh. A container is provided to seal the lithium-6 coated mesh and the gas mixture in a volume from which water vapor and atmospheric gases are excluded, the container having one or more walls that are transmissive to neutrons. Monitoring equipment in contact with the gas mixture detects the generation of charged particles in the gas mixture and, in response to such charged particles, provides an indication of the flux of neutrons passing through the volume of the detector.



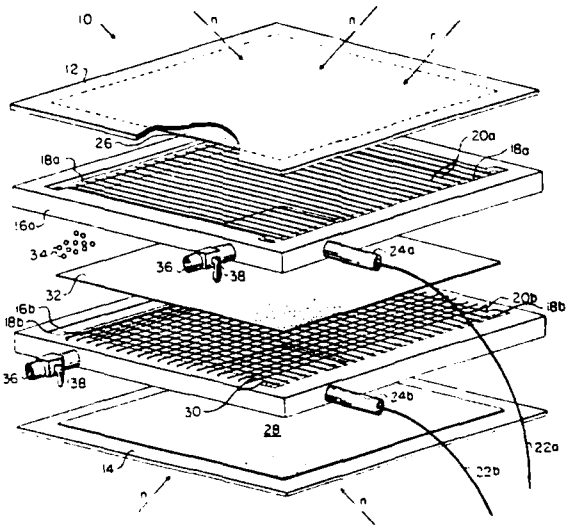
STAGE OF DEVELOPMENT: The detector concept has been verified in principle by small-scale, mock-up experiments. Full-scale experiments would require additional equipment for processing and handling the extremely active lithium metal. The development is not being pursued at this time.

APPLICATIONS: Neutron detectors built on this concept could be used in applications requiring monitoring on nuclear materials (e.g. reactors or fuel-processing facilities when space limitations make gaseous detectors unacceptable).

LITHIUM-6 FOIL NEUTRON DETECTOR

Inventor: Charles A. Young
Patent Number 4,365,159; dated 21 December 1982

ABSTRACT: A neutron detector apparatus is provided that includes a selected number of flat surfaces of lithium-6 foil, as well as a gas mixture in contact with each of the flat surfaces for selectively reacting to charged particles emitted by or radiated from the lithium foil. A container is provided to seal the lithium foil and the gas mixture in a volume from which water vapor and atmospheric gases are excluded, the container having one or more walls that are transmissive to neutrons. Monitoring equipment in contact with the gas mixture detects reactions taking place in the gas mixture and, in response to such reactions, provides notice of the flux of neutrons passing through the volume of the detector.



STAGE OF DEVELOPMENT: Several prototype detectors were fabricated and tested successfully over a period of several months. Sensitivity was in agreement with calculations, and remained stable during the evaluation period.

APPLICATIONS: This invention has applications in environmental surveys near nuclear reactors, accelerators, or radioactive neutron sources, especially where size and weight are a concern (e.g., in portable monitoring systems).

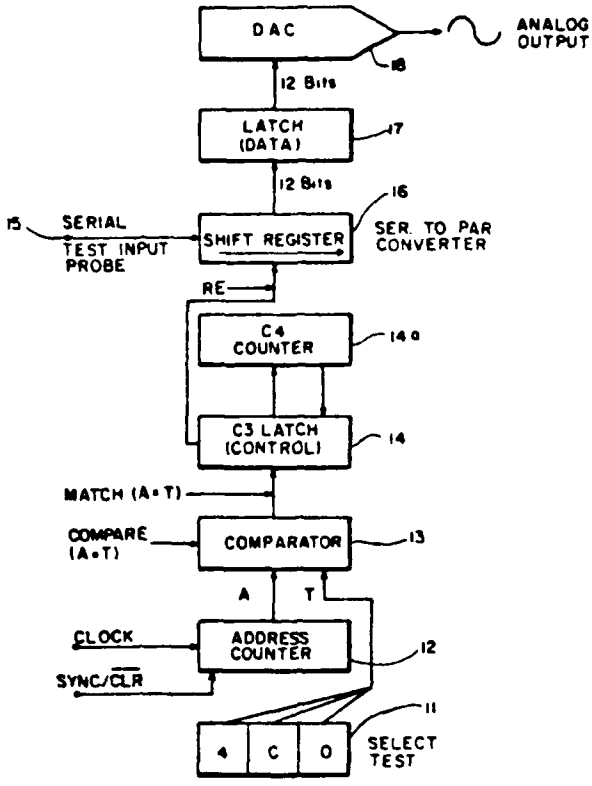
UNIVERSAL TEST BOARD, SERIAL INPUT (FOR SYNTHESIZER TESTING)

Inventor: Robert E. Page
Patent Number 4,658,209; dated 14 April 1987

ABSTRACT: An electronic system that processes or otherwise acts upon a serial data stream can be monitored at any one of several points to provide an indication that specific parts as well as the whole system are functioning properly. A selected digital address is dialed on a thumbwheel switch that provides a signal indicative of a particular time slot within a repetitive sequence of time slots. A counter produces a series of digital addresses that are representative of a repetitive sequence of time slots to enable a comparison and generation of a latch signal at the particular time slot indicated. A probe is placed in electrical engagement with that portion of the signal corresponding to the selected digital address and a serial test input signal is drawn from the system. The serial test input signal is converted from serial form to parallel form. A digital-to-analog converter generates a representative analog output signal that may be compared with a standardized analog signal that should be present at the desired point in the system when all components are functioning properly. Various synchronizing and clock signal rates can be provided to give the test apparatus the capability for accommodating differently sized signals for generating different test analog signals.

STAGE OF DEVELOPMENT: A prototype was built in 1986 and is part of the synthesizer located in a vault in Building 1, Bayside. It was used extensively for testing and proved essential in making the syn/prototype operational.

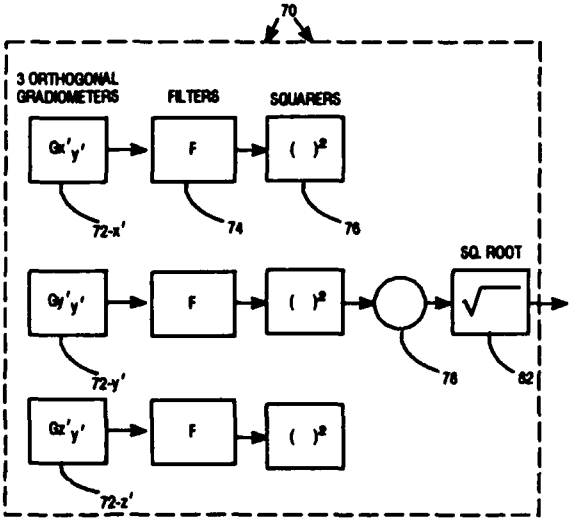
APPLICATIONS: This device has applications in digital systems where serial bit streams need to be checked and analyzed, especially where high-bit clocking rates are involved.



APPARATUS FOR MEASURING THE SPATIAL SCALAR VARIATION OF A MAGNETIC FIELD WITH VECTOR MAGNETIC SENSORS ON A MODERATELY STABLE MOVING PLATFORM

Inventor: George W. Byram
Patent Number 4,492,923; dated 8 January 1985

ABSTRACT: An apparatus, using three gradiometers, measures the spatial variation of a magnetic field along a path of motion of the apparatus. The apparatus comprises three gradiometers oriented along the mutually orthogonal axes, x', y', and z' defined on the moving platform. The outputs of the gradiometers are the gradients of the magnetic field when the motion is considered to be in the y' direction. Three filters, each having an input connected to the output of one of the gradiometers, are constructed to have an output signal that has a relatively narrow positive peak with a relatively wide negative area on each side of the peak. The net area is approximately zero when the input to the filter is a doublet. Three squares, each having an input connected to the output of a filter, square their input signals. A summer, having three inputs connected to the outputs of the squarers, obtains the sum of the squares of the high-pass-filtered components x', y', and z' of the magnetic field. A circuit, whose input is connected to the output of the summer, takes the square root of its input signal and outputs a signal corresponding to the magnitude of the variation of magnetic field along the path of motion of the platform.



PLATFORM MOVING in y' DIRECTION. y' IS APPROXIMATELY ALIGNED WITH y.

TYPICAL SYSTEM STRUCTURE

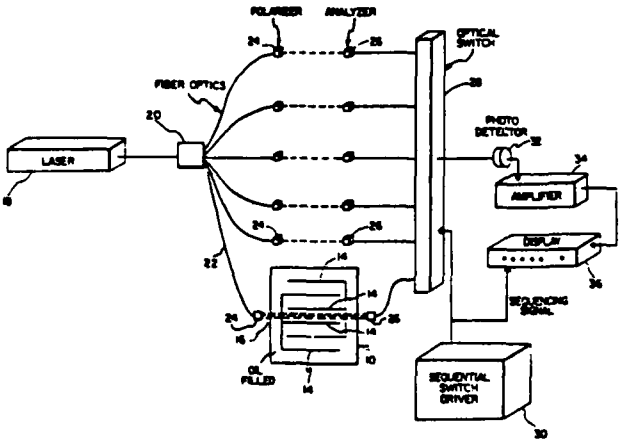
STAGE OF DEVELOPMENT: The method has been mathematically verified. Experimental hardware has not been constructed.

APPLICATIONS: This method has applications in the area of geomagnetic surveying.

METHOD AND MEANS OF MONITORING THE QUALITY OF A FLUID DIELECTRIC

Inventors: Herman H. Wieder and Neil M. Davis
Patent Number 4,102,574; dated 25 July 1978

ABSTRACT: A method and means of monitoring the quality of a fluid dielectric capacitor by measuring the Kerr signal of a dielectric fluid with the desired dielectric and breakdown properties, and continually measuring the Kerr signal of the same fluid dielectric while in use to determine any degradation of the fluid in use. The means for measuring the Kerr signal is by projecting a high-intensity light beam such as from a laser source through the dielectric fluid of a capacitor between two of the plates and detecting the amount of light passed through the dielectric, which is an indication of the condition of the dielectric liquid.



STAGE OF DEVELOPMENT: No experimental hardware has been constructed.

APPLICATIONS: This method can be used to predict the breakdown of oil-filled capacitors in high-power VLF transmitters.

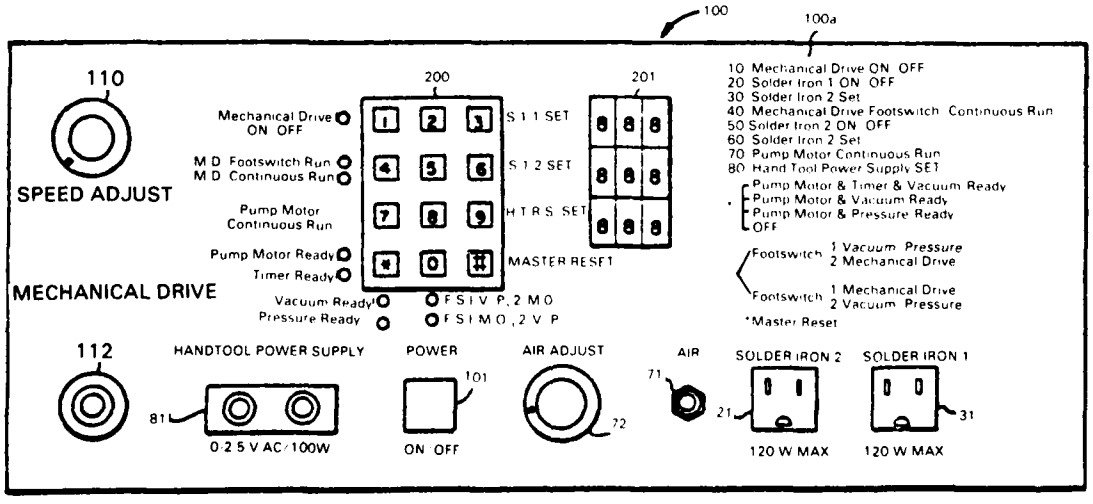
PORTABLE, ELECTRONICALLY CONTROLLED, INTEGRATED P.C.B. REWORK STATION

Inventor: Gerald D. Opfer
Patent Number 4,708,278; dated 24 November 1987

ABSTRACT: A portable work center is a self-contained, electronic, electromechanical, bench-top work unit used in the servicing of electronic circuits and specifically printed circuit boards. Solder iron temperature-adjust control functions, a continuously variable vacuum or pressure control function, a mechanical rotary-drive power control function, low-voltage, hand-tool power-supply function, and alternate foot-switch control unit, a digital display input for control and function selection, digital displays of status, solid-state control logic circuit for operation, and auxiliary-control power outlets are integrally contained in the unit to provide for *in situ* servicing of printed circuit boards.

STAGE OF DEVELOPMENT: First generation (as described in patent) and second generation (microprocessor version) have been built and proven operationally.

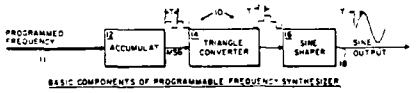
APPLICATIONS: This product has use in all electronic product fabrication, and maintenance and repair facilities where the absence of damaging transient voltage spikes is desirable. This unit uses zero voltage switching exclusively for all applications of alternating current, thereby eliminating voltage-switching transients during both selection and control. Manufacturers in support of the electronics industry can benefit by incorporation of these concepts into their product lines. Such products as soldering/desoldering equipment, resistance soldering, printed wiring board eyeleting, thermal wire-stripping equipment, and miniature rotary handtools are examples of OEM users. Other areas of industry that may have use for the control concepts are areas that involve explosive atmospheres (gas, vapor, dust) in which sparkless switching/control would be of benefit.



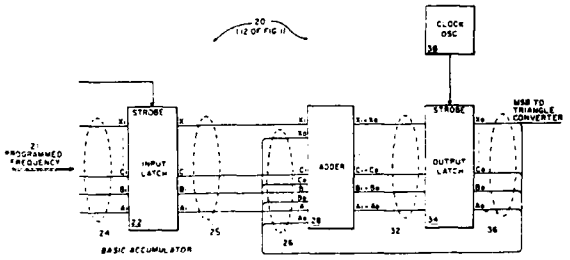
PROGRAMMABLE FREQUENCY SYNTHESIZER (PFS)

Inventor: Joseph L. Mantione
Patent Number 4,328,554; dated 4 May 1982

ABSTRACT: A programmable frequency synthesizer (PFS) consists of three serially connected stages: an accumulator, a triangle converter, and a sine shaper. The accumulator is the frequency-generating stage of the synthesizer. It consists of an input latch to store the binary programmed frequency, an adder, an output latch to store the output of the adder, and a clock oscillator. The output frequency of the accumulator can be directly scaled by changing its clocking frequency. The square-wave output of the accumulator is divided in frequency by the triangle converter, which produces a triangularly shaped staircase waveform. The sine-shaper stage employs diode limiters and filters to produce low-harmonic sinusoids from the triangular staircase.



BASIC COMPONENTS OF PROGRAMMABLE FREQUENCY SYNTHESIZER



BASIC ACCUMULATOR

STAGE OF DEVELOPMENT: In production.

APPLICATIONS: Where precise frequencies are required, under digital control, provision is made to allow for frequency modulation around a center frequency, including random frequency modulation within presentable band limits.

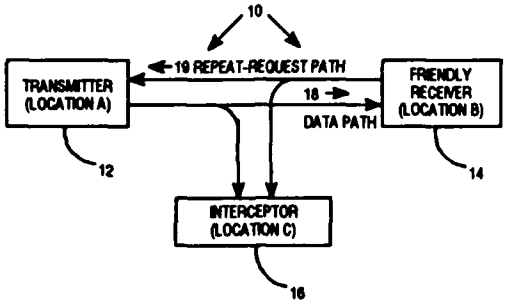
COMMUNICATIONS TECHNOLOGY AND DEVICES

INTERCEPT RESISTANT DATA TRANSMISSION SYSTEM

Inventor: George W. Byram
Patent Number 4,661,980; dated 28 April 1987

ABSTRACT: A secure communication system, which may be safely used even in the presence of an enemy interceptor, includes a transmitter and a receiver.

The transmitter comprises a first modulo-2 adder having, as one input, a sequence of N-bit binary numbers. A first random read-only memory (ROM), comprises a plurality of storage cells. The input of the ROM is connected to the output of the modulo-2 adder. Each of the cells of the ROM, which have distinct addresses, contain a random number, with no two cells containing the same random number. The input to the ROM is a binary number representing a specific address, whereas the output of the ROM is a signal representing a random binary number. A delay line has its input connected to the output of the random ROM, its output constituting the second input to the modulo-2 adder. A second random ROM, having the same type of hardware but different random content, has its input connected to the output of the delay line. A second modulo-2 adder has its two inputs connected to the outputs of the first and second random ROMs, the sequence of binary bits to be transmitted appearing at its output. Another component of the transmitter is a buffer memory, whose input and output are connected to the output of the second modulo-2 adder, the sequence of binary words to be transmitted appearing at the output of the second modulo-2 adder.



BASIC SECURE COMMUNICATION SYSTEM

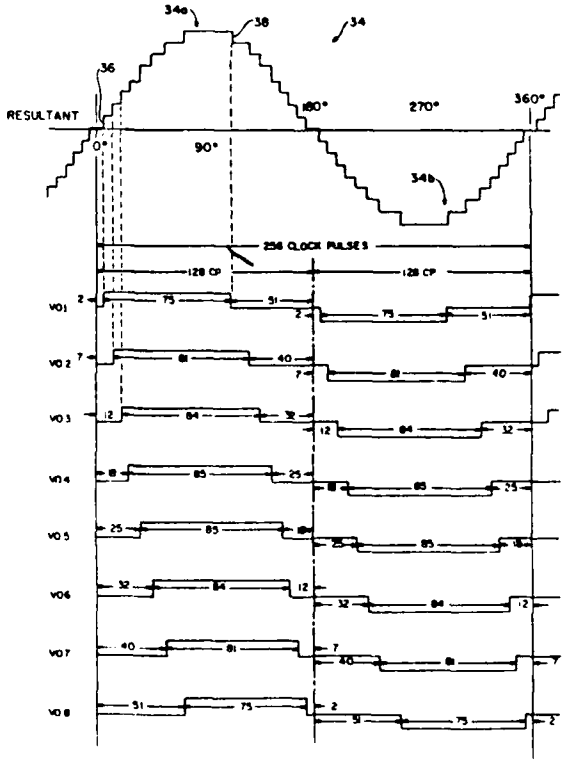
STAGE OF DEVELOPMENT: The method has been mathematically verified. Experimental hardware has not been constructed.

APPLICATIONS: This method is most applicable to two-way systems with a large and continuing data flow. Isolated short messages are probably better handled by the recently developed public-key encryption techniques. Independent of any intercept resistance considerations, the method provides a flexible way of introducing controlled redundancy into a transmission with specified probabilities of error detection versus back-search depth.

VLF LOOP ARRAY ANTENNA

Inventor: Elwin W. Seeley
Patent Number 4,171,525; dated 16 October 1979

ABSTRACT: A directional loop array antenna for very-low-frequency (VLF) reception. The array comprises four closely spaced loop antennas forming a unidirectional reception pattern with a main beam of less than 43° between half-power points. The array combines two double-loop coaxial antennas dispersed with their axes parallel along 45° lines. The signal from one double-loop array is delayed sufficiently such that a unidirectional reception pattern is formed.



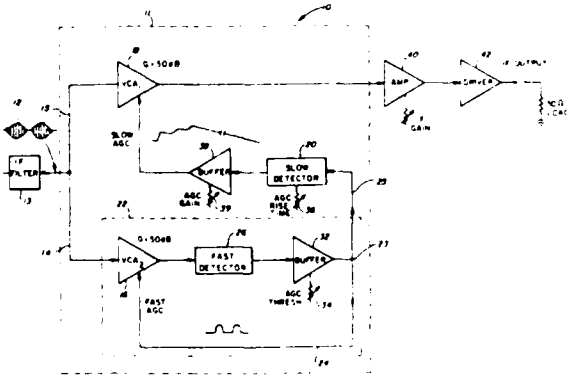
VLF LOOP STAGE OF DEVELOPMENT: The design has been mathematically modeled. Experimental hardware has not been constructed.

VLF LOOP APPLICATIONS: This design has application in the area of direction finding and/or atmospheric noise reduction.

CONSTANT-RISE AGC DEVICE

Inventor: Robert A. Slack
Patent Number 4,574,252; dated 4 March 1986

ABSTRACT: The device provides automatic gain control (AGC) of incoming signals over a large dynamic range of input levels with a constant rise time. The constant-rise AGC device includes a primary AGC loop for receiving the incoming or input signal and splitting the input signal to input and output components of the primary AGC loop. The input signal to the input component is processed within the primary AGC loop to control the gain of the input signal at the output component of the primary AGC loop. The primary AGC loop has a slow detector. A secondary AGC loop, provided within the primary AGC loop, includes the aforementioned input component and an output connected to the slow detector. The second AGC loop has a fast detector for preventing self-imposed saturation. Thus, the secondary AGC loop can be utilized to provide a constant AGC buildup signal for any input signal greater than a predetermined dB range. The remainder of the primary AGC loop, which receives the constant AGC buildup signal from the secondary AGC loop, can be optimized for desired rise and fall times so that the latter's output signal can be relatively unaffected by interference bursts, signal gaps, and fading in the input signal.



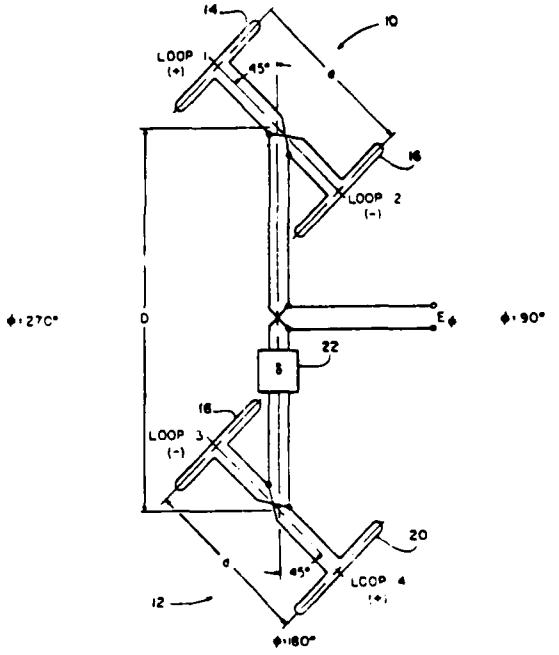
STAGE OF DEVELOPMENT: The circuit has been thoroughly verified on long-haul, high interference, HF communication paths with a wide range of signal levels, and has been incorporated in production receivers.

APPLICATIONS: The circuit can be used in any receiver IF circuit where fast, constant-rise AGC is required.

VECTOR SUMMATION POWER AMPLIFIER

Inventors: Russell E. Hammond and John L. Henry
Patent Number 4,575,811; dated 11 March 1986

ABSTRACT: A time sequence of square waves is summed to provide minimum distortion hign-power voltage sinusoids. The phase difference of two identical sinusoids is varied to control the resultant summed amplitude. Amplitude modulation of the sum sinusoid is achieved through varying the phase relationship between the two identical sinusoids. Frequency and phase modulation is achieved through digital control of the individual square waves.



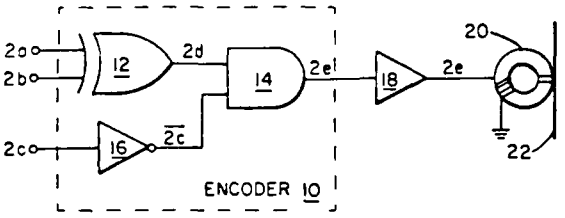
STAGE OF DEVELOPMENT: Extensive experimental hardware has been developed and tested.

APPLICATIONS: The method has application in communication transmitters and power frequency changers.

APPARATUS AND METHOD FOR ENCODING AND DECODING DIGITAL INFORMATION

Inventor: Edward W. Gennetten
Patent Number 4,063,291; dated 13 December 1977

ABSTRACT: An encoding system wherein digital information comprising data, clock, and partitioning components is coupled to an encoding means comprising interconnected digital elements to generate a serial encoded signal having the encoded data, clock, and partitioning components inherent in the structure of the encoded signal. The encoded signal may be stored in a magnetic record/reproduce system and subsequently coupled to a decoding means comprising interconnected digital elements to recover the data, clock, and partitioning components of the original digital information.



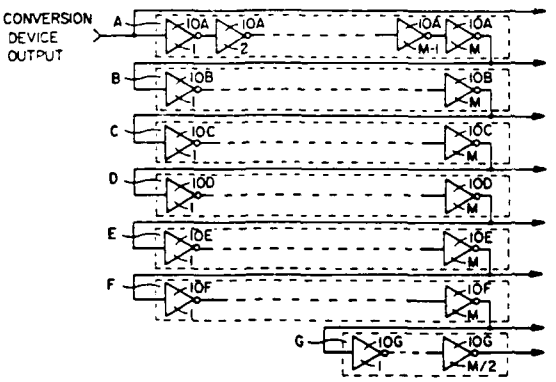
STAGE OF DEVELOPMENT: The preferred implementation of this technique is complete to the generic component level (e.g., AND gates, OR gates, etc.). A device technology has not been specified nor is the implementation dependent on any particular family of digital parts.

APPLICATIONS: This technique could serve as the basis for a serial digital data link or magnetic tape recorder encoder/decoder.

HIGH-SPEED SERIAL DATA SYNCHRONIZATION SCHE 1E

Inventor: Jerome J. Symanski
Patent Number 4,015,252; dated 29 March 1977

ABSTRACT: A serial-to-parallel data conversion and synchronization scheme in which a plurality of active logic elements are used as delay lines. Each of the delay lines introduces a delay equal to the period of one data bit, and one additional delay line introduces a delay equal to one-half the period of a data bit. The input of the first delay line is connected to the data input of a first flip-flop and the outputs of each of the plurality of delay lines are each connected to the data input of a flip-flop. The output of the additional delay line is connected to the clock inputs of each of the flip-flops, whereby the serial data word is converted to a parallel data word and the conversion is internally clocked by the delay lines themselves.



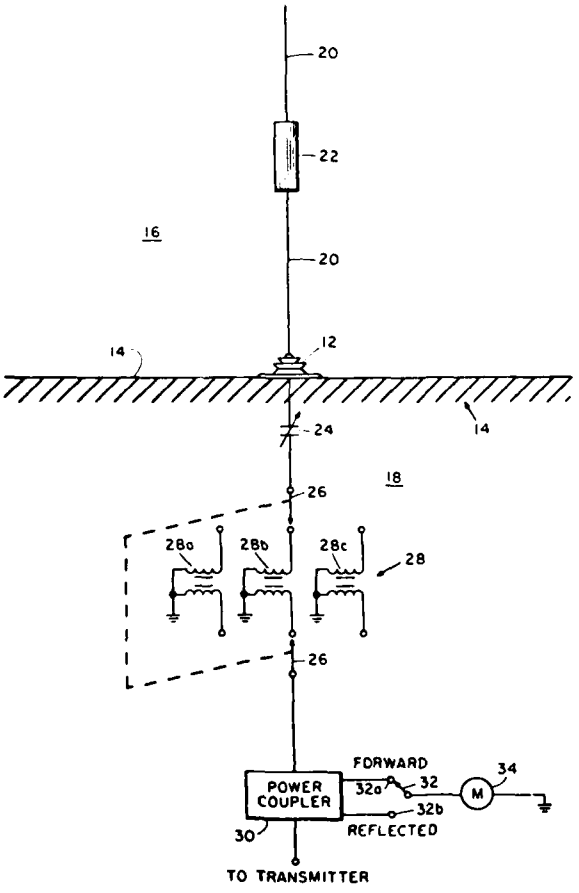
STAGE OF DEVELOPMENT: The method was implemented in prototype hardware used in communicating between computers. At the time of implementation in 1973, the technique resulted in error rates that were unacceptable for the application. No further work has been done.

APPLICATIONS: This technique, with a further refinement of the method, could be used in high-speed serial data communications applications.

MONOPOLE INDUCTIVELY LOADED ANTENNA SYSTEM

Inventor: Joseph E. Kershaw
Navy Case Number 65,571

ABSTRACT: A simple method of tuning an inductively loaded whip antenna over an extended band of frequencies has been developed. The method is ideal for inexperienced operators or an automated tuneup procedure because only two adjustments are required. The adjustment procedure is (1) resonate the antenna with a capacitor, and (2) select a matching transformer for minimum VSWR. A number of matching transformers are designed into the system so that an acceptably low VSWR is obtained for the range of resonated impedances over the frequency band.



STAGE OF DEVELOPMENT: The method has been verified and used in demonstration hardware in Navy applications.

APPLICATIONS: This method has applications where it is desired to improve the efficiency of antenna systems by inductive loading and at the same time operate over a wide band of frequencies.

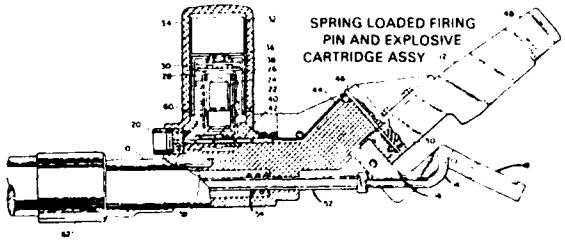
OCEAN TECHNOLOGY AND DEVICES

REMOTELY ACTIVATED CABLE CUTTER

Inventors: Michael W. Cooke, Arturo Arriola, Julius M. Stegman, and Kenneth D. Collins
Patent Number 4,495,849; dated 29 January 1985

ABSTRACT: This invention improves on explosively actuated cable cutters in that it incorporates a remote capability of activating the cutter. The improved apparatus comprises an acoustical transducer for receiving a remote coded signal, an electric circuit designed to detect the specific coded signal, and a motor and gear mechanism that is initiated upon detection of the remote coded signal to activate the explosively actuated cable cutter.

The electronics and motor compartment are hydrostatically sealed and fitted with a pressure switch and a water intrusion fail-safe circuit. The pressure switch is designed to inactivate the apparatus above a preset ocean depth, and the water intrusion fail-safe circuit is designed to detect any seawater seepage into the sealed electronics compartment. Upon the detection of such seepage, the intrusion fail safe circuit disconnects the system from the battery, thereby removing danger of premature triggering of the cable cutter.



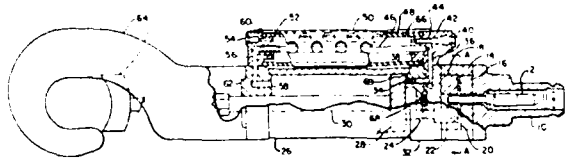
STAGE OF DEVELOPMENT: Many series of tests were performed to ensure (1) operation at low temperature of seawater; (2) that the cutter would break off if hit against a hard object; (3) that the device would not be damaged when first released at great depth; and (4) that battery life was sufficient.

APPLICATIONS: This cutter, along with ancillary equipment, is used by U.S. Naval forces for neutralization of moored mines after attachment by an undersea vehicle to the tethered mine.

DEEP-SUBMERGENCE VEHICLE (DSV) LIGHTWEIGHT CABLE CUTTER

Inventors: Ronald S. Reich, Jimmy L. Held, Arthur E. Munson, and James R. Hartley
Patent Number 4,463,496; dated 7 August 1984

ABSTRACT: This improved cable cutter for undersea use has a self-contained, pressure-compensated hydraulic system that allows it to operate in the deep ocean. The cable cutter is designed to operate from, and mate with, manipulators of Navy deep-submergence vehicles. The concept of this cable cutter is a closed hydraulic system that provides driving force on a piston pushing a cutting blade against an anvil. The hydraulic power is provided by an internal gear pump. The gear pump has a drive shaft that mates with the rotary output of a deep-submergence vehicle manipulator. The hydraulic fluid reservoir also serves as a pressure compensator for working in the deep ocean. The hydraulic fluid system comprises a main cylinder that contains the drive piston and a secondary cylinder consisting of a flexible tube that allows fluid pressure equalization with the environment as well as volume compensation. Both cylinders are mounted between manifold components. One manifold component is rigidly connected to the cutter end of the drive piston cylinder, and the other manifold component rigidly connected to the other end of the drive piston cylinder is in contact with an assembly containing the internal gear pump.



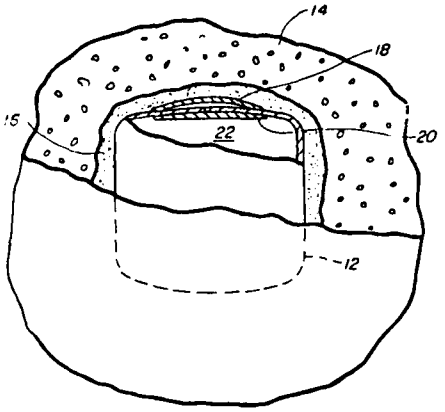
STAGE OF DEVELOPMENT: Two units are currently being used by the Fleet on the deep-submergence vehicles *Turtle* and *Sea Cliff*.

APPLICATIONS: The deep-submergence vehicles use the cutter for salvage operations.

CONCRETIZATION OF HIGH-LEVEL RADIOACTIVE SOURCE IN MARINE SEDIMENT

Inventor: Herbert V. Weiss
Patent Number 4,636,358; dated 13 January 1987

ABSTRACT: A concretized coating that encapsulates canisters of radioactive, heat-producing materials is formed by immersing said canister in a sea floor sedimentary layer, containing feldspathic material. The canister heats the surrounding water, causing alkali and alkaline materials to be leached from the seabed sediment. An indurated concretized layer of anhydrite and sedimentary particles is then formed by precipitation of anhydrite and other agents from the hot pore water; that is, water in the proximate environment of the canister. This concretized barrier provided protection to the fuel capsule against intrusion by the corrosive seawater.



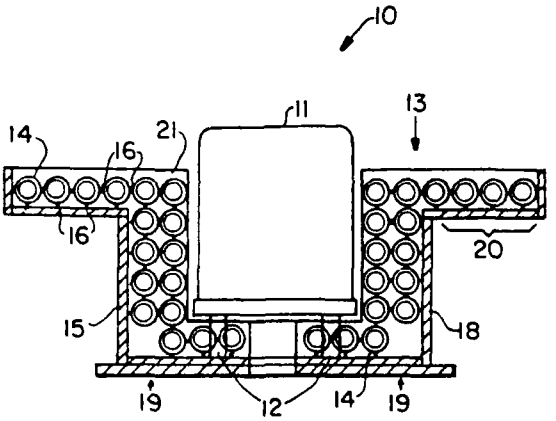
STAGE OF DEVELOPMENT: The reproducibility of this geochemical development has been verified and the thickness of the protective barrier appears to be a function of the thermal power of the heat source.

APPLICATIONS: The fission products formed from the fuel used in nuclear reactors generate heat in their radioactive decay. Calculations indicate that sufficient residual heat is contained within spent nuclear fuel one year after removal from the reactor to result in formation of a concretionary barrier. The relevancy of this circumstance to the disposal of high-level nuclear waste in the sea bed merits consideration.

DEEP-OCEAN WIDE-BAND ACOUSTIC BAFFLE

Inventors: Jimmy L. Held, Kenneth D. Collins, and Gerald R. Mackelburg
Patent Number 4,488,271; dated 11 December 1984

ABSTRACT: A hydroacoustic transducer provides an improved hemispherical radiation pattern throughout a wide range of operating depths. A can-shaped transducer is nestled in the inside of a hat-shaped array of hollow spheres. Resiliently mounting the spheres with respect to each other and a hat-shaped shell holds the array away from the surface of the transducer, and layering the hollow spheres assures the hemispherical pattern. Fashioning the spheres from hemispherical shells of aluminum and bonding them together makes the array insensitive to greater or lesser hydrostatic pressures. Potting the array in polyurethane presents a more rugged structure capable of withstanding the routine abuses of the ocean environment.

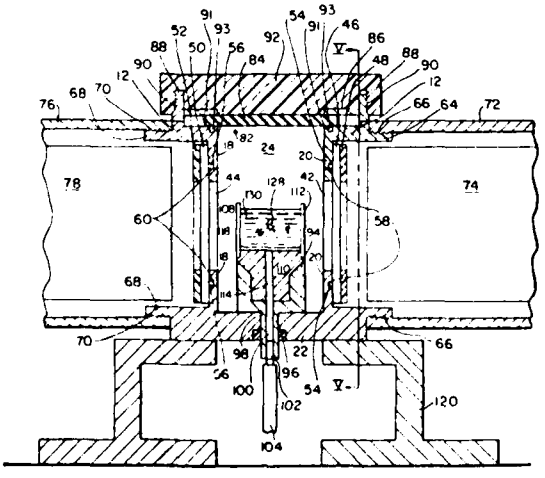


STAGE OF DEVELOPMENT: The characteristics of the device have been verified in a transducer test facility. The device is currently installed on a U.S. Navy deep-search vehicle at NOSC.

SYSTEM FOR MEASURING BIOLUMINESCENCE FLASH KINETICS

Inventors: Jon R. Losee and David Lapota
Patent Number 4,563,331; dated 7 January 1986

ABSTRACT: A test chamber determines the bioluminescent signatures of planktonic organisms in which a light-tight chamber has at least one light port, and preferably two light ports, where photomultiplier tubes are connected to the test chamber for detecting and measuring the flash kinetics of marine organisms. A door, pivotally mounted on the light-tight chamber, permits insertion and withdrawal of an organism sample holder. A vacuum tube is connected to the test chamber and to the sample holder via a passageway such that the organism can be excited by means of drawing off the fluid containing the organism. The bioluminescent characteristics of the organisms in the sample holder can then be detected and measured by means of the photomultiplier tubes. Preferably, a third port is provided on the test chamber where, alternatively, a third multiplier tube may be connected; or one of the two photomultiplier tubes can be connected with a different orientation with respect to the sample holder; or a light-tight diaphragm may be placed across the third light port such that chemical irritants may be injected into the sample holder by means of a syringe through the light-tight diaphragm without permitting the entry of light into the test chamber. The outputs of the photo-multiplier tubes measure the instantaneous intensity of the bioluminescent flashes of the organisms. Collected data may help identify which organisms are responsible for the measured bioluminescence in the surface waters of the world's oceans.



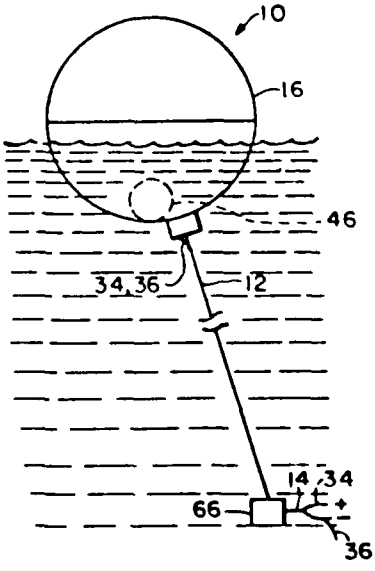
STAGE OF DEVELOPMENT: This instrument has been extensively used on many ocean cruises since 1981. The instrument has been calibrated by using a solution of luminous marine bacteria. A new version of the instrument is now being used that employs the same basic technique but uses an integrating sphere for light collection.

APPLICATIONS: The instrument is used to test the light emission of anything that will fit into 5-ml vials. Optical filters are used to select wavelength bands.

WAVE-POWERED BUOY GENERATOR

Inventor: Raymond A. Rowe
Patent Number 4,492,875; dated 8 January 1985

ABSTRACT: The wave-powered buoy generator includes a hollow buoy with inner and outer surfaces. The buoy is preferably spherical in shape. One or more windings are mounted to the buoy parallel to its surfaces, with each winding having a pair of ends. A magnetized device, preferably a ball, is located within the buoy for rolling back and forth therein. A device is connected to the ends of the windings for rectifying current flow therefrom. With this arrangement, the buoy can be moored in a body of water. Water motion causes the flux lines of the magnetized roller device to cut one or more windings, which causes electrical current flow to be provided through the rectifying device.



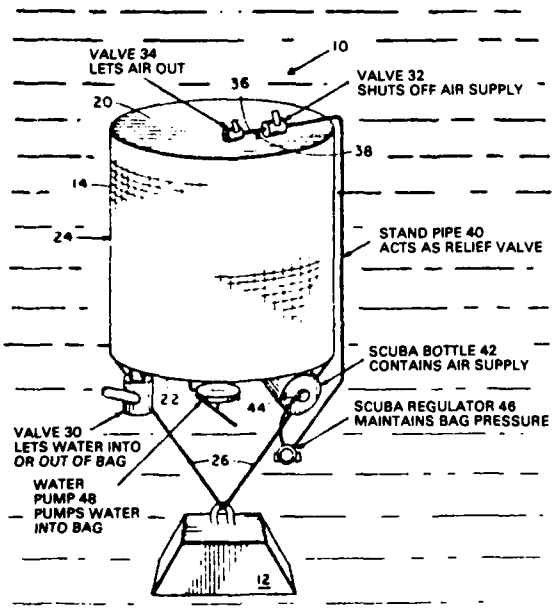
STAGE OF DEVELOPMENT: Only a concept has been approached. Experimental hardware has not been constructed.

APPLICATIONS: The concept may have application to power electrical sensors located in the water.

COLLAPSIBLE SALVAGE DRUM AND METHOD

Inventor: Roger W. Buecher
Patent Number 4,658,745; dated 21 April 1987

ABSTRACT: A salvage apparatus is provided that includes a bellows-type drum container. The container, which includes a flexible skirt, is generally tubular with top and bottom ends. The container further includes a pair of rigid plates, one of the plates being sealably mounted to the top of the skirt and the other plate being sealably mounted to the bottom of the skirt. It is important that the lateral area of each plate substantially encompass the lateral expanded area of the respective skirt end. A plurality of controllable valves are provided for selectively opening and closing the passage of fluid. One of these valves is located in the bottom plate for selectively allowing the passage of water into or out of the container, and another valve is located through the container for selectively introducing pressurized air into the container. A relief valve is also located through the container for relieving air from the container when the inside and outside differential pressure has exceeded a predetermined level.



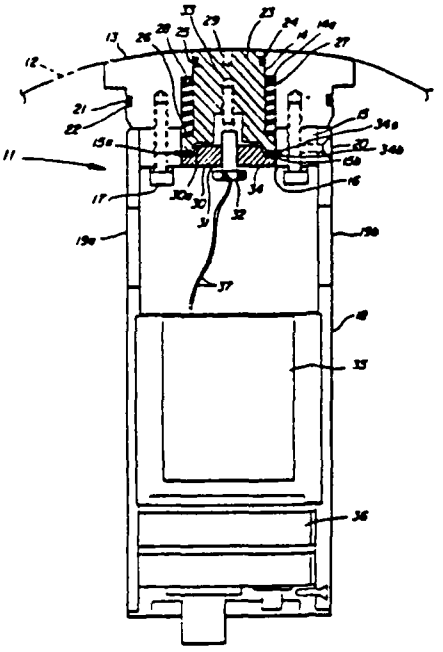
STAGE OF DEVELOPMENT: The device has been built and successfully tested.

APPLICATIONS: This device has applications in the field of underwater placement or retrieval of equipment or materials.

SCUTTLE VALVE

Inventor: Leonard J. Martini
Patent Number 4,846,209; dated 11 July 1989

ABSTRACT: A scuttle valve is provided for flooding a torpedo. The scuttle valve includes a housing that is fitted through the hull of the torpedo. The housing has a bore that, when vacant, serves as a port to enable water to enter the torpedo. A piston, slidably mounted within the bore of the housing, is spring biased towards the interior of the torpedo. An explosive bolt that is threaded into the piston extends through a tapered plate that cams a retainer ring across the interior end of the piston and into an interior annular recess in the housing to restrain the piston within the bore. When the explosive bolt is actuated, the bolt breaks and the retainer ring contracts to allow the spring to force the piston into the interior of the torpedo. Thus, water enters through the open bore of the housing and floods the torpedo.



STAGE OF DEVELOPMENT: Valves have been used in 24 torpedoes in the ICEX program and 50 valves are presently being procured for torpedo production for Mk 46 exercise vehicles.

APPLICATIONS: Any need for large volume flow, one-time actuation by an explosive bolt, through simplified means.

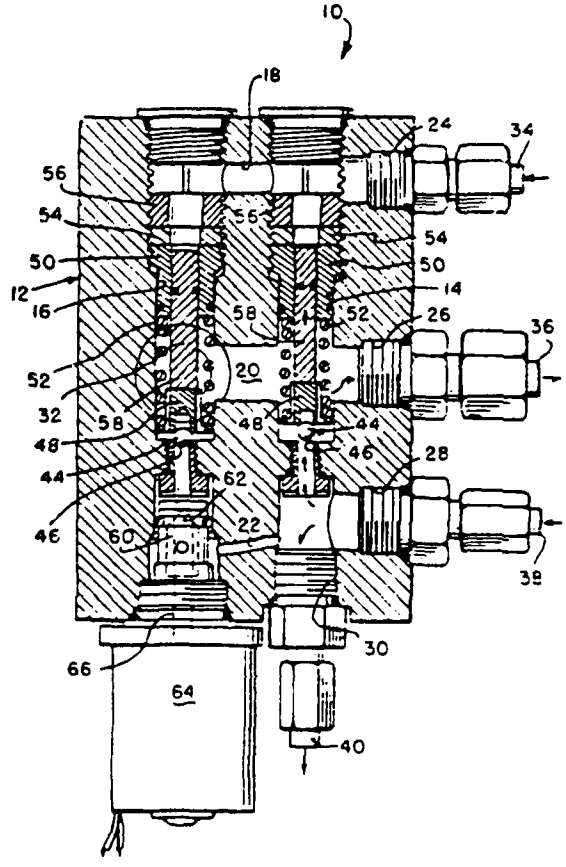
DUAL-SPEED FLUID CONTROL APPARATUS

Inventor: John P. Bott
Patent Number 4,204,552; dated 27 May 1980

ABSTRACT: A dual-speed fluid control apparatus is provided that includes a valve body having a high-pressure passageway and a low-pressure passageway extending vertically therethrough in a spaced apart relationship. A top portion of the passageways is interconnected by a top plenum, a middle portion of the passageways is interconnected by a middle plenum, and a bottom portion of the passageways is interconnected by a bottom plenum. The valve body has the following: an ambient pressure inlet into the top plenum, a fluid bypass outlet into the middle plenum, and a pressurized fluid inlet and fluid outlet into the bottom plenum. A valve is located within each passageway and is responsive to pressure in the bottom plenum for bypassing fluid from the bottom plenum to the middle plenum. A spring-biased device is located in each passageway and is responsive to the ambient pressure in the top plenum for pushing each valve toward the closed position against the pressure in the bottom plenum. The spring bias on the push device in the high-pressure passageway is greater than the spring bias on the push device in the low-pressure passageway. A control valve device is provided for selectively opening and closing the bottom plenum of the low-pressure passageway to the bottom plenum. With this arrangement, the fluid control apparatus will supply high-pressure fluid when the control valve means is closed and will supply low-pressure fluid when the control valve means is open, both of these pressures and flow rates being varied by the magnitude of the ambient pressure in the top plenum.

STAGE OF DEVELOPMENT: The device, which has been built and tested experimentally, is in production as part of the Mk 46 Mod 5 torpedo.

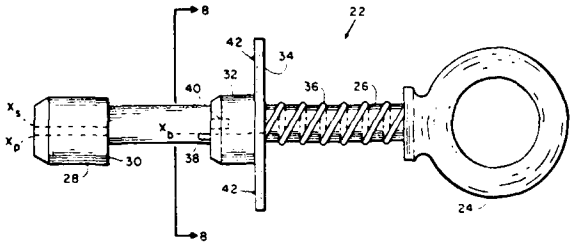
APPLICATIONS: The apparatus has applications for any purpose where high- and low-fluid rates/pressures are required.



COUPLING FOR QUICK ATTACHMENT TO PLATE-LIKE STRUCTURE

Inventors: Donald L. Endicott, Jr., James M. Walton, and Robert L. Wernli
Patent Number 4,315,651; dated 16 February 1982

ABSTRACT: A coupling that is readily attachable to a plate, panel, or like structure includes a rotatable shaft for thrusting a bearing element through a circular hole in the structure when the bearing element and the hole are in concentric relationship. Thereafter, the shaft is rotated by less than a complete revolution to bring the bearing element and the hole into a selected eccentric relationship, and also to activate a locking mechanism to maintain the eccentric relationship. When the bearing element and hole are in the eccentric relationship, a bearing surface of the bearing element abuts the structure to impose substantial force thereupon.



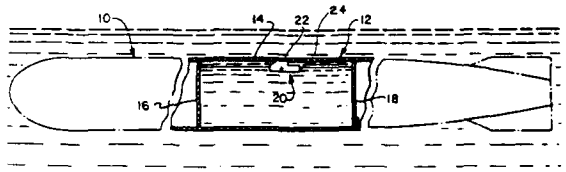
STAGE OF DEVELOPMENT: The device has been developed and tested by the U.S. Navy during at-sea operations for attachment to plate-like structures. Additional devices have not been used operationally since the initial development phase.

APPLICATIONS: These devices have applications in the areas of undersea salvage and work system operations. Although developed for use by vehicles with manipulator capability, they would be equally acceptable for use by divers.

SEA-WATER PRESSURE REGULATOR VALVE

Inventor: Leonard J. Martini
Patent Number 4,219,045; dated 26 August 1980

ABSTRACT: A sea-water pressure regulator valve is provided for a fuel tank. The valve includes an elongated body having a longitudinal cylindrical hole that opens into the fuel tank and a perpendicular passageway that is adapted to open the cylindrical hole to sea water. A slidably mounted piston in the cylindrical hole with an O-ring on each side of the perpendicular passageway renders the movement of the piston independent of sea-water pressure. The piston has a longitudinal passageway throughout its entire length so as to be open into the fuel tank at a downstream end and open into the bottom of the cylindrical hole at an upstream end. The piston has at least one aperture adjacent to a perpendicular passageway for variably opening the piston's longitudinal passageway to sea water. Thus, sea water will flow from the perpendicular passageway into the longitudinal passageway and out the downstream end of the piston into the fuel tank. A spring biases a piston downstream to open the aperture with respect to the perpendicular passageway. Thus, the strength of the spring and the effective areas of the upstream and downstream ends of the piston will cause a predetermined pressure in the fuel tank as the fuel is used, regardless of the pressure of the sea water.



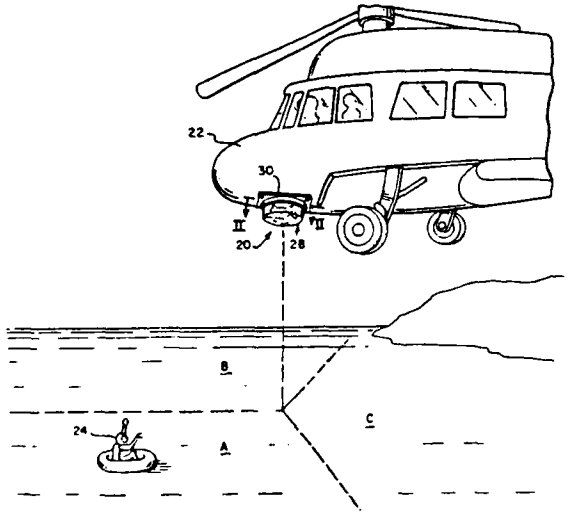
STAGE OF DEVELOPMENT: Mathematically verified, but no prototypes made and tested.

APPLICATIONS: This valve can be used for any downstream, pressure-regulation requirement independent of upstream pressure.

SEA HUNT SYSTEM

Inventor: James V. Simmons
Patent Number 4,261,284; dated 14 April 1981

ABSTRACT: A search apparatus is provided for an aircraft. The search apparatus includes a transparent observation chamber and a plurality of bulkheads that divide the chamber into at least two compartments. A cradle is mounted within each compartment for supporting a bird with the head of the bird facing outward with respect to the chamber. A peck key is mounted in each chamber in proximity to the outward end of the cradle, and a tray is provided for containing food for the bird. A device, mounted within each compartment, slides the tray inward or outward, the outward position being adapted to present food to the bird and the inward position being adapted to withdraw food from the bird. Indicators may be connected to the peck keys for indicating which bird in a chamber has visual contact with an object. A control device may be provided for selectively actuating the food trays for the inward and outward movements.



STAGE OF DEVELOPMENT: A prototype system has been developed and tested. Testing has been conducted by laboratory and operational personnel in ocean searches for lifevest-sized targets. Detection, false alarm, maintenance requirements, and operational employment data have been evaluated.

APPLICATIONS: This system has applications in daylight search missions.

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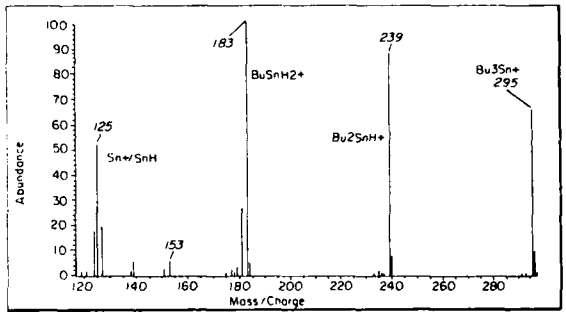
^{124}SN-LABELED TETRA-n-BUTYLTIN AND TRI-n-BUTYLTIN BROMIDE

Inventors: C. A. Dooley and J. P. Testa
Navy Case 71,191

ABSTRACT: Stable-isotope labeled compounds, used in biocide and marine antifoulant applications, have been synthesized and their distinctive mass spectral "signature" have been determined. These compounds impose no additional hazard in their use, which is to trace biological, chemical, and other physical processes in an environment that already may contain unlabeled compounds and their degradation products.



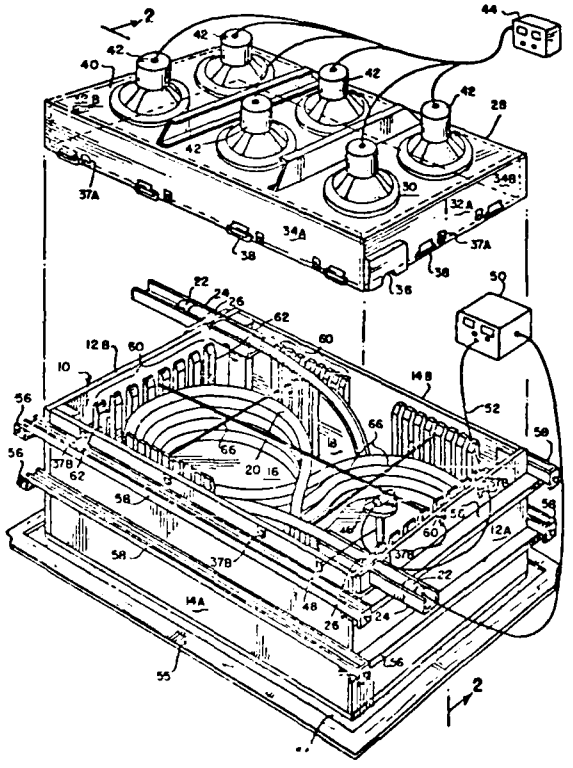
STAGE OF DEVELOPMENT: The compounds have been synthesized and used for selected experiments. The compounds have not been incorporated into coatings.

APPLICATIONS: These compounds can be used to trace the chemical, biological, and geological fate of the unlabeled analogues, which are used as biocides and marine antifoulants.

SEALED CAVITY HYDROPHONE ARRAY CALIBRATION

Inventor: George O. Pickens
Patent Number 4,205,394; dated 24 May 1980

ABSTRACT: An apparatus and method for calibrating a hydrophone array comprising a plurality of electrically interconnected hydrophones over a range of acoustic signal frequencies having a lower limit on the order of 1 Hz. Apparatus includes a container having a sealed cavity for sealing the hydrophone array in a selected fluid, an electro-acoustic projector for projecting acoustic signals of frequencies selected from the frequency range into the sealed cavity, and a reference hydrophone contained within the sealed cavity for generating a reference signal in response to each projected acoustic signal. The apparatus further includes monitoring equipment coupled to the reference hydrophone and to the hydrophone array for enabling a selected characteristic of one of the reference signals to be compared with the same characteristic of a signal generated by the hydrophone array when an acoustic signal is projected into the sealed cavity.



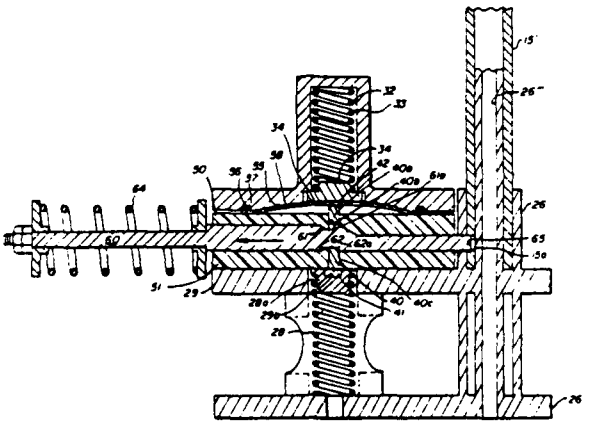
STAGE OF DEVELOPMENT: Engineering development models have been built and use tested.

APPLICATIONS: The unit has applications in the area of acoustic calibration and quality assurance.

PRESSURE ARMED RELEASE DEVICE

Inventors: Jimmy L. Held and Charles E. Tallerino
Patent Number 4,903,382; dated 27 February 1990

ABSTRACT: A mechanical release of an object occurs after a release device is subjected to a first pressure and then is brought to a second pressure that is less than the first. The first pressure enables or arms the device so that its actuation or release takes place when the second, specific release pressure is reached. The setting and releasing pressures are substantially less than the extremely high pressures that the device is capable of withstanding. A pair of opposed biasing springs and a diaphragm with a specifically contoured solid stop prevent deformation and any sliding of sealing surfaces to avoid failure.



STAGE OF DEVELOPMENT: The device has been manufactured and has proven itself in the field.

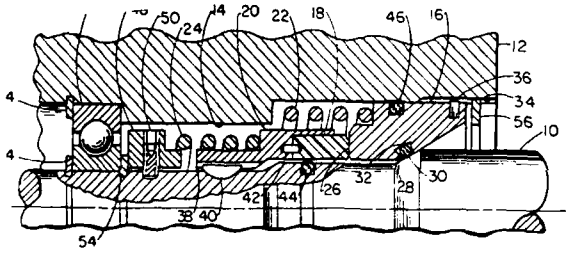
APPLICATIONS: The device has applications as a release device for oceanographic devices as well as Navy deep-submergence systems of various types.

INTEGRAL ELASTOMER/GRAPHITE DYNAMIC FACE SEAL

Inventor: Leonard J. Martini
Patent Number 4,415,165; dated 15 November 1983

ABSTRACT: A shaft seal is presented that combines the attributes of the low-pressure sealing of an O-ring and the high-pressure sealing of a carbon face seal. This invention provides a dynamic shaft seal with the advantage of a very reliable positive elastomeric O-ring seal for low-pressure sealing and the advantage of a reliable graphite face seal for high-pressure sealing incorporated into an integral configuration. This integral configuration allows a smooth transition between the low-pressure O-ring seal and the high-pressure carbon face seal without leakage. Springs are designed to provide the correct preload compression on the dynamic O-ring seal and the forces required such that the transition operation occurs at the proper differential pressure.

Mechanically, a rotating shaft within an aperture in a pressure-housing wall is fitted with a sleeve containing a carbon face seal that mates against the face of an elastomeric/graphite-interface seal. The carbon face seal components are keyed to rotate with the shaft while the elastomeric/graphite-interface seal is keyed to the aperture and remains fixed in place during the shaft's rotation. The elastomeric/graphite-interface seal also houses an O-ring that provides a dynamic seal for the shaft at low pressure. Actuation of either the high-pressure face-type seal or the low-pressure O-ring seal is adjustably controlled by compression springs in the mechanism.



STAGE OF DEVELOPMENT: A hardware prototype has been produced and successfully tested by EG&G Sealol at its Rhode Island facility.

APPLICATIONS: This can be used for dynamic shaft seals, high- and low-pressure differentials.

ORGANOTIN COMPOUNDS

Inventors: Carol A. Dooley and Elek Lindner
Navy Case 71,163

ABSTRACT: Tributyltin analogues containing double bonds at C-1 or C-3 were synthesized for use as antifouling toxicants in marine antifouling coatings and other biocide applications. These compounds should be environmentally acceptable as they have increased degradation rates.

STAGE OF DEVELOPMENT: Compounds have been synthesized and successfully incorporated into a coating matrix. Resulting antifouling coating formulation needs optimization.

APPLICATIONS: These compounds can replace currently used organotin compounds in biocide and antifouling compositions.

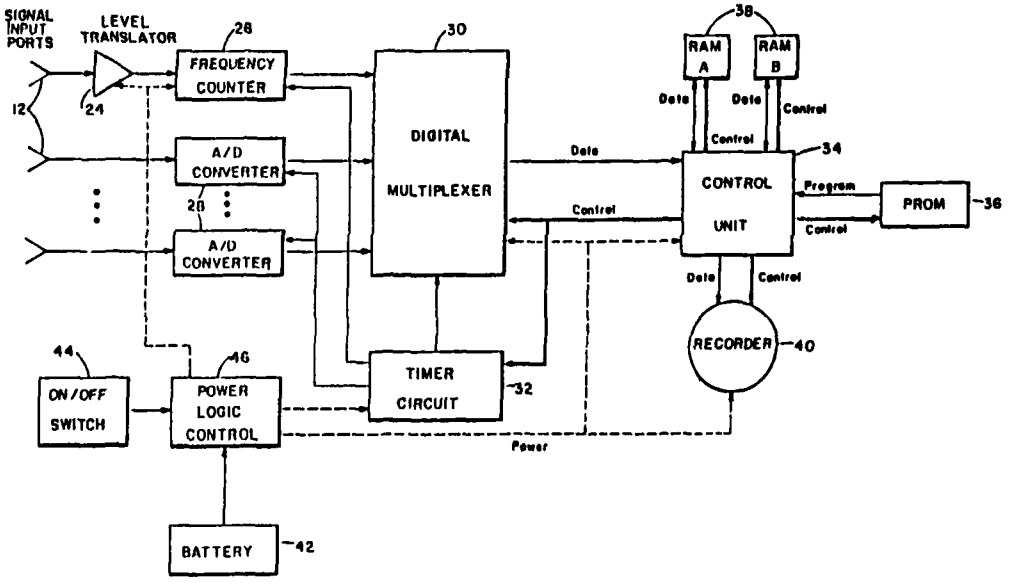
REMOTE SELF-CONTAINED UNDERSEA MONITOR

Inventor: Robert E. Page
Patent Number 4,480,323; dated 30 October 1984

ABSTRACT: A remote oceanographic data recording systems which is self-contained, battery operated and removably attachable to an external surface of a submerged hull without a need to penetrate said hull, is presented. The system is capable of gathering and recording oceanographic data and may be joined to the hull of a submarine without interfering in submarine operation in any way. The system receives analog ac and dc electrical input signals from a variety of oceanographic data sensors and converts the signals to digital data signals for recording on magnetic tape cassette. The housing for the system is watertight and capable of withstanding external hydrostatic pressures up to 1620 psi.

STAGE OF DEVELOPMENT: Two prototypes were built in 1980 and delivered to NUSC. The systems were checked out at NOSC before delivery. The completed system included a second unit for playback and data retrieval. This is required in order to read the tapes.

APPLICATIONS: This device has applications in underwater monitoring of structures in hostile environments for long unattended periods of time. The device can be retrieved, when desired, for removal of tapes.

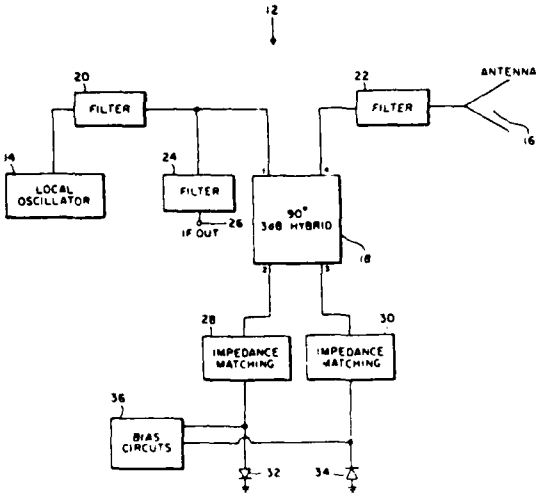


MICROWAVE/MILLIMETER WAVE TECHNOLOGY AND DEVICES

SWITCHING MIXER

Inventor: Alfred R. Hislop
Patent Number 4,492,960; dated 8 January 1985

ABSTRACT: An RF system is disclosed in which the input mixer of the system is also used as a switch to allow the local oscillator to be used as the transmitter oscillator. The switching mixer may also be used as an attenuator or signal modulator. A local oscillator is connected via a filter to a 90° 3-dB hybrid coupler. Two of the four ports of the hybrid coupler are coupled through impedance matching networks to reversely polarized mixer diodes. Bias circuits are connected to the mixer diodes for variably adjusting the bias current to the mixer diodes to thereby adjust their reflection/absorption characteristics. A second filter is connected between the first filter and the hybrid coupler for extracting an intermediate frequency signal. A third filter is connected to the fourth port of the hybrid coupler and to the antenna of the RF system. The first and third filters pass RF and local oscillator signals and block IF signals.



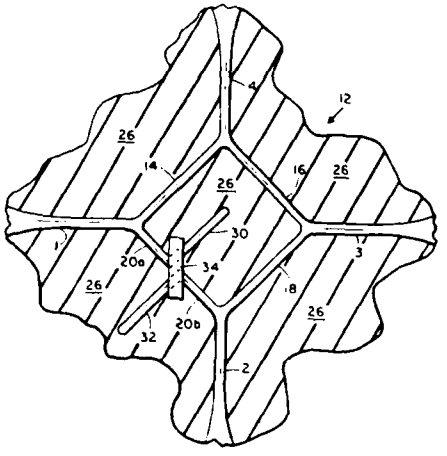
STAGE OF DEVELOPMENT: The technique has been verified experimentally and several operational transceivers have been built.

APPLICATIONS: The technique is applicable to low-power transceivers in general, and in particular to millimeter-wave transceivers where the cost of front-end components is high.

SLOTLINE REVERSE-PHASED HYBRID RING COUPLER

Inventor: John Reindel
Patent Number 4,419,635; dated 6 December 1983

ABSTRACT: A slotline directional coupler is disclosed that introduces a 180° phase reversal in one of the arms of the coupler to isolate opposite ports of the coupler. One of the arms of the coupler is split and a quarter-wave shorted slotline is added to each portion of the split coupler arm. The split coupler arm is bridged by a short conductive strap that, in a first embodiment, is grounded on both ends to the slotline ground plane or, in a second embodiment, is extended to appear as though grounded. In the first embodiment, the conductive strap is separated from the ground plane by air. In the second embodiment, the dielectric substrate of the coupler separates the strap from the ground plane. The conductive strap serves as a slotline-to-microstrip-to-slotline transition which introduces a 180° phase shift in a signal propagating through it.



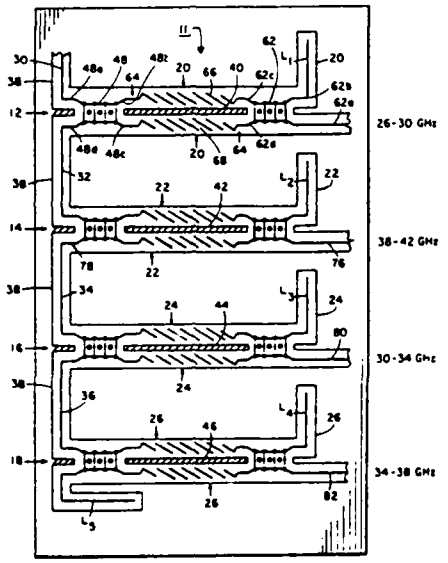
STAGE OF DEVELOPMENT: Hybrids have been built and found to work as described.

APPLICATIONS: Wideband 180° slotline hybrid; wideband balanced mixer.

MILLIMETER-WAVE SUSPENDED-SUBSTRATE MULTIPLEXER

Inventor: Alfred R. Hislop and David Rubin
Patent Number 4,433,314; dated 21 February 1984

ABSTRACT: A millimeter-wave suspended-substrate multiplexer is disclosed that is comprised of a plurality of hybrid-filter-hybrid channel dropping sections. The components of the multiplexer are enclosed in a metallic housing forming a cavity surrounding the multiplexer components. Each of the hybrid-filter-hybrid sections is comprised of first and second 90° hybrid couplers that are connected by a pair of identical bandpass filters. Spurious waveguide energy propagation modes that would otherwise be generated in the cavity surrounding the 90° suspended hybrid couplers are eliminated by the use of a plurality of mode suppression pins extending between the top and bottom portions of the metallic housing and passing through the branch lines of the couplers.



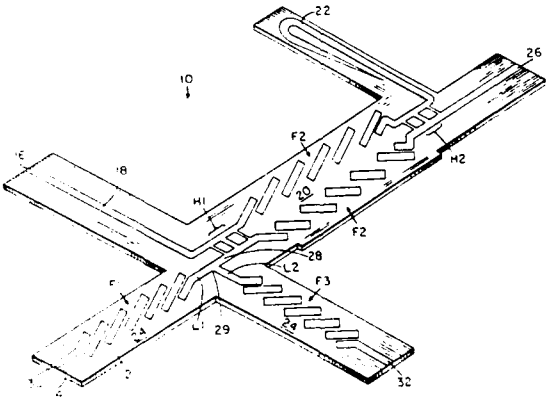
STAGE OF DEVELOPMENT: The multiplexer was developed and tested over a 26- to 42-GHz band. The band was divided into 4 channels.

APPLICATIONS: The multiplexer would mainly be used to separate large millimeter bandwidths into segments (channels) that can be downconverted for use at microwave frequencies. The bandwidth limitations mainly are dependent on the quadrature 3-dB hybrids. Any waveguide bands with upper limit below 90 GHz are likely candidates.

MILLIMETER-WAVE MICROSTRIP TRIPLEXER

Inventor: David Rubin
Patent Number 4,210,881; dated 1 July 1980

ABSTRACT: A planar millimeter-wave microstrip triplexer for separating three contiguous bands of frequencies (lower, middle, and upper bands). The middle band is separated by the use of a diplexer comprising two quadrature couplers connected by dual identical planar-bandpass filter sections. A second diplexer comprised of two edge-coupled filter sections is connected to the isolated port of the input quadrature coupler of the first diplexer. Signal components contained in the upper and lower frequency bands appear at the respective outputs of the second diplexer.



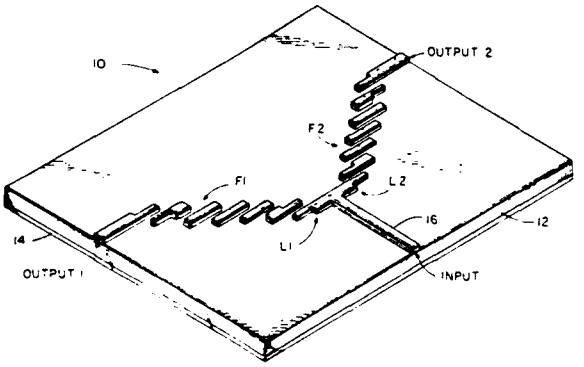
STAGE OF DEVELOPMENT: The triplexer was developed and tested over 28 to 40 GHz, the resulting channels having 4-GHz bandwidths.

APPLICATIONS: This form of multiplexer is limited to three channels, although it could be extended to six if preceded by a very wideband diplexer. The bandwidth limitation of the triplexer is set by the quadrature couplers used in the first channel.

MILLIMETER-WAVE MIC DIPLEXER

Inventor: David Rubin
Patent Number 4,168,479; dated 18 September 1979

ABSTRACT: A millimeter-wave MIC diplexer constructed in either stripline or microstrip comprising two edge-coupled bandpass filters separated by specific lengths of transmission lines designed to separate two bands of frequencies. Input signals having frequencies within a first band are passed through one of the bandpass filters while being isolated from the other, and input signals having frequencies within a second band are passed through the other bandpass filter while being isolated from the first filter.



STAGE OF DEVELOPMENT: Diplexers of this type have been fabricated on microstrip and suspended substrate for both contiguous and noncontiguous frequency ranges and used throughout the millimeter-wavelength bands. Another form of this diplexer utilizes the first section of a coupled line filter to do the equivalent separation. The latter is particularly useful for wide-bandwidth contiguous filters (i.e., dividing full waveguide bands in half).

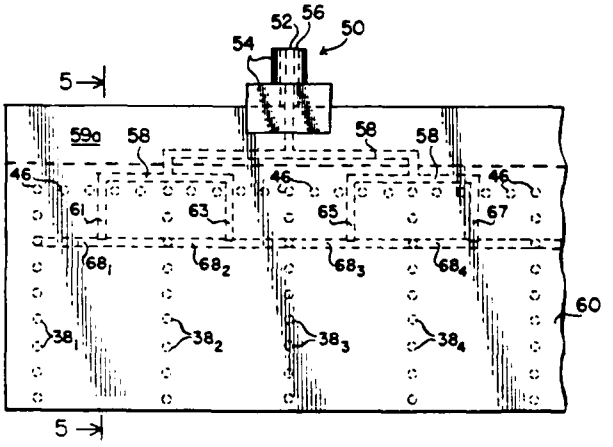
APPLICATIONS: Diplexers are useful for separating signals of different frequencies from a common path. They are found as integral parts of multiplexers, mixers, frequency stabilizers, etc.

Diplexers based on complimentary-type filters (high pass/low pass), wherein admittances cancel, are relatively easy to fabricate at low microwave frequencies but are nearly impossible at mm wavelengths. On the other hand, edge-coupled filters, or their equivalents, are quite simple to design and construct. These are not complimentary and cannot be used together without decoupling them from each other. The above patent, and its cited extension, provide a very simple means of providing this separation.

LIGHTWEIGHT LOW-COST ANTENNA ELEMENT

Inventor: David Proctor
Patent Number 4,156,242; dated 22 May 1979

ABSTRACT: An antenna array is disclosed comprising a plurality of antenna elements formed from metal-clad boards and conductive pins. Two metal-clad boards are placed together to form a sandwich, the metal-clad surfaces of the boards forming the top and bottom walls of a waveguide. Pins are placed perpendicular to the clad surfaces to form the sidewalls. The signal is introduced by a coaxial probe in the broad wall of the waveguide in a conventional manner. A row of pins defines the backwall of the waveguide.



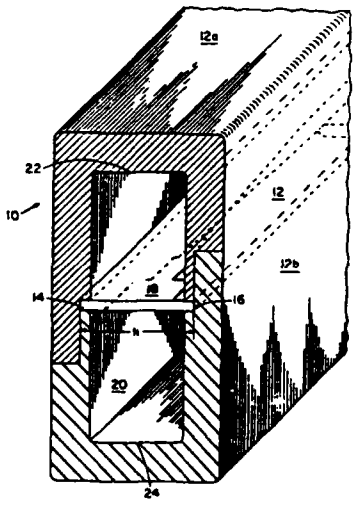
STAGE OF DEVELOPMENT: These elements were built and tested at several frequencies in the 2- to 10-GHz region.

APPLICATIONS: Multifrequency phased arrays.

MICROPROCESSOR-BASED PROGRAMMABLE FREQUENCY CONTROLLER FOR FREQUENCY-AGILE RADAR

Inventor: Michael J. Prickett, Murray H. Mott, and Nicholas Panas
Patent Number 4,631,541; dated 23 December 1986

ABSTRACT: The invention is a programmable frequency controller for a frequency-agile radar system. The system comprises a microprocessor that includes a clock generator, a front-panel radar parameter input unit, a program memory, data memory, a front-panel radar, an input buffer port, a microprocessor data bus, an output buffer port, a front-panel display unit, a radar data-collection system, a radar synthesizer, and a frequency-agile radar system with antenna. The control system operates, monitors, and collects operational data during operation of the frequency-agile radar system. Input control parameters are preset at the front-panel radar parameter input unit. Program memory contains preprogrammed computer control instructions for the microprocessor in performing control and management of operational data during radar operation. The data memory unit provides the capability of storing and transferring data during operation of the system. The front-panel display allows for the display of selected parameters for realtime monitoring of the system's operation.



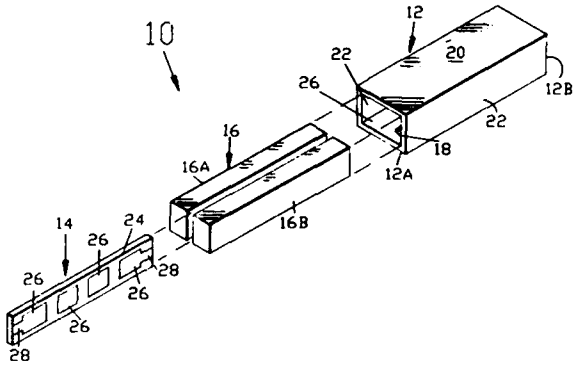
The radar data collection system is comprised of high-speed, multichannel, magnetic-tape recorder units that record select data for further or later processing. Operation of the radar system by the microprocessor is controlled through the synthesizer output port and the frequency synthesizer. The frequency synthesizer receives operational command from the microprocessor, interprets these commands, and generates the control frequency cycle by which the radar system is to operate. Necessary control functions for operation of the system occur within the pulse repetition time, which can be as short as 20 microseconds.

STAGE OF DEVELOPMENT: The method has been developed, experimentally verified, and used by the U.S. Navy and NOSC for several years.

WAVEGUIDE BANDPASS FILTER HAVING A NONCONTACTING PRINTED-CIRCUIT FILTER ASSEMBLY

Inventor: John Reindel
Navy Case 70,532

ABSTRACT: The present invention relates to a waveguide that employs a noncontacting printed-circuit filter assembly of half-wavelength conductive elements for providing a bandpass filter. The bandpass filter of the present invention employs a simple method of construction that eliminates machining by utilizing a "push-in" printed-circuit substrate and an open waveguide, thereby reducing cost of waveguide filters considerably. Further, design accuracy is enhanced by employment of conventional lithographics and chemical etching techniques.



STAGE OF DEVELOPMENT: Filters have been designed, built, and tested in the lower part of the EHF band.

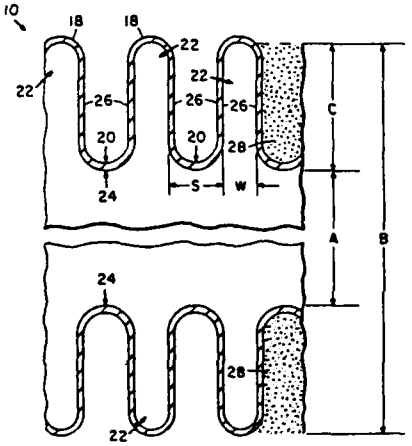
APPLICATIONS: Microwave receiver front ends.

MICROWAVE/MILLIMETER WAVE TECHNOLOGY AND DEVICES

FLEXIBEND CORRUGATED WAVEGUIDE

Inventor: Joseph M. Devan
Patent Number 4,429,290; dated 31 January 1984

ABSTRACT: An unsymmetrically corrugated TE_{01} mode circular waveguide bend. Unsymmetrical corrugations approximately one-quarter wavelength deep are utilized to suppress energy transfer to other modes inherent in smooth-wall circular guide bends. The corrugations are comprised of a plurality of adjacent internal ridges and valleys having substantially parallel walls such that the distance between the parallel walls of the internal ridges are at least twice the distance between the parallel walls of the internal valleys.



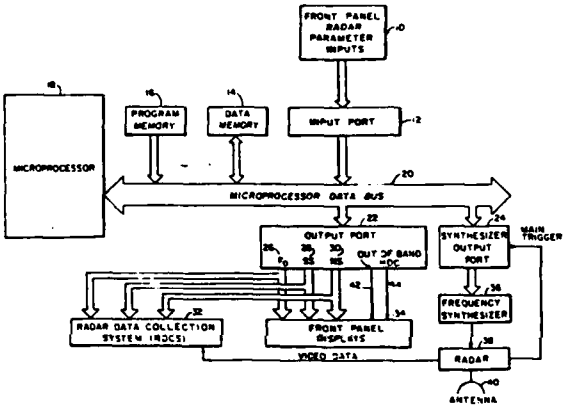
STAGE OF DEVELOPMENT: Corrugated waveguide bends and flex sections have been designed, fabricated, and tested to verify performance.

APPLICATIONS: The corrugated waveguide structure is suitable for bends and flex sections for low-loss circular waveguide operating in the TE_{01} mode.

PRINTED CIRCUIT WAVEGUIDE TO MICROSTRIP TRANSITION

Inventor: David L. Saul
Patent Number 4,260,964; dated 7 April 1981

ABSTRACT: A waveguide to microstrip transition for transferring guided electromagnetic signals from dominant-mode rectangular waveguide to microstrip line and vice versa. A microstrip printed circuit card is disposed in parallel to the narrow walls of a waveguide. The printed-circuit card includes a microstrip stepped transformer section followed by a linear-taper crossover section. The linear-taper crossover section leads into a microstrip line conductor and ground plane for completing the transition.



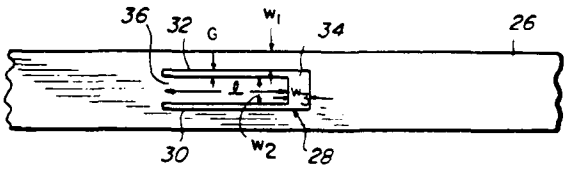
STAGE OF DEVELOPMENT: Transitions were built and used for WR-28 and WR-19 waveguide bands. The design can be extended to higher or lower bands.

APPLICATIONS: A convenient means of using waveguide test equipment to evaluate microstrip circuits; a means of connecting components with waveguide ports, such as antennas, to printed circuits.

INTERNAL TRANSMISSION LINE FILTER ELEMENT

Inventor: Alfred R. Hislop
Patent Number 4,873,501, dated 10 October 1989

ABSTRACT: An improved transmission-line filter element allows a higher difference between even and odd mode impedances than previously obtainable from planar structures. The filter element comprises a U-shaped gap formed in the strip conductor of a strip-line transmission line, a microstrip structure, or a suspended strip-line structure. The internal transmission line filters can be cascaded to produce electromagnetic energy filters with deeper notches and steeper skirts than previously obtainable from other planar structures with the same number of elements.



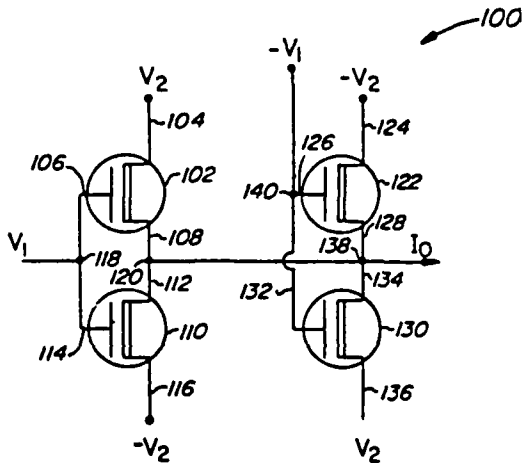
STAGE OF DEVELOPMENT: Filters have been built and tested up through 100 GHz.

APPLICATIONS: This filter provides a convenient means of blocking and rejecting unwanted signals in SHF-EHF receiver front ends.

CMOS ANALOG FOUR-QUADRANT MULTIPLIER

Inventor: Patrick A. Shoemaker and Gene L. Haviland
Patent Number 4,906,873; dated 6 March 1990

ABSTRACT: A four-quadrant analog multiplier circuit provides an output that is proportional to two voltage inputs. The circuit includes a pair of depletion mode transistors having gain constants equal in magnitude and threshold voltages equal in magnitude. The gates of the transistors are coupled in common. One input is applied to the common gates. The other input and its inverse are separately applied to source/drain terminals of the two transistors.



STAGE OF DEVELOPMENT: The method has been both mathematically verified and experimentally demonstrated.

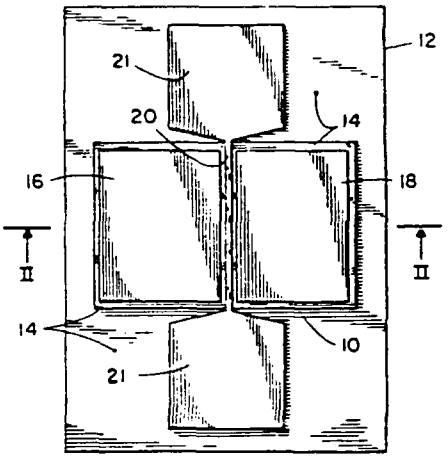
APPLICATIONS: This method has applications in the area of analog silicon large-scale integrated circuitry and particularly to the emerging field of Artificial Neural Networks (ANNs).

MICROWAVE/MILLIMETER WAVE TECHNOLOGY AND DEVICES

MICROWAVE InP/SiO_2 INSULATED GATE FIELD EFFECT TRANSISTOR

Inventor: Louis J. Messick
Patent Number 4,194,021; dated 18 March 1980

ABSTRACT: An InP/SiO_2 insulated-gate field-effect transistor that exhibits power gain at microwave frequencies is manufactured by using an n-type epitaxial semiconducting InP film on a semi-insulating InP substrate and depositing a pyrolytic silicon dioxide insulating film on the conducting InP film to form the gate insulator.



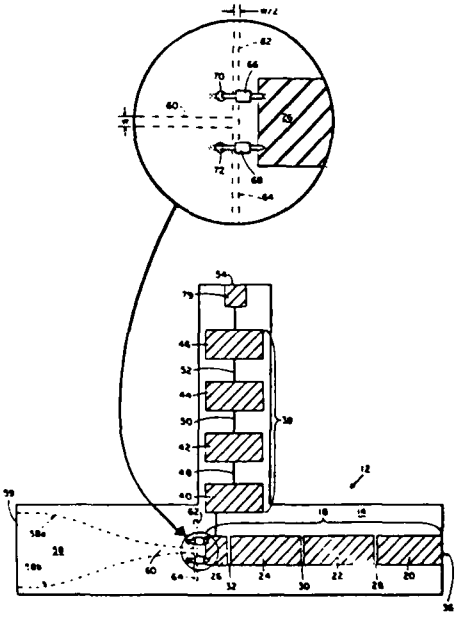
STAGE OF DEVELOPMENT: These transistors have been fabricated and tested. Test results show they perform as stated in the patent.

APPLICATIONS: These devices have applications in microwave, millimeter wave, and EHF high-power and low-noise amplification as well as high-speed digital logic for use in systems including communications, radar, missiles, smart munitions, and high-speed data processing. Civilian applications range from home security systems to collision avoidance systems in automobiles and to telecommunications.

MILLIMETER-WAVE PRINTED CIRCUIT MIXER

Inventor: John Reindel
Patent Number 4,406,020; dated 20 September 1983

ABSTRACT: A millimeter-wave printed circuit mixer with extended RF and IF bandwidths is disclosed. A dual-ridge waveguide-to-slotline transition is utilized to bring the RF signal into the device. The waveguide-to-slotline transition is terminated in first and second shorted RF slotlines formed on the bottom of a dielectric substrate and extending from the RF slotline. A microstrip LO bandpass filter terminating in a microstrip line is formed on the dielectric substrate and is utilized to bring the local oscillator signal to the device. First and second beam-lead diodes are connected from the microstrip line through apertures in the dielectric substrate and, thence, are connected across the dual-shorted RF slotlines and connected to the groundplane conductor on the underside of the dielectric substrate. An IF filter is formed on the dielectric substrate and connected to the microstrip line for removing the IF signal from the device. The dielectric substrate and the elements formed on the substrate are enclosed within a waveguide housing.



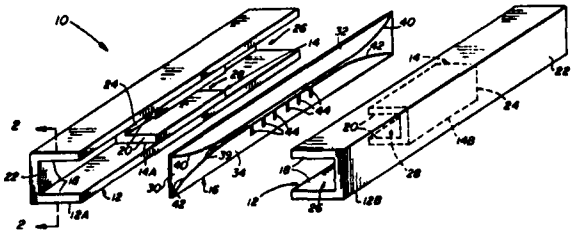
STAGE OF DEVELOPMENT: Mixers have been built for waveguide bands from 18 GHz up to 110 GHz.

APPLICATIONS: Wideband SHF-EHF receivers.

SHF-EHF PRINTED-CIRCUIT LOW-PASS FILTER

Inventor: John Reidel
Patent Number 70,533

ABSTRACT: The present invention relates to a constricted split-block waveguide low-pass filter that permits the use of low-cost construction techniques while, at the same time, providing very broad rejection bands. The low-pass filter of the present invention uses a simple method of construction that eliminates machining by assembling a smaller inner split-block waveguide within a larger outer split-block waveguide and mounting a printed-circuit filter substrate longitudinally therebetween. The printed circuit filter substrate enhances design accuracy by employment of conventional lithographics and chemical etching techniques.



STAGE OF DEVELOPMENT: Laboratory models have been designed, built, and tested in the SHF band and lower part of the EHF band.

APPLICATIONS: This has applications in electronic warfare and surveillance receivers plus use as a general purpose low-pass filter in laboratory measurements.

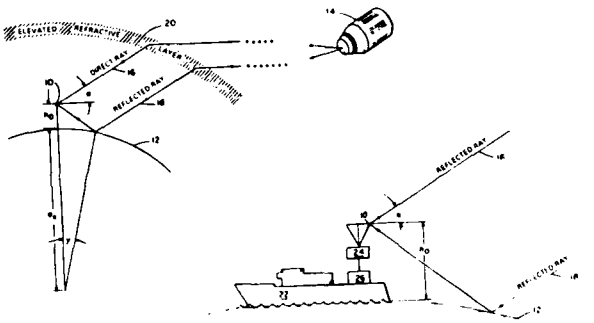
ATMOSPHERIC-PREDICTION TECHNOLOGY

ATMOSPHERIC PREDICTION TECHNOLOGY

MEANS FOR DETERMINING THE REFRACTIVE INDEX PROFILE OF THE ATMOSPHERE

Inventor: Herbert V. Hitney
Patent Number 4,093,918; dated 6 June 1978

ABSTRACT: In a method for inferring the refractive index profile of the lower atmosphere a signal pattern comprising interference nulls is observed by receiving a signal from a satellite transmitter over a period of time. Hypothetical signal patterns are successively calculated by hypothesizing the validity of different refractive index profiles and comparing them to the observed signal pattern until one of them matches the observed signal pattern to within a selected limit of error.



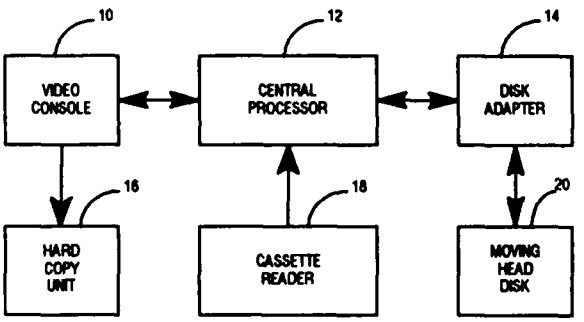
STAGE OF DEVELOPMENT: The method has been implemented and shown to give acceptable inferred profiles about half of the time. No further work is planned.

APPLICATIONS: If the method could be shown to work reliably, it could be used in place of expendable balloon-borne radiosondes to infer vertical structure of the atmosphere.

INTEGRATED REFRACTIVE EFFECTS PREDICTION

Inventor: Herbert V. Hitney
Patent Number 4,125,893; dated 14 November 1978

ABSTRACT: A method and means of assessing the effects of the lower atmosphere on the performance capabilities of a variety of electromagnetic systems. Environmental data are entered manually into a computer by means of a keyboard or on digital tapes in cassette form. A mathematical model is selected and will generate the type of display desired when the required information and a specific electromagnetic system of interest are selected. A display will appear on the graphics-display screen from which hard copies can be made for use in deploying and making tactical decisions as to stationing of assets.



STAGE OF DEVELOPMENT: The method has been verified and implemented on several computer systems for use within the U.S. Navy. The method has also evolved into the Engineer's Refractive Effects Prediction System (EREPS) for use by scientists and engineers.

APPLICATIONS: This method has applications for anyone who wants to assess environmental effects on existing or proposed radar, communications, or other specialized electromagnetic systems operating in the 100-MHz to 20-GHz frequency range.

DISPLAY TECHNOLOGY

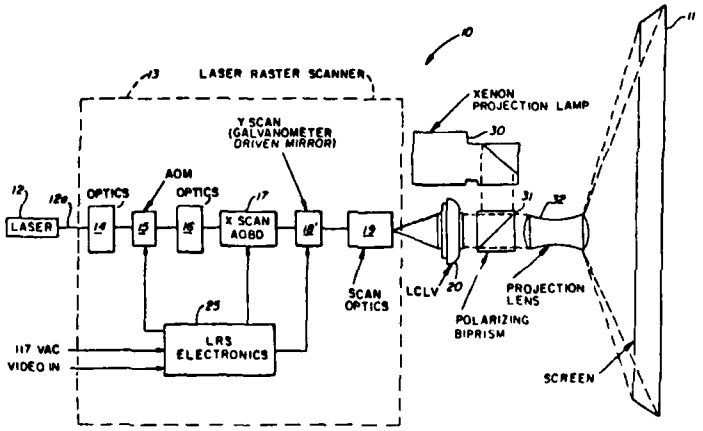
REAL-TIME ULTRA-HIGH RESOLUTION IMAGE PROJECTION DISPLAY USING LASER-ADDRESSED LIQUID-CRYSTAL LIGHT VALVE

Inventor: John Trias
Patent Number: 4,611,245; dated 9 September 1986

ABSTRACT: A wide-screen display enables viewers the simultaneous viewing of rapidly updated data in real time at video rates. A beam of coherent radiation from a laser is modulated at video rates in an acousto-optic modulator. The modulated beam is fed to an X-scanner that imparts an acousto-optic displacement of the modulated beam in the X-direction. A Y-scanner is aligned to receive the X-scanned modulated beam and imparts an acousto-optic reciprocal displacement of the beam so that the video modulated beam is displaced in both the X- and Y-directions. A liquid-crystal light valve is disposed to receive the X and Y displaced modulated beam so that it scans the surface of the light valve to stimulate the photosensor layers within. This causes the impression of a replica voltage pattern on a bi-refringent liquid crystal in the valve. A high-intensity lamp projects a high-intensity incoherent light beam onto the liquid-crystal light valve via a polarizing biprism. Since the bi-refringent liquid crystal has been modulated by the X- and Y-scanned modulated coherent beam, a corresponding image is reflected from the bi-refringent liquid crystal and onto the screen. The acousto-optic modulation X-scan and Y-scan occur at much higher rates and with greater control than conventional arrangements so that the resolution of about 2,000 lines at a video rate is possible. The real-time display gives viewers a more realistic image so that responsive decisions and actions may be taken.

STAGE OF DEVELOPMENT: A prototype 525-line laser-light-valve monochrome projector to interface with Standard TV, RS-170, was demonstrated at NOSC for the first time with internal development support. This prototype laser-addressed LCLV large-screen projector was tested on board an aircraft carrier for four weeks. It was also demonstrated at NOSC that using a single-line scanning system at video scan rates with 2000-TV-line resolution was possible. Current effort involves development of the 1280-by 1024-resolution AO Laser Raster Scanner (LRS). Design for a color projector to incorporate this display technique is in progress, coupling this LRS with a high-efficiency, compact Nd:YAG-KTP laser source.

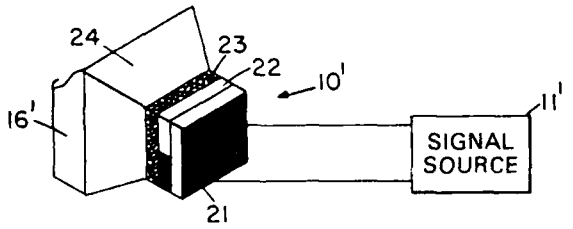
APPLICATIONS: Military applications of this large-screen display (image refresh at TV frame rates) are (1) for situation group view displays—such as command control centers, tactical operation rooms, firing range supervision, and teleconferencing; (2) very large screen displays for simulation training devices—for air, sea, and land combat operations and for navigation; (3) group view displays—to provide symbol generation, mapping lines, velocity vectors, test formatting, and high-resolution graphics. Commercial and industrial applications are (1) education displays—in scientific, technical, or medical fields; (2) group view displays—for computer-aided instruction or presenting; (3) computer-aided design—engineering drawing, semi-conductor chip layout, and so on; (4) large-screen live news and situation telecasts; and (5) various commercial and entertainment displays—theaters, fairs, and sport arenas.



LIQUID CRYSTAL FIBER-OPTICS LARGE SCREEN DISPLAY PANEL

Inventors: Parviz Soltan and Paul C. Fletcher
Patent Number 4,299,447; dated 10 November 1981

ABSTRACT: A display screen shows a number of alphanumeric characters in accordance with computer originating signals. These signals are fed to a liquid-crystal panel that responsively varies its opacity. Preferably, tapered fiber optics extend from one side of the liquid-crystal panel to the screen. In one mode, light originating from an high-intensity source behind the screen is transmitted through the fiber optics. In another mode, light from the front of the screen is reflected from a reflector surface behind the liquid-crystal panel to the display screen. Either mode of operation allows the fabrication of a matrix of a number of liquid-crystal panels and their associated fiber optics to provide an expanded display screen. Thus, an expanded visual presentation is read out from a computer or similar source of controlling signals to assure that several observers as reliably informed.



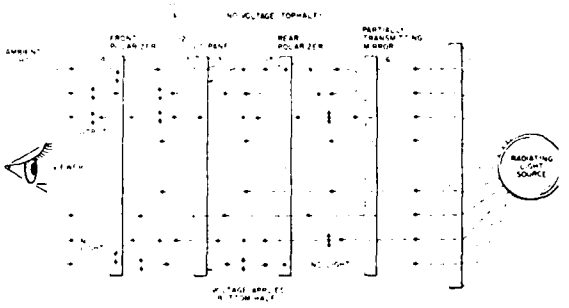
STAGE OF DEVELOPMENT: (1) Japan's Toray Industries Inc., in Shiga, Japan, has already developed a 120-inch diagonal video display that consists of plastic optical-fiber blocks, and an active 5-inch matrix liquid-crystal color display panel; this has sufficient resolution for TV Video signals (see Japan 1989 Display Conference proceedings held in Kyoto, Japan); and (2) Under DoD's SBIR Program, Physical Optics Corp., of Torrance, California, has successfully demonstrated the feasibility of developing plastic-fiber-optics modules in order to be driven by a liquid-crystal active panel. They are currently awaiting the Phase 2 funding of this SBIR Program.

APPLICATIONS: (1) Commercial display of large-size video information (static or dynamic) for advertising, sport stadiums, airport terminals, public meetings, and high-definition TV (HDTV) applications; and (2) Military Applications for Army's tactical displays, Navy's status boards where all the standard vertical plot panels (high resolution and 42" by 42" in size) will benefit group viewing at all DoD's command centers, similarly for NASA and NATO applications.

TRANSMISSIVE AND REFLECTIVE LIQUID CRYSTAL DISPLAY

Inventors: William H. McKnight, Larry B. Stotts and Michael A. Monahan
Patent Number 4,315,258; dated 9 February 1982

ABSTRACT: A visual display has an increased readout capability due to its operation in the transflective mode. A source of ambient light and light for radiation through the display from the backside together assure the increased readout capability. Heretofore, ambient light would degrade or wash out a display, making it nearly impossible for monitoring personnel to decipher alphanumeric or pictorial displays due to the decreased contrast. A pair of linear polarizers sandwich a twisted nematic liquid crystal and have their polarization axes either parallel or mutually orthogonally disposed so that the crystal will present bright or dark areas in response to applied potentials. Because a partially transmitting mirror is interposed between the sandwiched liquid crystal and the radiating light source, the ambient light augments the radiated light to enhance the visual display.



STAGE OF DEVELOPMENT: An analytical model and parameter optimization has not yet been carried out. An experimental prototype is also still awaited.

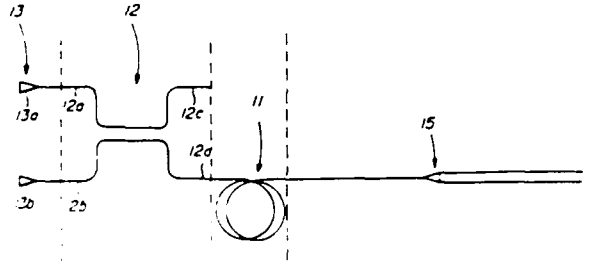
APPLICATIONS: This display device is useful in any situation where any other display device could be used, but it is clearly most superior in situations where ambient lighting conditions vary over a significant extent and washout is a problem.

FIBER-OPTIC TECHNOLOGY

ALL-FIBER SFPM AMPLIFIER

Inventors: Timothy C. Stamnitz and Stephen D. Russell
Patent Number 4,867,518; dated 19 September 1989

ABSTRACT: An "integrated fiber" device provides optical signal amplification to (1) provide for increased distances between undersea repeaters and/or optical regeneration nodes in fiber-optic transmission systems, or (2) support an increased number of multiple users on an optical data bus network or multiple parallel signal-processing channels in an optical processor/computer. In the latter case, a greater number of divisions of the signal can occur before the divided signal amplitude falls below the threshold needed for processing or detection. A combination of incorporated fiber components includes two optically tapered portions for conditioning of two input laser beams to a wavelength selective single-mode coupler used to combine the concentrated information signal and concentrated pump wave; one of these output ports is then optically coupled to a predetermined length of single-mode fiber. The fibers' optogeometric parameters are especially designed for intrinsic phase-matching to effect pump-wave frequency conversion and signal amplification by the nonlinear optical process of stimulated four-photon mixing. The amplified signal light is coupled out of the especially designed SFPM fiber by a mode-field conditioning device enabling beam expansion, such that the output core diameter of the mode-field conditioner equals the core diameter of the single-mode fiber used in the transmission link. This invention can be configured for field and/or undersea installation.



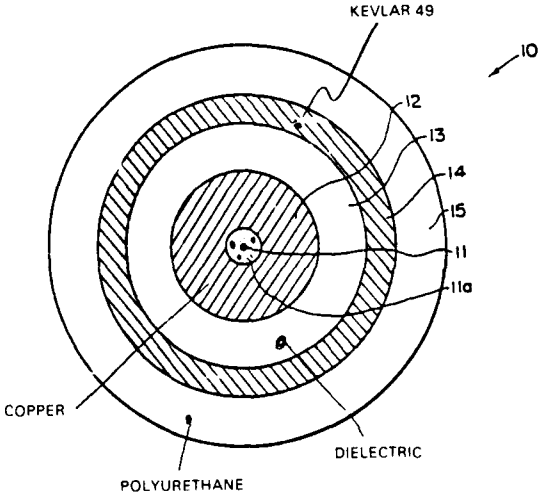
STAGE OF DEVELOPMENT: Fiber tapers have been manufactured elsewhere and characterized for optical coupling. Generation of SFPM within these tapers has been mathematically verified. Fiber couplers and SFPM amplifiers have been demonstrated in the laboratory.

APPLICATIONS: This device has applications in long-haul, repeaterless optical-fiber communications and for local area networks (LANs).

ULTIMATE LOW-LOSS ELECTRO-OPTICAL CABLE

Inventor: George A. Wilkins
Patent Number: 4,763,981; dated 16 August 1988

ABSTRACT: An undersea cable reliably transmits optical control signals and data. At least one optical fiber is axially disposed in an otherwise solid electrical conductor that transmits power the length of the cable. A concentrically disposed dielectric insulating layer prevents shorting with the surrounding seawater, and a load-bearing annulus coaxially contains the other elements to also protect them from environmental abuse. During deployment or towing, the load-bearing annulus shares part of the load with the solid electrical conductor. A coaxially disposed sleeve encloses all of the other elements to prevent a leaching action of seawater and to defocus externally originating concentrated forces.



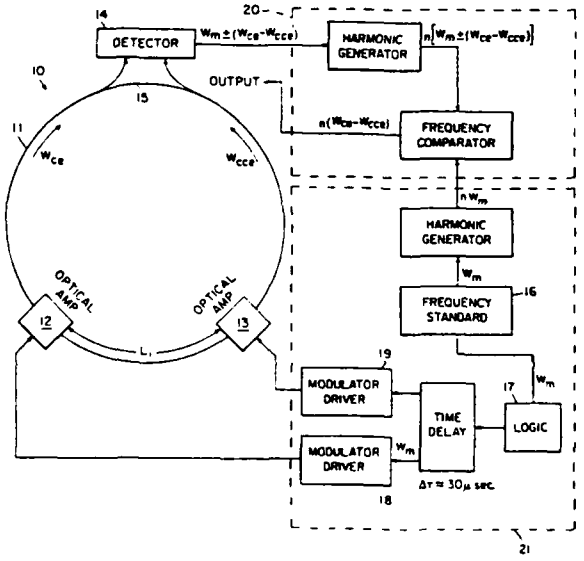
STAGE OF DEVELOPMENT: The design has been experimentally verified.

APPLICATIONS: This cable has application in commercial and military telecommunications, military surveillance, and oceanography.

PULSED-RING LASER FIBER GYRO

Inventors: Paul C. Fletcher and Verne E. Hildebrand
Patent Number 4,258,336; dated 24 March 1985

ABSTRACT: An improvement for a ring laser gyro employs pulsed optical signals in a fiber-optic loop. Clockwise and counterclockwise traveling pulsed optical signals are generated by a pair of optical amplifiers and a beamsplitter/coupler feeds the signals to a detector. The clockwise and counterclockwise signals do not meet in either of the optical amplifiers, but do arrive in coincidence at the beamsplitter and detector. Although low-rotation-rate lockin limits the minimum detection rate in a continuous-wave laser gyro, it does not so restrict the pulsed laser gyro's ability to detect low-rotation rates because there is little, if any, coupling between the clockwise and counterclockwise modes of signal propagation.



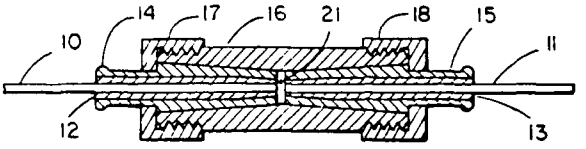
STAGE OF DEVELOPMENT: No work has been done at this laboratory beyond the patent. However, the components required to accomplish this are now commercially developed. In-line amplifiers were demonstrated at the last CLEOS conference. Low-loss, polarization maintaining fibers have been available for several years. Couplers are also available commercially.

APPLICATION: This is applicable wherever gyros would be used. The technology (i.e., in-line amplifiers in a ring configuration), could be used for optical data storage and other optical signal-processing operations.

LOW-LOSS SINGLE-FILAMENT FIBER-OPTIC CONNECTOR WITH THREE CONCENTRIC TAPERED MEMBERS FOR EACH FILAMENT

Inventors: Adolph L. Lewis, Daniel E. Altman, and Harold R. Fear
Patent Number 4,087,158; dated 2 May 1978

ABSTRACT: Single-filament fiber-optic cables are aligned within a connector to provide low-loss light transmittance from one to the other. Since it is virtually impossible to drill holes in a connector as small as the 0.005-inch typical diameter of a single-filament fiber-optic cable, the fiber-optic cable ends are bonded within a section of microtubing of the stainless-steel type used for the micro syringe portion of a hypodermic needle. The single-filament fiber-optic cable ends bonded within the microtubing are received within terminal members of a selected metal material having internal bores that are readily drilled by conventional means to receive the microtubing with the bonded ends of the fiber-optic cables. This assembly is made by force fit and each such assembled terminal of the single-filament fiber-optic cable is optically ground and polished at its end. Two such fiber-optic cable end terminals, which preferably have a slight taper, are received into a central cylindrical member that has a configuring taper and aligns the two single-filament fiber-optic cable ends to facilitate the transmittance of optical energy with minimal light loss. A suitable end cap at each end of the central member retains the two terminal members in desired abutting alignment. Preferably, the central cylindrical member is fabricated of a metal dissimilar to the metal of the terminal members that it receives in its internal bore.



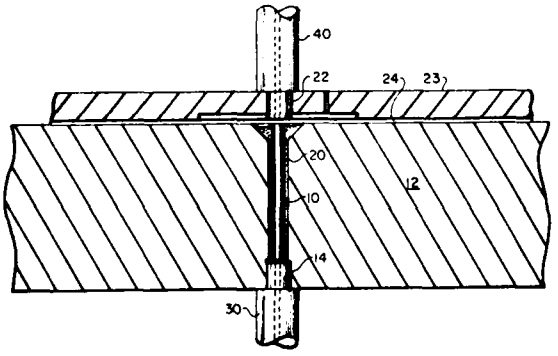
STAGE OF DEVELOPMENT: Prototypes have been fabricated, but manufacturability has not been demonstrated.

APPLICATIONS: This device has uses in single-filament fiber systems where demountability is essential.

METHOD OF MAKING AN UNDERSEA, HIGH-PRESSURE BULKHEAD PENETRATOR FOR USE WITH FIBER-OPTIC CABLES

Inventors: Steven J. Cowen, James H. Daughtry, Christopher M. Young, and John T. Redfern
Patent Number 4,469,399; dated 4 September 1984

ABSTRACT: A high-pressure penetrator for use with fiber-optic cables is fabricated by a method that assures reliable operation. The fabrication method first calls for a bore through the pressure wall of a container of instrumentation. Applying wax to one end of a cylindrically shaped lens prepares it for alignment in the bore. A suitable lens is the one-half pitch graded refractive-index lens of the type marketed under the trademark, SELFOC. The cylindrically shaped lens is inserted into the bore to locate its far end flush with one side of the wall. Thus, the wax-applied end of the lens lies within the bore at the wall's opposite side. Melting the wax allows it to flow around the tip of the wax applied end of the lens. A subsequent cooling of the melted wax precisely fixes the cylindrically shaped lens into position within the bore. A high-strength epoxy resin is potted in the clearance space between the lens and the bore by vacuum drawing the resin into the clearing space. Upon curing the resin, the lens will be securely held in place to permit an optical aligning of fibers on either end of the lens to assure optical signal transfer.



STAGE OF DEVELOPMENT: The method was initially used to construct prototype fiber-optic penetrators at NOSC and is currently employed at Giannini Petromarine Corporation to assemble production units. Commercial optical penetrators are produced by using this assembly technique.

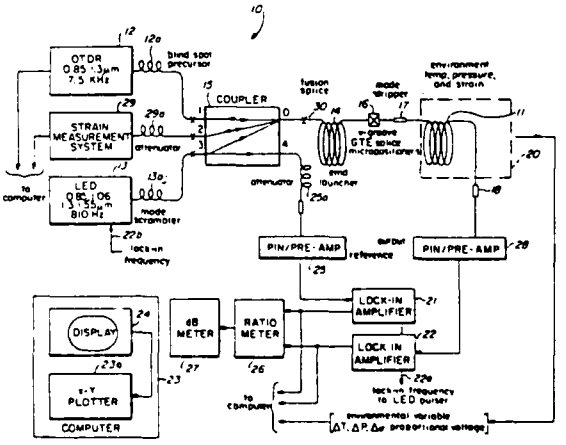
APPLICATIONS: The technique is generally applicable to assembly of optical devices that employ Graded Refractive Index (GRIN) optical lenses.

INTEGRATED OPTICAL TIME DOMAIN REFLECTOMETER/INSERTION LOSS MEASUREMENT SYSTEM

Inventor: Michael R. Brininstool
Patent Number 4,685,799; dated 11 August 1987

ABSTRACT: A combination optical time domain reflectometer (OTDR) and insertion-loss measurement system evaluates environmental stress effects on a test optic cable. A multiport coupler joins the OTDR and insertion-loss system to the test fiber-optic cables via a precursor of like type and length with respect to the test cable. Nondestructive analysis, continuously and throughout, measures attenuation between any two points within the equilibrium region of the test cable, the quality of the splice between the precursor and the test cable, and the degree of EMD disruption. Attenuation measurements over operating environmental conditions can be made to precisely determine the maximum allowable cable length. Visual readouts and permanent records of the EMD disruption and resultant excess attenuation provide realtime analysis so that responsive corrective actions can be made.

STAGE OF DEVELOPMENT: The system has been successfully demonstrated in the lab. A prototype system is presently used at NOSC.



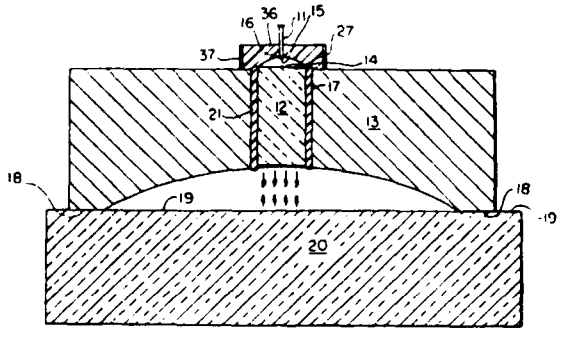
APPLICATIONS: The integrated measurement system has application in the area of fiber-optic cable environmental testing.

RETRO-REFLECTIVE ALIGNMENT TECHNIQUE FOR FIBER-OPTICAL CONNECTORS

Inventors: Christopher M. Young and Steven J. Cowen
Patent Number 4,545,643; dated 8 October 1985

ABSTRACT: An apparatus and method provides an optically aligned connector for at least one optical fiber. A connector plate, machined with one flat surface, is placed in an abutting relationship on an optically flat mirror surface. A quarter-pitch graded refractive index lens is inserted in a hole through the connector plate and bonded in place. The hole through the connector need not be precision bored, nor is the fit between the lens and hole critical since the optical alignment is not dependent on these fittings but rather upon the abutting relationship of the flat surface and the mirror surface. An optically excited fiber is brought to the close proximity of the lens and suitably micropositioned to a location where a maximum light intensity is monitored by a detector optically coupled to the excited fiber. When the fiber is positioned so that a maximum reflected intensity is monitored, the fiber is secured in place by, for example, a UV cureable adhesive. Mechanically indexing mating connector plates assures that an optical alignment from one fiber through its lens to another lens and onto another fiber is created. Multiple optical couplings between several pairs of fiber lenses can simultaneously be created between a pair of appropriately designed connector plates. Optionally, appropriately machined collars held between single or multi-fibered connector plates are filled with an acceptable index-matching fluid to assure suitable optical coupling.

STAGE OF DEVELOPMENT: The method has been verified experimentally and fiber-optic connectors have been produced by using this method.

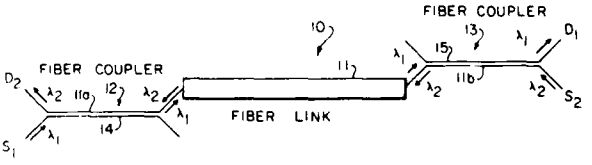


APPLICATIONS: This method is applicable to all fiber-optic connectors using collimating optical systems. It is particularly suited to the manufacture of connectors using graded refractive index (GRIN) rod lenses.

METHOD OF WAVELENGTH MULTIPLEXING IN FUSED SINGLE-MODE FIBER COUPLERS

Inventor: Matthew N. McLandrich
Patent Number 4,557,553; dated 10 December 1985

ABSTRACT: An apparatus and method of entering and extracting a discrete wavelength of optical data in a single-mode duplex optical data transmission system relies on a selective evanescent field coupling. A continuous single-mode fiber transmits the two wavelengths in opposite directions with respect to each other. A length of a like single-mode fiber is fused to the continuous single-mode fiber such that the product of the fused length and the coupling coefficient of the fiber pairs equals $\pi/2$ at one of the optical frequencies to effect one-hundred-percent evanescent field coupling to and from the continuous fiber. The product of the coupling coefficient and the fused length equals π at the other optical wavelenght to effect a zero-percent evanescent field coupling. The other wavelength travels the length of the continuous single-mode fiber uninterrupted, while the first wave-length is selectively coupled and decoupled from the fiber as desired.



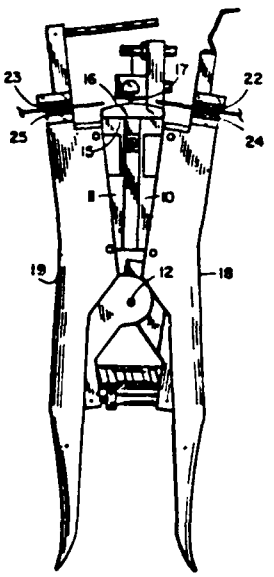
STAGE OF DEVELOPMENT: The WDM fiber couplers have been reduced to practice and are commercially available.

APPLICATIONS: The technology is applicable to fiber-optic transmission systems using wavelength division multiplexing or duplexing of laser transmitter signals at wavelengths corresponding to all commercially available laser diodes.

SINGLE-FILAMENT FIBER-OPTIC CABLE PARTING TOOL

Inventor: Adolph L. Lewis
Patent Number 4,154,385; dated 15 May 1979

ABSTRACT: A hand-held, manually operative tool is designed for severing single-filament, fiber-optic cable. The exertion of a squeeze-like pressure on the handles of the tool causes the fiber-optic cable to be gripped firmly and positioned on an anvil member where it may be scored by a sharpened hard element such as a diamond point; for example, at a selectively determined point along the axis of the fiber-optic cable. Further actuation of the tool causes the gripping members to be pivoted away from each other, thus parting the fiber-optic cable at the selectively determined point. The coacting members of the tool are spring loaded for return to their normal unactuated state and the anvil member is preferably a curved surface so as to retain the fiber-optic cable in a desired disposition during the scoring operation.



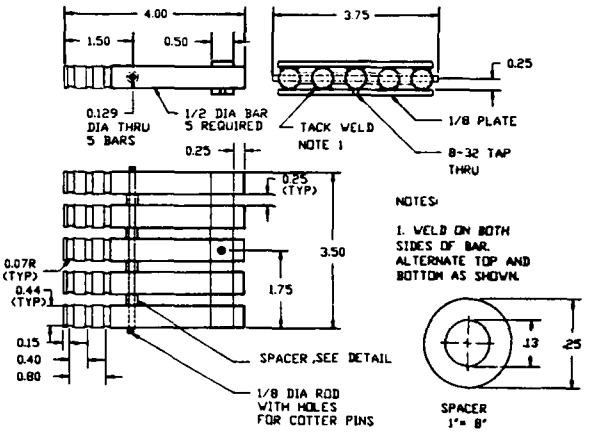
STAGE OF DEVELOPMENT: The tool has been designed and fabricated. Some limited field testing has been carried out.

APPLICATIONS: This tool has uses in both field and laboratory preparation of fiber end faces in fiber-optic systems.

CALIBRATED BENDER FOR FIBER-OPTIC CABLE POSITION DETERMINATION

Inventor: Willard Stevenson
Navy Case 70,788

ABSTRACT: During the course of developing and testing undersea fiber-optic cables, a tool was developed to aid in inspection, repair, and failure analysis of deployed cable. The diver- or ROV-held tool bends a small diameter cable sufficiently to induce a discernible optical loss at that point without damaging the fiber or cable. The loss can then be localized with an optical time-domain reflectometer (OTDR), a standard piece of equipment used with fiber-optic systems. This allows test engineers to nondestructively localize cable failures *in situ*.



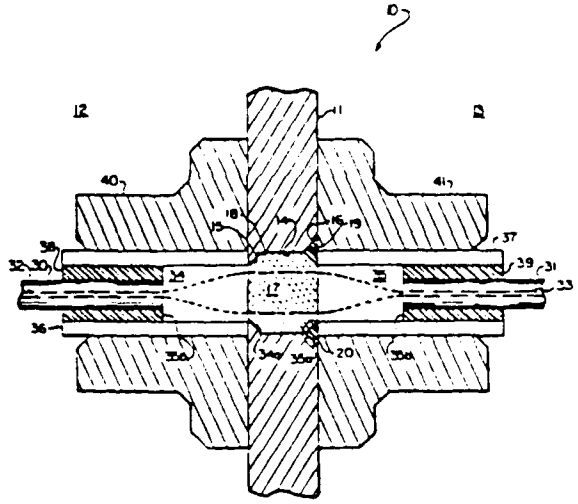
STAGE OF DEVELOPMENT: A prototype has been built and tested in the laboratory as well as at sea. A modified version was attached to the manipulator of a remotely operated vehicle (ROV) used in underwater cable tracking tests. The results indicated a successful implementation of the device.

APPLICATIONS: The tool can be used with a diver or ROV to assist in locating faults in small-diameter undersea fiber-optic cables. It also can be used in the laboratory or cable manufacturing plant to determine the location (relative to a known point) of a point of interest. Once the tool is calibrated, it can be used as an optical attenuator.

HERMETIC HIGH-PRESSURE FIBER-OPTIC BULKHEAD PENETRATOR

Inventor: Steven J. Cowen
Patent Number 4,682,846; dated 28 July 1987

ABSTRACT: A method and apparatus of transmitting optical data through a wall separating a first fiber in a first medium from a second fiber in a higher-pressure medium assures optical information transfer. A bore is provided in the wall that has an inwardly extending annular rim. A cylindrically shaped optical-glass plug is sized to fit within the bore and configured to abut the annular rim, and a hard solder seal, a ceramic seal, or a fused frit is disposed between the bore and the glass plug to hermetically seal one side of the wall from the other. A quarter-pitch graded index of refraction rod lens contacts opposite sides of the optical glass plug. The first and second optical fiber are held in an aligned relationship with the rod lenses and glass plug to assure bidirectional transmission of optical data. The apparatus and method assure reliable optical transmission with long-term stabilities in high-pressure differentials.



STAGE OF DEVELOPMENT: Initially used to contruct prototype fiber-optic penetrators at NOSC in 1982, these proof-of-performance penetrator units employed developmental, collimating fiber-optic connectors containing graded refractive index (GRIN) rod lenses. Both single-channel and three-channel operational penetrator models were constructed and shown to function with low optical insertion loss and high repeatability. Commerical fiber-optic penetrator units, which subsequently appeared on the market, make use of this patented principle, although we are not aware of any formal licensing arrangements between the manufacturers of such devices and the U.S. Government.

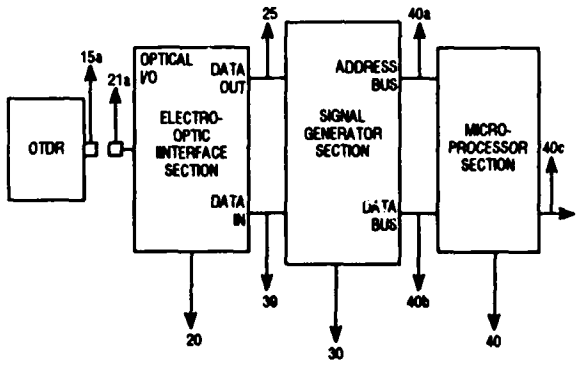
APPLICATIONS: The concept is applicable to many diverse applications requiring a hermetic seal and transmission of fiber-optic signals (i.e., undersea, nuclear, medical and space).

OPTICAL-FIBER BACKSCATTER SIGNATURE GENERATOR

Inventors: Neil T. Kamikawa, Arthur T. Nakagawa, Grant A. Tanaka, and Ken K. Yamada
Navy Case 70,993

ABSTRACT: An optical-fiber backscatter signature generator (OFBSG) has been developed to calibrate optical time-domain reflectometers (OTDR). An OTDR measures attenuation and locates breaks in a fiber-optic cable by detecting optical power that is scattered backwards from forward-traveling optical pulses. These short-duration pulses are generated by a laser in the OTDR and launched into the cable under test. The fiber-optic cable can be replaced by the OFBSG, which generates similar backscatter signatures to test an OTDR's loss accuracy, dynamic range, spatial resolution, loss resolution, and receiver recovery time. The OFBSG can also function as a cable simulator to train OTDR operators.

The OFBSG consists of an optical source, an optical receiver, a Z80 microprocessor board, and processing logic. It resides in a lightweight, compact chassis, and interfaces to the OTDR via a short fiber-optic cable and coupler. The OFBSG detects narrow pulses launched from the OTDR and returns computer-generated backscatter. These signatures can be imported from a lap-top computer and can be tailored for short-haul and long-haul OTDRs.



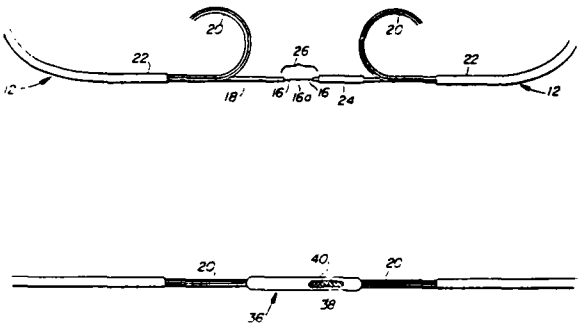
STAGE OF DEVELOPMENT: An engineering model has been developed to demonstrate feasibility.

APPLICATIONS: The OFBSG can be used as an automated test fixture to calibrate OTDRs and as a cable simulator for OTDR operator training.

FIBER-OPTIC CABLE SPLICE

Inventors: Andrew R. Estabrook, Laura A. Shook, Gerard N. Daguio, and Robert M. Baker
Patent Number 4,846,545; dated 11 July 1989

ABSTRACT: An apparatus that joins ends of fiber-optic cables includes a fiber protection sleeve fitted over an area of optical coupling to cover bare optical fibers at the coupling. The sleeve extends from the bare fibers to cover a portion of a buffer section of each cable. The fiber protection sleeve has an inner heat-shrinkable tube that overlaps the area of optical coupling, a flexure suppressant rigidity member disposed exteriorly adjacent to the inner heat-shrinkable tube, and an outer heat-shrinkable tube that overlaps the rigidity member and the inner heat-shrinkable tube. The inner and outer heat-shrinkable tubes are shrink-fitted to strengthen and seal the area of optical coupling. Additionally, a strength-member sleeve is fitted over cable strength-member sections that are interlayed over the fiber protection sleeve. The strength-member sleeve includes a solder-impregnated tubular braid and a heat-shrinkable tube covering the braid. Heating the strength-member sleeve causes solder within the braid to join the braid with the interlayed strength members, and causes the heat-shrinkable tube surrounding the tubular braid to shrink the braid and itself upon the interlayed strength members. An encapsulant-lined outer protective heat-shrinkable sheath overlaps the other elements of the invention and extends onto a portion of the sheath of each cable. The outer protective sheath is heat shrunk to seal the area of optical coupling from the ambient and to distribute the encapsulant throughout the sheath to further seal the area of optical coupling.



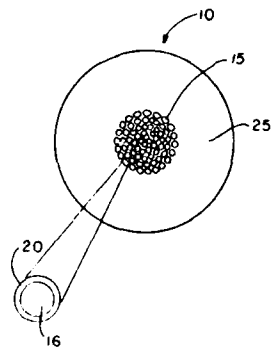
STAGE OF DEVELOPMENT: Splices made by using this technique have been tested both in the laboratory and on the ocean floor. A splice deployed in 1986 in a water depth of 3000 feet is still functioning without degradation in optical throughput. Currently, this method only applies to cables with metallic strength-members, however, the concept is applicable to cables with synthetic strength-members.

APPLICATIONS: This method of cable connection can be used for virtually any application requiring that cable sections be joined or a damaged section repaired.

METALLIZED SYNTHETIC CABLE

Inventor: Thomas E. Jones
Patent Number: 4,518,632; dated 21 May 1985

ABSTRACT: A method and apparatus provides an essentially neutrally buoyant undersea electronic data communications link. A bundle of continuous synthetic fibers, each having a diameter of about ten microns, has individualized metalized layers coated to a thickness of about one to three microns. All are covered by dielectric insulation. The synthetic fibers, aromatic polyamide fibers, or graphic fibers are relatively lightweight, with high-tensile strengths to assure sufficient load-bearing capability for undersea use. The thin metallized coatings provide the electrical data-transmission capability without unduly weighting down the cable. The dielectric insulation layer is disposed coaxially outward of the coated fibers and is optionally provided with an outer sheath of conductive material for a return path. However, in some applications, a seawater return path is better. The size of the undersea link is variable to accommodate different frequency responses. The metallized layers are variable to allow for different weights and desired transmission characteristics. Optionally, the fibers can be intercalated to aid in signal transmission.



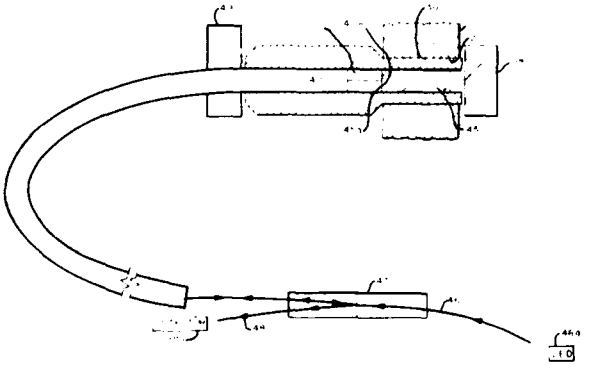
STAGE OF DEVELOPMENT: Techniques for metallizing synthetic fibers are well established. Several companies in the United States have coated bundles of synthetic fibers in lengths greater than one hundred feet. The metallization, whether achieved by chemical or vapor deposition, is a continuous process and there is no limit to the available length. Calculations of signal attenuation in various configurations are part of this patent and the results agree with handbook values for conventional cables.

APPLICATIONS: These metallized synthetic cables and conductors will have applications, (1) wherever size and weight are primary concerns, such as at sea and in space, and where the losses associated with conductors made with materials other than solid copper are acceptable, and (2) in lightweight heating elements for clothing where the greater resistance is desirable.

REPRODUCIBLE STANDARD FOR ALIGNING FIBER-OPTIC CONNECTORS WHICH EMPLOY GRADED REFRACTIVE INDEX ROD LENSES

Inventors: Steven J. Cowen and
Christopher M. Young
Patent Number 4,509,827; dated 9 April 1985

ABSTRACT: A method of fabricating an optically aligned coupling between an optical fiber and a connector having a precision-bored bushing guarantees proper light-beam collimation. GRIN rod lenses are coupled to the optical fiber by an installation procedure having a readily reproducible measurement standard. Calibrating an alignment fixture calls for the insertion of a fused-quartz right cylinder having a diameter that allows a snug fitting in the precision-bored bushing. The cylinder has an integral, axially exposed mirrored face for reflecting the beam to create a calibration autocollimation with a beam from a laser projected through and in parallel with the axis of the precision-bored bushing. Disposing a mirror surface separated from and perpendicular to the axis of the precision-bored bushing allows reflection of the projected beam back over its own path to result in autocollimation of the projected and reflected beams. Inserting a close-fitting GRIN lens into an alignment ferrule that goes into the precision-bored bushing and exciting the optical fiber by a light source permits the positioning of the excited optical fiber on an axially exposed surface of the GRIN lens. Next, the light intensity reflected through the GRIN lens and into the optical fiber from the mirror surface is monitored. When the monitored light is maximum, the fiber is secured in place on the GRIN lens surface to assure the optically aligned coupling.



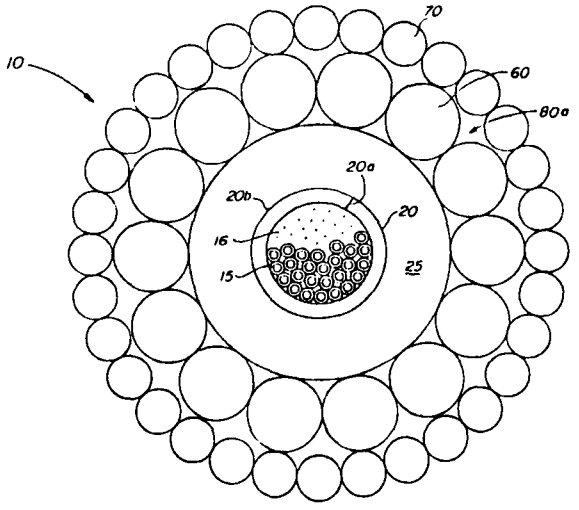
STAGE OF DEVELOPMENT: The method was initially used to construct prototype fiber-optic penetractors at NOSC where developmental, collimating fiber-optic connectors containing GRIN rod lenses were employed. It solved the immediate problem of interchangeability with regard to the connectors and did not require the use of a connector reference standard. The technique obviously was applicable to a much broader range of applications and superior in most respects to the techniques that were in use commercially.

APPLICATIONS: The technique is generally applicable to all types of collimating fiber-optic connectors, which require that the position of the optical fiber be such that a best approximation to true light collimation occurs. It has been specifically applied to connectors which employ GRIN optical lenses as collimators.

ELECTRO-OPTO-MECHANICAL CABLE FOR FIBER-OPTIC TRANSMISSION SYSTEMS

Inventor: Timothy C. Stamnitz
Navy Case 71,401

ABSTRACT: An electro-opto-mechanical cable includes at least one thin-wall steel-alloy tube containing at least one single-mode fiber and a void-filling gel to assure the capability for transmitting low-noise, optical-phase data. A dielectric annulus and an electrically conductive layer disposed therein helps further assure watertight integrity and power or electrical signal transfer. An optical double-layer contrahelical or three or four layer, torque-balanced, steel-wire strength member provides additional protection as well as capability to be towed deployed, and recovered from the seafloor at abysmal depths. The steel armor and cable core interface eliminates all interstitial spaces associated with the armor wires to produce a firm, hard cable that experiences minimal residual strain (creep) due to extensive load cycling. A pressure extruded outer jacket aids in assuring the protection of the individual steel wires from point loadings and from strength degradation due to corrosion. Further, the integral steel armor and jacketing structure provides protection for the electro-optic core from abrasion against rock or coral at cable suspension points during sustained cable strumming.



STAGE OF DEVELOPMENT: Some experimental data have been obtained.

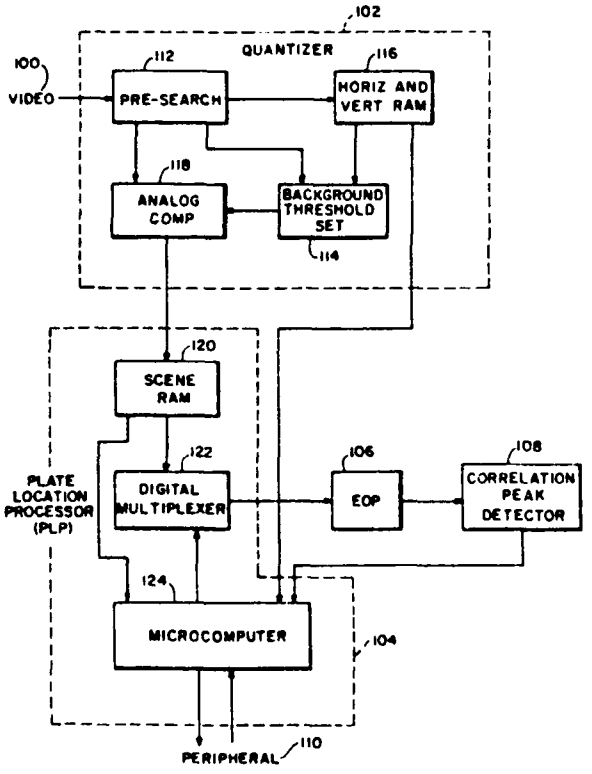
APPLICATIONS: This cable has application in undersea and towed aray environments.

OPTICAL-SYSTEMS TECHNOLOGY

AUTOMATIC CHARACTER RECOGNITION SYSTEM

Inventor: Travis W. Metcalf
Patent Number: 4,567,609; dated 28 January 1986

ABSTRACT: An apparatus and method for automatic character recognition is presented that automatically locates and recognizes alphanumeric characters in a scene viewed by a raster-scan type of sensor. By this method, the apparatus can search the entire scene in less than 1.5 seconds and recognize up to seven alphanumeric characters in a bounded area of known size by the correlation technique. The technique used first locates the bounded area and alphanumeric characters and then performs the recognition. Two different feature extraction methods are used to locate the characters in the scene. The recognition function is performed by correlation, using an incoherent electrooptical processor.



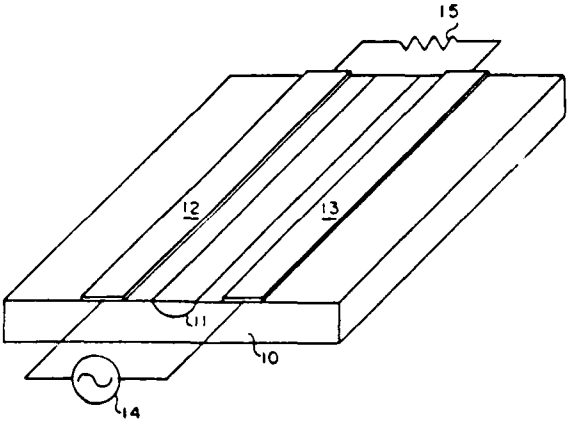
STAGE OF DEVELOPMENT: An analysis of the performance of the apparatus has been completed. The incoherent electrooptical processor portion of the apparatus has been developed and fabricated.

APPLICATION: The apparatus can be used by the Border Patrol or other law-enforcement agencies to identify automobile license plates. With minor modifications, any specific objects in the scene can be identified.

BROAD-BANDWIDTH OPTICAL MODULATOR AND SWITCH

Inventor: William M. Caton
Patent Number 4,005,927; dated 1 February 1977

ABSTRACT: A modulator and switch for optical energy includes an optical waveguide defining a path for the propagation of optical energy, a source of microwave energy, and at least one strip transmission line disposed in codirectional proximity relative to the optical waveguide and connected to the source of microwave energy. The strip transmission line is designed to have dimensions and dielectric constants for producing a propagation velocity of the microwave energy substantially equal to the propagation velocity of the optical energy in the optical waveguide. A suitable microwave load is connected to the transmission line for completing an electrical circuit with the source of microwave energy.



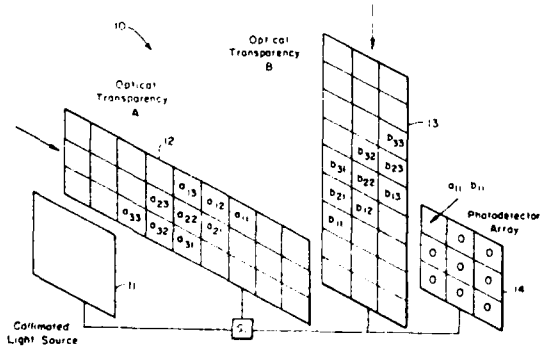
STAGE OF DEVELOPMENT: Traveling-wave electrooptic waveguide modulators are commercially available today.

APPLICATIONS: These high-speed waveguide modulators are used in fiber-optic communication systems as well as in optical signal-processing applications.

MATRIX-MATRIX MULTIPLICATION BY USING AN ELECTRO-OPTICAL SYSTOLIC/ENGAGEMENT ARRAY PROCESSING ARCHITECTURE

Inventors: Richard P. Bocker, Henry J. Caufied, and Keith Bromley
Patent Number 4,603,398; dated 29 July 1986

ABSTRACT: An electro-optic systolic array architecture performs matrix-matrix multiplication by using incoherent light. The incoherent light is collimated, passed through a polarizing beamsplitter and onto a pair of optically reflecting light valves. Each valve has a number of cells that are continuously being updated in a clocked sequence to vary their reflectivity in accordance with the data sequence. As the collimated incoherent light source is pulsed, the reflectivity of the cells of the two light valves is reflected back through the polarizing beamsplitter and onto a photodetector array. The photodetector array senses the multiplied signals from the two valves and provides a representative output in the same time frame as the pulsed, collimated light source. Another polarizing beamsplitter can be disposed to receive the multiplied signals from the first two valves and combined or multiplied with the input from yet another light valve, which is, in turn, received by an additional photodetector array. This sequence can be repeated, depending on the number of stages desired. A feedback capability is also provided for when iterative processing.



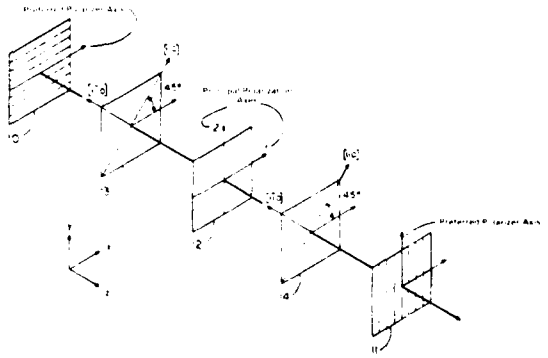
STAGE OF DEVELOPMENT: The method has been verified theoretically.

APPLICATIONS: Matrix-matrix multipliers are key components in systolic array processors capable of performing matrix operations such as QR factorization, LU factorization, singular value decomposition, and the solution of simultaneous equations. These operations are useful in modern day image, signal, and information processing.

COMPLEX PHOTODICHROIC SPATIAL FILTER

Inventors: Richard P. Bocker
Patent Number 4,110,004; dated 29 August 1978

ABSTRACT: A complex spatial filter is provided by the combination of two dichroic crystal plates, one quarter-wave plate, and two linear polarizers. The complex spatial filter consists of real and imaginary parts, both of which can have either a positive or negative sign. The structure is capable of eraseably recording varying degrees of absorbency that exhibit polarization discrimination in a desired format that can be used to process the Fourier transform of a light beam containing desired information.



STAGE OF DEVELOPMENT: The method has been theoretically verified. Experimental hardware has not been constructed.

APPLICATIONS: This filter has application in the areas of image enhancement, pattern recognition, word recognition, fingerprint identification, radar signal processing, and sonar signal processing.

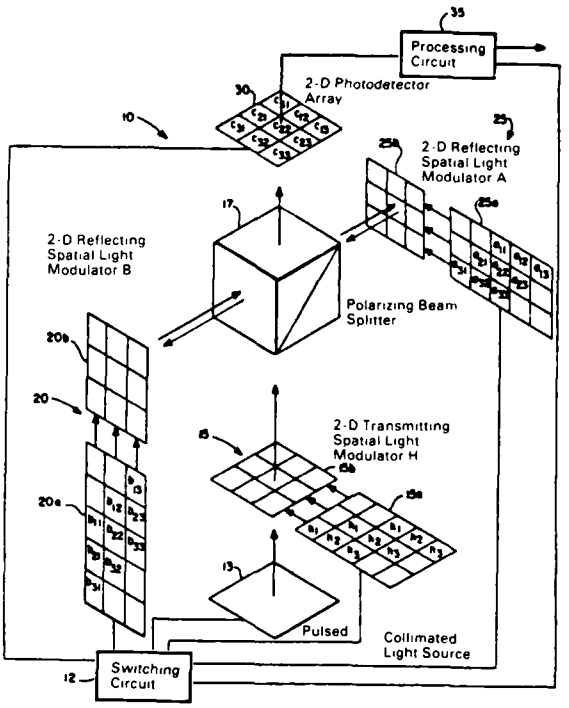
ADVANCED CUBE PROCESSOR

Inventor: Richard P. Bocker
Patent Number 4,633,427; dated 30 December 1986

ABSTRACT: An apparatus and method provide for the electrooptic performing of matrix-matrix multiplication, computation of the cross-ambiguity function, and calculation of triple correlations. A collimated light source is pulsed to illuminate a first matrix of optically encoded information. Since the first matrix functions in the transmissive mode, the same pulsed light is deflected by a polarizing beamsplitter to a second matrix of optically encoded information. This matrix, functioning in the reflective mode, reflects the pulsed, collimated light back through the beamsplitter onto a third matrix of optically encoded information. The third matrix is operated in the reflective mode and reflects the pulsed, collimated light back to the polarizing beamsplitter and onto a two-dimensional photodetector array. The photodetector array adds the successively arithmetically processed encoded information from the first, second, and third matrices of information. The information of the first matrix is advanced across the light path from the pulsed, collimated light source, and the encoded information from the second and third matrices are advanced across opposite faces of the polarizing beamsplitter in a mutually orthogonally displacement with respect to one another. Optionally, the information in the first matrix can be advanced across the path of the pulsed, collimated light at right angles to that described above to effect substantially the same mathematical operations called for above.

STAGE OF DEVELOPMENT: The method has been verified theoretically.

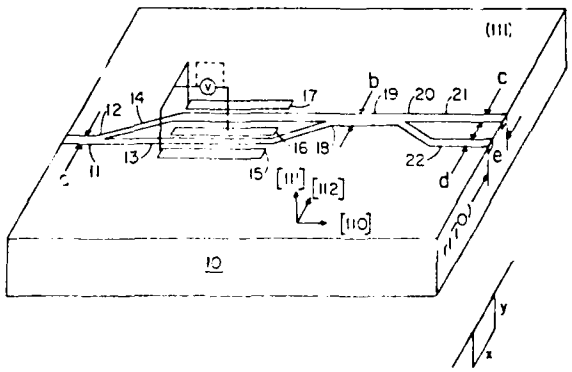
APPLICATIONS: Matrix multipliers are key components in systolic array processors capable of performing matrix operations such as QR factorizations, LU factorization, singular value decomposition, and the solution of simultaneous equations. These operations are useful in modern-day image, signal, radar, and information processing



OPTICAL-WAVEGUIDE INTERFEROMETER MODULATOR SWITCH

Inventor: William E. Martin
Patent Number 4,070,094; dated 11 August 1987

ABSTRACT: An optical-waveguide arrangement operates in the manner of an interferometer to provide modular and/or switching functions. Two optical-waveguide branches having a common connection diverge along a substantially coextensive distance and reconverge to provide first and second light paths of identical optical length. Conductive electrodes are disposed contiguous to at least one of the optical-waveguide branches, and are connectable through a controlling switch to a source of electrical energy for producing an electric field across the energized electrodes. In the absence of such electric field, light energy entering the two optical-waveguide branches will propagate along identical optical path lengths and recombine constructively at the reconvergence of the waveguide branches. However, a selectively applied electrical energy changes the optical property of at least one of the optical-waveguide branches, causing phase differences in the optical energy transmitted by the branches and producing destructive interference at the reconvergence of the optical-waveguide branches. The addition of two optical-waveguide sections having different dimensions provides a switch function when one of such additional waveguides is dimensioned to be conducive to the propagation of first-order-mode light energy while the other waveguide is dimensioned to be conducive to the propagation of second-order-mode light energy.



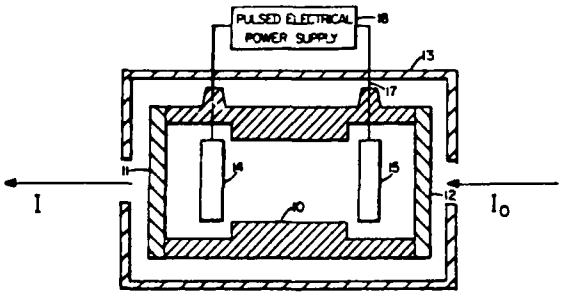
STAGE OF DEVELOPMENT: This technique is being used today to fabricate Lithium Niobate Optical Waveguide modulators.

APPLICATIONS: Optical communications and signal processing.

ELECTRICALLY CONTROLLABLE WIDE-ANGLE-OF-VIEW OPTICAL NOTCH FILTER

Inventors: Myer Geller, Daniel E. Altman, and Glidden J. Barstow
Patent Number 4,179,194; dated 18 December 1979

ABSTRACT: An electronically controllable, wide-angle-of-view, notch filter operates to attenuate predeterminable narrow-bandwidth wavelengths of light energy. An enclosure contains a selected material characterized by exhibiting strong quantum-mechanical coupling between two determinable energy states of different levels above its ground energy state. Also produced is radiated emission within the desired narrow bandwidth wavelengths when externally excited to populate the upper of the two determinable energy states. Transparent windows at opposite ends complete the enclosure, which is maintained at a desired temperature to vaporize the selected material. Two electrodes, oppositely positioned within the enclosure contiguous to its optical path, are connectable to a source of pulsed electrical energy to generate an electric discharge across the electrodes of sufficient strength to raise the vaporized selected material from its ground energy state to the lower of the two determined higher energy states, causing selective absorption of predetermined narrow-bandwidth wavelengths of light energy under the timed control of electrical actuation.



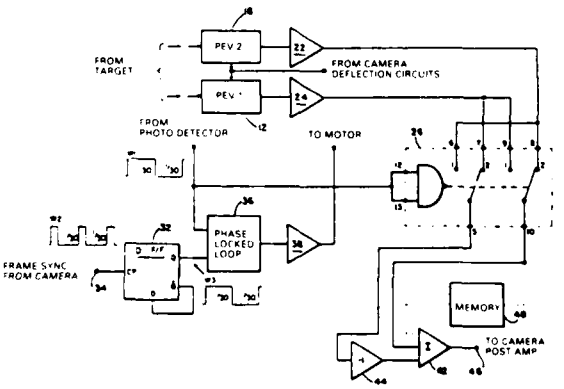
STAGE OF DEVELOPMENT: Prototype has been constructed and the function has been verified.

APPLICATIONS: Removal of unwanted optical signals in the time domain as would be desirable in OTDR and RADAR applications.

DUAL PYROELECTRIC VIDICON INFRARED CAMERA

Inventor: Travis W. Metcalf
Patent Number 4,164,753; dated 14 August 1979

ABSTRACT: Two pyroelectric vidicons are adapted to alternately receive infrared energy radiated from an object by means of a rotating half-circle-mirror and fixed-mirror arrangement. The alternations of the infrared energy received between the two vidicons are synchronized by means of a synchronization and drive circuit adapted to receive frame sync pulses from the camera circuitry. By this arrangement, information is received by the camera 100 percent of the time.



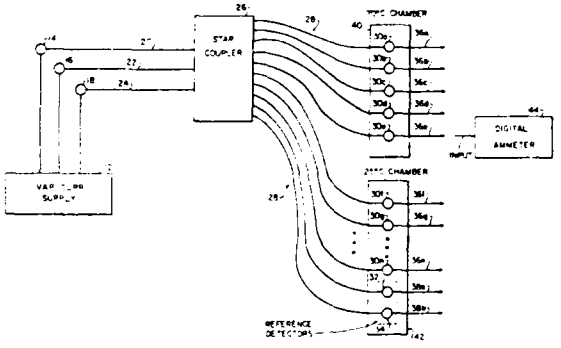
STAGE OF DEVELOPMENT: Experimental hardware was developed and the concept verified.

APPLICATIONS: This method can improve the performance and utility of low-cost pyroelectric vidicon cameras for some surveillance applications.

METHOD AND APPARATUS FOR PRECISE MEASUREMENT OF LONG-TERM STABILITY OF PHOTODETECTORS

Inventor: Stephen A. Miller
Patent Number: 4,459,547; dated 10 July 1984

ABSTRACT: A method and appa atus is disclosed for the measurement of the long-term stability of photodetectors. A fiber-optic star coupler divides optical flux from a source of light into highly stable, proportioned light outputs. Each of the photodetectors to be tested is connected to be irradiated by one of the star-coupler light outputs. Each of at least one reference photodetector having known stabilities is connected to one of the remaining outputs of the star coupler. Resulting outputs of the photodetectors to be tested are compared against the resulting output from the reference photodetector.



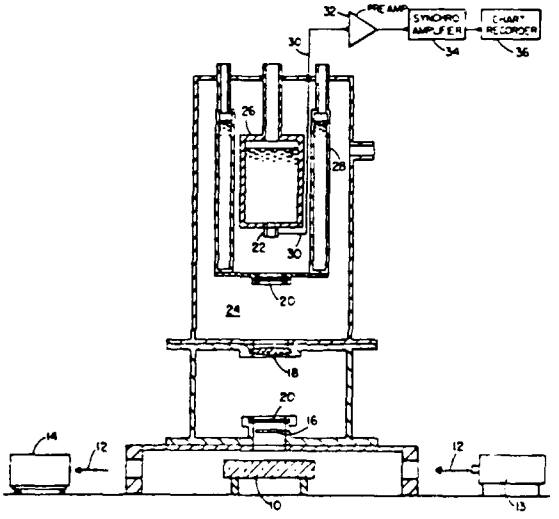
STAGE OF DEVELOPMENT: This invention has been implemented in hardware and all aspects of its functions have been verified experimentally.

APPLICATIONS: This invention relates generally to the field of optics and more specifically to the field of measurement and testing of the long-term stability of large numbers of photodetectors. The technique has been applied to the characterization of silicon avalanche photodiodes whose gain variations have been monitored for up to one year with precision on the order of 1 percent.

EMITTANCE CALORIMETRIC METHOD

Inventors: Roy F. Potter and Donald L. Stierwalt
Patent Number 4,041,313; dated 9 August 1977

ABSTRACT: A precise measurement of the absorption of weakly absorbing optical material is measured by measuring the temperature rise of the sample when light of the wavelength of interest passes through it. The temperature rise is determined by measuring the emission from the sample due to phonon absorption processes. This emission is of a much longer wavelength than the wavelength of interest. The temperature rise is determined by measuring the rate of increase of the emitted radiation power from the sample at the longer wavelength.



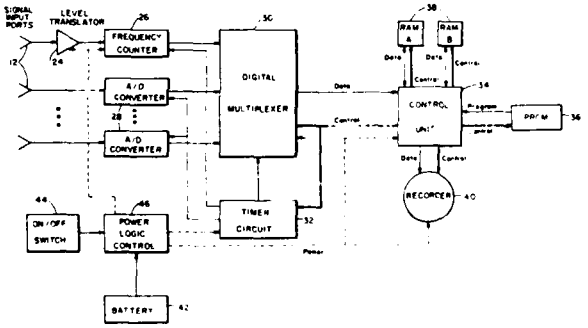
STAGE OF DEVELOPMENT: Sensitivity of measurement has been calculated. No hardware has been constructed.

APPLICATIONS: For measuring absorption of weakly absorbing materials such as laser windows.

REMOTE SELF-CONTAINED UNDERSEA MONITOR

Inventor: Robert E. Page
Patent Number 4,480,323; dated 30 October 1984

ABSTRACT: A remote oceanographic-data recording system that is self-contained, battery operated, and removably attachable to an external surface of a submerged hull without a need to penetrate said hull is presented. The system is capable of gathering and recording oceanographic data and may be joined to the hull of a submarine without interfering in submarine operation in any way. The system receives analog ac and dc electrical input signals from a variety of oceanographic data sensors and converts the signals to digital data signals for recording on magnetic tape cassette. The housing for the system is watertight and capable of withstanding external hydrostatic pressure up to 1620 psi.



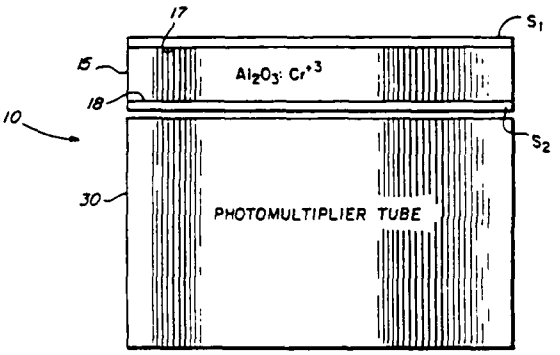
STAGE OF DEVELOPMENT: Two prototypes were built in 1980 and delivered to NUSC. The systems were checked out here at NOSC before delivery. The complete system included a second unit for playback and data retrieval. This is required in order to read the tapes.

APPLICATIONS: This device has applications in underwater monitoring of structures in hostile environments for long, unattended periods of time. The device can be retrieved when desired for removal of tapes.

NARROW-SPECTRAL-BANDWIDTH, UV-SOLAR-BLIND DETECTOR

Inventor: Myer Geller
Patent Number 4,731,881; dated 15 March 1988

ABSTRACT: Detection of 253.7-nm radiation in the solar blind UV spectrum is enhanced by using an energy wavelength shifter with a photomultiplier tube that senses fluorescent emissions. A ruby block wavelength shifter has a coating that passes energy, including the 253.7-nm radiation, and a layer that passes radiation within a bandwidth including the fluorescent emissions. The ruby block absorbs the energy of the 253.7-nm radiation and produces fluorescent emission that passes through the layer. The photomultiplier tube is sensitive to the fluorescent wavelengths to aid in detection. The relatively large coated area provides a wide-aperture, wide-field-of-view detection of the 253.7-nm radiation.

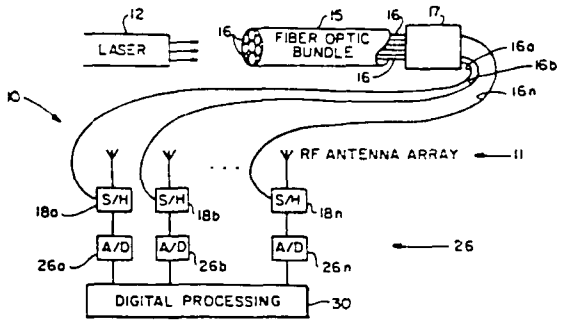


STAGE OF DEVELOPMENT: It would be easy to apply and construct the hardware for application in communications and various optical devices.

HIGH-SPEED OPTICALLY CONTROLLED SAMPLING SYSTEM

Inventors: Harper J. Whitehouse and William H. McKnight
Patent Number 4,546,249; dated 8 October 1985

ABSTRACT: A number of high-frequency signal sources, such as a number of receiving antennas, have their information content extracted by an optoelectronic synchronous sampling system. A laser provides pulses of proper frequency and duration, and feeds them to a fiberoptic bundle. In one embodiment, the fibers are lengthened to be simultaneously actuated. Otherwise, each of the fibers in the bundle has a different length so that light emanating from their distal ends appears as a delayed series of actuating light pulses. Phase shifters, pressure, or electric field effects can effect delay and consequent beamforming. Optoelectronic switches are disposed adjacent the distal ends so that the delayed series of actuating pulses actuates the switches in a synchronous sequence to sample the high-frequency signals received by each of the antennas. Interconnected analog-to-digital and processing circuitry conditions the synchronously received samples for further use. The discrete delays assured by the different lengths of the optical fibers and the opto-electronic switches enable responsive synchronous sampling of the number of high-frequency sources to extract their information content. Neither EMI nor RFI are generated. This can effectively operate in a high-noise environment.



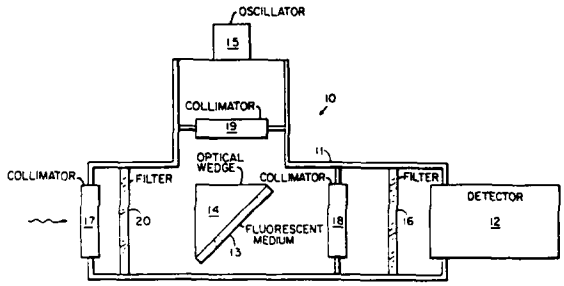
STAGE OF DEVELOPMENT: The method has been conceptually verified and potentially suitable photo-conductor switches have been designed, fabricated, and experimentally characterized. Other high-speed supporting circuitry is in the planning, design and simulation stage. Complete development (including hardware prototyping) at NOSC is currently funded by DARPA.

APPLICATIONS: This invention is especially suitable for High-Frequency Direction Finding (HFDF), but is also very useful in any analog-to-digital conversion or other signal-processing application where high speed (frequency) and high precision (reduced aperture uncertainty or pulse jitter) are needed.

OPTICAL GAIN-CONTROL DEVICE

Inventor: Howard E. Rast
Patent Number: 4,314,743; dated 9 February 1982

ABSTRACT: An optical gain-control device limits the light intensity incident on a photodetector or photomultiplier. A fluorescent medium is interposed between a monitored source of electromagnetic energy and the detector, and is irradiated by a local oscillator. The irradiation is absorbed by the fluorescent material, which undergoes an electronic transition from the ground state to a first excited state. Photons impinging on the fluorescent material from the monitored electromagnetic source cause another transition to a second, more excited state. When the relaxation occurs from the higher state back to the ground, the material fluoresces. Because the magnitude of the local oscillator irradiation is kept within prescribed limits, the number of ions in the fluorescing material that are brought to the first excited state stay within certain limits. Consequently, the impinging monitored electromagnetic energy cannot excite more ions to the second higher state than were irradiated to the first excited state. Thus, high energy bursts of the monitored electromagnetic energy will not be transmitted to the detection device. Including a blocking filter having one passband that directly receives the monitored electromagnetic energy and another filter having a different passband that is located between the fluorescing material and the detection device, the transmission of dangerous levels of electromagnetic energy is further prevented. Protection of the detection device is automatic and does not depend on any mechanical coaction to assure quick response and long-term high reliability.



STAGE OF DEVELOPMENT: The physical principles of the invention have been experimentally demonstrated in the laboratory. Portable hardware has not been constructed.

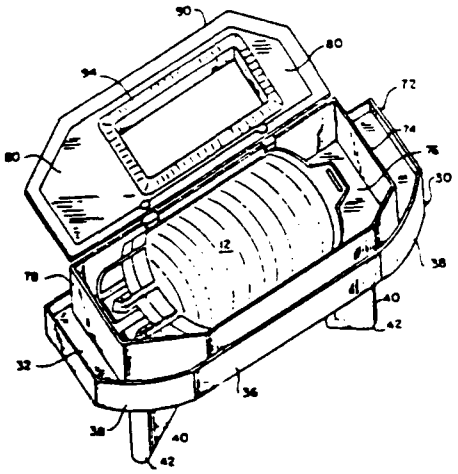
APPLICATIONS: Optical communications, video photography, remote optical sensing, spaceborne surveillance, and observation.

MISCELLANEOUS TECHNOLOGY

SHIELDING APPARATUS FOR MICROWAVE THAWING

Inventors: Nancy L. Campbell, John G. Pinto, John A. Drewe, Patrick D. Hayes, and Robert A. Nelson
Patent Number 4,503,307; dated 5 March 1985

ABSTRACT: A shielding apparatus is provided for containing frozen bags of fluid and, more particularly, for containing frozen bags of blood components during microwave thaw. The apparatus includes a metal box for receiving a blood bag, the box having a bottom and sides. A metallic lid is provided, and a hinging device pivotally mounts the lid to the box for enclosing the blood bag therein. The lid and, optionally, the bottom of the box may be provided with an aperture for allowing microwaves to enter the box. Radiation absorbing strips are mounted along the edges of the apertures for absorbing E-field reflections toward the blood bag. The apertures allow microwave energy to be concentrated in the more voluminous part of the blood bag while the edges of the bag as well as any tubing are shielded by the metallic box. This apparatus prevents boiling of the blood in the lower volume areas of the bag.



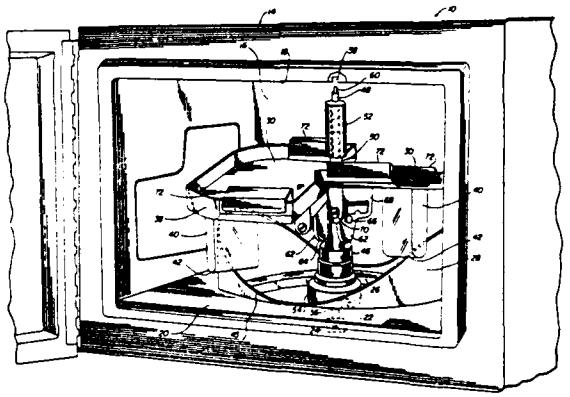
STAGE OF DEVELOPMENT: Several shields have been developed to accommodate different-sized blood bags. Blood components have been successfully thawed by using these shields.

APPLICATIONS: This device may be used to shield specific portions of any item requiring selective microwave exposure.

MICROWAVE APPARATUS FOR HEATING CONTAINED LIQUID

Inventors: Nancy L. Campbell, John G. Pinto, John A. Drewe, Gerald W. Ghing, and Franklin R. Borkat
Patent Number 4,742,202; dated 3 May 1988

ABSTRACT: An apparatus is provided for heating contained liquid, particularly for thawing frozen blood components that are contained in a bag. The heating apparatus includes a microwave oven, with a cavity for receiving objects to be heated. A track, mounted in the oven cavity, has a peak and a valley with respect to the cavity floor. A tray is provided for supporting the liquid container. A device is provided for pivotally supporting the tray within the cavity with the tray in contact with the track means. A device, located within the oven, imparts relative motion between the tray and the track. Thus, the liquid container can be moved in a rocking motion to mix the warm and cold portions of the liquid and, with regard to frozen blood, the thawed liquid portions of the blood will flow over the still-frozen portions so as to dissipate heat therebetween.



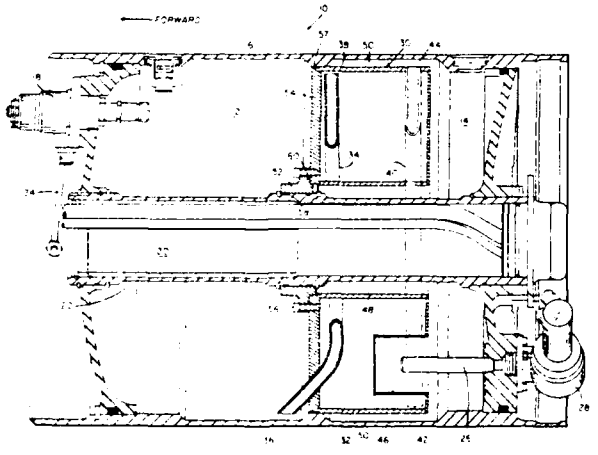
STAGE OF DEVELOPMENT: The apparatus is fully developed and tested. Medical evaluation and ruggedness testing have not yet been performed.

APPLICATIONS: The apparatus has an immediate application in the Navy's blood program and in private blood banks.

ANTI-SLOSH BAFFLE COMPARTMENT ASSEMBLY

Inventors: Edward G. Parks and J. Troncale, Jr.
Patent Number 4,324,272; dated 13 April 1982

ABSTRACT: An anti-slosh fuel compartment assembly is provided for a vehicle wherein the vehicle has a forward gas pressurized fuel compartment and an aft fuel feeding compartment. The anti-slosh fuel compartment assembly includes an intermediate compartment mounted between the forward and aft fuel compartments. A device seals the intermediate compartment to the vehicle so that the forward and aft fuel compartments are sealably separated from one another. An upwardly extending tube is mounted in a forepart of the intermediate compartment with a bottom end of the tube opening into a bottom portion of the forward compartment and a top end opening into a top portion of the intermediate compartment. Another upwardly extending tube is mounted in an after part of the intermediate compartment with a bottom end spaced from the bottom of the intermediate compartment and a top end in communication with the aft compartment so that fuel is communicable from the forward compartment to the aft compartment through the intermediate compartment. Thus, gas is trapped in the intermediate compartment, preventing its travel to the aft compartment even though the vehicle undergoes severe down movement.



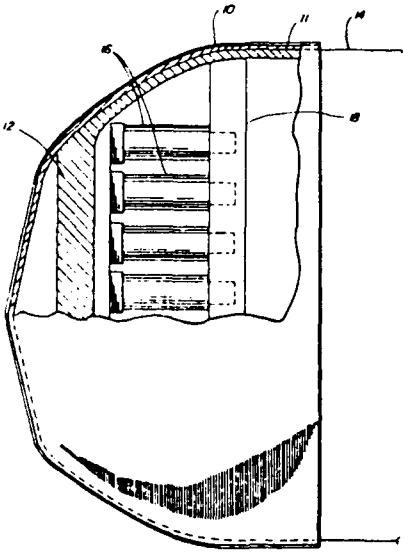
STAGE OF DEVELOPMENT: Development is complete. Production units have been manufactured and used extensively for several years.

APPLICATIONS: Liquid-fuel gas pressurized propulsion systems subjected to severe maneuvering during operation.

COMBINATION FRANGIBLE NOSE CAP EMI SHIELD

Inventor: Harvey J. Klee
Patent Number 4,593,637; dated 10 June 1986

ABSTRACT: An improved frangible nose cap is presented, that, in addition to providing mechanical protection to the torpedo nose, also provides electromagnetic interference (EMI) protection to the torpedo electronics systems. The improved nose cap is made up of a frangible material that may be impregnated or coated by methods well known in the prior art, with a conductive layer that can be electrically connected to the torpedo's electronic circuit ground for the EMI shielding.



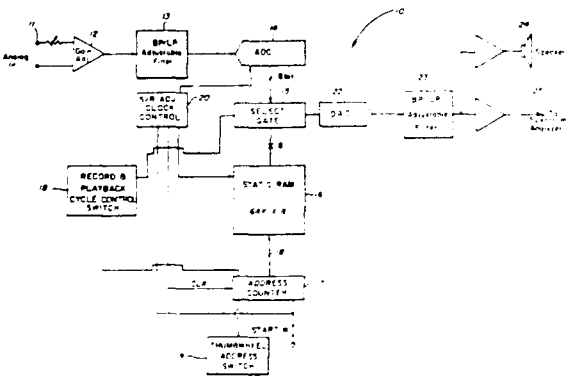
STAGE OF DEVELOPMENT: This technique has been demonstrated during actual water-entry tests for acoustic array protection, and in laboratory tests against electromagnetic interference damage to internal electronics.

APPLICATIONS: This invention has application to all air launched torpedoes or electronic modules.

ACOUSTIC REGENERATOR

Inventor: Robert E. Page
Patent Number 4,759,067; dated 19 July 1988

ABSTRACT: An apparatus for extracting, storing, and repetitively replaying a broadband data sample is fabricated from proven electronic components to assure long-term reliability and reproducibility. A broadband acoustic signal is digitized and stored in a RAM until it is loaded with the desired signal. An adjustable clock controls the rate at which the stored signal is loaded and repetitively displayed so that its spectrum and characteristics can be fully analyzed. Appropriate filters are provided on the input and output sides to block incoming signals outside of the range of interest and those signal components attributed to the variable clock. Selection of particular portions of the stored desired signal may be addressed for detailed analysis on a repetitive basis if needed. Thus, any portion of a continuous broadband acoustic signal may be selected for storing and repetitive cycle analyses without introducing distortion that might otherwise be attributed to conventional approaches relying upon mechanical reproduction and recycling devices.



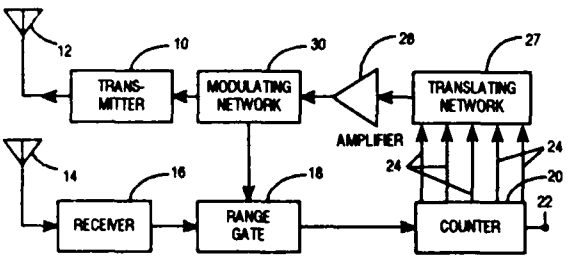
STAGE OF DEVELOPMENT: A prototype, constructed in 1986, was used for dissection of data taken off tape. By choosing a portion of information from the tape, storing it in RAM and looping, jockeying the tape back and forth to look at the data was no longer necessary. The start/stop times were always exact with no overlap. This gave us a tremendous advantage in accuracy and time saving.

APPLICATIONS: This device has applications in speech, music, sonar, and data even beyond the human sound range, speech synthesis and speech-recognition analysis, audio crypto systems, and even music development. Once the information is stored in RAM (memory), every sample of data can be accessed (addressed) and controlled. For example, data can be stored and then played back in any order; reversed, segmented, and translated.

TARGET DETECTING DEVICE WITH IMPROVED COUNTER-COUNTERMEASURES CAPABILITY

Inventors: Robert A. Creighton and Stephen M. Engel
Patent Number 4,323,897; dated 6 April 1982

ABSTRACT: A system, which in response to a received signal, alters the transmit characteristics in a manner that cannot be predicted by any enemy attempting to jam the target detecting device and has no effect on the inherent probability of detecting a target. Any signal passed by the threshold of the receiver is processed and fed to the pulse-repetition-frequency generator and will randomly change the pulse-repetition frequency of the transmitted signal.



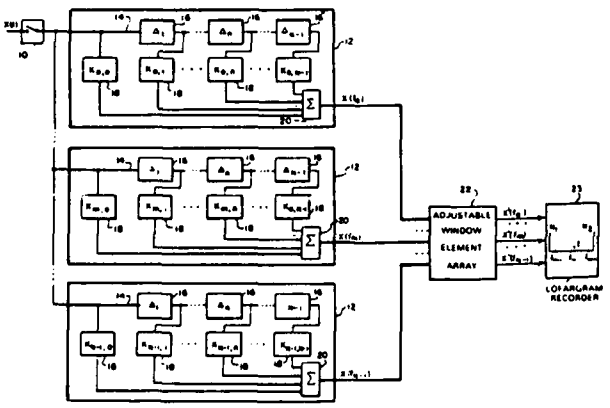
STAGE OF DEVELOPMENT: Circuit design in 1970 along with the patent application.

APPLICATIONS: Military use to provide immunity to pulse capture-type countermeasures emitters.

FAST-FOURIER TRANSFORM SPECTRAL ANALYSIS SYSTEM EMPLOYING ADAPTIVE WINDOW

Inventor: John E. Timm
Patent Number 4,231,103; dated 28 October 1980

ABSTRACT: A spectral analysis system includes a Fast-Fourier Transform (FFT) processor that receives a time-domain signal and provides a specified number of initial signal-strength estimates. Each of the initial estimates is equal to one of the frequency-domain coefficients of the Fast-Fourier Transform of the time-domain signal that is generated when the time-domain signal is sampled at a number of intervals equal to the number of initial estimates over a time period of specified duration. The system further includes an adjustable window element receiving a selected number of the initial estimates for sensing or detecting the presence of a leakage component in a given one of the initial estimates, and for providing an adjusted signal-strength estimate, the adjusted signal-strength estimate comprising the difference between the given initial estimate and the leakage component. A spectral recorder receiving a number of adjusted estimates is provided to record the spectral lines, or frequency components, of the time-domain signal, and the relative strengths thereof.



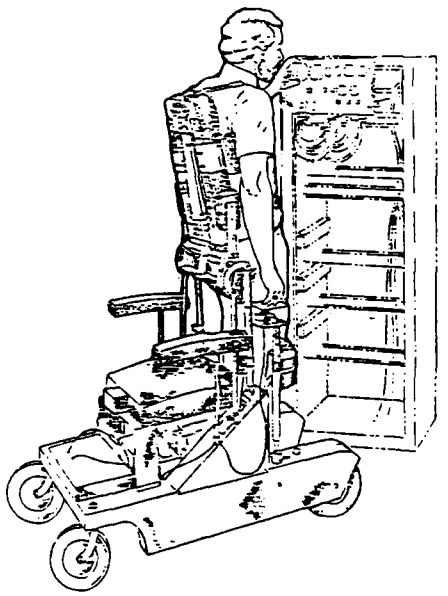
STAGE OF DEVELOPMENT: The method has been mathematically verified.

APPLICATIONS: The method has applications in spectral analysis and signal detection.

STAND-AID INVALID WHEELCHAIR

Inventors: Robert K. Fogg, Jr., and Christopher P. Staehli
Patent Number 4,054,319; dated 18 October 1987

ABSTRACT: A wheelchair is designed to enable an invalid to stand, sit, or choose at will any intermediate position to perform useful work, and to move about in any of said positions. The wheelchair helps to fulfill the psychological and physiological needs of handicapped persons. The lifting and lowering operations are so arranged that practically no dislocation of the invalid's clothes occurs during the operations. The wheelchair has a minimum of physical encumbrances permitting the invalid to function near normally in average living or working spaces.



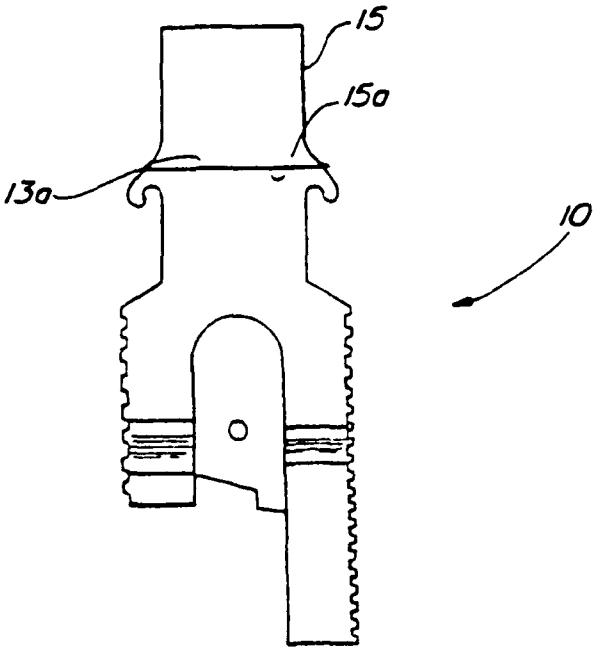
STAGE OF DEVELOPMENT: The design has been completed and a prototype chair has been fabricated and tested.

APPLICATIONS: This wheelchair could prove useful to most physically disabled (paraplegic) persons by providing them with mobility and the ability to stand without assistance from others.

METAL MATRIX COMPOSITE PISTON HEAD AND METHOD OF FABRICATION

Inventor: David M. Bullat
Patent Number 4,706,550; dated 17 November 1987

ABSTRACT: An aluminum torpedo piston is provided with a piston head fabricated from a metal-matrix composite material composed of aluminum and silicon carbide fibers that are integrally joined by an inertial welding technique. A 23-percent weight of silicon carbide fibers to powdered aluminum was selected. Resistance to intense heating, which would otherwise cause melting and erosion of the piston, is avoided to permit longer, high-speed runs.



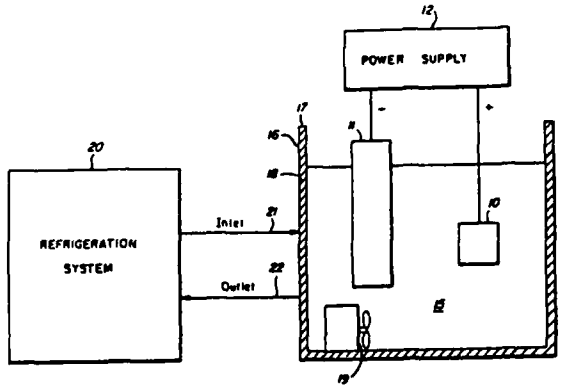
STAGE OF DEVELOPMENT: The concept has been demonstrated by fabrication and testing in a hot gas engine.

APPLICATIONS: This method has application in any piston-driven engine.

ANODIC COATING WITH ENHANCED THERMAL CONDUCTIVITY

Inventor: Thomas R. Ogden
Patent Number 4,822,458; dated 18 April 1989

ABSTRACT: A method of and apparatus for anodization uses an electrolyte consisting of 1.0 percent by weight of aqueous solution of oxalic acid, an anodization temperature in the range of 0° to 5°C, and an anodization voltage starting at 100 volts and progressing to 300 volts after 90 minutes at an anodization current density of 2 to 3 amperes per decimeter^2 to provide a 30- to 40-micrometer thickness having a thermal conductivity of 1.3 Watt/meter/°C.



STAGE OF DEVELOPMENT: The thermal conductivity results have been experimentally verified.

APPLICATIONS: This process has applications in the manufacture of high-efficiency heat exchangers and electronic circuit boards.

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