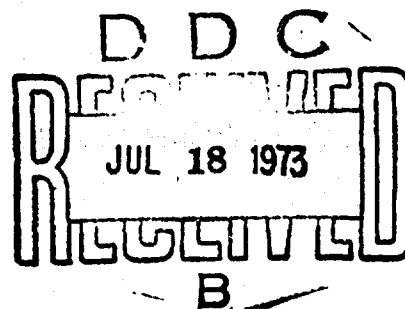


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Requests from persons inside NWC for retention copies of official publications listed herein should be submitted to Code 7506 in writing over the signature of a branch head or higher. Loan copies are available from the Technical Library, China Lake (Code 753). Requests originating outside NWC should be addressed to Commander (Code 7506), Naval Weapons Center, China Lake, CA 93555, or to the National Technical Information Service, Operations Division, Springfield, VA 22151.

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Copies of NWC patents are accessible for reading in the Office of Patent Counsel (Code 95); or they may be purchased from the U.S. Patent Office, Washington, DC 20231.

Published by the Publishing Division, Technical Information Department; first printing 1,045 copies.

## PREFACE

This booklet has been prepared by the Technical Information Department. It lists titles and abstracts of unrestricted publications written by employees of the Naval Weapons Center that were issued during 1972. The listing includes official publications, professional papers published in the open literature, and U.S. patents. Editions of this booklet previous to 1970 listed official publications released to the National Technical Information Service. Official publications were omitted from the 1970 and 1971 editions because of changes in distribution policies within the Department of Defense. The official publication listing is resumed in this 1972 edition.

The official publications are listed by series number (NWC TP); the professional papers are listed alphabetically by first author; and the patents by U.S. Patent Number. An author index appears at the end.

Part 2 of the *Naval Weapons Center Technical History 1972* (NWC TP 5442, Part 2) records all the technical publications of this Center issued during the year. In addition to the listing herein, it includes official publications of limited distribution, technical motion pictures, and Navy patent cases under secrecy order. These are available to persons with established need-to-know through the channels for classified information.

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Released by  
C. E. VAN HAGAN, *Head,*  
*Technical Information*  
*Department*  
1 April 1973

Under authority of  
H. G. WILSON  
*Technical Director*

## OFFICIAL PUBLICATIONS

### NWC Technical Publication 5124

*Analysis of a Discrete Matrix Riccati Equation of Linear Control and Kalman Filtering*, by G. A. Hewer. China Lake, Calif., NWC, December 1971. 14 pp. Publication UNCLASSIFIED.

A characterization of the interrelationship between the recursive Riccati difference equation and its steady-state form is developed via the method of quasi-linearization. Not only does this approach unify the discussion, but also strengthens known results. In addition, this method yields an algorithm for computing the solution of the steady-state equation.

### NWC Technical Publication 5180

*FORTRAN Programs to Solve the Steady-State Matrix Riccati Equations Arising in Kalman Filtering Theory*, by L. W. Lucas and G. A. Hewer. China Lake, Calif., NWC, December 1971. 52 pp. Publication UNCLASSIFIED.

This report describes a package of FORTRAN programs to solve the continuous and discrete matrix Riccati equations which arise in optimal filtering theory. A quasi-linearization algorithm is employed which is quadratically convergent.

**NWC Technical Publication 5206, Revision 1**

*Longitudinal Mode Acoustic Losses in Short Nozzles, Revision 1*, by Ben T. Zinn. China Lake, Calif., NWC, June 1972. 22 pp. Publication UNCLASSIFIED.

This paper is a professorial treatise concerning acoustic damping by a "short nozzle". It is for the most part not original but is written in such a manner that it can be read by an engineer without need to resort to the plethora of more sophisticated analyses available in the literature.

**NWC Technical Publication 5244**

*A Technique for Determining the Modes of Response of a Beam Using Quasi-Stationary Random Forcing Function Inputs*, by Robert G. Christiansen and Wallace W. Parmenter. China Lake, Calif., NWC, December 1971. 54 pp. Publication UNCLASSIFIED.

A slender beam is subjected to random vibration. The modes of response of the beam are determined using spectral analysis techniques made available by the NWC spectral analysis computer program.

**NWC Technical Publication 5294**

*A Solution of the Spherical Diffusion Equation and its Application to Nucleating Particle Lifetimes*, by R. J. Stirton. China Lake, Calif., NWC, January 1972. 26 pp. Publication UNCLASSIFIED.

The dissolution of a spherical particle in a spherical water drop is governed by the radial diffusion equation provided the predominate transport process is diffusion. The boundary conditions are (1) no flow through the water-drop surface and (2) a saturated solution of the particle material at the particle-water interface. The initial condition is an arbitrary radial distribution of concentration. Since the particle radius is shrinking, the inner boundary condition is time dependent. However, instead of attempting the solution with a moving boundary, the concept of a fixed, effective particle radius is introduced. With these boundary and

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Initial conditions, an infinite series solution to the diffusion equation is found by the Laplace transform technique. The particle lifetime is found by using this solution of the diffusion equation to determine the time at which the particle has just completely dissolved. Curves of lifetimes as functions of solubility and particle and drop radii are given.

### NWC Technical Publication 5297

*Project Foggy Cloud III, Phase I*, by Tommy L. Wright, Richard S. Clark, and Pierre St.-Amand. China Lake, Calif., NWC, April 1972. 68 pp. Publication UNCLASSIFIED.

Foggy Cloud III, Phase I is part of a continuing series of experiments concerning the modification and dispersal of warm fog and stratus clouds. Tests were conducted at the Arcata-Eureka Airport, Humboldt County, Calif. from 27 July to 24 October 1970, using fixed-wing aircraft as delivery vehicles. The seeding agents were (1) a solution of ammonium nitrate, urea, and water developed during Foggy Cloud I, and (2) water.

Of the 19 seeding tests, 17 showed some response to seeding. The results of seeding seven fogs classified as steady-state were completely successful, with ceilings and visibilities improved sufficiently to permit normal flight operations.

### NWC Technical Publication 5303

*The Formation of Secondary Defects in Face-Centred Cubic Metals*, by K. H. Westmacott. China Lake, Calif., NWC, February 1972. 6 pp. (A reprint from PHIL MAG, Vol. 24, No. 188, August 1971.) Publication UNCLASSIFIED.

The formation of secondary defects by quenching has been studied in Ag and Cu of several different purities. It is shown implicitly that the mobility of vacancies and formation of visible defects are strongly dependent on the concentration of residual oxygen in the materials. An estimate of the  $O_2$ /vacancy binding energy in copper is obtained, and the implications of the results on previous experiments performed on less pure materials are briefly discussed.

### NWC Technical Publication 5304

*A Determination of the Vacancy/Solute*

*Atom Binding Energy in Aluminium-Silicon from Dislocation-Loop Annealing*, by R. L. Peck and K. H. Westmacott. China Lake, Calif., NWC, February 1972. 5 pp. (A reprint from METAL SCI J, Vol. 5, 1971.) Publication UNCLASSIFIED.

The shrinkage of faulted dislocation loops in pure aluminium and aluminium-silicon alloys has been studied by quantitative transmission electron-microscopy techniques to obtain activation energies for vacancy diffusion. Many of the inaccuracies normally present in such experiments have been eliminated by adopting comparative techniques. Differences in the observed apparent activation for loop shrinkage between the pure metal and alloys are interpreted in terms of vacancy/solute atom interactions during diffusion of the vacancies from the loop to the foil surfaces. A theory of Damask and Dienes that relates the apparent activation energy for vacancy diffusion in dilute alloys to the solute concentration and vacancy/solute binding energy ( $B$ ) was used in analyzing the results. The observed variations in activation energy with solute concentration are in good accord with this theory, and a consistent value of  $B = 0.17$  eV obtained from the results is in excellent agreement with the most reliable value derived by other methods.

#### NWC Technical Publication 5307

*Optimal Management of the Erythroblastotic Pregnancy*, by J. M. O'Lane, LCDR, MC, USN, and F. C. Reed. China Lake, Calif., NWC, February 1972. 30 pp. Publication UNCLASSIFIED.

This report presents a mathematical model suitable for management of the erythroblastotic pregnancy. Optimal management balances the risks associated with intrauterine transfusions and early delivery against the cumulative effects of erythroblastosis. An appropriate functional equation solved using dynamic programming generates optimal management policies.

#### NWC Technical Publication 5310

*Experimental Modeling of Network-Like Systems*, by Allen B. Gates. China Lake, Calif., NWC, January 1972. 114 pp. Publication UNCLASSIFIED.

Techniques for construction of mathematical models of linear, time-invariant, network-like systems are

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presented. The problem considered falls in the general category of the identification problem in control system theory. Noiseless measurements are assumed for development of the algorithms.

The thesis covers two areas. The first area is concerned with time-domain techniques for determining the system and input matrices. First, a model adaptive algorithm is derived assuming the entire state input vector is measured. Secondly, a non-linear observer parameter estimator technique is presented for the case where a subset of states and the input vector is measured.

The second area is concerned with extracting the parameter submatrices of the network-like system from the system input and system matrices.

Some theoretical results are presented.

The report is a facsimile of the thesis prepared in partial satisfaction of the requirements for the Degree of Doctor of Philosophy awarded by the Division of Systems Engineering, Case-Western Reserve University, Cleveland, Ohio.

### NWC Technical Publication 5311

*An Iterative Technique for the Computation of the Steady-State Gains for the Discrete Optimal Regulator*, by G. A. Hewer. China Lake, Calif., NWC, January 1972. 4 pp. (A reprint from INST ELEC ELECTRON ENG, TRANS, AUTONOM CONTR, Vol. AC-16, No. 4, August 1971.) Publication UNCLASSIFIED.

In this correspondence an algorithm is presented for computing the steady-state optimal feedback law of the discrete-time invariant linear regulator that converges quadratically in a neighborhood of the steady state.

### NWC Technical Publication 5330

*Beryllium Particle Combustion (Final Report)*, by Jack L. Prentice. China Lake, Calif., NWC, June 1972. 62 pp. Publication UNCLASSIFIED.

This report summarizes a two year study of the combustion efficiency of single beryllium droplets burning in a variety of oxidizers, but primarily mixtures of oxygen/argon and oxygen/nitrogen. An advanced laser heating technique has been used to acquire systematic quantitative data on the burning of single beryllium droplets at atmospheric pressure. This research confirms the sensitivity of beryllium droplet combustion to the

chemistry of environmental species and provides experimental documentation for the nitrogen-induced droplet fragmentation of burning beryllium droplets. These studies clearly reveal the inadequacies of current droplet burning models as applied to beryllium but they also provide the sort of detailed, systematic foundation necessary for future rational development of the theory.

#### NWC Technical Publication 5336

*Frequency 'Agile' Laser Techniques*, by Michael K. Giles and R. S. Hughes. China Lake, Calif., NWC, March 1972. 38 pp. Publication UNCLASSIFIED.

Three rapidly tunable organic dye lasers have been developed and evaluated in an effort to produce a frequency Agile laser with optimum beam properties. The basic design of each system comprises a pulsed nitrogen gas laser optical pump source, a  $10^{-3}$  M rhodamine 6G/ethanol active medium, and an optical resonant cavity with an intracavity tuning device that rapidly changes the wavelength of narrow-band stable oscillation. Their difference lies in the type of intracavity tuning device employed. One system is operated with a galvanometer-driven optical scanner, another with an optical scanner driven by piezoelectric bimorph strips, and the third with a rapid scanning Fabry Perot interferometer. The results of the evaluation reveal that the galvanometer-driven scanner out-performs the other tuning devices. At present, the only limitation on its wavelength-modulation frequency is the 500-pps pulse repetition frequency of the nitrogen gas laser. With higher pulse repetition frequencies, this tuning device can be operated at frequencies into the kilohertz range. Furthermore, the system equipped with the galvanometer-driven scanner has a high pump efficiency (12%), a high radiance ( $3.5 \times 10^{10}$  W/sr-cm<sup>2</sup>), and a spatial coherence ( $\lambda^2/\Delta\lambda = 0.13$  cm), which is suitable for many applications.

#### NWC Technical Publication 5339

*High Electron Affinity Molecules. A Descriptive Framework for Some Inorganic Materials and Some Dependent Properties*, by P. R. Hammond, R. R. Lake, R. H. Knipe, L. A. Burkardt, and W. S. McEwan. China Lake, Calif., NWC, April 1972. 48 pp. (Reprints from CHEM

## OFFICIAL PUBLICATIONS

### SOC. J. SECT A, 1971.) Publication UNCLASSIFIED.

A systematic examination is made of many of the highest valency halides, oxyhalides, and oxides of the elements in their interactions with aromatic hydrocarbons and fluorocarbons. Important to this study is the disappearance of color in the frozen mixtures of many weakly interacting materials that occurs when a binary system exhibiting an intermolecular charge-transfer transition produces a simple eutectic phase-diagram. The following generalizations are tested: (1) the covalent, highest-valency halides, oxyhalides, and oxides of the elements include high electron-affinity molecules that demonstrate charge-transfer spectra with the strictly  $\pi$ -donors, such as the aromatic hydrocarbons and fluorocarbons; (2) such  $\pi$ -donors produce stable complexes only in close 'plane-to-plane' combinations, and since the interactions are mostly of the 'ball-to-plane' type, the associations are very weak or just contact. Difficulties encountered in obtaining and interpreting the measurement of extremely weak interactions are emphasized. In terms of equilibrium, enthalpy, and thermochromism measurements, nearly all interactions are extremely weak or experimentally contact. Two major reasons for the weakness of the interactions are suggested: (1) geometrical factors impede the already feeble interactions of purely  $\pi$ -donors, and (2) the overlap is small for an acceptance orbital situated mainly on the central atom. If displacement of the spectra is interpreted to be caused by changes in molecular electron affinities of the acceptor  $MX_n$ , it appears that for a series of related compounds of the Group A elements, the strongest acceptors occur toward the top of the periodic table, whereas the compounds of main Group B elements behave atypically and are strongest for the heavier elements. Such trends are related by a simple thermodynamic cycle to the electron affinity of the ion  $M^{II}$  to the work of bringing up an electron to the center against the ligand screening electrons, and to a difference in enthalpy terms that includes the heats of formation.

### NWC Technical Publication 5345

*A Two-Camera System to Study Underwater Explosions*, by John Pearson, Lawrence N. Cosner, and Rolland Gallup. China Lake, Calif., NWC, April 1972. 24 pp. Publication UNCLASSIFIED.

A photographic system is described which uses two high-speed framing cameras, special illumination techniques, and appropriate synchronization to study the

behavior of small underwater explosions in both the microsecond and millisecond time ranges. A Cordin camera is used to study pressure pulse behavior and the formation of cavitation fields. A Fastax camera is used to study the bubble effect and gross water motion. Typical results obtained from such a two-camera system are discussed in terms of one specific test.

#### NWC Technical Publication 5349

*Interactions Between the Flow Field, Combustion, and Wave Motions in Rocket Motors*, by F. E. C. Culick. China Lake, Calif., NWC, June 1972. 72 pp. Publication UNCLASSIFIED.

The stability of small amplitude oscillations in combustion chambers is analyzed for one- and three-dimensional problems. In addition to combustion and mass addition at the boundaries, residual combustion and the presence of particulate matter within the chamber are accounted for. The results for the one-dimensional problem introduce new contributions, to the balance of acoustic energy, associated essentially with boundary layer processes acting if there is a component of acoustical motion parallel to the surface. These are incorporated in the general three-dimensional problem, and are shown to have a significant influence on the predicted stability of motions in a rocket motor.

#### NWC Technical Publication 5366

*5-Designs in Affine Spaces*, by W. O. Alltop. China Lake, Calif., NWC, June 1972. 8 pp. (A reprint from PACIFIC MATH J, Vol. 39, No. 3 (1971), pp. 547-51.) Publication UNCLASSIFIED.

The  $n$ -dimensional affine group over  $GF(2)$  is triply transitive on  $2^n$  symbols. For  $n \geq 4$ ,  $4 \leq k \leq 2^{n-1}$ , any orbit of  $k$ -subsets is a  $3-(2^n, k, \lambda)$  design. In this paper a sufficient condition that such a design be a 4-design is given. It is also shown that such a 4-design must always be a 5-design. A 5-design on 256 varieties with block size 24 is constructed in this fashion.

#### NWC Technical Publication 5369

*A FORTRAN Program for Trajectory Optimization Using the Epsilon Method*, by E. Y.

#### OFFICIAL PUBLICATIONS

Mikami. China Lake, Calif., NWC, July 1972. 20 pp. Publication UNCLASSIFIED.

A FORTRAN program for solving optimal control problems using the epsilon method is given. Problems are restricted to those having a scalar bounded control, a cost functional of the form  $G(x(t_f), t_f)$ , and a growth restriction on the dynamic function.

#### NWC Technical Publication 5388

*A Holographic Optical Element for Visual Display Applications* by D. G. McCauley, C. E. Simpson, and W. J. Murbach. China Lake, Calif., NWC, June 1972. 24 pp. Publication UNCLASSIFIED.

Off-axis and off-bisector reflection-type holographic visual display elements have been recorded in dichromated gelatin deposited on planar or spherical shell substrates of glass or Plexiglas. A procedure for bonding gelatin to Plexiglas is given. Holographic elements are recorded at the argon wavelength of 514.5 nm and reconstructed with spectral lines from a low pressure mercury arc lamp. Measured image characteristics for a flat substrate hologram agree with ray-tracing calculations. A swelling of the gelatin by approximately 6.6% after processing does not perceptibly affect the dispersion, astigmatism, or distortion in the image. That is, the grating equation depends on the spacing between the fringes on the surface of the gelatin and is not affected by the swelling or shrinking. However, the Bragg equation depends on the distance normal to the fringe planes, and is affected by thickness changes of the gelatin. Therefore this thickness change is taken as an independent parameter and used to adjust the wavelength for maximum diffraction efficiency, without affecting the image angle. Data reveal a near linear relationship between the dichromate concentration of 0.5% to 10% used to photosensitize the gelatin and the display wavelength of maximum diffraction efficiency. Lateral dispersion is  $0.12 \pm 0.01^\circ/\text{nanometer}$  for both planar and spherical shell substrate elements recorded in quite similar geometry, but their astigmatisms are not alike.

This report is a copy of a manuscript submitted for publication in the journal of *Applied Optics*.

#### NWC Technical Publication 5389

*Clouding of Pressed Potassium Bromide Powder*, by William F. Norris, Allen L. Olsen, and

Richard G. Brophy, China Lake, Calif., NWC, June 1972. 8 pp. (A reprint from APPL SPECTROS, Vol. 26, 1972.) Publication UNCLASSIFIED.

The monomolecular layer of water adsorbed on KBr particles is responsible for clouding of disks pressed from finely ground powder. Cloudiness is caused by formation of a multitude of cracks in the disk. The initial cracking can be observed with a low power optical microscope and the extensive cracking in the fully cloudy region is observable with a scanning electron microscope. It is suggested that adsorbed water promotes recrystallization, generating weak zones in the work hardened, elastically stressed disk which fails by cracking.

#### NWC Technical Publication 5393

*Experimental Surface Pressure Distributions on Three Bodies of Revolution at Mach Numbers From 0.7 to 2.02*, by C. Franklyn Markarian. China Lake, Calif., NWC, August 1972. 132 pp. Publication UNCLASSIFIED.

Wind tunnel tests were conducted to measure surface pressure distributions on three bodies of revolution at Mach numbers from 0.7 to 2.02 and angle of attack from 19 to -10 degrees. Tests were conducted at the Naval Ordnance Laboratory, White Oak, Silver Spring, Md. and the Naval Ship Research and Development Center, Carderock, Md. The three bodies were based on the same ogive-cylinder with one having a sharp nose and the other two being spherically tipped. Surface pressure distributions are presented, along with expressions relating the flow angle to the pressure difference across the spherical nose caps.

#### NWC Technical Publication 5402

*FEATHER-Finite Element Analysis for Three-Dimensional Elastic Response*, by L. G. Selna, UCLA, and J. E. Serpanos, NWC. China Lake, Calif., NWC, August 1972. 128 pp. Publication UNCLASSIFIED.

A digital computer program for three-dimensional stress analysis of complex structures is presented. The solution is based on the finite element technique employing a general 8-nodal-point element with 3 translational degrees of freedom per nodal point. A mathematical theory using generalized coordinate technique was developed; however, attempts to solve

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three-dimensional problems having known exact solutions were thwarted by the failure of the iterative procedures used to form the generalized coordinates to produce sufficiently orthogonal systems of coordinates. Accordingly, it became apparent that the method was not suitable for structures having complex boundaries. Hence, the solution to static analysis problems is obtained herein by employing the most useful large-capacity simultaneous equation solution methods available. Three-dimensional structures of the order of 15,000 degrees of freedom may be solved. Three-dimensional plotting capabilities are included. Two-dimensional plots, including contour line displays of stresses at selected cross sections of the 3-D structure, are also available. The program is coded in FORTRAN IV; the plotting capabilities are designed for use with the SC4060 software.

### NWC Technical Publication 5406

*Theoretical Design of an Indium Antimonide Photoparametric Detector-Amplifier*, by Walter Emil Freitag, China Lake, Calif., NWC, August 1972. 66 pp. Publication UNCLASSIFIED.

This thesis discusses the feasibility of operating a photovoltaic (junction photodiode) IR (3- to 6-micron) detector with internal parametric amplification. The detector and integral parametric amplifier, called a photoparamp, offers the possibility of combining the high sensitivity of modern detectors with the very low noise characteristics of parametric amplifiers.

The particular device selected for illustration is the indium antimonide photovoltaic detector. This detector is selected for its high sensitivity ( $D^*$ ), electrical characteristics applicable to parametric amplification, and high degree of usage in modern infrared technology.

Advantages and disadvantages of photoparamp operation are explored in considerable detail. Characteristics of the detector and the required operating conditions of the parametric amplifier are developed. Noise characteristics for both the paramp and the detector are discussed, with emphasis on the interrelationships and effects of parametric operation on the detection characteristics.

This report is a facsimile of a thesis submitted to the University of California, Los Angeles, in partial fulfillment of the requirements for a master's degree of science in engineering.

### NWC Technical Publication 5439

*High-Temperature Contact Nucleation of*

*Supercooled Water by Organic Chemicals and Appendix of Compounds Tested*, by A. N. Fletcher. China Lake, Calif., NWC, November 1972. 16 pp. (Reprint from J APPL METEOROL, Vol. 11, 1972.) Publication UNCLASSIFIED.

A simple, rapid test is described that measures contact nucleation of supercooled water. Application of this contact-nucleation test at  $-3^{\circ}\text{C}$  to over 1000 organic compounds resulted in only 47 that could be considered as "active." There was a close correlation between the present test and Fukuta's *Method b* when the samples were in the same physical condition (freshly ground). Materials such as metaldehyde, fluorenone, phenazine and phloroglucinol dihydrate were not found to be sufficiently "active" to pass the contact-nucleation test in an unground state.

It is proposed that the initial water-air interface may pass through a configuration that promotes the growth of ice embryos even though the final compound-water interface has a low "activity," i.e., a low prewet-nucleation temperature. Conversely, some compounds such as phloroglucinol dihydrate show little "activity" for contact nucleation yet have a high prewet-nucleation temperature.

## PROFESSIONAL PAPERS

### OL 1508

Abbott, S. W., L. D. Smoot, and K. Schadow. "Direct Mixing and Combustion Measurements in Ducted, Particle-Laden Jets," New York, American Institute of Aeronautics and Astronautics, 1972. Preprint No. 72-1177.

Using water-cooled probes and hot-gas valves, gas particle samples were withdrawn from the secondary duct of an air-augmented laboratory burner. Using a boron-loaded propellant, air/fuel ratio and secondary duct pressure were varied from 12/1 to 32/1 and from 82 to 127 psia respectively. From sample analysis of chlorine, argon (air tracer), boron, and boron oxide, radial and axial profiles of air, gaseous fuel, particulate fuel and percent of boron combustion were determined. Particles and gases mixed at significantly different rates. Measured gas-phase mixing rates were more rapid than model predictions, which assumed particles to be in equilibrium with gases. Boron combustion efficiency varied markedly with duct position, air/fuel ratio and secondary chamber pressure. Low boron combustion efficiency results principally from lack of early ignition of the gaseous fuels before dilution by air reduces resulting gas-phase temperatures below the boron ignition temperature. This is especially true at low secondary duct pressures.

### OL 1509

Adicoff, Arnold, and Eugene C. Martin. "A

Method for Calculating Extent of Reaction from Titration," J POLYMER SCI, Vol. 10, Part A-1, No. 6 (June 1972), pp. 1877-78.

During the reaction of difunctional polymers it is often of interest to determine the extent of reaction. A procedure is presented for computing the extent of reaction from standard titration parameters without having to separate the reacted materials and determine weights and concentrations of these quantities separately.

## OL 1510

Alltop, W. O. "An Infinite Class of 5-Designs," J COMBINATORIAL THEORY, Vol. 12, No. 3 (May 1972), pp. 390-95.

$(\Omega, D)$  is called a  $t$ -( $v, n, \lambda$ ) design provided  $|\Omega| = v$  and  $D$  is a family of  $k$ -subsets of  $\Omega$  such that every  $t$ -subset of  $\Omega$  is contained in exactly  $\lambda$  members of  $D$ . Here we construct a  $5$ -( $2^n + 2, 2^{n-1} + 1, \lambda$ ) design for every  $n \geq 4$ , with  $\lambda = (2^{n-1} - 3)(2^{n-2} - 1)$ . Letting  $\Omega$  be the projective line over  $GF(2^n)$ , we first construct a  $4$ -( $2^n + 1, 2^{n-1}, \lambda$ ) design on  $\Omega$ . Such a design can always be extended to a 5-design.

## OL 1511

Alltop W. O. "5-Designs in Affine Spaces," PACIFIC J MATH, Vol. 39, No. 3 (1971), pp. 547-51.

The  $n$ -dimensional affine group over  $GF(2)$  is triply transitive on  $2^n$  symbols. For  $n \geq 4$ ,  $4 \leq k \leq 2^{n-1}$ , any orbit of  $k$ -subsets is a  $3$ -( $2^n, k, \lambda$ ) design. In this paper a sufficient condition that such a design be a 4-design is given. It is also shown that such a 4-design must always be a 5-design. A 5-design on 256 varieties with block size 24 is constructed in this fashion.

## OL 1512

Ansell, Gerald B. "Crystal Structure of 1,3-Dimethylimidazole-2(3H)-thione( $C_5H_8N_2S$ )," J CHEM SOC (London), PERKIN TRANS II, 1972, pp. 841-3.

The structure of the title compound has been established by x-ray crystallography from diffractometer data. Crystals are orthorhombic, space group either  $Bmmb$  or  $Bm2_1b$ ,  $Z = 4$ , with cell dimensions:  $a = 8.475 \pm 0.002$ ,  $b = 6.826 \pm 0.003$ ,  $c = 11.206 \pm 0.005$  Å.

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In space group Bmmb, 195 observable reflections were refined to R 0.028. The molecule has mm symmetry. The C-S distance and bond lengths within the five membered ring clearly indicate that (Ib) is the major contributor to the resonance hybrid (Ic). The planar molecules are stacked along the b axis with a perpendicular separation of 3.413 Å. All intermolecular distances appear to be van der Waals separations. The model was investigated for the effects of thermal motion on bond lengths. The corrections were of the order of the estimated standard deviations for the corresponding bonds.

In space group Bm2<sub>1</sub>b refinement stops at R 0.027. The molecule has m (pseudo-m) symmetry and differs only very slightly from the previous model. There are small changes in thermal parameters (particularly for hydrogen) and the methyl group is twisted very slightly so as not to lie symmetrically above, below, and in the plane formed by the heavy atoms. The ring hydrogens also deviate slightly from this plane.

## OL 1513

Ansell, G. B., D. W. Moore, and A. T. Nielsen. "Intramolecular Reactions of Nitro-olefin-Cyclohexane-1,3-dione Michael Adducts. Crystal Structure of 3-(4-Bromophenyl)-6,7-dihydro-2-hydroxyiminobenzofuran-4(5H)-one," J PHYS ORG CHEM, SECT B, 1971, pp. 2376-82.

Cyclohexane-1,3-dione and its 5,5-dimethyl derivative (dimedone), in contrast to other  $\beta$ -diketones, behave abnormally in Michael additions to nitro-olefins. From nitro-olefins  $RCH=CH-NO_2$  (R= alkyl or aryl, not H) 3-substituted 6,7-dihydro-2-hydroxyiminobenzofuran-4(5H)-ones can be prepared. These compounds are the first known butenolide derivatives having a 2-hydroxyimino-substituent. 3-(4-Bromophenyl)-6,7-dihydro-2-hydroxyiminobenzofuran-4(5H)-one has been prepared from cyclohexane-1,3-dione and 4-bromo- $\beta$ -nitrostyrene and resolved into pure *syn*- and *anti*-forms. The structures of both forms have been established from n.m.r. spectra, and by X-ray crystallography from diffractometer data. Single crystals of a 1:2 mixture of *syn*- and *anti*-forms (VIIA and B; *anti:syn*=2:1) are orthorhombic with space-group *Pbca*, cell dimensions  $a=17.37$ ,  $b=7.89$ , and  $c=19.76$  Å. The crystals were found to be disordered because they contain a mixture of *syn*- and *anti*-forms of the oxime. Three possible ways of describing the mixture of *syn*- and *anti*-forms were refined by full-matrix least-squares of 805 statistically significant reflections to weighted R values of 0.051, 0.056, and 0.073. None of the three refinements gave good agreement with bond

distances previously reported for C=N and N-OH in oxime structures (although mean values for the 0.051 and 0.057 refinements did). The observed apparent planarity of the cyclohexenone ring is attributed to the presence of equal amounts of both ring-inversion isomers in the crystalline state. Short intermolecular distances of 2.63 and 2.84 Å between the oxygen of both *syn*- and *anti*-oxime groups and the ketonic oxygens give strong evidence for intermolecular hydrogen bonding.

## OL 1514

Aspnes, D. E., and N. Bottka. "Electric-Field Effects on the Dielectric Function of Semiconductors and Insulators," in *Semiconductors and Semimetals*, Vol. 9, ed. by R. K. Willardson and Albert C. Beer. New York, Academic Press, 1972. Chap. 6, pp. 457-543.

## OL 1515

Bennett, H. E., and Jean M. Bennett. "Precision Measurements in Thin Film Optics," in *Physics of Thin Films*, ed. by G. Hass and R. E. Thun. New York, Academic Press, 1967. Vol. 4, pp. 1-96.

## OL 1516

Bennett, Jean M., and E. J. Ashley. "Calibration of Instruments Measuring Reflectance and Transmittance," *APPL OPT*, Vol. 11, No. 8 (August 1972), pp. 1749-55.

In calibrating instruments that measure reflectance and transmittance to a few tenths of a percent, it is desirable to have a sample that is smooth, uniform, nonabsorbing, and stable, so that the measured reflectance and transmittance will add to unity, and no light will be either absorbed or scattered outside the collecting optics. A properly prepared, thin, transparent, high index film (such as  $\text{CeO}_2$  or  $\text{TiO}_2$ ) on a fused quartz substrate is suitable for a calibration sample. Equations are given to calculate the reflectance and transmittance both at normal incidence and nonnormal incidence, as well as to correct for multiple reflections in the substrate and reflection from the back surface of the substrate. Factors such as aging and optical thickness nonuniformity, which can

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introduce systematic errors into the calibration, must be minimized by proper choice of materials and preparation techniques.

#### OL 1517

Boggs, T. L., and D. E. Zurn. "The Deflagration of Ammonium Perchlorate-Polymeric Binder Sandwich Models," *COMBUST SCI TECHNOL*, Vol. 4, No. 6 (February 1972), pp. 279-92.

#### OL 1518

Boggs, T. L., and D. E. Zurn. "The Deflagration of Ammonium Perchlorate-Polymeric Binder Sandwich Models," in *8th JANNAF Combustion Meeting*, Comp. by Chemical Propulsion Information Agency. Silver Spring, Md., CPIA, November 1971. CPIA Pub. No. 220, Vol. 1, pp. 101-18.

#### OL 1519

Boggs, T. L., and D. E. Zurn. "The Temperature Sensitivity of the Deflagration Rates of Pure and Doped Ammonium Perchlorate," *COMBUST SCI TECHNOL*, Vol. 4, No. 5 (January 1972), pp. 227-32.

#### OL 1520

Boggs, T. L., and D. E. Zurn. "The Temperature Sensitivity of the Deflagration Rates of Pure and Doped Ammonium Perchlorate," in *8th JANNAF Combustion Meeting*, Comp. by Chemical Propulsion Information Agency. Silver Spring, Md., CPIA, November 1971. CPIA Pub. No. 220, Vol. 1, pp. 137-43.

#### OL 1521

Boggs, T. L., K. J. Kraeutle, and D. E.

Zurn. "Decomposition, Pyrolysis, and Deflagration of Pure and Isomorphously Doped Ammonium Perchlorate," AMER INST AERON ASTRONAUT J, Vol. 10, No. 1 (January 1972), pp. 15-16.

Ammonium perchlorate (AP) is the oxidizer and principal ingredient in most composite solid propellants and its behavior in the combustion zone affects the overall combustion characteristics of the propellant. Because the written word can only partially describe this behavior, a 16 mm film has been prepared in which scanning electron micrographs (SEM), cinephotomicrography, graphs, charts, and plots are used to describe the phase changes orthorhombic to cubic and cubic to orthorhombic; the sublimation, isothermal decomposition, pyrolysis, and self-deflagration of pure AP; and the self-deflagration of AP crystals isomorphously doped with  $K^+$ ,  $Cr_2O_7^{2-}$  and  $MnO_4^-$  ions.

#### OL 1522

Boggs, T. L., E. E. Petersen, and D. M. Watt, Jr. "Comment on The Deflagration of Single Crystals of Ammonium Perchlorate," COMBUST FLAME, Vol. 19, No. 1 (August 1972), pp. 131-33.

#### OL 1523

Burkardt, L. A., William G. Finnegan, F. Kirk Odencrantz, and Pierre St.-Amand. "Pyrotechnic Production of Nucleants for Cloud Modification. Part IV. Compositional Effects on Ice Nuclei Activity," J WEATHER MOD, Vol. 2, No. 1 (May 1970), pp. 65-76.

Fine particle dispersions of silver iodide and mixtures and complexes of silver iodide with alkali iodides can be generated by pyrotechnic combustion of compositions containing energetic oxygenated precursors of the metal iodides. The solid products of combustion of such pyrotechnics have been characterized by wet chemical and X-ray diffraction analysis and by comparison of data obtained on synthetic samples.

The chemical complexes of silver iodide with the alkali metal iodides are active ice nuclei although their physical and chemical properties differ from those of silver iodide.

Ice nuclei activity studies of simple and complex nuclei generated by pyrotechnics have been made. Nuclei from pyrotechnics burned in a 24 m<sup>3</sup> cloud chamber in

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the presence of the supercooled fog, show enhanced activities at warm temperatures compared to activities obtained by nuclei dilution and injection techniques.

### OL 1524

Burkardt, L. A., P. R. Hammond, R. H. Knipe, and R. R. Lake. "Electron Acceptor-Electron Donor Interactions. Part XVIII. Charge-Transfer Interactions of Some of the Highest-Valency Halides, Oxyhalides, and Oxides With Aromatic Hydrocarbons and Fluorocarbons. Ball-Plane Interactions. Group IV," J CHEM SOC, SECT A, December 1971, pp. 3789-3800.

We report a systematic examination of the interactions of the title. The disappearance of colour in the frozen mixtures of many weakly interacting materials is important to this study, and occurs when a binary system exhibiting an intermolecular charge-transfer transition produces a simple eutectic phase-diagram. The following generalisations are tested: (1) the covalent, highest-valency halides, oxyhalides, and oxides of the elements include high electron-affinity molecules that demonstrate charge-transfer spectra with the strictly  $\pi$ -donors such as the aromatic hydrocarbons and fluorocarbons; (2) as such donors produce stable complexes only in close 'plane-to-plane' combinations, and since the interactions are mostly of the 'ball-to-plane' type, the associations are very weak or just contact. Difficulties encountered in measuring and interpreting the measurement of extremely weak interactions are emphasized. Earlier reports of intermolecular transitions in  $\text{TiCl}_4$  and  $\text{SnCl}_4$  systems are confirmed and spectral changes for some  $\text{GeCl}_4$ ,  $\text{PbCl}_4$ , and  $\text{CCl}_4$  systems are assigned similarly. On the other hand the interactions are extremely weak according to equilibrium and enthalpy studies, and many of the two-component mixtures are thermochromic, although X-ray diffraction patterns of the frozen materials in capillaries are diffuse. Positions of the absorptions are related to the order of vertical electron affinities. Silicon tetrachloride is effectively an inert, non-perturbing medium, and aromatic hydrocarbons dissolved in it produce spectra nearly identical to their cyclohexane solutions. Some anomalies of the methylbenzene spectra are described and a very low intensity absorption in hexamethylbenzene is identified tentatively as a  $T \leftarrow S$  transition. The method of continuous variations is discussed and a previous equilibrium measurement based on this method is criticized.

## OL 1525

Carroz, John W., and Ronald C. Noles. "A New Ground-Based Solution Burner for Cloud Seeding and Production of Atmospheric Tracer Materials," in *Proceedings of Third Conference on Weather Modification*, Rapid City, S.D., 26-29 June 1972, American Meteorological Society. Pp. 37-39.

A ground-based solution burner has been constructed and tested. This burner was built primarily to provide a simple, reliable unit for ground-based seeding. When used in full capacity, the burner generates large-sized ice nuclei that should best survive a warm, moist environment prior to functioning at the freezing level. The burner functions with only a flammable solution of the agent, without propane or other additional fuel. This paper describes the design and operating characteristics of the burner.

## OL 1526

Carroz, John W., Pierre St.-Amand, and Donald R. Cruise. "The Use of Highly Charged Hygroscopic Drops for Fog Dispersal," *J WEATHER MOD*, Vol. 4, No. 1 (April 1972), pp. 54-69.

Hygroscopic solutions sprayed into a fog can be used to disperse the fog and to improve visibility. However, present techniques require such large amounts of material that cost and inconvenience make them unattractive for large scale routine use. This paper estimates the advantages to be gained from electrifying the drops of hygroscopic material.

The growth of an electrically neutral hygroscopic drop by diffusion of water vapor was calculated using Fukuta's equation. To this was added the growth by collision followed by coalescence with smaller uncharged droplets of the fog.

The growth by collision and coalescence for an electrically charged drop falling through a fog was calculated using Cochet's equations. Fukuta's equation was used to calculate the diffusional growth of a charged drop. The growth by diffusion was added to that by collision.

The uncharged drops of hygroscopic solution should grow from 40 to 88 microns in 200 meters of

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fall. Hygroscopic drops of 40 microns radius charged to the Rayleigh limit should grow to 112 microns, a gain of 22 times the initial volume.

These calculations were then used to estimate the fog clearing potential of electrically charged drops. It should be possible to increase the visibility in fog up to 20 times when treating advection type fogs with as little as 10 gallons per acre of agent. The visibility increase is less when a significant portion of the fog droplets is smaller than a few microns.

The feasibility of fog clearance can be improved if a method for charging the spray droplets to near the Rayleigh limit can be developed.

### OL 1527

Clark, R. S., P. St-Amand, and T. L. Wright. "Modification of Warm Convective Clouds by Hygroscopic and Hydrophilic Materials," in *Proceedings of Third Conference on Weather Modification*, Rapid City, S. D., 26-29 June 1972, American Meteorological Society. Pp. 179-181.

Results from a study of warm convective clouds are presented. The studies were conducted in 1969, 1970, and 1971 over the Gulf of Mexico in the vicinity of Brownsville, Texas. The studies may be divided into three phases.

One phase consisted of life cycle studies of untreated warm cumulus clouds. The data included droplet spectrum, temperature, dewpoint, liquid water content, updraft and downdraft velocity, cloud dimension and rain rate.

The other phases included measurement of the above parameters prior to and after treatment with the modification agent. Modifications were attempted by dropping highly hygroscopic solutions of ammonium nitrate and urea (Phase 2), and hydrophilic powders, principally Portland cement (Phase 3), into the clouds. Treatment varied from less than ten to several hundred pounds per cubic mile of cloud. The effect of the treatment with varying dosage rates, state of cloud development and area of application ranged from nothing to complete collapse and dissipation.

### OL 1528

Cronin, Harold E. "A Computer Program for Fog Prediction at Portland, Oregon," *J WEATHER MOD*, Vol. 4, No. 1 (April 1972), pp. 85-93.

The results given from two studies of fog prediction at Portland, Oregon have been translated into a program for operation on a minicomputer. Although this program is quite short, with few data inputs, it shows promise as a first step in developing a more complete program and in developing similar programs for other fog prone locations.

## OL 1529

Donnan, John A., Donald N. Blair, William G. Finnegan, and Pierre St.-Amand. "Nucleation Efficiencies of AgI-NH<sub>4</sub>I and AgI-NaI Acetone Solutions and Pyrotechnic Generators as a Function of LWC and Generator Flame Temperature, A Preliminary Report," J WEATHER MOD, Vol. 2, No. 1 (May 1970). pp. 155-64.

The activity of ice nuclei depends upon their chemical composition, physical properties, and their environmental history. Glacogenic nuclei, generated in clouds at ambient temperatures below their maximum effective temperature, function well but those involving complexes of silver iodide and alkali iodides are considerably altered by residence in warmer moist air or in cloud. In order to find an acetone burner system that would result in relatively pure AgI so that the effects of exposure of the nuclei to the environment would be minimized, Vonnegut's earlier concept of using NH<sub>4</sub>I as a solubilizing agent in an acetone solution was tested in the South Dakota School of Mines' nucleation test facility, using a Lohse burner. Nuclei produced by the NH<sub>4</sub>I-AgI systems are effective at higher temperatures than those of the NaI-AgI system. Values in excess of 10<sup>11</sup> snowflakes per gram of AgI have been attained at -4°C with a 35% solution of NH<sub>4</sub>I-AgI. The NaI-AgI system produced fewer nuclei than the NH<sub>4</sub>I system at all temperatures above -8°C.

Numerical output of effective nuclei of the NaI-AgI system appears relatively unaffected by changes in burner flame temperature. Numerical output of the NH<sub>4</sub>I-AgI system is markedly improved by reduction of the flame temperature. Optimum results are expected at flame temperatures of about 700°C.

The effectiveness of the nucleants, from pyrotechnics and from acetone systems, as a function of the liquid water content of the cold boxes depends upon the chemistry of the nucleant, and upon the temperature. These numerical counts of snowflake/gram from nucleants having little or no complexing agents or soluble components appear to be higher at higher temperatures and less dependent upon the liquid water content.

For seeding clouds from below cloud base or

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under conditions in which the nuclei have to pass through warm moist air or cloud, it seems clear that those having only slight amounts of solubilizing agents, such as the LW 83 pyrotechnic or the  $\text{NH}_4\text{I-Agl}$  acetone system, are markedly superior.

### OL 1530

Eisel, John L. "Observations of the Surface Details of Burning  $\text{Mg}/\text{NaNO}_3$ /Binder Flares," in *Proceedings of Third International Pyrotechnics Seminar*, 21-25 August 1972, Colorado Springs, Colo. Denver Research Institute/University of Denver. Pp. 435-41.

Because the physical-chemical details of flare combustion are largely unknown, a study was undertaken to elucidate certain aspects of these processes. The surface processes of the combustion were observed using high speed (up to 4000 frames per second) and high magnification (up to 4x on the film) color cinematography. It was observed that at the surface the  $\text{NaNO}_3$  melts, flows together into large masses and decomposes. Non-molten Mg particles are captured at these decomposition sites and are ejected—still nonmolten—into the flame zone away from the surface. Although sodium D line radiation accompanies this ejection process most of the illuminating radiation appears to take place in the metal combustion region away from the surface. The degree of activity and surface structure are observed to vary as a function of particle size and composition.

### OL 1531

Eisel, J. L., N. W. Ryan, and A. D. Baer. "Flame Spectra of Solid Propellants During Unstable Combustion," New York, American Institute of Aeronautics and Astronautics, 1972. Preprint No. 72-32.

The spectral and temporal details of the flames of a series of ammonium perchlorate-polyurethane propellants during both unstable and stable combustion were observed experimentally. A 400 scan per second optical spectrometer operating in the middle infrared region was used. During unstable combustion at low  $L^*$  three different frequencies were observed simultaneously. These were attributable to at least two mechanisms. During "stable" combustion periodic fluctuations in flame

temperature and composition were also observed. Some aspects of theory of bulk mode instability were confirmed but the assumptions of constant flame temperature and constant composition were found to be inaccurate.

## OL 1532

Eisel, J. L., N. W. Ryan, and A. D. Baer. "Spectral and Temporal Resolution of Propellant Flames During Bulk Mode Instability," in *8th JANNAF Combustion Meeting*, Comp. by Chemical Propulsion Information Agency Silver Spring, Md., CPIA, November 1971. CPIA Pub. No. 220, Vol. 1, pp. 373-78.

A study was undertaken to elucidate the spectral details of the flame of a composite propellant burning under unstable conditions. The tests were conducted using a series of polyurethane-ammonium perchlorate propellants burning at low pressure and at low values of  $L^*$ . Spectral measurements were made using a rapid scanning spectrometer which sampled radiation in the wavelength region from  $1.7\mu\text{m}$  to  $4.8\mu\text{m}$  400 times per second. From these data flame temperature and flame composition were monitored as a function of time. The phase relationships between mass rate and pressure were determined and compared to theoretical predictions.

## OL 1533

Elliott, Robert D., Pierre St.-Amand, and John R. Thompson. "Santa Barbara Pyrotechnic Cloud Seeding Test Results 1967-70," *J APPL METEOROL*, Vol. 10, No. 4 (August 1971), pp. 785-95.

Tests of the effectiveness of ground-released pyrotechnics in enhancing precipitation in storms in Santa Barbara County were conducted during the three winter seasons of 1967-68, 1968-69 and 1969-70. The mode of operation and the type of pyrotechnic device remained fixed through the three years in order to develop a large sample of data. The observation unit employed was a convective band embedded within a general storm system. A series of pyrotechnic candles of the LW-83 formulation were ignited just prior to and during the passage of convective bands over the seeding site, located on a 3500-ft mountain ridge in the Santa Ynez mountains. The bands were detected upwind of the test area and tracked into the test area by use of telemetered raingages and

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weather radar. Out of a total of 85 bands, 43 were seeded and 42 not-seeded. The selection of bands to seed was made on a random basis following declaration of the approach of a seedable band.

Over 80 recording raingages extending over an area of ~1500 mi<sup>2</sup> provided the basic evaluation data. Soundings taken with a GMD-1 system just prior to band passage into the test area provided useful air mass documentation. The cases were stratified by stability and 500-mb temperature categories.

The statistical analysis shows that there was a statistically significant difference between the distributions of seeded and not-seeded band precipitation totals for stations distributed over a several hundred square mile area downwind of the point source of nuclei. Indications were that precipitation was increased by 50% or more. The effect was greatest in the case of the warmer and more unstable categories.

When the overall precipitation is considered, including the between-band (not-seeded) component, the net increase is about 32%. Precipitation between bands was not significantly changed by seeding.

A computerized seeding-area-of-effect model was employed to predict an envelope of areas of seeding effect for the various categories of seeded bands. The bulk of the stations for which seeded precipitation distributions were significantly different from the not-seeded distributions fell within these areas.

The test results show the value of seeding winter convective orographic systems with this pyrotechnic device. The test results also demonstrate the value of employing the convection band as a natural unit of seeding and of observation. The sensitivity of the statistical evaluation was greatly enhanced through the use of this approach.

### OL 1534

Finnegan, W. G., P. St.-Amand, and L. A. Burkardt. *Evaluation of Ice Nuclei Generator Systems*, NATURE, Vol. 232, No. 5306 (July 1971), pp. 113-114.

The ice nucleating ability of uncomplexed silver iodide is superior to that of silver iodide complexes when warm cloud base or out-of-cloud seeding techniques are employed.

### OL 1535

Fischer, John E., and Terence M. Donovan. "Optical and Photoelectric Properties of

Amorphous Silicon," J NON-CRYSTALLINE SOLIDS, Vol. 8-10 (June 1972), pp. 202-08.

We have measured optical absorption and photoconductivity spectra of amorphous silicon films in the vicinity of the absorption threshold. The two spectra are essentially identical. Noting the fast response time at 300°K and 77°K, the magnitude of the photocurrent and the absence of strong temperature dependence, we conclude that the photocarriers must be drifting in extended rather than localized states. We find evidence neither for tailing of valence and conduction bands into the forbidden gap nor for the existence of a mobility edge.

## OL 1536

Fletcher, Aaron N. "High-Temperature Contact Nucleation of Supercooled Water by Organic Chemicals," J APPL METEOROL, Vol. 11, No. 6 (September 1972), pp. 988-93.

A simple, rapid test is described that measures contact nucleation of supercooled water. Application of this contact-nucleation test at -3C to over 1000 organic compounds resulted in only 47 that could be considered as "active." There was a close correlation between the present test and Fukuta's *Method b* when the samples were in the same physical condition (freshly ground). Materials such as metaldehyde, fluorenone, phenazine and phloroglucinol dihydrate were not found to be sufficiently "active" to pass the contact-nucleation test in an unground state.

It is proposed that the initial water-air interface may pass through a configuration that promotes the growth of ice embryos even though the final compound-water interface has a low "activity," i.e., a low prewet-nucleation temperature. Conversely, some compounds such as phloroglucinol dihydrate show little "activity" for contact nucleation yet have a high prewet-nucleation temperature.

## OL 1537

Fletcher, Aaron N. "Molecular Structure of Ethanol-d<sub>1</sub> Solutions. A Near-Infrared Study of Hydrogen Bonding," J PHYS CHEM, Vol. 76 (1972), pp. 2562-71.

By making use of the absorptivity of monomer and polymer bands, a near-infrared study of CH<sub>3</sub>CH<sub>2</sub>OD solutions has been made. Using n-decane as a solvent, formal concentrations of ethanol-d<sub>1</sub> were varied from

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between 0.01 and 17 M at -10, 25, and 60°. The hydrogen-bonded molecular structure of pure  $\text{CH}_3\text{CH}_2\text{OD}$  at 25° was found to consist primarily of monomer, acyclic tetramer, and cyclic tetramer in ratios of 1:3.4:10.9, respectively. The concentration of the (acyclic) dimer was estimated as being less than 0.01% of the formal concentration of  $\text{CH}_3\text{CH}_2\text{OD}$ . The average energy of the  $^2\text{H}$  hydrogen bonds was found to be  $5.37 \pm 0.03$  and  $4.83 \pm 0.03$  kcal for the acyclic and cyclic tetramer, respectively. The difference in these values suggests that ring strain exists in the cyclic tetramer, i.e., that its  $\text{O}-\text{H} \cdots \text{O}$  grouping is not linear. Concentration equilibrium quotients and most  $\text{O}-\text{H}$  absorption band wavelengths were found to be independent of the proportions of the solvent.

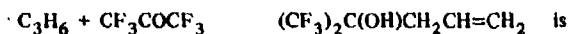
### OL 1538

Gordon, Alvin S. "Pyrolysis of 4,4-Bis(perfluoromethyl)butene-1,4 01 in the Gas Phase," INT J CHEM KINET, Vol. IV (1972), pp. 541-45.

Pyrolysis of  $(\text{CF}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CH}=\text{CH}_2$ , the reverse of the reaction between perfluoroacetone and propene, has been studied in the gas phase between 475° and 598°K. Even at 573°K, the unimolecular reaction rate constant appears to be in its pressure-independent region at 20.0 torr pressure. In a quartz vessel, the decomposition is homogeneous. The specific unimolecular rate constant is

$$k = T^{1/2} 10^{(10.3 \pm 0.10) - (\frac{40300 \pm 300}{4.575T})} \text{ sec}^{-1}$$

where the limits are for one standard deviation. Combining these results with the previously reported results on the reverse reaction, the equilibrium constant for the reaction



$$K_p = 10^{(1/4.575) (-34.0 \pm 1.0) + (\frac{18700 \pm 400}{T})} \text{ atm}^{-1}.$$

### OL 1539

Hammond, P. R. "Electron Acceptor-Electron Donor Interactions. Part XXIII. Charge-Transfer Interactions of the Highest-Valency Halides, Oxyhalides, and Oxides With Aromatic Hydrocarbons and Fluorocarbons. Ball-Plane

Interactions. Conclusions." J CHEM SOC, SECT A, December 1971, pp. 3826-32.

Some of the conclusions from the preceding papers are tabulated. In terms of equilibrium, enthalpy, and thermochromism measurements nearly all interactions qualify for the description 'extremely weak or experimentally contact'. There is a need for further study, for example, of thermodynamic excess functions. As two major reasons why they are weak it is suggested that (1) geometrical factors impede the already feeble interactions of purely  $\pi$ -donors, and (2) for an acceptation orbital situated mainly on the central atom the overlap is small. If displacement of the spectra are interpreted as due to changes in molecular electron affinities of the acceptor  $MX_n$ , it appears that for a series of related compounds of the Group A elements, strongest acceptors occur towards the top of the Periodic Table, whereas the Main Groups B behave 'atypically' and are strongest for the heavier elements. Such trends are related by a simple thermodynamic cycle to the electron affinity of the ion  $M^{n+}$ , the work of bringing up an electron to the centre against the ligand screening electrons, and a difference in enthalpy terms that includes the heats of formation.

#### OL 1540

Hammond, P. R., and R. S. Hughes. "Search for Wide-Range Tunable Dye Laser Systems," NATUR PHYS SCI, Vol. 231 (May 1971), pp. 59-62.

Two mechanisms of 'exciplex emission' namely the 'proton exciplex', which relates to changes in conventional acidity and basicity in the excited state; and the 'molecular exciplex', which relates to changes in electron-acceptor and electron-donor properties (i.e., changes in Lewis acidity and basicity), were examined for the purpose of making wide-range tunable dye lasers. Wide tuning range (blue-violet to yellow-green, 122 nanometers) is reported for 4,8-dimethylumbelliferone. It is proposed that this dye operates by a double proton exciplex mechanism, wherein the molecule is both a stronger acid and a stronger base in the excited state. Peculiarities in the lasing action of 9-aminoacridine are discussed. No system was found that gave wide range laser action according to the molecular exciplex principle, and a high concentration of exciplex species in solution may result in the shortening of their lifetime by a bimolecular process.

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### OL 1541

Hammond, P. R., and R. R. Lake.  
"Electron Acceptor-Electron Donor Interactions.  
Part XIX. Charge-Transfer Interactions of Some of  
the Highest-Valency Halides, Oxyhalides, and  
Oxides With Aromatic Hydrocarbons and  
Fluorocarbons. Ball-Plane Interactions. Group VA,"  
J CHEM SOC, SECT A, December 1971, pp.  
3800-06.

Vanadium oxytrichloride, pentafluoride, and niobium and tantalum pentachlorides, oxytrichlorides, and pentafluorides are examined. Intermolecular charge-transfer spectra are established for aromatic hydrocarbons or fluorocarbons with vanadium oxytrichloride, niobium and tantalum pentachlorides, and possibly in one case vanadium pentafluoride. The vanadium oxytrichloride interactions are extremely weak or just contact in terms of equilibrium measurements for the solvents cyclohexane and carbon tetrachloride, and in terms of the effect of temperature on the benzene and naphthalene spectra. Thermochromism, namely coloured liquids that freeze to solids the colour of the components, occurs for vanadium oxytrichloride and tantalum pentachloride with benzene and octafluoronaphthalene. Equilibrium constants for the niobium and tantalum pentachloride interactions also show them to be very weak, although the derived enthalpies, ca.  $1.5 \text{ kcal mol}^{-1}$ , though small are the largest in this series of papers. It is speculated that the extended dimer structures may afford more favourable conditions for molecular association. The remaining halides and oxyhalides do not show intermolecular spectra, but in some cases react chemically. For comparable molecular species, increasing electron affinities occur in the order  $\text{Ta} < \text{Nb} < \text{V}$ .

### OL 1542

Hammond, P. R., and R. R. Lake.  
"Electron Acceptor-Electron Donor Interactions.  
Part XX. Charge-Transfer Interactions of Some of  
the Highest-Valency Halides, Oxyhalides, and  
Oxides With Aromatic Hydrocarbons and  
Fluorocarbons. Ball-Plane Interactions. Group VB,"  
J CHEM SOC, SECT A, December 1971, pp.  
3806-12.

We examine the species  $\text{NF}_3\text{O}$ ,  $\text{PF}_5$ ,  $\text{PF}_3\text{O}$ ,  $\text{PCl}_5$ ,  $\text{PCl}_3\text{O}$ ,  $\text{AsF}_5$ ,  $\text{SbCl}_5$  and  $\text{SbF}_5$ . Both phosphorus and antimony pentachlorides, particularly the latter, are reactive and impose restrictions on the choice of donors.

for equilibrium studies. Nevertheless, phosphorus pentachloride with naphthalene and antimony pentachloride with benzene and octafluoronaphthalene demonstrate intermolecular spectra and exhibit extremely weak 1:1 interactions in a number of solvents; moreover the naphthalene-phosphorus pentachloride system is thermochromic. Phosphoryl chloride behaves like carbon tetrachloride in that it enhances markedly the spectra of hexamethylbenzene in solution (less so for benzene, naphthalene, anthracene, and pyrene) and this characterizes an extremely weak or just contact 1:1 interaction. The transition is assigned tentatively to a combined intensity-borrowing and electron-transfer process. Intermolecular charge-transfer spectra are not observed with other compounds of Group VB, although some of the materials are reactive chemically. Attempts at detecting arsenic and bismuth pentachlorides are unsuccessful. A spectrophotometric method for determining molecular self-association is suggested and it is pointed out that continuous-variation plots for a weakly interacting system do not provide information on molecularity.

#### OL 1543

Hammond, P. R., and R. R. Lake.  
 "Electron Acceptor-Electron Donor Interactions. Part XXII. Charge-Transfer Interactions of Some of the Highest-Valency Halides, Oxyhalides, and Oxides With Aromatic Hydrocarbons and Fluorocarbons. Ball-Plane Interactions. Some Remaining Elements," J CHEM SOC, SECT A, December 1971, pp. 3819-25.

Among the compounds examined, intermolecular charge-transfer spectra are demonstrated for  $\pi$ -donors with sulphuryl chloride, selenium hexafluoride, tellurium hexafluoride, perchloryl fluoride, iodine heptafluoride, iodine oxide pentafluoride, ruthenium tetroxide, and osmium tetroxide. Colours of many of the two-component mixtures vanish when frozen, and the selenium and tellurium hexafluorides in p-xylene (m.p. 13°C) effervesce and expel the acceptor into the vapour phase. The spectra define extremely weak interactions in the solvents carbon tetrachloride or cyclohexane, although in some cases the systems are too reactive for convenient quantitative study, whereas the precision of measurement is low for the volatile hexafluorides. For the same molar concentrations, selenium and tellurium hexafluorides produce nearly identical spectra with respect to wavelength position and small absorptivity values. Both show broad structureless absorptions at the 220 nm

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region for solutions in cyclohexane which are not observed in carbon tetrachloride or perfluoromethylcyclohexane and these are ascribed to hydrocarbon to  $MF_6$  intermolecular charge-transfer transitions.

### OL 1544

Hammond, P. R., and W. S. McEwan.  
"Electron Acceptor-Electron Donor Interactions. Part XXI. Charge-Transfer Interactions of Some of the Highest-Valency Halides, Oxyhalides, and Oxides With Aromatic Hydrocarbons and Fluorocarbons. Ball-Plane Interactions. Group  $VI_A$ ," J CHEM SOC, SECT A, December 1971, pp. 3812-19.

Interactions of the compounds chromyl chloride, molybdenum, tungsten, and uranium dioxide dichlorides, molybdenum hexafluoride, tungsten hexafluoride and hexachloride, uranium hexafluoride, and tungsten oxide tetrachloride towards aromatic hydrocarbons and fluorocarbons are examined. Colour changes are observed in most cases (with  $CrO_2Cl_2$ ,  $MoO_2Cl_2$ ,  $MoF_6$ ,  $WF_6$ ,  $WCl_6$ ,  $WOCl_4$ , and  $UF_6$ ), although with the exception of tungsten hexafluoride it is necessary to select carefully the appropriate unreactive donors. We attribute the absorptions principally to intermolecular charge-transfer transitions. Systems sufficiently stable for measurement show very small association constants (ca.  $0.0\text{--}1\text{ l mol}^{-1}$ ) in carbon tetrachloride, and in aliphatic hydrocarbon and fluorocarbon solvents; whereas temperature effects, expressed as enthalpies, show  $\Delta H$  values typically less than  $200\text{ cal mol}^{-1}$ . Colours of many of the two-component mixtures vanish in the frozen solids. Positions of the bands indicate an order  $Cr > Mo > W$  of decreasing electron affinities for comparable molecular species, and the materials include the strongest acceptors of this series of papers. Absorptions of molybdenum and tungsten hexafluorides and other compounds change according to the 'inert' solvent used, and the differences are ascribed to intermolecular solvent (e.g., cyclohexane) to acceptor transitions.

### OL 1545

Henry, Ronald A., and Donald W. Moore.  
"Intramolecular Cyclization of N-Alkyl-3,3',4,4'-tetrahydro-1,1'-bisoquinolinium Salts," J ORG CHEM, Vol. 37 (June 1972), pp. 2039-40.

7-Methyl-5,6,10,11-tetrahydro-8H-dilisoquino-[1,2-c:2',1'-e]imidazolidinium diiodide  $\underline{1}$  (mp indefinite) is a by-product of the dimethylation of 3,3',4,4'-tetrahydro-1,1'-biisoquinoline with excess methyl iodide.  $\underline{1}$  heated to 155-165° gives 5,6,10,11-tetrahydrodilisoquino[1,2-c:2',1'-e]imidazolium iodide, 296-298° (dec). Refluxing 2-methyl- or 2-benzyl-3,3',4,4'-tetrahydro-1,1'-biisoquinolinium halide in acetonitrile also effects an intramolecular cyclization; 5,6,10,11-tetrahydro-8-phenyl-dilisoquino-[1,2-c:2',1'-e]imidazolium perchlorate, 283-285° (dec). The changes are conveniently followed by <sup>1</sup>Hnmr; a mechanism is proposed.

## OL 1546

Henry, Ronald A., Arnold T. Nielsen, and Donald W. Moore. "Reactions of Epimeric 2,2'-Diacetyl-1,1',2,2'-tetrahydro-1,1'-biisoquinolines," J ORG CHEM, Vol. 37, No. 21, (October 1972), pp. 3206-09.

The title compounds are brominated by NBS to yield epimeric 2,2'-diacetyl-4,4'-dibromo-1,1',2,2'-tetrahydro-1,1'-biisoquinolines rather than 1,1'-dibromo derivatives as reported previously. Cleavage of the 1,1' bond characterizes attempts to aromatize these compounds by oxidative methods; e.g., the dibromo derivatives are converted to 4-bromoisquinoline in 90% yield by 5.3 N nitric acid at 30°. *dl*- and *meso*-4,4'-dibenzal-1,1',4,4'-tetrahydro-1,1'-biisoquinolines are recovered in low yields when the title compounds are heated in ethanol with benzaldehyde and concentrated hydrochloric acid; extensive cleavage of the 1,1' bond again occurs with the formation of 4-benzal-1,4- (and 3,4-) dihydroisoquinoline. 5,5'-Dinitro- and 5-nitro-1,1'-biisoquinoline are described.

## OL 1547

Hewer, G. A. "A Note on Controllability of Linear Systems With Time Delay," INST ELEC ELECTRON ENG, TRANS, AUTOMAT CONTR, Vol. AC-17, No. 5 (October 1972), pp. 733-34.

That the controllability of a linear time-invariant delay-differential equation is always implied by the usual algebraic criterion for controllability of the same system without delay is established.

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### OL 1548

Hindman, Edward E., II. "Meteorological Conditions Favorable for the Artificial Dissipation of Warm Fog," in *Proceedings of Third Conference on Weather Modification*, 26-29 June 1972. Rapid City, S.D., American Meteorological Society. Pp. 54-56.

Experiments to improve visibility in warm fog have been conducted by the Naval Weapons Center during the summer and fall months of 1968 through 1971 at the Arcata-Eureka Airport, McKinleyville, Calif. A hygroscopic solution was sprayed from an aircraft within a volume of fog as the volume drifted toward the airport. The solution was applied so the improvement in visibility would occur as the volume drifted across the airport.

The results indicate that the improvement in visibility depends on the meteorological conditions. For example, during the 1971 experiments, fogs on two separate days were drizzling and were each treated during the 30-min period before sunrise. No increases in visibility were observed following either seeding even though in both cases significant quantities of solution precipitated onto the runway. In contrast, also during the 1971 experiments, a fog which was not drizzling was treated during a 30-min period 2 hr following sunrise. A cleared "tunnel" drifted across the runway at a time following seeding when the treated volume was predicted to drift across the runway.

The data from these experiments and other unsuccessful and successful experiments are being analyzed. The range of meteorological conditions within which fog has been successfully cleared are being identified and will be presented. The range of conditions should be expanded by improving the present treatment system. An improved treatment system based on extrapolations of available data and theoretical considerations will be presented.

### OL 1549

Hindman, Edward E., II, and David B. Johnson. "Numerical Simulation of Ice Particle Growth in a Cloud of Supercooled Water Droplets," *J ATMOS SCI*, Vol. 29, No. 7 (October 1972), pp. 1313-21.

An empirical approximation is presented for estimating the growth of ice crystals by diffusion. The approximation is valid for computing crystal growth under conditions of constant temperature and water saturation. Crystal growth in these conditions has been realistically

simulated for a period of 30 min in the range of temperatures from  $-1$  to  $-30^{\circ}\text{C}$ . Modifications to the approximation are presented which permit it to be applied to varying temperature and varying saturation.

The approximation for diffusion growth was coupled with an approximation for accretion growth to simulate ice particle growth by diffusion plus accretion. These calculations indicated that  $1\text{-}\mu\text{m}$  ice crystals could grow to a size sufficient to collect supercooled droplets within a period of roughly 2 min regardless of the temperature and liquid water content conditions. The calculations also indicated that 1-cm hail could form from  $1\text{-}\mu\text{m}$  ice crystals in roughly 27 min. The hail was calculated to form in a cloud of supercooled droplets containing  $3.0\text{ gm m}^{-3}$  of liquid water at a temperature of  $-15^{\circ}\text{C}$ .

#### OL 1550

Hutcheson, Lynn D., and R. S. Hughes. "Rapid Transverse Acousto-Optic Tuning of an Organic Dye Laser," APPL OPT, Vol. 11 (December 1972), pp. 2981-83.

Rapid tuning of a dye laser, pumped by a 500 pps  $\text{N}_2$  laser, has been achieved by inserting an acousto-optic deflection cell in the laser cavity in such a way that Bragg diffraction occurs. This implies that the acoustic wave propagates essentially transversely to the direction of propagation of the optical wave, and this transverse geometry provides for tuning rates approximately 100 times greater than those provided by colinear acousto-optic tuning.

#### OL 1551

Kaufman, Martin H. "Anionic Polymerization of a Fluorinated Butadiene," POLYMER SCI, Part A-1, Vol. 10, (1972), pp. 455-64.

1,1-Bis(trifluoromethyl)-1,3-butadiene (I) is cleanly prepared in three steps. I produces an amorphous polymer by free-radical catalysis. Crystalline poly-I is produced by butyllithium catalysis in tetrahydrofuran at  $-78^{\circ}\text{C}$ . Qualitative kinetic experiments indicate that the anionic polymerization proceeds by a "living polymer" process. An AB block copolymer may be formed by adding I to anionically propagating butadiene; however, the reverse does not occur.

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### OL 1552

Knotek, M. L., and M. Pollak. "Correlation Effects in Hopping Conduction: Hopping as a Multi-Electron Transition," *J NON-CRYSTALLINE SOLIDS*, Vol. 8-10 (June 1972), pp. 505-10.

The treatment of hopping between localized states as a one electron transition breaks down at high densities. We have treated the problem in terms of a correlated two electron (one phonon) transition. We neglect exchange effects. The correlation effect consists of the movement of two (or more) electrons simultaneously whenever it lowers the energy difference between initial and final state of the system. This is seen to lower the activation energy over the one electron process, an effect noticeable at low temperatures, moderate densities, and moderate compensation in impurity conduction. The onset of the effect is seen to occur at a density on the order of  $(3/4\pi) (e^2 a / 2kTK)^{-3/2}$  for a temperature  $T$ , where  $K$  is the dielectric constant of the host medium and  $a$  is the Bohr radius of an impurity state.

### OL 1553

Lepie, Albert H., and Arnold Adicoff. "Dynamic Mechanical Behavior of Highly Filled Polymers: Dewetting Effect," *APPL POLYMER SCI*, Vol. 16 (May 1972), pp. 1155-66.

This paper describes the results of simultaneous dynamic measurements in tension and torsion made on propellant samples. The complex dynamic moduli  $E'$ ,  $E''$ ,  $G'$ , and  $G''$  at low frequencies were determined within a temperature range from room temperature to  $-90^\circ\text{C}$ . Time temperature shift factors and reduced master curves for both tension and shear properties are discussed. The effect of dewetting on the dynamic properties in tension and shear was also investigated. A preliminary attempt is made to compute the degree of dewetting in a propellant by applying Beer-Lambert's law.

### OL 1554

Mathews, L. A., and P. St.-Amand. "The Contribution of Interfacial Kinetics and of Diffusion to the Rate of Solution of Silver Iodide Particles and Its Effect on Nucleation," in *Proceedings of Third Conference on Weather Modification*, 26-29 June 1972, Rapid City, S.D.,

American Meteorological Society. Pp. 1-4.

The rate of solution of a silver iodide particle of initial radius  $r_{A0}$  to decrease to radius  $r_A$  in a water drop of radius  $r_D$  is determined. The dissolution of silver iodide at the liquid-solid interface, as well as the diffusion of silver iodide from the interface to the bulk of the solution, is considered in the calculation of the rates.

The rates of solution of various sized particles and drops are calculated for several temperatures. The time required for solution is compared to that for formation of a critical ice embryo for a given radius of silver iodide, and limits imposed on nucleation by the rate of solution are discussed.

#### OL 1555

Mathews, L. A., D. W. Reed, P. St.-Amand, and R. J. Stirton. "Rate of Solution of Ice Nuclei in Water Drops and Its Effect on Nucleation," J APPL METEOROL, Vol. 11, No. 5 (August 1972), pp. 813-17.

The time required for an ice nucleus of radius  $r_A$  to dissolve in a water drop of radius  $r_D$  is found for solubilities ranging from  $5 \times 10^{-10} \text{ gm cm}^{-3}$  (pure silver iodide at 0C) to  $10^{-3} \text{ gm cm}^{-3}$ . The basic assumption is that the dissolution of the liquid-solid interface is rapid compared to the diffusion of solute from the interface to the bulk of the solution, and hence the latter controls the rate of solution. The calculations show that most ice nuclei smaller than  $0.01$  or  $0.05 \mu$  in radius will be dissolved within a period of a few seconds and in some cases within a fraction of a second.

#### OL 1556

Miles, M. H., and W. S. McEwan. "Electrochemical Preparation of Cadmium and Mercury Tellurides," J ELECTROCHEM SOC, Vol. 119, No. 9 (September 1972), pp. 1188-90.

Telluride compounds are of growing interest due to their properties as semiconductors and semimetals. The solid solution system  $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$  is an outstanding infrared detector material. Cadmium telluride is useful for windows in infrared lasers and infrared modulators and also as a nuclear radiation detector. Although telluride compounds are often prepared by direct union of the elements at high temperatures, a convenient electrolytic method for preparing tellurides from aqueous solution at room temperature has been described. The application of electrochemical methods is investigated for the preparation

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of CdTe and HgTe.

### OL 1557

Nielsen, Arnold T., Richard C. Weiss, and Donald W. Moore. "Base-Catalyzed Intermolecular Condensation of  $\alpha,\beta$ -Unsaturated Ketones. Dimerization of 2,4-Diarylidene-cyclobutanones to 2-Spiro(2-oxocyclobutyl)bicyclo[3.2.0]heptan-6-one Derivatives," J ORG CHEM, Vol. 37 (April 1972), pp. 1086-92.

The self-condensation of 2,4-dibenzylidenecyclobutanone in aqueous ethanolic sodium hydroxide produces a crystalline dimer, 7-benzylidene-3,4-diphenyl-2-spiro(2-oxo-3-benzylidenecyclobutyl) bicyclo[3.2.0]heptan-6-one in 20-30% yield. Its structure has been established from chemical and spectral evidence, including nmr spectra of 5a and its  $d_1$ ,  $d_{20}$ ,  $d_{24}$ , and  $d_{25}$  deuterio derivatives, prepared by dimerization of 2a, 2a- $d_{10}$ , and 2a- $d_{12}$  in aqueous ethanol or deuterium oxide-ethanol- $O_d$ . Other 2,4-diarylidene-cyclobutanones (4-methylbenzylidene and 3,4-dimethoxybenzylidene) form crystalline dimers. The base-catalyzed dimerization reactions proceed through the unique 2,4-diarylidene-cyclobutanone anion intermediate and involve an intermolecular Michael addition followed by intramolecular Michael cyclization. The stereochemistry of dimer 5a is discussed.

### OL 1558

Norris, William P. "Poly- $\alpha,\alpha,2,3,5,6$ -hexafluoro-p-xylylene," J ORG CHEM, Vol. 37 (January 1972), pp. 147-48.

Octafluorotoluene reacts with sodio ethyl cyanoacetate in dimethylformamide to give ethyl (4-trifluoromethyl-2,3,5,6-tetrafluorophenyl)cyanoacetate which may be hydrolyzed and decarboxylated to (4-trifluoromethyl-2,3,5,6-tetrafluorophenyl)acetic acid. Pyrolysis of potassium (4-trifluoromethyl-2,3,5,6-tetrafluorophenyl)acetate at 250°/0.01 mm causes 1,6-elimination of  $CO_2$  and fluoride to give  $\alpha,\alpha,2,3,5,6$ -hexafluoro-p-xylylene which polymerizes upon condensation to poly- $\alpha,\alpha,2,3,5,6$ -hexafluoro-p-xylylene.

### OL 1559

Norris, William P. "Reactions of

Tetrakis(Dimethylamino)Ethylene With Weak Acids," *Tetrahedron*, Vol. 28 (1972), pp. 1965-72.

Tetrakis(dimethylamino)ethylene reacts in methanol at 25° to give carbon-carbon bond cleavage, substitution of methoxyl for dimethylamino and addition of methanol to the double bond. The principal products are dimethylamine, dimethoxydimethylaminomethane and 1,1,2-trimethoxy-1,2-bis(dimethylamino)ethane. Minor products are methoxydimethylamino-N,N-dimethylacetamide, trimethylamine and dimethyl ether. An oxidation-reduction side reaction forms a very small amount of the radical cation of tetrakis(dimethylamino)ethylene. In the presence of sodium methoxide no carbon-carbon bond cleavage occurs and no radical cation is formed. When methanol is dissolved in tetrakis(dimethylamino)ethylene (methanol 1 M), the principal products are 1,1,2-trimethoxy-1,2-bis(dimethylamino)ethane and dimethylamine with small amounts of tris(dimethylamino)methoxyethylene and 1,2-bis(dimethylamino)-1,2-dimethoxyethylene. Tetrakis(dimethylamino)ethylene and water give dimethylamine and dimethylformamide.

#### OL 1560

Norris, William P., Allen L. Olsen, and Richard G. Brophy. "Clouding of Pressed Potassium Bromide Powder," *APPL SPECTROS*, Vol. 26 (March/April 1972), pp. 247-51.

The monomolecular layer of water adsorbed on KBr particles is responsible for clouding of disks pressed from finely ground powder. Cloudiness is caused by formation of a multitude of cracks in the disk. The initial cracking can be observed with a low power optical microscope and the extensive cracking in the fully cloudy region is observable with a scanning electron microscope. It is suggested that adsorbed water promotes recrystallization, generating weak zones in the workhardened, elastically stressed disk which fails by cracking.

#### OL 1561

O'Hara, Norbert W., and William J. Hinze. "Basement Geology of the Lake Michigan Area From Aeromagnetic Studies," *GEOI. SOC AMER. BU'L*, Vol. 83 (June 1972), pp. 1771-86.

The magnetic field of Lake Michigan is dominated

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by a series of alternating regional maxima which are, in general, directly related to gravity anomalies on the perimeter of the lake. These magnetic zones are believed to be primarily related to Penokean basement trends which extend from Wisconsin across Lake Michigan into the Southern Peninsula of Michigan. The strike of these zones changes from northeast in southern Wisconsin and east in northern Wisconsin to east and east-southeast respectively in eastern Lake Michigan and Michigan. Exceptions are found in the northern and southern extremities of the lake. In southern Lake Michigan, southeast-trending magnetic anomalies are related to a regional gravity high extending across southwestern Michigan into northeastern Indiana. The positive magnetic zone in northern Lake Michigan strikes north from Grand Traverse Bay to north of Beaver Island, where it bifurcates with one limb extending north-northwest through Lake Superior to the Keweenaw basalt on Keweenaw Point. The other limb continues into the eastern portion of the Northern Peninsula of Michigan, and another segment of this branch connects to the Keweenaw flows on Mamie Point on the eastern shore of Lake Superior. In the Grand Traverse Bay area this positive magnetic zone becomes strongly negative and connects to the south with the mid-Michigan gravity and magnetic anomaly.

### OL 1562

Pearson, John. "The Energetics of Explosive Operations," in *Behavior and Utilization of Explosives in Engineering Design*, 12th Annual Symposium, 2-3 March 1972. Albuquerque, N. Mex. Univ. of New Mexico College of Engineering. Pp. 69-84.

### OL 1563

Porteus, J. O., and W. N. Faith. "Inelastic Low-Energy Electron Diffraction Measurements on Al(111)," *VACUUM SCI TECHNOL*, J, Vol. 9, No. 3 (May-June 1972), pp. 1062-72.

An experimental study has been made of electrons in the energy range 40-80 eV, inelastically scattered and diffracted from a clean Al(111) surface. The surface is prepared by epitaxial vapor deposition on a Si(111)

single-crystal surface in ultrahigh vacuum immediately precoding the measurements. The inelastic electron intensity at a given energy loss and angle is obtained as the energy derivative of the amplified electron current from a Faraday collector having a retarding field analyzer and limited angular acceptance. The energy derivative comes from the digitally computed average of a repeatedly measured difference in dc signal accompanying a fixed increment in retarding field. Using this method inelastic angular and loss profiles at  $15^\circ$  incidence have been obtained in the vicinity of a Bragg maximum of the 00 elastic beam. The profiles show structure related to the surface and volume plasmon momenta by a two-step model of inelastic diffraction. Dispersion data inferred by applying this model to the "loss-before-diffraction" structure are compared with results from other sources. The surface plasmon dispersion obtained from inelastic low energy electron diffraction measurements shows promise as a new means of characterizing solid crystalline surfaces.

## OL 1564

Prentice, Jack L. "Reaction of Nitrogen With Burning Beryllium Droplets," COMBUST SCI TECH J, Vol. 5, No. 6 (August 1972), pp. 273-85.

This paper describes the results of a systematic quantitative study of the combustion of single laser-ignited beryllium droplets burning in mixtures of oxygen/nitrogen. Nitrogen is shown here to raise the ignition limit and retard the combustion relative to oxygen/argon. Nitrogen-induced fragmentation of beryllium droplets is demonstrated for the first time. The results of these studies are compared with earlier quantitative data on beryllium droplets burning in oxygen/argon and it is shown that the rates, mechanisms and nature of the debris from burning are all affected by environmental species. The significant contribution of condensed phase processes occurring at the droplet surface to the overall combustion reveal clearly the inadequacy of a vapor phase combustion model for beryllium.

## OL 1565

Price, E. W., H. B. Mathes, O. H. Madden, and B. G. Brown. "Pulsed T-Burner Testing of Combustion Dynamics of Aluminized Solid Propellants," AMER INST AERON ASTRONAUT J. Vol. 10, No. 4 (April 1972), pp. 65-67.

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### OL 1566

Rehn, Victor, and D. S. Kysel. "Symmetry of the 4.5-eV Optical Interband Threshold in GaAs," PHYS REV LETT, Vol. 28, No. 8 (21 February 1972), pp. 494-97.

We report on the polarization dependence of the transverse electroreflectance spectrum of the 4.5-eV ( $E_0$ ) structure in GaAs. An interpretation using Bottka-Fischer symmetry analysis shows that this transition has  $\Delta$  symmetry, in contrast to the corresponding transition in Ge.

### OL 1567

Robertson, W. E. "Igniter Material Considerations and Applications," New York, American Institute of Aeronautics and Astronautics, 1972. Preprint No. 72-1195.

Igniter material data have been compiled to provide information relative to the selection of materials having capabilities for optimum performance while functioning within specific limitations imposed by such restricting factors as propellant ignition characteristics, hardware design and environment. Data summaries and material evaluations, discussions of materials and their application in the ignition of solid propellants, characteristics and function, configuration and application capabilities and a review of ten of the more commonly used main-charge igniter materials are given. The listed materials, with a compilation of their characteristics, are presented in the order to their importance with respect to utility. The characterizations include physical and chemical characteristics and qualities of the materials and the averaged heat-of-reaction and burning-rate values as determined by arc-image testing.

### OL 1568

St.-Amand, Pierre, and Shelden D. Elliott, Jr. "How To Seed Cumulus Clouds," J WEATHER MOD, Vol. 4, No. 1 (April 1972), pp. 17-49.

Techniques useful for seeding cumulus clouds, with glacogenic nuclei, for rain augmentation are discussed in detail.

Clouds are seeded by emplacement of glacogenic nuclei in updrafts at the top of unsheared clouds at the warmest temperature at which the nucleant is effective. Sheared clouds are seeded in updrafts on the upshear side of sheared clouds at the same temperature level.

(U) Usage rates, aircraft handling procedures and operational considerations are discussed.

OL 1569

St.-Amand, Pierre, Lohr A. Burkardt, William G. Finnegan, John A. Donnan, and Paul T. Jorgensen. "Pyrotechnic Production of Nucleants for Cloud Modification. Part I. General Principles," J WEATHER MOD, Vol. 2, No. 1 (May 1970), pp. 25-32.

In order to develop means for modification of clouds as a step to climatic management, the art of pyrotechnics has been applied to the problem of nuclei production and delivery. Pyrotechnics have advantages of easy, precise delivery of very specific agents at reasonable cost. As a by-product of colored smoke production, Dr. Burkardt and Dr. Finnegan began devising means of silver iodide production by reduction of silver iodate. This is done by use of pyrotechnic mixes that can be burned without confinement; propellant mixes that must be burned under pressure; or by gas-generating compounds that disseminate the material at a low temperature.

Both freezing and hygroscopic nuclei were produced. An outline of the research program is presented, showing the type of nucleant available and the practical distribution system for each type.

OL 1570

St.-Amand, Pierre, Lohr A. Burkardt, William G. Finnegan, L. Lee Wilson, Shelden D. Elliott, Jr., and Paul T. Jorgensen. "Pyrotechnic Production of Nucleants for Cloud Modification. Part II. Pyrotechnic Compounds and Delivery Systems for Freezing Nucleants," J WEATHER MOD, Vol. 2, No. 1 (May 1970), pp. 33-52.

The pyrotechnic systems in general use are discussed. Three techniques are in common use: (1) production of AgI smoke by thermal dissemination, (2) dispersal of AgI by gas-generating compounds, and (3) evaporation and/or combustion of solutions of silver iodide and/or a complex of AgI and an alkali iodide. Systems 1 and 2 produce AgI and other combustion products. System 3, with one exception, produces a complex of AgI and alkali iodide.

Formulations are given for production of AgI and some complexes, aluminum and magnesium oxide and ruby spinel. Lead iodide is rarely produced

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pyrotechnically; usually a lead oxyiodide results that also serves as an effective nucleant.

Delivery techniques are reviewed.

### OL 1571

St.-Amand, Pierre, Lohr A. Burkardt, William G. Finnegan, Glenn V. Binns, John B. Burmeister, Ronald F. Vetter, J. A. Donnan, and Otho E. Hart. "Pyrotechnic Production of Nucleants for Cloud Modification. Part V. Devices for Massive Seeding and Hurricane Modification," J WEATHER MOD, Vol. 2, No. 1 (May 1970), pp. 77-97.

Cyclops I, a parachute-retarded, nonpropulsive rocket motor delivering 4.5 kg of silver iodide smoke, was used in Project Cyclops, the forerunner of Project Stormfury, in 1961. Cyclops II, a polybutadiene fueled propulsive rocket motor equipped with fins that cause it to describe a helix as it falls, was used in hurricane Beulah in 1963. It delivers 30 kg of silver iodide smoke. Alecto is a polybutadiene fueled rocket motor launched from the M123 photoflash dispenser. It produces 1.7 kg of silver iodide. Imperfect centering of the nozzles imparts an erratic trajectory to encourage mixing with the air. It may be used as a fixed flare for horizontal seeding.

Trajectories, mass flow, and nuclei production rates as a function of altitude are given for Alecto.

### OL 1572

San Miguel, Anthony. "An Automated Biaxial Sheet Tester," EX MECH, Vol. 12, No. 3 (March 1972), pp. 155-57.

A mechanical system is described which can stretch a sheet of solid propellant in two directions as a function of time. The sheet displacements along each of the two directions are independently controlled from a computer tape. Two load cells record the instantaneous resulting loads. Biaxial strains are measured by means of a 70-mm camera, which also is operated by the tape. The instrument is designed to stretch a 10-cm square by 0.25-cm-thick sheet to 50-percent strains at cross-head rates from quasi-static to 150 cm/min.

## OL 1573

San Miguel, Anthony, and Robert M. McCarten. "Heat Transfer in Solid-Propellant Motors," SPACECRAFT ROCKETS, Vol. 9, No. 3 (March 1972), pp. 129-30.

Further evidence is presented that a serious discrepancy exists between measured transient temperatures in solid-propellant motors as obtained from embedded thermocouples, and those predicted by the classical Fourier heat conduction equation using independently-measured (laboratory) thermal properties. A consequence of such poor predictions is that a viscoelastic stress analysis is significantly limited in accuracy, since an accurate temperature history is a prerequisite for predicting stress history and eventual mechanical failure.

## OL 1574

Schadow, K. "Boron Combustion Characteristics in Ducted Rockets," COMBUST SCI TECH J, Vol. 5, No. 3, (May 1972), pp. 107-17.

A test program was performed with the objective of experimentally investigating the boron reaction characteristics in a ducted rocket by systematically varying the primary chamber conditions.

In order to vary the primary chamber conditions a test device was used which burned boron powder and gaseous propellants (hydrogen or carbon monoxide, oxygen and nitrogen) in the primary motor. The reaction characteristics in the secondary chamber were observed by color photography through quartz windows of the secondary chamber. In the tests the following parameters were varied: (1) primary chamber temperature, (2) mixture ratio of the gaseous fuel in the primary chamber from below stoichiometric to above stoichiometric at different primary chamber temperature levels in order to vary the afterburning capabilities of the gaseous exhaust in the secondary chamber, and (3) secondary chamber pressure.

At primary motor conditions which approximated propellants with high boron and low oxidizer/fuel content the boron particle temperature at the primary nozzle exit was not sufficient to initiate self-sustained boron combustion in the air. In order to further heat up and cause ignition of the boron particles in the secondary chamber it was necessary to burn additional gaseous fuel in the secondary chamber. It was also demonstrated that the hot (probably reacting, but not ignited) boron particles were necessary for triggering the gaseous fuel ignition in the air.

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### OL 1575

Schadow, K. "Study of Gaseous Nonequilibrium Effects in Particle-Laden, Ducted Flows for Improvement of the Combustion Efficiency," in *AIAA 10th Aerospace Sciences Meeting*. New York, American Institute of Aeronautics and Astronautics, 1972. Preprint No. 72-36, 10 pp.

The reaction of a particle-laden plume with a ducted subsonic airstream was experimentally studied by burning boron containing solid propellants and exhausting the products into a fuel-air combustion chamber. The observed reduced boron combustion efficiency with decreasing afterburner pressure was attributed to not achieving intensive reaction between the excess gaseous fuel from the solid propellant motor and the oxygen of the incoming air in the beginning of the mixing process. Because this reaction did not occur at all or started downstream in regions where intense mixing with the relative cool air had already taken place, the boron particles were not heated to a temperature where self-sustained particle combustion could occur.

### OL 1576

Schleusener, Richard A., Pierre St.-Amand, Wayne Sand, and John A. Donnan. "Pyrotechnic Production of Nucleants for Cloud Modification. Part VI. Case Study of Apparent Stimulation of Convection by Seeding a Thunderstorm With Alecto Pyrotechnic Devices," *J WEATHER MOD.* Vol. 2, No. 1 (May 1970), pp. 98-117.

During the summer of 1963, a number of thunderstorms were seeded with silver iodide-alkali iodide nuclei as a part of a hail suppression experiment in northeastern Colorado. One of the storms was treated with relatively pure silver iodide produced by five Alecto units burned in a strong updraft at the northwestern base of the storm. Rainfall increased rapidly. As much as 3 in. fell nearby with amounts as great as 1 in. falling for several tens of miles along the storm track. Rainfall of this intensity occurs less often than once in 12 years. The radar echo from the storm grew rapidly northward and eastward of the seeded area. The northward component of the velocity of the edge of the radar echo averaged 104 knots over a 5-min period. This rate of advance of radar echoes is observed less often than once in 35 years. While it cannot be proved in this way that seeding altered the storm, it is extremely unlikely that the increased

growth and increased rainfall were caused by natural processes alone, and it is very likely that artificial stimulation of the convective activity by the silver iodide was responsible for these phenomena. No hail was observed.

**OL 1577**

Seraphin, B. O. "Modulated Reflectance," in *Optical Properties of Solids*, ed. by F. Abeles. Amsterdam, North-Holland Publishing Co., 1972. Chap. 4, pp. 164-276.

**OL 1578**

Seraphin, B. O. "Electroreflectance," in *Semiconductors and Semimetals*, Vol. 9, ed. by R. K. Willardson and Albert C. Beer. New York, Academic Press, 1972. Chap. 1, "Electroreflectance," pp. 1-149.

**OL 1579**

Sewell, R. G. S., and G. F. Kinney. "Pressure Rises in Internal Explosions," in *Behavior and Utilization of Explosives in Engineering Design*, 12th Annual Symposium, 2-3 March 1972. Albuquerque, N.Mex. University of New Mexico College of Engineering. Pp. 161-66.

**OL 1580**

Smallman, R. E., and K. H. Westmacott. "Invited Review: The Nature and Behaviour of Vacancy Clusters in Close-Packed Metals," *MATER SCI ENG*, Vol. 9, No. 5 (May 1972), pp. 249-72.

In the 12 years since transmission electron microscopy was first used to observe directly the vacancy clusters which form in quenched metals, a very large number of similar observations have been reported. In the present paper the main results which have led to a greatly improved understanding of the nature of point defect clusters are first reviewed and rationalized. This is

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followed by a discussion of the stability and annealing behaviour of secondary defects and the ways in which such studies give information on important metallurgical parameters. Finally, a general discussion of the nucleation of secondary defects is given, and important areas for further study are outlined.

### OL 1581

Smith, M. H. "Fog Modification by Means of Electrified Droplets," J WEATHER MOD, Vol. 4, No. 1 (April 1972), pp. 70-84.

A system for induction charging of sprayed droplets was designed and built at the Naval Weapons Center. This system was tested in the field during actual fog conditions.

Theory of fog dispersal with charged droplets, system design, theoretical operation of the spray system, theoretical limitations, and practical operation of the spray system are discussed.

### OL 1582

Soli, Giorgio. "A Method of 'Staining' Bacterial Cells for the Scanning Electron Microscope." MICROSCOPICA ACTA, Vol. 72, No. 2 (May-June 1972), pp. 150-53.

A technique is presented which utilizes certain salt solutions in the treatment of bacteria prior to their exposure to the electron beam of a scanning electron microscope. Tridimensional, well resolved images are thus obtained without any need for coating the cells with either gold or aluminum.

### OL 1583

Soli, Giorgio, and E. M. Bens. "Bacteria Which Attack Petroleum Hydrocarbons in a Saline Medium," BIOTECHNOL BIOENG, Vol. XIV (May 1972), pp. 319-30.

Bacterial strains were isolated from California coastal areas which showed the ability to oxidize normal paraffins, iso-paraffins, and aromatic hydrocarbons in a synthetic seawater medium. The ability to utilize a particular hydrocarbon was established not only on the basis of visible bacterial growth but also through a chromatographic technique which was standardized and

which could define the amount of each hydrocarbon consumed by the bacteria in a mixture. Some of the strains exhibited vigorous hydrocarbon oxidation when exposed to synthetic mixtures of hydrocarbons as well as crude oil. Under conditions of aeration and agitation, mixed cultures could destroy approximately 50% of a South Louisiana crude oil in a period of 48 hr.

#### OL 1584

Spicer, W. E., T. M. Donovan, and J. E. Fischer. "The Case for Sharp Band Edges in Amorphous Ge and Si," *J NON-CRYSTALLINE SOLIDS*, Vol. 8-10 (June 1972), pp. 122-27.

Must the absence of long range order alone result in the loss of well defined valence and conduction band edges in the density of states? The available experimental data for amorphous Ge and Si is examined. It is concluded that, for samples where the density of microvoids and other intrinsic defects are kept sufficiently small, the experimental data strongly suggests sharp band edges.

#### OL 1585

Stronge, W. J. "An Accelerating Force on a String," *ACOUST SOC AMER J*, Vol. 50, No. 5, Part 2 (November 1971), pp. 1382-83.

An infinitely long, perfectly flexible string is subjected to a transverse force that moves with arbitrary speed. The effect of the force accelerating through a resonant speed is determined. This invariably results in large deformations if the force is concentrated. With a distributed force, the deformations can remain small if the force accelerates through the resonant speed rapidly.

#### OL 1586

Thompson, J. R., S. D. Elliott, Jr., and J. W. Carroz. "Santa Barbara Aerial Seeding Program 1971-72," in *Proceedings of Third Conference on Weather Modification*, 26-29 June 1972, Rapid City, S.D., American Meteorological Society. Pp. 325-32.

For the fifth winter season, 1971-72, of randomized seeding of convection bands within storms

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passing over Santa Barbara County, pyrotechnic seeding from a fixed ground station was replaced by aerial seeding along a track normal to the storm movement vector just off the coastline. The light-twin seeding aircraft was flown just below the freezing level, under control from Vandenberg Air Force Base, and dispensed AgI nuclei from an NWC-developed burner using an AgI-NH<sub>4</sub>I-acetone solution. The previous randomization scheme was revised in that all the convection bands which occurred in a given storm period were similarly treated (either all seeded or all not seeded).

As in previous years, the primary mode of evaluation was by rainfall, the former control and target zones being combined into a single 2500 mi<sup>2</sup> target area containing 75 raingages. A single-ratio analysis of seeded to not-seeded convection band precipitation and a single-ratio analysis of seeded to not-seeded storm (a rigid 48-hr time block) precipitation were both employed. In addition, cloud top heights were measured with the X-band tracking unit of an M-33 radar, while precipitation echo movement and evolution were monitored with an L-band TPS-1D radar, both provided by NWC. Additional information was provided by the ARSR I-band radar at Vandenberg and a Raytheon X-band radar at project headquarters in Goleta.

The project operating procedures, radar utilization, and seeding generators are described, and results of a preliminary evaluation of the season's results are discussed.

## OL 1587

Vetter, Ronald F., William G. Finnegan, Lohr A. Burkardt, Pierre St.-Amand, H. Sampson, and Martin H. Kaufman. "Pyrotechnic Production of Nucleants for Cloud Modification. Part III. Propellant Compositions for Generation of Silver Iodide," J WEATHER MOD, Vol. 2, No. 1 (May 1970), pp. 53-64.

Propellant formulations for production of silver iodide began with the use of AgI<sub>2</sub> and poly(2-methyl-5-vinyl) tetrazole. This yields very pure silver iodide, but is expensive and difficult to use. Plasticized nitrocellulose is an effective binder for use in rocket motors, fuzes, and flares, but is not suited for projectiles. Polybutadiene fuels are excellent for use in rocket motors, but are unsuitable for other uses. Magnesium fluorocarbons are well suited for any use requiring ignition and combustion at high altitudes and in any application requiring physical strength. Polyurethanes are well suited for use as flares, candles, and energetic rocket propellants; double base systems produce

exceptionally pure silver iodide and are used for ground burning or applications involving production of precisely reproducible numbers of nuclei such as intercalibration of cold boxes. Extremely high yields are possible from double base materials.

#### OL 1588

Westmacott, K. H. "The Role of Impurities in the Formation of Damage in Quenched and Neutron-Irradiated Materials," presented at the III Inter-American Conference on Materials Technology, Rio de Janeiro, August 1972. Published by Centro Regional de Ayuda Tecnica, Mexico/Buenos Aires. Pp. 197-200.

Transmission electron microscopy (TEM) studies of the structure of quenched or neutron-irradiated metals are continuing in attempts to understand the basic mechanisms of defect cluster nucleation and growth. Such information is essential for developing improved structural materials to meet increasingly demanding nuclear reactor requirements. In the present paper recent results which demonstrate the importance of trace amounts of certain impurities on the type and stability of the defect structure which is developed are reviewed and a discussion of a recent nucleation model given.

#### OL 1589

Westmacott, K. H. "Secondary Defect Formation in Quenched Gold," JAP J APPL PHYS, Vol. 11, No. 7 (July 1972), pp. 1064-65.

#### OL 1590

Zinn, Ben T. "Review of Present Understanding of Damping of Combustion Instabilities by Solid-Propellant Rocket Motor Nozzles," New York, American Institute of Aeronautics and Astronautics, 1972. Preprint No. 72-1050.

This paper reviews the state of knowledge regarding the capabilities of solid propellant rocket motor nozzles to attenuate combustion instabilities. To obtain a better physical appreciation of the problem, the various

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modes of wave energy losses through the nozzle are discussed. Next, available theories for the prediction of nozzle losses are reviewed and the relationships between nozzle losses, the nozzle admittance, and the nozzle decay coefficient are discussed. The quality of nozzle admittance data measured by use of the Half-Power Bandwidth Method, the Direct Method, and the Impedance Tube Method is discussed, and these data are compared with one another as well as with available theoretical predictions.

## PATENTS

### U.S. Patent 3,609,488

Speed Control for a Synchronous Motor, by John B. Sampson and Hadyn L. Smith, NWC. 28 September 1971. Patent UNCLASSIFIED.

A motor control means to accomplish frequency changing which in turn achieves a speed change in a synchronous motor comprising a voltage controlled oscillator which responds to a discriminator circuit which either increases or decreases the frequency output of the oscillator in accordance with whether a synchronizing pulse is early or late with respect to an enabling pulse.

### U.S. Patent 3,609,590

Expanded Laser Beam Output, by James L. Jernigan, NWC. 28 September 1971. Patent UNCLASSIFIED.

A laser utilizing two 100 percent reflective surfaces and a prism positioned in the laser cavity between the reflective surfaces. A majority of the beam is reflected off one side of the prism and directed to a reflective surface where it reflects toward the prism while the rest of the beam is transmitted through the prism to form an elliptical output beam.

### U.S. Patent 3,610,099

Fluoric Diode, by Dewey P. Ankeney,

## PATENTS

NWC. 5 October 1971. Patent UNCLASSIFIED.

A fluoric diode responsive to electronic digital command wherein the position of a piston within a cylinder is controlled. A fluoric interface shifts fluid flow and by adding or subtracting digital information the flow rate can be increased or decreased thus changing the rate of piston movement.

U.S. Patent 3,611,157

Pulse Width Discriminator, by Richard Smith Hughes, NWC. 5 October 1971. Patent UNCLASSIFIED.

A pulse width discriminator for discriminating between pulses on the basis of pulse width, even though the pulse width may be ill defined, incorporating a differencing amplifier, peak detector, one-shot, attenuator and Schmitt trigger.

U.S. Patent 3,613,373

Hybrid High Energy Propulsion Methods, by Martin H. Kaufman, NWC. 19 October 1971. Patent UNCLASSIFIED.

The present invention relates to an improved high energy propellant and to the preparation thereof.

U.S. Patent 3,613,581

Explosive Device for Perforating High-Strength Metal Plates, by John Pearson and Lawrence N. Cosner, NWC. 19 October 1971. Patent UNCLASSIFIED.

This invention relates to a novel-shaped charge device, and more particularly to such a device for producing a circular perforation in relatively thick, high-strength, metal plate structures.

U.S. Patent 3,613,621

Oceanographic Observation Platform, by Larry E. McKinley, NUWC, and William E. Evans, NMC. 19 October 1971. Patent UNCLASSIFIED.

An underwater viewing vehicle comprising a viewing compartment fixedly attached to a vertical entry tube and a winch for raising and lowering the viewing

compartment, all carried on a catamaran.

**U.S. Patent 3,616,593**

**Method for Preparing Chemiluminescent Compositions and Devices Containing Tetrakis(Disubstitutedamino)Ethylenes**, by Sydney Shefler and Harold S. Duff, NWC. 2 November 1971. Patent UNCLASSIFIED.

A method for preparing chemiluminescent compositions and devices containing tetrakis(disubstitutedamino)ethylenes, which comprises formulating the composition or filling the device in a normal atmosphere.

**U.S. Patent 3,617,015**

**Head Coupled Missile Aiming Device**, by Floyd A. Kinder, NWC. 2 November 1971. Patent UNCLASSIFIED.

A device having multiple sensors which provide a voltage, responsive to the movement of the head of an aircraft pilot, proportional to an angle from the axis of the aircraft to align the tracking unit of a missile with a target to permit firing of the missile when the aircraft cannot be aligned with the target.

**U.S. Patent 3,620,672**

**Restraining Collar Device for Squibbing Missile Motors**, by Allan G. Barrett and Francis L. Albers, NWC. 16 November 1971. Patent UNCLASSIFIED.

A device for restraining missile motors for squibbing. It comprises an alignment fixture and a restraining collar assembly mounted to a back plate whereby when a missile is moved into alignment the restraining collar assembly engages the missile hook or hanger on the outside of the motor casing thereby accurately positioning the missile so that current will flow. Only when accurately positioned will the missile motor be squibbed.

**U.S. Patent 3,620,162**

**Rifle Launched Rocket**, by Paul C. King,

## PATENTS

NWC. 16 November 1971. Patent UNCLASSIFIED.

A rifle launched rocket which comprises a rocket motor provided with a bullet catcher and a warhead with a fuse assembly and means for attachment of the rocket to the muzzle of a field rifle.

U.S. Patent 3,620,694

Method for Removing Dissolved Oxygen From Hydrocarbon Gels, by Ken Posey Jr., contractor. 16 November 1971. Patent UNCLASSIFIED.

A method of removing dissolved atmospheric oxygen from hydrocarbon liquids and gels which comprises incorporating pyrogallol in the alkaline portion of a three-component flame fuel system consisting of an alkaline portion, a nonalkaline portion, and a hydrocarbon liquid portion. This method effectively reduces swelling of the product formed.

U.S. Patent 3,622,814

Negatively Charging Piezoelectric Power Supply, by Thomas E. Carlson, Honeywell, Inc. 23 November 1971. Patent UNCLASSIFIED.

A negatively charging piezoelectric power supply including a case, piezoelectric crystal, set back weight, probe switch and rubber disk such that on accelerating the projectile containing the piezoelectric power supply, the probe shorts the charge generated by the crystal to the case through compressing the rubber disk by the weight and on lessening of the acceleration the short is removed and a negative charge produced by the crystal relaxation.

U.S. Patent 3,623,215

Method of Making Wire-Wound Shaped Charge Conical Liner, by Clarence E. Weinland, NWC. 30 November 1971. Patent UNCLASSIFIED.

A method of fabricating a conical metal cavity liner such that its mass in any section transverse to its axis is uniformly distributed. The method includes the steps of anchoring copper or other wire in place on a conical mandrel and winding this basic wire onto the

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mandrel until a cone is formed, winding a soldering or filler wire into the grooves formed between adjacent turns of the basic wire winding, heating the mandrel with the double winding in place so as to fuse the filler wire and basic wire into an integral unit. After cooling, the cone formed is removed as a unit from the mandrel.

**U.S. Patent 3,623,375**

Gyro-Nutation Damper, by William H. Woodworth, Jack A. Crawford, and James A. Parmerlee, NWC. 30 November 1971. Patent UNCLASSIFIED.

A gyro-nutation damper having a mass and spring combination with a resonant frequency equal to the nutation frequency. The nutation causes the mass to rotate. The rotation is started in first one direction and then the other by springs connected to the mass and the coupling shaft.

**U.S. Patent 3,623,727**

Tow Target Including a Controllable Source of Heat Radiation, by Ephraim Regelson and William S. Roney, NWC. 30 November 1971. Patent UNCLASSIFIED.

An aerial tow target consisting essentially of two orthogonal triangular airframes has been augmented with a butane burner or the like to provide a target for radiation seeking missiles.

**U.S. Patent 3,624,365**

Vertical Attitude Measuring Device, by William H. Woodworth, NWC. 30 November 1971. Patent UNCLASSIFIED.

A device for detecting the angular variation of an aerodynamic vehicle measured from a line normal to the surface of the earth utilizing a rate gyro, an angle of roll means and an integrating amplifier. The signal received from the rate gyro is integrated. The integrator output is summed with the output of the angle of roll means, and fed back to the input of the integrator. The integrator output now is proportional to the angle of roll of the aerodynamic vehicle.

## PATENTS

### U.S. Patent 3,624,751

**Aerodynamic Air Inlet for Air-Breathing Propulsion Systems**, by Ronald F. Dettling, NWC. 30 November 1971. Patent UNCLASSIFIED.

Means for effecting the induction of outside air into the combustion process of an air-breathing propulsion system such as ram jets, ducted rockets, and air-augmented rockets. A jet of fluid is exhausted at high velocity into the airstream just behind an open port in the skin of the vehicle. The injection of this fluid causes the formation of a shock wave some distance upstream of the point of injection. Air between this shock wave and the injection point is at a high pressure and thus flows into the open port in the skin of the vehicle. Thus, no external obstruction need be attached to the vehicle to divert air into the port.

### U.S. Patent 3,626,032

**Preparation of Poly- $\alpha,\alpha$ , 2,3,5,6-Hexafluoro-P-Xylylene**, by William P. Norris, NWC. 7 December 1971. Patent UNCLASSIFIED.

A method for the preparation of new highly fluorinated p-xylylene monomers and polymers which have excellent chemical and thermal properties.

### U.S. Patent 3,626,581

**Wire Wound Conical Liner for Shaped Charge Warhead**, by Clarence E. Weinland, Vista, Calif. 14 December 1971. Patent UNCLASSIFIED.

Conical metallic liners for shaped charges which comprises providing a suitably formed mandrel precoated with a release agent, winding wire of uniform diameter on said mandrel and bonding each turn in place.

### U.S. Patent 3,626,697

**Method and Means for Controlling the Thrust in a Solid Propellant Rocket Motor**, by Robert H. Nunn, Davis, Calif., and Lane Curtis Chaffin, NWC. 14 December 1971. Patent UNCLASSIFIED.

The present invention relates generally to

Improvements in rocket motor control techniques and more particularly to an improved method and means for selectively controlling propellant burning and, consequently, the thrust of solid propellant rocket motors through the utilization of pressurized fluid injected into the throat of rocket motor nozzles.

**U.S. Patent 3,626,852**

Warhead Initiation Transfer Link, by Richard Plauson, NWC. 14 December 1971. Patent UNCLASSIFIED.

A nose-fused warhead is provided with means for initiated detonation of the explosive charge from the rear. A detonating shock is passed through a transfer link from the nose-fuse to a booster charge at the rear of the warhead.

**U.S. Patent 3,627,428**

Optical Quadrature, by Truman G. Bergman, NWC. 14 December 1971. Patent UNCLASSIFIED.

A lens assembly and associated detectors for providing directional information concerning the location of a source of light with respect to the system optical axis comprising a lens system for separating light rays entering therein into quadrants, a focusing lens for focusing light rays on the lens system and detectors positioned with respect to the lens system such that the separated light rays impinge on the detectors and the outputs of the detectors provide directional information with respect to the system optical axis.

**U.S. Patent 3,629,020**

Castable Fluorocarbon Composite Propellants, by Martin H. Kaufman and John D. O'Drobinak, NWC. 21 December 1971. Patent UNCLASSIFIED.

This invention relates to a novel castable high-density composite propellant composition and to the preparation thereof.

**U.S. Patent 3,631,250**

Optical Positive Feedback Sensor Circuit,

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by Lyman F. Van Buskirk, NWC. 28 December 1971. Patent UNCLASSIFIED.

An optical positive feedback sensor circuit which converts regularly coded information into electrical signals. When not obstructed by the coded opaque pattern of a moving information carrier light from a light emitting diode is detected by a phototransistor. The output of the phototransistor is then amplified. A portion of the amplifier output provides positive feedback through the light emitting diode, driving the circuit into saturation. A circuit is included to maintain a light level at least sufficient to restart the operation after a period of light obstruction.

### U.S. Patent 3,631,551

Prepackaged Monopropellant Gas Generator Buoyancy System, by Donald Miller, NWC. 4 January 1972. Patent UNCLASSIFIED.

A prepackaged monopropellant gas generator buoyancy system having a variable lift capability wherein the effective volume of the lifting compartment may be variably adjusted by the user and incorporates a stainless steel bellows as the fuel compartment.

### U.S. Patent 3,631,678

Exhaust System, by Jerry L. Reed, NWC. 4 January 1972. Patent UNCLASSIFIED.

Exhaust systems with a group of exhaust tubes wherein the group of tubes contains a torsional rotation of 180° or more. The group is covered with an outer shroud and coolant is forced to flow in the interstices between tubes.

### U.S. Patent 3,633,507

Air-To-Ground Target-Marking Device, by Carl H. Morley, NWC, and Howell M. Sumrall, San Diego. 11 January 1972. Patent UNCLASSIFIED.

A delivery system for air-to-ground markings which comprises a bomblet-containing marking material and provided with a sensor which operates to trigger release of said marking material within a few inches of treetop or near ground surface.

**U.S. Patent 3,633,510**

Dual Mode Fuze Explosive Train, by R. A. Bernardin, Honeywell, Inc. 11 January 1972. Patent UNCLASSIFIED.

A dual mode fuze explosive train which comprises the combination of a superquick firing pin assembly and an inertial firing pin assembly whereby the inertial pin comes forward to initiate the stab primer when the fuze hits a soft target and the superquick firing pin is driven into a stab detonator thereby initiating the end initiator when a hard target is struck.

**U.S. Patent 3,633,846**

Expandable Aerodynamic Fin, by Lawrence M. Biggs, Jr., NWC. 11 January 1972. Patent UNCLASSIFIED.

An expandable aerodynamic fin comprising a hollow primary fin housing provided with a recess within which is sealed a secondary fin composed of a flexible membrane in the form of a pouch being attached at its edges to the periphery of the inner wall of said primary fin. A pressurization device is positioned adjacent the primary fin base with gas pressure lines leading through the base to the recess. Upon actuation of this device sufficient gas pressure is created to fill the secondary fin and force it to expand thereby rupturing the seal and fanning out to become an integral part of the primary fin.

**U.S. Patent 3,633,988**

Helmet-Mounted Holographic Aiming Sight, by Reed A. Farrar, NWC. 11 January 1972. Patent UNCLASSIFIED.

A head-coupled sighting reticle having a hologram incorporated in a helmet faceplate illuminated by a point source of light. The hologram is constructed by creating a spherical-plane wave-interference pattern. In operation, the pilot looks through the hologram, and superimposes the virtual image of a point source, or other configuration, on the target. The pilot's head position then indicates the direction to the target.

**PATENTS**

**U.S. Patent 3,634,154**

**Solid Propellant Composition Containing Gelled Hydrazine**, by George William Burdette, NWC. 11 January 1972. Patent UNCLASSIFIED.

A method for the preparation of a propellant composition which comprises the steps of (a) stirring antimonyl potassium tartrate crystals into a solution consisting of hydrazine and sodium carboxymethylcellulose at room temperature until a homogeneous mixture results, and (b) curing said mixture overnight; whereby a nonreversible gel forms.

**U.S. Patent 3,636,380**

**Power Amplifier**, by Vernon A. Anderson, NWC. 18 January 1972. Patent UNCLASSIFIED.  
An amplifier using a Schmitt trigger.

**U.S. Patent 3,638,045**

**Pulse Stretcher**, by Richard Smith Hughes, NWC. 25 January 1972. Patent UNCLASSIFIED.

A follow-hold circuit wherein the output follows the input until an external gating trigger disables the circuit, whereupon the output remains at the last input level until the gating trigger enables the circuit again, wherein the circuit comprises a differential feedback video amplifier and transistorized switch.

**U.S. Patent 3,638,698**

**Crosslinked Carboxymethyl Cellulose Nitrates**, by Alan L. Woodman and Arnold Adicoff, NWC. 1 February 1972. Patent UNCLASSIFIED.

The invention relates to a method for preparing crosslinked carboxymethyl cellulose nitrate and to the product thereof.

**U.S. Patent 3,639,183**

**Gas Generator Compositions**, by Frank G.

Crescenzo and Robert L. Dow, NWC. 1 February 1972. Patent UNCLASSIFIED.

The present invention relates to solid propellant compositions and in particular to an improved gas generator composition.

**U.S. Patent 3,640,070**

Hybrid Propellants System, by Martin H. Kaufman, John D. O'Drobinak, and James O. Dake, Jr., NWC. 8 February 1972. Patent UNCLASSIFIED.

The method for creating propulsive thrust by burning a solid phase with a liquid phase injectant and exhausting the products from a rocket nozzle.

**U.S. Patent 3,640,484**

A Release Mechanism, by Harry B. Porter and Robert A. Weinhardt, NWC. 8 February 1972. Patent UNCLASSIFIED.

A release mechanism for stabilizing rolleron of a missile.

**U.S. Patent 3,640,785**

Castable Fluorocarbon Binders, by John O'Drobinak and Martin H. Kaufman, NWC. 8 February 1972. Patent UNCLASSIFIED.

The invention relates to new fluorocarbon binder composition and to the preparation thereof.

**U.S. Patent 3,650,857**

Gelled Amine Rocket Fuels, by George W. Burdette and Dean H. Couch, NWC. 21 March 1972. Patent UNCLASSIFIED.

A gelled amine rocket fuel comprising hydrazine or derivatives thereof, cellulose acetate and hydroxyethylcellulose, for use in modern missile systems.

## **PATENTS**

### **U.S. Patent 3,661,047**

**Apparatus for Casting Thin Walled Hollow Cylindrical Inserts**, by Wallace E. Silver and Jack Sherman, NWC. 9 May 1972. Patent UNCLASSIFIED.

A mold for casting thin-walled hollow cylindrical inserts from hazardous materials for use in warheads, rocket motors and pyrotechnic flares. The apparatus comprises a plurality of disposable presized tubes fitted within each other, and spaced apart so as to form mold spaces or chambers which are filled with a hazardous material, such as explosive. Upon curing the tubes are peeled off leaving thin-walled tubular inserts.

### **U.S. Patent 3,661,083**

**Device for Rapidly Mixing and Agitating Chemicals in Sealed Containers**, by James E. Weimholt, NWC. 9 May 1972. Patent UNCLASSIFIED.

The invention comprises an apparatus for maintaining liquid and dry chemicals safely separate in hermetically sealed containers and for rapidly mixing and agitating the chemicals in flight just prior to launch of the munition.

### **U.S. Patent 3,661,084**

**Band Release**, by Ronald C. Noles, NWC. 9 May 1972. Patent UNCLASSIFIED.

Separation of a fastening band is accomplished by firing a small shaped charge device in such a way as to cut a link in the band. The shaped charge device is contained in an adapter which positions the charge over the link and confines the force of the charge to the desired area. The adapter holds the shaped charge device to a timer mechanism in position to be detonated by a stab primer or the like.

### **U.S. Patent 3,661,087**

**Flare Deployment System**, by Robert C. Willard, Harold L. Daurer, and Ronald Clifford Noles, NWC. 9 May 1972. Patent UNCLASSIFIED.

The deployment of a hot air suspended flare system is enhanced by a time delay venting and destruct system. As the balloon is deployed with the aid of a drogue chute, a lanyard attached to the chute extracts a safety wire from a firing device which ignites a length of safety fuze proportioned to ignite a first segment of stranded propellant after a predetermined time for cutting a vent in the balloon and at the same time igniting a second proportioned length of safety fuze. The second length of safety fuze, in turn, ignites a second pattern of stranded propellant which completely destroys the lifting power of the balloon.

**U.S. Patent 3,661,347**

Gain Changer, by William H. Woodworth and Jack A. Crawford, NWC. 9 May 1972. Patent UNCLASSIFIED.

A device for adjusting the gain of the amplifier which drives the control surfaces of an aerodynamic vehicle to compensate for changes in lateral acceleration of the vehicle wherein the acceleration component of the commanded guidance is compared to the measured acceleration normal to the longitudinal axis of the vehicle. If the commanded acceleration is higher than that measured, the gain of the variable gain amplifier which drives the control surfaces of the aerodynamic vehicle is increased.

**U.S. Patent 3,661,525**

Process for Neutralization of Amorphous Boron, by Benjamin Y. S. Lee and John Gonzales, NWC. 9 May 1972. Patent UNCLASSIFIED.

A process for the neutralization of large quantities of amorphous boron with anhydrous ammonia for use in fuel-rich solid propellant formulations wherein boron is used in large amounts.

**U.S. Patent 3,662,386**

Programmable 20-Bit Pseudorandom (PRF) Generator, by Kenneth O. Bryant, NWC. 9 May 1972. Patent UNCLASSIFIED.

A programmable pseudorandom PRF generator for generating allowable combinations of PRF and jitter percent comprising a program selector means for

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inspecting the output of the selector for unwanted codes and a 20-bit pseudorandom generator for generating an output pulse having an allowed combination of PRF and jitter percent such that the output pulse, when jittered, has the same average frequency as the unjittered pulse.

### U.S. Patent 3,665,706

Igniter-Attenuator Device for Attenuating Combustion Instability in Rocket Motors, by Edward W. Price, NWC. 30 May 1972. Patent UNCLASSIFIED.

A device for attenuating oscillatory combustion in solid rocket motors which comprises an igniter-attenuator device attached at the forward end of a rocket motor combustion chamber so that oscillatory combustion is effectively attenuated.

### U.S. Patent 3,667,847

Method and Apparatus for Investigation of Projectile Flight, by William C. Griffin, NWC. 6 June 1972. Patent UNCLASSIFIED.

A device comprising two intersecting planar mirrors is placed adjacent to the flight path of a projectile with the line of intersection of the two mirrors normal to the line of sight of a camera. The angle at which the mirrors intersect is chosen to provide five separate images visible in a single photograph made of the projectile by the camera.

### U.S. Patent 3,669,912

Method of Making Deep Ocean Buoyant Material, by Roy F. Hinton, NWC. 13 June 1972. Patent UNCLASSIFIED.

A buoyant, nonabsorbent, high-strength, low-density, bulk filler material which can be readily mixed and cast for use in the displacement of sea water at great ocean depths. The material of varying pellet-size is formed by dropping epoxy resin into a bed of microspheres under ambient conditions. The droplets absorb the microsphere thereby forming uncured pellets, the size of which is controlled by the size of the droplet. They are then cured for several hours at an elevated temperature.

**U.S. Patent 3,671,341**

Dense Propellant Composition, by Jack Dierolf, NWC. 20 June 1972. Patent UNCLASSIFIED.

A propellant which has a flame temperature of 4700°F or lower. It consists of a mixture of Teflon, Viton, a dense metal oxidizer such as mercuric oxide, and a heavy metal such as uranium.

**U.S. Patent 3,671,609**

New Polymeric Compositions, by Martin H. Kaufman, NWC. 20 June 1972. Patent UNCLASSIFIED.

Polymeric compositions characterized by being fiber-forming and stereospecific and capable of being melted and drawn into strong crystalline filaments and fibers. The compositions are useful as storage stable binders as well as adhesives for fluorocarbon material.

**U.S. Patent 3,672,303**

Temperature Sensing Squib Firing Device, by John M. Brawn, NWC. 27 June 1972. Patent UNCLASSIFIED.

An atmospheric temperature sensing squib firing contrivance for igniting an explosive device at a specific outside temperature, comprising an atmospheric temperature sensor, a time delay safety function that prevents premature ignition, an enabling function that allows ignition when the desired input conditions are met, the ignition function, and an inside temperature sensor that stabilizes the circuits against changing ambient temperature of the explosive device.

**U.S. Patent 3,672,659**

Method and Apparatus for Fabricating Structures, by James E. Grasswick, NWC. 27 June 1972. Patent UNCLASSIFIED.

A method and apparatus by which physical structures are fabricated substantially entirely of resilient members or modules. The structures may be compressed for shipment and, when released from restraint, spring into the final shape of structure desired.

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### **U.S. Patent 3,674,648**

**Bacterial Lamp**, by Giorgio Soli, NWC. 4 July 1972. Patent UNCLASSIFIED.

A bacterial lamp which produces a blue-green light which is particularly useful to divers to illuminate the immediate environment around them. The lamp comprises two vessels connected by valve means. One vessel is substantially filled with a bacteria culture medium and the other with a suspension of luminous bacteria in a non-nutrient medium. An oxygen bottle is connected by suitable means to the vessel containing the bacterial suspension and in operation gas pressure forces a predetermined amount of the bacterial suspension into the vessel containing the nutrient medium, whereupon the bacteria start to grow and a light output of considerable intensity is produced.

### **U.S. Patent 3,683,385**

**Direction Finding Antenna System**, by Robert G. Corzine and Joseph A. Mosko, NWC. 8 August 1972. Patent UNCLASSIFIED.

A missile-mounted antenna array includes a pair of concentric spaced spiral antennas to provide information as to angle and direction of displacement off the boresight axis of an external radiation source.

### **U.S. Patent 3,691,770**

**Thrust Control Means for a Solid Propellant Rocket Motor**, by Robert H. Nunn, NWC. 19 September 1972. Patent UNCLASSIFIED.

This invention relates to a rocket motor of the solid propellant type in which the magnitude of thrust is controlled by by-passing products of combustion into an effective throat of a convergent/divergent nozzle.

### **U.S. Patent 3,693,880**

**Infrared Suppressor Means**, by Edward F. Versaw and Herbert C. Moe, Lockheed, and Jerry L. Reed, NWC. 26 September 1972. Patent UNCLASSIFIED.

NWC TP 5443

An air-cooled contoured plug fitted within the exhaust pipe of a gas turbine engine is designed also for use with an afterburning turbojet type having variable position nozzle leaves.

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