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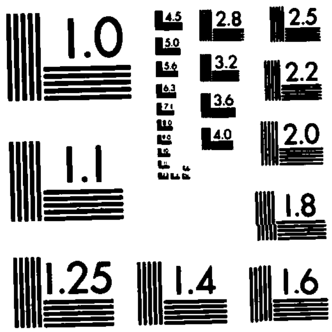

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RESEARCH AND DEVELOPMENT TECHNICAL REPORT

CECOM-82-4

AD A123509

FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

VOLUME 1, NUMBER 1

ROY E. GORDON

MICHAEL C. SACHS

DECEMBER 1982

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Laser	Timing	Radiation Detection
Modem	Multipactor	Fuel Cells

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Technical Disclosure Bulletin is intended as a vehicle for publicizing inventions for which a patent application will not be filed. It contains fact sheets and sketches of a number of innovations developed at Fort Monmouth or under contract with various companies, from the time period of December 1978 to August 1980.

FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

Volume 1, Number 1; December 1982

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PREFACE

FORT MONMOUTH TECHNICAL DISCLOSURE BULLETIN

The following inventions have been generated by the scientific and technical personnel of the U.S. Army, Fort Monmouth, New Jersey and by personnel of companies under research and development contracts with Fort Monmouth. The purpose of the bulletin is to disclose inventions for which the filing of patent applications is not planned, and which otherwise would remain unpublicized.

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December, 1982

Chief, Patent Prosecution
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MODEM EMPLOYING SPECTRUM CONTROL

by F.A. Wissel and D.A. Kiliman, D-1949

In communication systems where bandwidth is at a premium, as where use of closely packed channels may occur for instance, maximization of energy transfer is of great importance. A modem has been proposed which will optimally contain the energy spectrum to available bandwidth by minimizing the out-of-band energy. The principle of operation for the modem is a method of replacing the waveform edges of the digital signals transferred with fractions of sinusoidal waveforms. In this way the rising edge of a digital "one" is replaced by a positive sine while the falling edge is replaced by a positive cosine. Similarly, the edges of a digital zero are replaced by negative sine and cosine. These waveforms are normally timed so that the sum $I^2 + Q^2$ is a constant (where I and Q respectively are the "in phase" and "quadrature phase" modulated components). This insures a constant envelope output and the spectral containment is both originally achieved and maintained in an efficient, simple, and practical overall system design. Such would allow maximization of the in-band to out-of-band energy ratio without creating intersymbol interference, and still allows synthesis of a constant envelope signal. The concept of utilizing fractions of sinusoids is believed to represent a novel approach.

Previous methods of maximizing energy transfer in a modem had disadvantages which involved filtering digital waveshapes to eliminate sharp edges (rise and fall times) to reduce out-of-band energy created by the high frequency edge components. Such filtering was either applied to the baseband pre-modulation circuitry or to the modulated carrier signal. However, this filtering has two basic disadvantages, one of which is unique to Offset QPSK modulation. The more typical infinite impulse response (IIR) design produces delay distortion (versus frequency) which contributes to intersymbol interference and subsequently to poorer data error rate. Another problem results from the desirability of preserving a constant total envelope power (versus time) due to summation of the two quadrature relative contributing components. If this goal is achieved, the filtered modulated signal can be processed through simple, efficient, non-linear amplifiers without reintroduction of undesired spectral components. There are a limited number of step responses for the two quadrature channels that meet this criterion. These responses may not be practically obtained by filtering techniques, but can be obtained by the methods proposed in this discussion. A block diagram of an AQPSK modulator for this modem, and its timing and waveshape diagram appear in Figures 1-2.

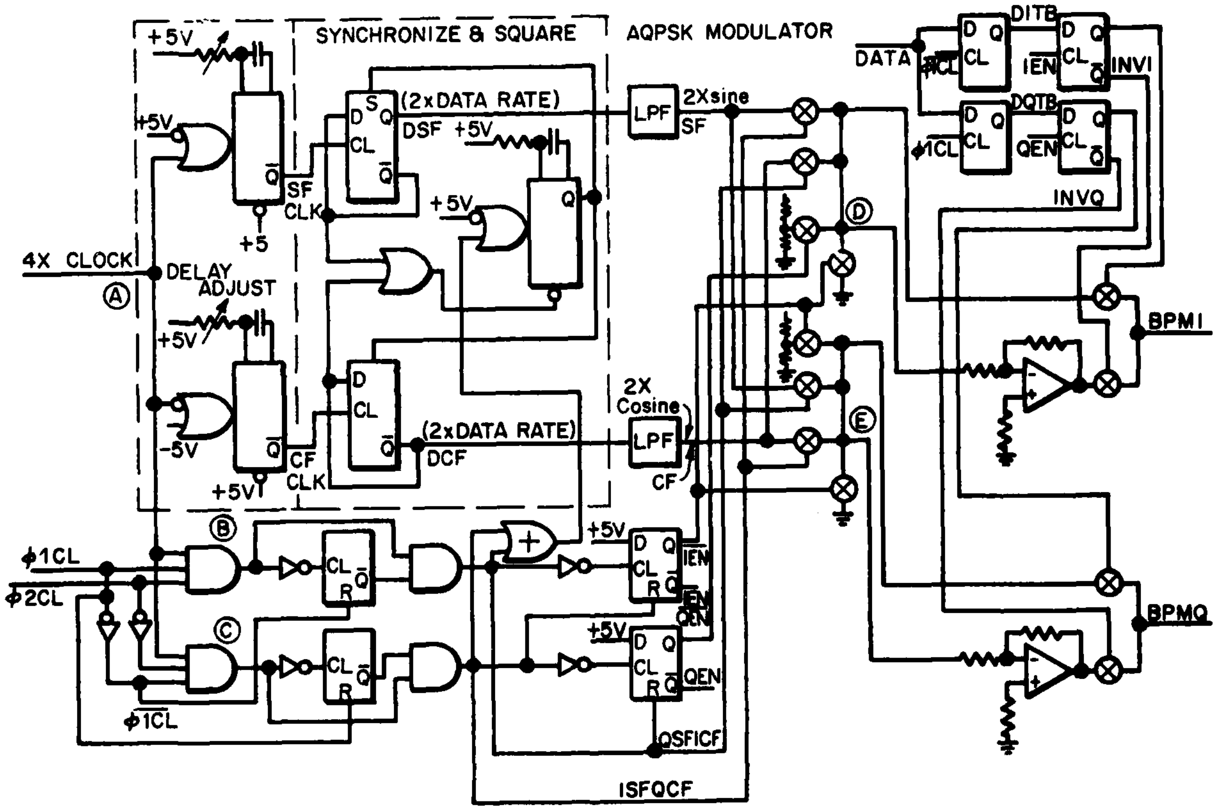
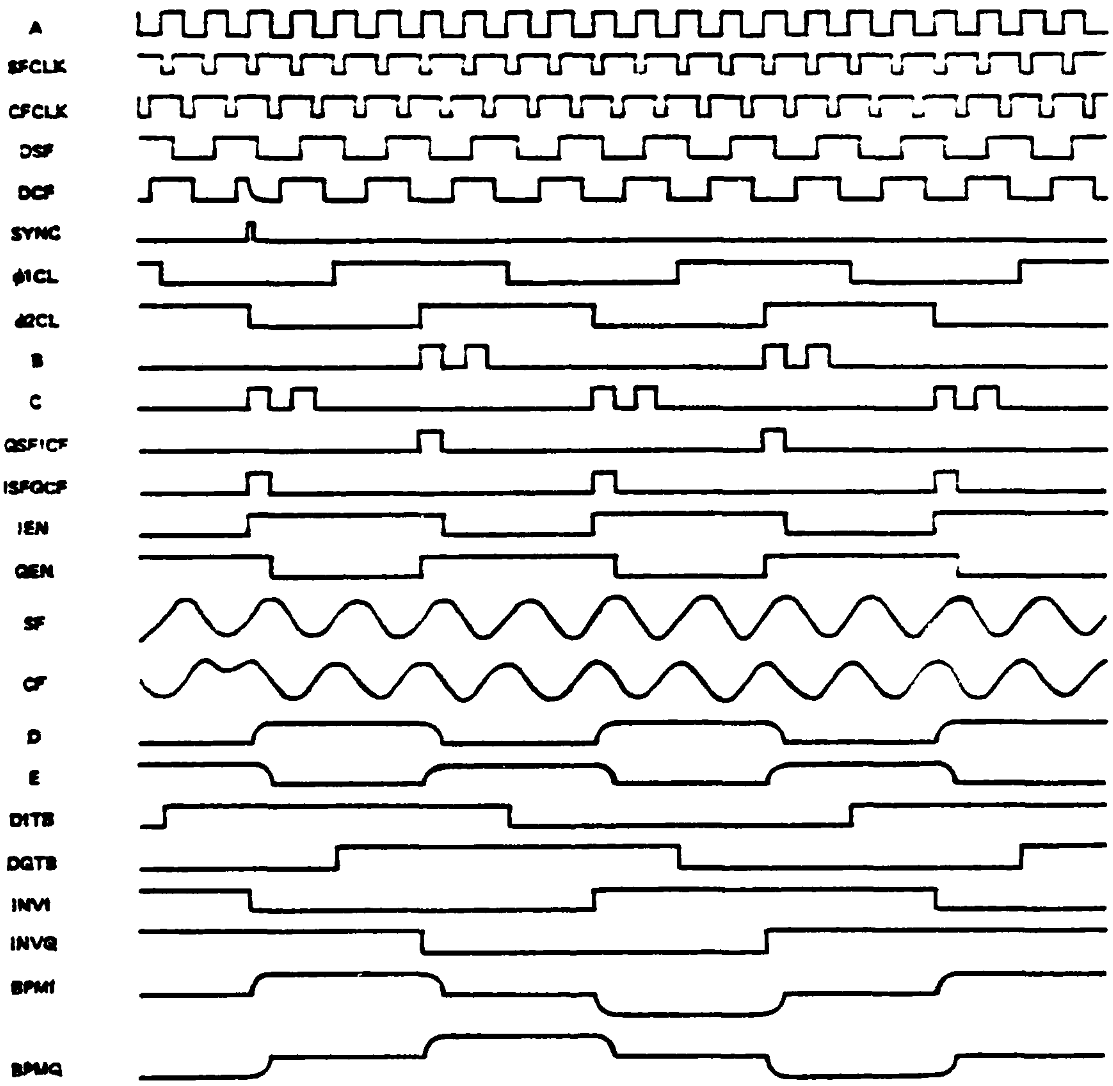


FIGURE 1. MODULATOR BLOCK DIAGRAM



AQPSK MODULATOR TIMING

FIGURE 2. MODULATOR TIMING DIAGRAM

TIMING MAINTENANCE FOR LONG RADIO FADES

by I. Havel and
J. Hackendorf, D-2030

In digital communications systems subject to random (fade) or periodic interruptions, bit count integrity (BCI) must be assured by timing maintenance, otherwise a loss of bit count integrity would result in an extended system outage while multiplexers re-frame and crypto units re-synchronize following a fade. The conventional timing maintenance method is to use a phase locked loop which is operated open loop during fades. This method enables recovery from phase errors of many cycles without losing BCI. A framing bit in the multiplexed data stream provides a phase reference at a rate much lower than the bit rate. By monitoring the position of the frame bit after the fade, the number of bit cycles which were slipped during the fade can be determined,and the loop allowed to restore the slipped clock cycles. This principle can be used with any digital signal containing regularly spaced synchronization bits or characters or else additional synchronization bits can be added.

The Figure shows a receiver modified to maintain timing through long fades without losing bit count integrity. An incoming signal is detected and written into a RAM buffer with recovered timing. A WRITE ADDRESS counter is reset to address zero each time the frame bit occurs in the data bit stream (e.g. every 64 data bits with an eight bit buffer). Buffer size (modulus of the address counters) must be equal to frame length or be evenly divisible thereto. Data is read out of the RAM buffer with the clock generated by the timing maintenance phase locked loop. The loop is locked with the buffer half full. The voltage controlled oscillator (VCO) control voltage is ac/dc converted and stored digitally in a continuously clocked latch. When a fade is detected, the latch clock is inhibited and the VCO frequency is held at the last value stored before the fade. After the fade is over, the latch clock remains inhibited until after frame sync has been established and the frame pulses have reset the WRITE ADDRESS counter. The loop then adjusts its frequency t correct the phase difference between the READ and WRITE count and restore any cycles slipped during the fade. In this eigh bit buffer, ± 4 cycles can be slipped without losing BCI. With a 1.0 ppm frequency error during the fade, BCI can be maintained for 200 millisecond fades. Increasing the buffer size (up to a maximum of the frame length) will increase the timing maintenance period proportionally. This invention can be used on DGM cable modems to maintain BCI for some 560 milliseconds and 8 seconds, e.g. Applications are possible in troposcatter radio modems or in burst communications systems. A variation of this idea can be used to maintain bit timing from burst-to-burst in a time division demodulator.

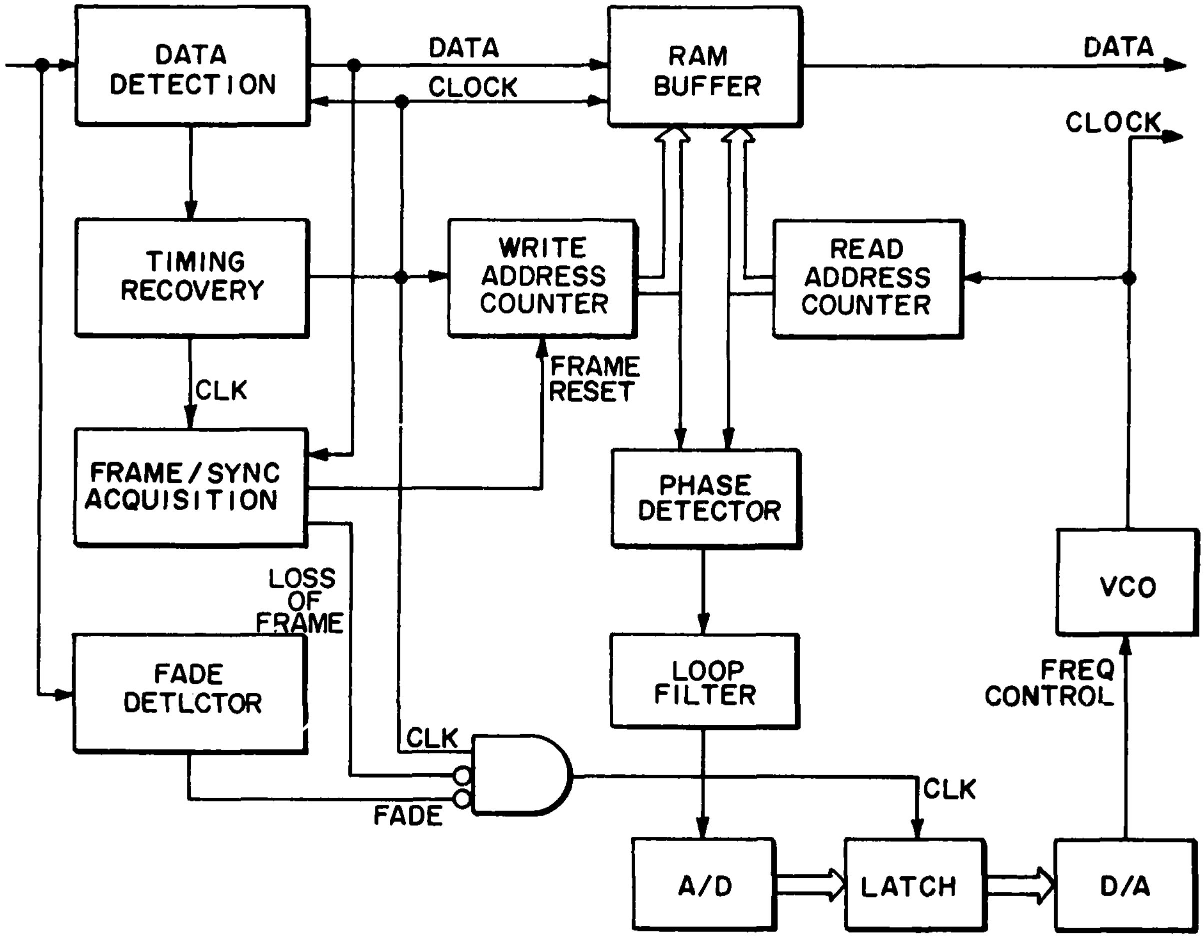


FIGURE 1. MODIFIED RECEIVER

THIN FILM ELECTROLUMINESCENT DISPLAY

Panel by Z. Kun, D. Leksell, F. Kuo,
J. Murphy, D-2172

Thin film electroluminescent panel displays are commonly comprised of display elements which are addressed by means of intersecting horizontal and vertical bus bars, however, such devices have serious addressing limitations. In the described invention, an active rather than passive addressing scheme is employed to improve addressing. Each element in an array incorporates a light emitting storage capacitor as a memory, and a pair of thin film transistors with which the capacitor can be controlled. The procedure for depositing an electroluminescent structure on top of a thin film transistor (TFT) circuit array results in a spot brightness of approximately 100 foot-lamberts with an ac excitation voltage of approximately 75 volts rms, within capabilities of the TFTs to withstand the resulting dc voltages that develop when the transistors are in off condition. One method of combining TFTs with a thin film electroluminescent (TFEL) display is to deposit the TFEL structure on a glass substrate that already has the TFT circuits on it. Another is to deposit the TFEL structure on a glass substrate that is covered with a transparent electrode. The TFT circuits are then fabricated on top of the TFEL structure. In the former method, one restriction that presence of the TFT circuits impose upon the fabrication technique of TFEL structures is that the circuits should never be exposed to see temperatures exceeding approximately 300°C, such as in post zinc sulfide deposition annealing, e.g.; higher temperatures would likely damage the semiconductor. The TFEL device should operate at a low enough voltage which will not exceed the capabilities of the TFT devices. The TFT device must be capable of withstanding twice the full peak ac voltage applied to the display because of charging in the TFEL capacitor when the transistors are switched off. Also, another important consideration is that the ac required to drive the TFEL must be electrically isolated from the TFT gates so as not to turn them on inadvertently. Isolation is also required in order to minimize total capacitive current. It is possible to lower the gate drive and voltage requirements by shunting the TFT by a hybrid capacitor, not thin-film, if its value is high relative to TFEL capacitance. The cell configuration described has been successfully used in TFT matrix displays using powdered phosphors,and liquid crystals using sophisticated fabrication techniques.

Figure #1 shows a TFEL structure cross section which consists of two 2000 Å thick yttrium oxide layers. Sandwiched between them is a 4000 Å thick ZnS:Mn:C layer. When the yttrium oxide is deposited the oxygen is shut off during the deposition of 200 Å thick layers immediately adjacent to both sides of the zinc sulfide. Aluminum electrodes, identical to those in the TFT circuits, are deposited upon the TFEL structure; these electrodes are registered to the electrodes pad in the TFT circuits. Next, a photoresist layer is laminated over the active area (ZnS covered area of the panel) and via holes etched in it, is registered to the electrode pads. Finally, a 5000 Å thick aluminum layer is deposited over the whole photoresist to make electrical contact to the aluminum pads on the top of the TFEL structure through the holes.

Shown therefore is means of fabricating a thin addressable display panel on a glass substrate that incorporates a thin film transistor circuit to excite a two dimensional array of electroluminescent dots, the brightness of each dot being individually controlled by external signals applied to the control electrodes. Isolation between the TFT circuit source for the TFEL is obtained, wherever the panel is to remain inactive, by interposing a thick layer of an insulator between the last yttrium oxide layer of electroluminescent structure, and the heavy back electrode that is connected to the TFEL excitation source. This, in effect, puts small capacitance in series with the TFEL at those places, thereby reducing the voltage across the TFEL structure. The very steep brightness voltage characteristic of the TFEL results in permanently inactive regions being those at which the thick insulator has been removed, allowing the heavy back electrode to make contact with the top yttrium oxide layer of the TFEL structure. The holes in the thick insulator are placed so as to be aligned with conducting pads that are a part of the underlying thin film transistor circuit. Light is generated in the TFEL structure only in the vicinity of the holes in the heavy insulator.

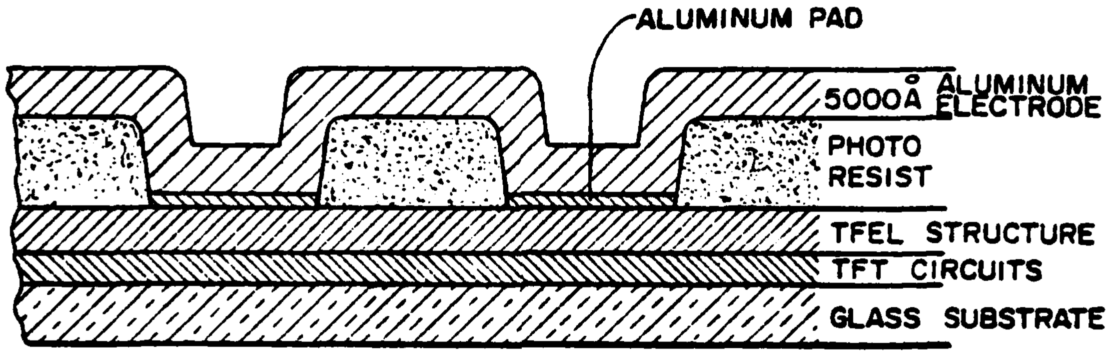


FIGURE 1. TFEL STRUCTURE

MULTIPACTOR DRIVEN INJECTION LASER

by Charles M. DeSantis and Joseph D. Evankow, D-2281

A technique is disclosed which allows extremely fast modulation of light for fiber optic communications, communication systems and target acquisition (CS-TA), and in general, for radio frequency (RF) energy converted to light energy. In CS-TA field units, such new biasing mechanisms could accomplish improved resolution of a target image. As shown in Figure 1, an injection laser A may be placed between two plates in an evacuated area, and a space charge cloud caused by a multipactor may be made to move between the plates. Window E allows modulated light to escape. An electron space charge cloud, which may be formed by thermionic or nuclear emission, moves vertically in either direction between the plates and when moving past the injection laser, a forward bias condition will exist and lasing will result. By adding semiconductor material of a high secondary emission ratio, the multipactor can be initiated at lower power input levels. The semiconductor layers may be formed by epitaxial methods. Cavity size is made proportionally smaller with frequency; epitaxial methods are among the best choices for fabrication. The ratio of secondary emission which is present may be controlled by a dc bias applied at a lower layer A', thus allowing varied power input and maintenance of constant electron emission by a controlling of the rate of emission through biasing. The semiconductor might also be located outside the vacuum chamber, as in Figure 2, thus eliminating the problem, at higher frequencies, of placing lasers in the vacuum. It is well to forward bias the laser for increased sensitivity if voltage swing caused by the multipactor proves insufficient.

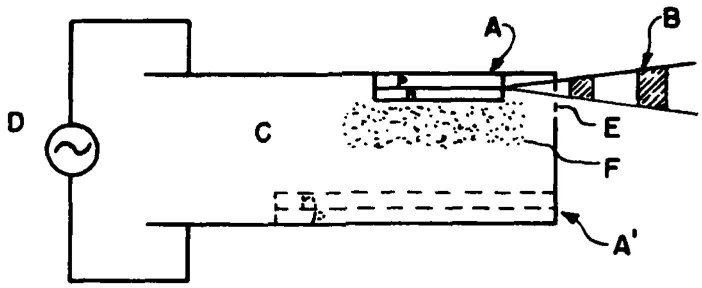


FIGURE 1. MULTIPACTOR LASER

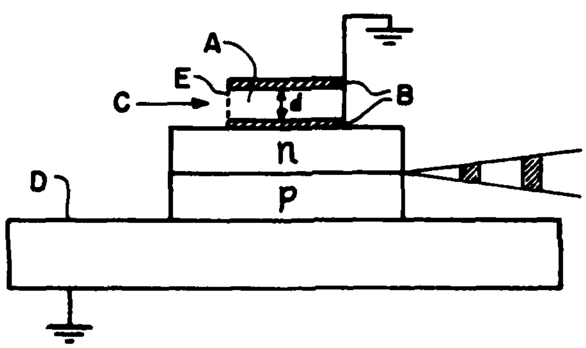


FIGURE 2. MULTIPACTOR LASER-
EXTERNAL SEMICONDUCTOR

TRANSPARENT ELECTRODE FOR LONG-LIFE ELECTROLUMINESCENT PHOSPHOR LAMPS

by J.X. Przybysz, D-2267

The invention is a vacuum-evaporated transparent electrode for electroluminescent phosphor lamps. The device is particularly well-suited to application with flat panel electroluminescent displays of the thin film transistor(TFT)-addressed design. The electrode is composed of layers of CdF_2 and Au. This new composition is chemically compatible with the CdS-ZnS powder phosphor and results in longer life for the phosphor lamp than previous electrodes.

The beneficial effect of the new composition results from increased chemical compatibility between the electrode and the powder phosphor. The ZnS/Cds powder phosphor is known to be extremely sensitive to its chemical environment. Moisture is very detrimental to long life, and lead oxides can be suspected as well. With standard heats of formation for PbO=-52, CdS=-34, and ZnS=-48 kcal/mole, these basic components of the system are energetically unstable against formation of $PbSO_4$=-219, $PbSO_4 \cdot 3PbO$ = -403, $ZnSO_4$ = -234, and $CdSO_4$=-221 kcal/mole. The new dielectric, CdF_2, with heat of formation -165 kcal/mole is inherently more stable and also less chemically reactive with CdS and ZnS.

In these applications using electroluminescent phosphors, the lamp is constructed by embedding powder phosphor particles in a plastic binder. The thin layer of phosphor/binder (~1 mil) is sandwiched between two conducting electrodes. The phosphor is excited by the application of an alternating voltage to the electrodes. Because powder phosphors are used in flat panel TFT-addressed displays, the lamps are constructed by putting an opaque metal electrode on a glass substrate and applying the phosphor/binder mix to this electrode. A transparent top electrode is then evaporated on top of the plastic binder. The top electrode consists of 50Å of an insulating dielectric CdF_2, followed by 75Å of a thin transparent, conducting gold film. The dielectric film is necessary to obtain good adhesion of metal film to the thermoplastic binder.

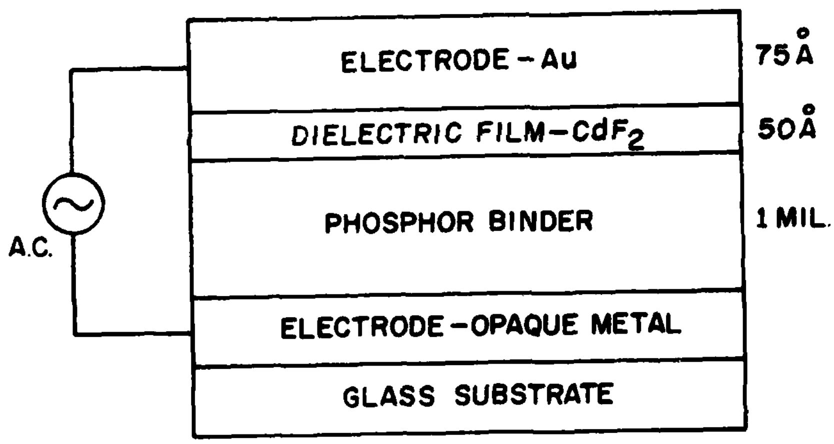


FIGURE 1. TFT-ADDRESSED DISPLAY LAMP

METHOD FOR RAPID START OF HYDROGEN DESORPTION FROM Mg-ALLOY GRAPHITE HYDROGEN STORAGE MODULES

by Frederick Rothwarf, D-1998

A method is provided for the rapid desorption of hydrogen from Mg-alloy graphite storage modules. The method is useful in combustion engines, fuel cells, and other devices using hydrogen fuel. According to the method, heat is rapidly introduced into the modules so as to effect the rapid and continuous desorption of hydrogen for use as a fuel or in other applications requiring a continuous flow of hydrogen.

More specifically, the invention encompasses first the fabrication of Mg-alloy graphite composites in the form of long rods of circular or rectangular cross-section. The rods are then assembled parallel to one another in an array such that each rod is electrically insulated from its neighbors by thin sheets of some dielectric material, such as teflon or alumina. Such an array constitutes one hydrogen storage module. The fuel tank of an automobile for example, using hydrogen as a fuel consists of several such modules enclosed in a suitable pressure tight container. The ends of the rods in a given array are electrically connected in a series-parallel arrangement so that when a switch connecting the array to a battery is closed, a suitable electric current flows through the rod elements causing a rapid I^2R heating to a temperature sufficient to desorb hydrogen from the rods at a useful pressure. Provision is made to switch a new module into operation when a given module is depleted of its hydrogen.

The pressure tight module container is fitted with suitable gas flow regulating valves, piping for leading the hydrogen gas to the automobile engine or device active combustion chamber, and finally with heat exchanges for using the exhaust heat from the engine or device to assist in supplying the heat of desorption to the hydrogen module.

The foregoing description illustrates how one can make use of the unique structural integrity of Mg/graphite composites on hydriding to design modules that can be rapidly desorbed by electrical heating to provide quick starting, hydrogen-fueled devices. Probable uses include the convenient start-up of automobiles, fuel cells, home heating systems and other devices which will employ hydrogen as a fuel.

The advantage of the invention stems from the fact that Mg-alloy graphite composites maintain their structural integrity after many hydriding/dehydriding cycles. Because a solid has two orders of magnitude better heat diffusivity than does a powder, it is possible to more efficiently introduce heat into such Mg/graphite composite storage modules than would be the case for the powdered hydride materials, FeTi, $LaNi_5$ and $CaNi_5$, which constitute the hydrogen storage beds being tried for automotive and heat pump application.

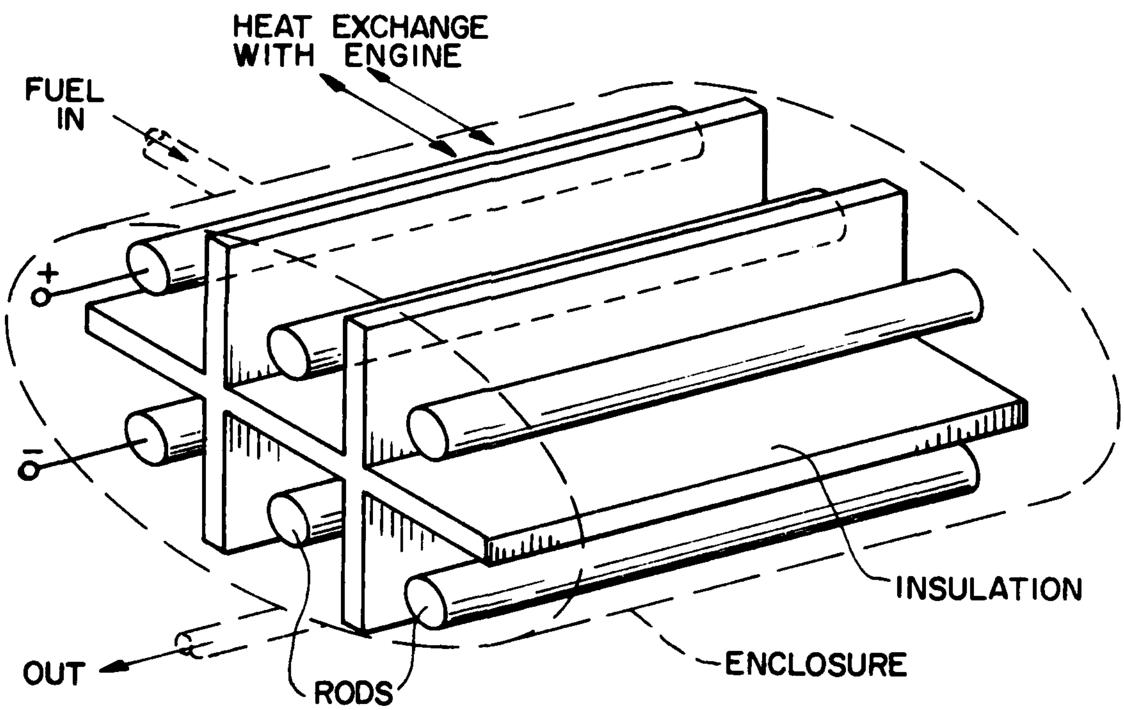


FIGURE 1. HYDROGEN STORAGE MODULE

ENRICHED CADMIUM TELLURIDE CRYSTALS FOR RADIATION DETECTION

by Louis E. Branovich, Willis M. Smith, Stanley DuBuske, Adolph Hagar and Gerard L. Freeman, D-2045

A combination of cadmium telluride crystals depleted in cadmium isotope-113, and cadmium telluride crystals enriched in cadmium isotope-113, is used to accurately detect thermal neutrons, gamma, and beta radiation in a thermal neutron environment. The term depleted refers to a cadmium telluride crystal that has no, or very little, cadmium isotope-113 in it. The term enriched refers to a cadmium telluride crystal that has an atom percent of cadmium isotope-113 greater than that which occurs in nature (12.27 atom percent to 100.00 atoms percent).

In the aforedescribed combination, the depleted cadmium telluride crystals are found to be excellent gamma detectors in thermal neutron environments. The enriched cadmium telluride crystals prove to be excellent thermal neutron detectors, and possess greater sensitivity to neutron radiation when compared to the natural cadmium telluride crystal detector. The following reaction may be used as an illustration:

$$_{48}Cd^{113} + {}_{0}n^{1} \longrightarrow {}_{48}Cd^{114} + \gamma$$

It may be seen that neutron bombardment of cadmium 113 yields X-rays, in addition to cadmium 114, which rays would register during gamma ray readings and result in erroneously high measurments. However, other non-113 cadmium isotopes do not cause this problem. Removal of cadmium 113 therefore, would yield more accurate readings of neutrons. The invention, therefore, comprises use of cadmium telluride crystals depleted of cadmium 113 for certain purposes, and enriched in cadmium 113 for other uses. Enriched cadmium 113 compositions for example, would last longer and be more efficient in thermal neutron environments. Depleted cadmium 113 compositions would give accurate results in the detection of gamma radiation in the presence of thermal neutrons.

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