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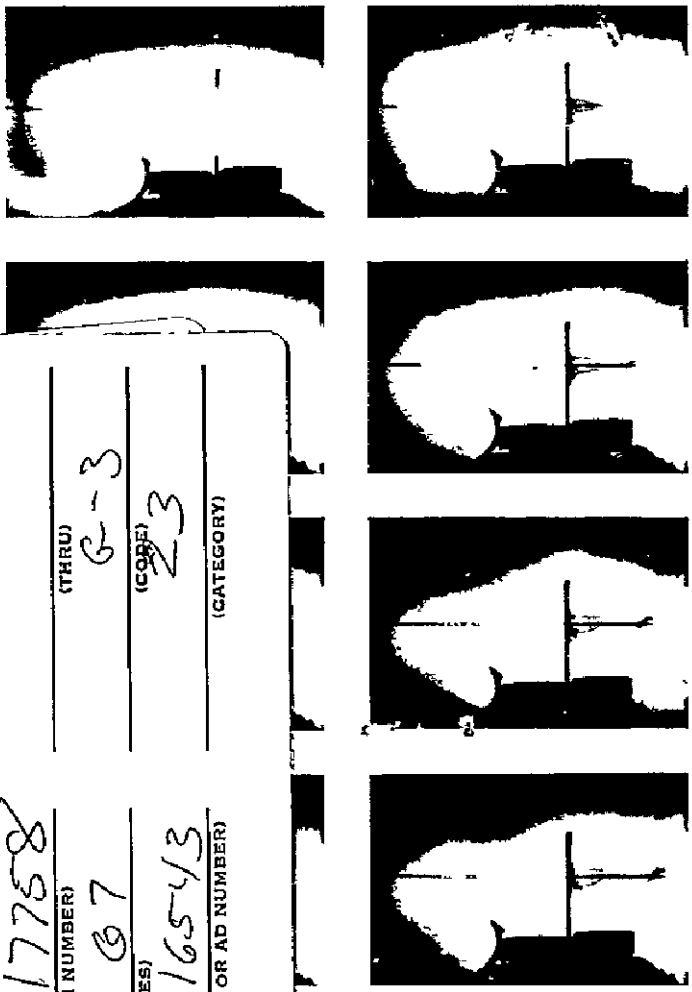

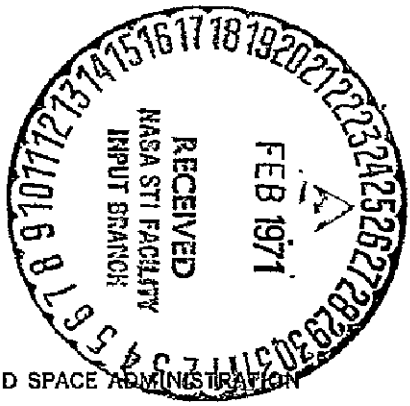

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

JPL BIBLIOGRAPHY 39-12

PRERELEASE FOR AUGUST 1970

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

Prepared Under Contract No. NAS 7-100
National Aeronautics and Space Administration

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COVER: Shock resulting from impact of Q-switched laser pulse on thin film of carbon on far side of glass plate. Use of a high-velocity laser-generated shock for ignition eliminates the possibility of inadvertent initiation that is inherent in electro-explosive devices. Various experiments with the laser-initiated ignition of explosive materials and their conclusions are discussed in Space Programs Summary 37-63, Vol. III, pp. 167–169. See Menichelli, V. J.

PREFACE

The JPL Bibliography describes and indexes the formalized technical reporting resulting from scientific and engineering work performed, or managed, by the Jet Propulsion Laboratory. Four classes of publications are included:

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Volume I. *Flight Projects*
Volume II *The Deep Space Network*
Volume III. *Supporting Research and Advanced Development*
Volume IV. *Flight Projects and Supporting Research and Advanced Development* (contents classified)

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Prereleases for the JPL Bibliography are published monthly, at the end of each fiscal year, these prereleases are combined as a final report (39 series). Technical Reports, Technical Memorandums, and Space Programs Summary articles are listed in the prerelease for the month in which they are released. Open literature articles not released as Technical Reports are listed when the author's reprints are received by JPL.

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PRERELEASE FOR AUGUST 1970

AUTHOR INDEX

time to evaluate system performance. In the event of telemetry system anomalies, corrective courses of action are recommended. A description of the analysis function and the services provided by the Operations Group are given.

ANDERSON, J. D.

A04 Celestial Mechanics Experiment for *Mariner* Mars 1971

J. Lorell, J. D. Anderson, and I. I Shapiro (Massachusetts Institute of Technology)
Icarus- Int. J. Sol. Sys., Vol. 12, No. 1, pp. 78–81, January 1970

For abstract, see Lorell, J.

ARNOLD, J. R.

A05 Gamma Ray Spectroscopic Measurements of Mars

A. E. Metzger and J. R. Arnold (University of California, San Diego)
Appl Opt., Vol. 9, No. 6, pp. 1289–1303, June 1970

For abstract, see Metzger, A. E.

ARTHUR, E.

A06 Spectral Observations of Jupiter in the Frequency Interval 18.5–24.0 GHz: 1968

D. E. Jones (Brigham Young University), B. L. Meredith, and E Arthur
Pub. Astron. Soc. Pacific, Vol 82, No. 484, pp. 122–125, February 1970

For abstract, see Jones, D. E.

AVIŽIENIS, A.

A07 Digital Fault Diagnosis by Low-Cost Arithmetical Coding Techniques

A. Avižienis
Technical Report 32-1476, August 1, 1970

Error-detecting and correcting codes may be employed to diagnose (i.e , detect and locate) logic faults in a digital computer concurrently with its normal operation. Arithmetic error codes must be used if the same code is to be used in the entire computer. A class of arithmetic codes with a low-cost check algorithm is analyzed which possesses partial fault location properties. Complete fault location (i e , single error correction) is then attained by multiple encodings. The results are applied to both residue and product (or An) arithmetic error codes.

BARTERA, R. E.

B01 Application of Imposed Magnetic Fields to Compact-Arc Lamps
C. G. Miller and R. E. Bartera
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol III, pp 161–166, June 30, 1970

For abstract, see Miller, C. G.

BEHM, J. W.

B02 Study of the Effects of Heat Sterilization and Vacuum Storage on the Ignition of Solid Propellant Rockets
L Strand, J A. Mattice, and J. W. Behm
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 196–206, June 30, 1970

For abstract, see Strand, L.

BLINN, J. C., III

B03 Multispectral Remote Sensing of an Exposed Volcanic Province
J. G. Quade (University of Nevada), P. E. Chapman (University of Nevada), P. A Brennan (University of Nevada), and J. C. Blinn III
Technical Memorandum 33-453, June 15, 1970

For abstract, see Quade, J. G.

BOETTGER, H. G.

B04 Pyrolysis of Natural Products: Identification of Products From Nucleotide Pyrolysis by High Resolution Mass Spectrometry
H G. Boettger and A. M Kelly
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 10–13, June 30, 1970

Experiments are described in which the behavior of RNA and DNA polymers, nucleotide and nucleoside monomers as well as the free bases has been investigated under thermal analysis conditions. Mass spectrometry by itself and in conjunction with gas chromatography has been used to identify the degradation products. Characteristic compounds, i.e., the corresponding purine or pyrimidine bases, are formed at 120 to 200°C, but fail to pass through the gas chromatograph At 500°C, low molecular weight products of no structural significance are formed.

BORNCAMP, F.

B05 A Proposed Method of Counting Doppler With the Digital Tracking Subsystem

F. Borncamp

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 112–116, May 31, 1970

The Digital Tracking Subsystem (DTS) provides the first opportunity to use data smoothing techniques to minimize high-frequency doppler noise and provide a better estimate of the true phase of the received signal at the time of sampling. This proposal assumes the doppler counter will be sampled at a rate of 100 times per second, while the maximum output rate and/or permanent storage rate would be 10 samples per second. Thus, the samples that reside within ± 0.04 *s* of the points on the integer tenth of seconds could be used to form an uncorrelated or at least non-overlapping set of improved estimates of the phase on the integer tenths of the second. This technique is easy to implement in the DTS since it consists of single integer multiplications on each subsample and then a summation of terms. The resultant improvement is a lowering of the one-sigma noise on the doppler estimates to $\approx 50\%$ of the original value.

BRENNAN, P. A.

B06 Multispectral Remote Sensing of an Exposed Volcanic Province

J. G. Quade (University of Nevada), P. E. Chapman (University of Nevada), P. A. Brennan (University of Nevada), and J. C. Blinn III

Technical Memorandum 33-453, June 15, 1970

For abstract, see Quade, J. G.

BUCHANAN, H. R.

B07 Polarization Converter

H. R. Buchanan

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 44–47, May 31, 1970

The polarization incompatibility between the *Pioneer* space probe antennas and the Deep Space Instrumentation Facility (DSIF) antennas brought about the development of a polarization converter. A relatively simple device has been devised which can be easily and quickly installed in front of the DSIF antenna feedhorn. This device effectively converts the normally circular polarization of the DSIF feed to linear polarization, which is compatible with the *Pioneer* space probes. A nominal 3-dB improvement in downlink and uplink signal strength has resulted.

BUNKER, E. R., JR.

B08 Large-Scale Hybrid Prototype—Method of Functionally Checking Hybrid Layouts Prior to Processing

E. R. Bunker, Jr.

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 140–143, June 30, 1970

At the present time, the functional evaluation of a hybrid electronic circuit can only be achieved by going through the whole sequence of operations used to produce a functioning module. Usually several iterations are required before all the errors and possible crosstalk effects are eliminated.

A novel approach to check the hybrid layout prior to processing is to fabricate a functioning module the same size as the initial art work. Conductor patterns are fabricated on a pyrex sheet to scale from adhesive-backed copper tape, with insulating tape of the proper thickness and electrical parameters used for cross-overs. Conventional, active, and passive components, such as transistors, capacitors, composition resistors, etc., electrically equivalent to the microminiature components to be installed on the final hybrid, but of conventional discrete component size, are soldered in place. Then the prototype is connected into the subsystem for functional test. Two circuits, one simple and one complex, have been fabricated and are undergoing tests

BUTMAN, S.

B09 Coding and Synchronization Research: Efficient Multichannel Space Telemetry

S. Butman and U. Timor

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 34–37, June 30, 1970

The Interplex modulation scheme for two-channel telemetry is extended to n, channels By properly choosing the modulation indices, the power loss due to intermodulation can be minimized. This loss can no longer be made equal to zero (as for $n = 2$); however, in the case of one high rate data channel and several low rate channels, the loss is negligible.

B10 Coding and Synchronization Research: Decision Rules for a Two-Channel Deep-Space Telemetry System

S. Butman, J. E. Savage, and U. Timor

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 38–41, June 30, 1970

Optimum and suboptimum decision rules are examined for a telemetry system in which the modulation consists of phase modulation with two orthogonal phase functions. Coherent demodulation is assumed and two statistically dependent communication channels are created. An optimum decision rule that uses this statistical dependence is examined as well as two rules which use this dependence partially. One of these rules is the appropriate one to use when the channel conditions are those which prevailed in the *Mariner* Mars 1969 system. This rule, however, is far superior to that which is now used.

CAPUTO, R. S.

C01 Multi-Hundred-Watt Radioisotope Thermoelectric Generator Radiant Interchange Factors

R. S. Caputo

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 86–93, June 30, 1970

The radiative thermal interaction is evaluated between the multi-hundred-watt radioisotope thermoelectric generators (MHW-RTGs) and the Thermoelectric Outer-Planet Spacecraft. The study is made for RTG-spacecraft positions that exist from pad operation through orbital deployment. The RTG arrangement used is the two-in-tandem, two-in-parallel arrangement. The geometric view factors from the RTGs to the surrounding objects are calculated, and determination is made of the overall radiation interchange factors of the RTGs. These data are also transformed for use as input for a transient performance RTG computer code.

CARL, C.

C02 Approximate Analysis of Command Lock Detector Performance

C. Carl

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 51–58, June 30, 1970

An approximate analysis of a coherent, additive gaussian noise channel lock detector preceded by a bandpass limiter is presented The analysis covers the error-rate performance for both the signal-plus-noise and noise-only input conditions. Results are given for various values of the input bandwidth-bit time product and the detector threshold. A comparison with experimental data shows good agreement with the analytic results over the range of practical interest.

CARLS, L. W.

C03 **Results of the Near Infrared Multidetector Grating Spectrometer Study**
I. W. Carls and P. W. Schaper
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 1–5, June 30, 1970

The results of the study task for the Near Infrared Multidetector Grating Spectrometer for the *Nimbus F* spacecraft are summarized. The task consisted of two approaches: (1) to arrive at a conceptual design for the instrument, and (2) to demonstrate a system of data utilization for the experiment.

CHAPMAN, P. E.

C04 **Multispectral Remote Sensing of an Exposed Volcanic Province**
J. G. Quade (University of Nevada), P. E. Chapman (University of Nevada), P. A Brennan (University of Nevada), and J. C Blinn III
Technical Memorandum 33-453, June 15, 1970

For abstract, see Quade, J. G.

CONEL, J. E.

C05 **A New Method for Determining SiO_2 Abundance in Silicate Glass From Powder Film Transmission Measurements in the Infrared**
J. E. Conel
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol III, pp. 7–9, June 30, 1970

The Christiansen frequency of a substance is conveniently determined from transmission measurements on thin (~30 μm) films of powder with particle sizes on the order of 10 μm or greater in diameter. This frequency is defined by the position of maximum transmission and represents the frequency of minimum scattering for the (average) complex refractive indices of the materials involved Transmission measurements on silicate glasses prepared from naturally occurring igneous rocks and the plagioclase mineral series have revealed a striking relationship between Christiansen frequency and SiO_2 abundance. The data illustrates a simple, rapid method for semiquantitative determination of silica abundances in synthetic rock and mineral glasses and the crystalline material from which they were prepared.

COSTOGUE, E. N.

C06 **Solar Electric Propulsion System Tests**
E. V. Pawlik, E. N. Costogue, J. D. Ferrera, and T. W. Macie

For abstract, see Pawlik, E. V.

CROW, R. B.

C07 1.0002-MHz Frequency Synthesizer

R. B. Crow

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 42–45, May 31, 1970

A stable frequency synthesizer has been developed to furnish the transmit coder clock (1.0002 MHz) and the reference for the clock doppler detector (1.0000 MHz) for the Planetary Ranging System. The prime requirement for this module is to maintain stability between the 1.000- and 1.0002-MHz outputs. Drift between these two outputs appears as drift in range. An improvement of 50 to 1 was achieved by careful attention to component drift and the design of the phase-locked loop used in the 1.0002-MHz frequency synthesizer module.

C08 DSIF Multiple-Mission Command System

R. Crow, S. Friesema, J. Wilcher, and J. Woo

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 77–94, May 31, 1970

Progress continues on the design and hardware–software development for the Deep Space Instrumentation Facility (DSIF) Multiple-Mission Command System reported earlier. An engineering model of the command modulator assembly (CMA) has been constructed and is undergoing evaluation tests. To evaluate the performance of the CMAs when coupled to the telemetry and command processor computers, a Multiple-Mission Command Demonstration–Test Program has been written. This program will also be used for system-integration tests when the CMAs are implemented. Included in this article are descriptions and theory of operation on each of the CMA digital subassemblies and CMA analog equipment.

DALLAS, S. S.

D01 Prediction of the Position and Velocity of a Satellite After Many Revolutions: The Differential Equations of Motion

S. S. Dallas

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 24–29, May 31, 1970

A set of normalized differential equations of motion that govern the motion of a solar-powered satellite are derived. The perturbative accelerations consist

of those due to oblateness of the central body, solar gravity, and aerodynamic drag.

DAWE, R. H.

D02 TOPS Electronic Packaging and Cabling

R. H. Dawe

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 143–149, June 30, 1970

The objectives for Thermoelectric Outer-Planet Spacecraft (TOPS) electronic packaging and cabling are to apply proven principles to develop a lighter weight, low-stress, high-density, packaging system. The principles that have been used for the packaging system are reviewed and various configurations considered. The approach taken is to provide single side access plug-in assemblies utilizing new miniature high-density connectors. The assemblies are utilized in conjunction with an integrated structure providing flexible packaging arrangements and having high structural and thermal efficiencies.

DeMORE, W. B.

D03 Rates and Mechanism of Alkyne Ozonation

W. B. DeMore

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 14–22, June 30, 1970

The rates and products of the reactions of acetylene, methylacetylene, dimethylacetylene, and ethylacetylene with ozone have been studied in a long-path infrared cell at 21 ± 1°C. The acetylene rate constant agrees well with the Arrhenius parameters for that reaction which were previously measured by a different method. Within experimental error, the ozonation rates of the substituted acetylenes are identical to that of acetylene at 21°C. The results provide further support for the previously derived high A-factor for the acetylene ozonation relative to alkenes, and thus tend to raise some question regarding the concerted reaction mechanism for 1,3 cycloaddition reactions, of which the ozonation reactions are one type.

Product formation in the gas phase alkyne ozonations is postulated to stem from unimolecular fission of an acid anhydride intermediate, the latter being the primary, albeit short-lived, reaction product. Diketone formation was observed in every case, but there is evidence that formation of that product was a side reaction on the walls. It is pointed out that the precursor of the anhydride intermediate is essentially a zwitterionic structure, analogous to the Criegee zwitterion produced in alkene ozonations.

DORE, M. A.

D04 Gamma Ray and Neutron Analysis for a 15-W(th) $Pu^{238}O_2$ Isotopic Heater

M. A. Dore

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 93–97, June 30, 1970

Gamma ray and neutron spectra, dose rates, and flux levels are determined by Monte Carlo methods for all space in the vicinity of a 15-W(th) $Pu^{238}O_2$ isotopic heater of the type used on the *Apollo* Passive Seismic Experiment Package. Heaters of similar design are anticipated for possible inclusion on the Thermoelectric Outer-Planet Spacecraft; utilization of this particular design for this preliminary analysis allows comparison with results previously determined by Mound Laboratories. Five fuel ages, from 0 to 18 yr, are considered, assuming nominal (i.e., 1.2 ppm Pu^{236} and 0.204% O^{18}) fuel, to allow meaningful comparison with previous results. Excellent agreement (<5% difference) is obtained for 10- to 18-yr-old fuel for all locations except very near the surface of the heater, where the results obtained are about 12% higher than those of Mound. One possible explanation for this discrepancy is that the value given by Mound was extrapolated from measurements at larger distances, perhaps based upon $1/r^2$ fall-off, in which case a lower than actual value would result. Since the actual fuel was not 10 to 18 yr old, a small though consistent error in the source strengths used is indicated.

DORROH, W. E., JR.

D05 Attitude Control of a TOPS-Based Outer Planet Orbiter Spacecraft

W. E. Dorroh, Jr.

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 111–114, June 30, 1970

The Thermoelectric Outer-Planet Spacecraft (TOPS) attitude control subsystem requires few changes for use on the outer planet orbiter spacecraft of the 1980s. The subsystem functional requirements, vehicle moments of inertia, and mass expulsion impulse requirements are approximately the same as for TOPS, and the gravity gradient effects from the planets are minimal. The only major change required is in the autopilot required to control the throttling of the liquid-fuel vernier engines, as opposed to the gimballed autopilot of a single liquid-fuel engine for TOPS.

FERRERA, J. D.

F01 Solar Electric Propulsion System Tests
E. V Pawlik, E. N. Costogue, J D. Ferrera; and T. W. Macie
Technical Report 32-1480, August 15, 1970

For abstract, see Pawlik, E. V.

FISHER, J. G.

F02 Development of a Conical–Gregorian High Gain Antenna
J. G. Fisher
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 124–128,
June 30, 1970

The conical–Gregorian antenna concept has several theoretical advantages over conventional parabolic reflector types. Among these are the potential elimination of "reverse pillowing" due to chording of mesh surfaces in rib-and-mesh designs, by furling with a simple bending of the reflector surface. First development efforts toward the practical design and construction of a conical–Gregorian antenna are described. Two models were produced. one a rigidified assembly for RF testing, and the other for experiments in furling Problems arising in the construction of these antennas, and steps taken toward their solution, are discussed

FREY, W.

F03 Multiple Mission Telemetry 1971 Configuration
W. Frey, R. Petrie, R. Greenberg, J. McInnis, and R. Wengert
The Deep Space Network, Space Programs Summary 37-63,
Vol. II, pp 63–77, May 31, 1970

Increased telemetry data-handling requirements placed on the Deep Space Instrumentation Facility (DSIF) to support future flight projects have necessitated an update of the DSIF multiple mission telemetry (MMT) system. The update will allow the DSIF to (1) handle higher telemetry data rates, (2) operate on block-coded data, and (3) process more telemetry data channels simultaneously. This article reports on the progress being made on the block decoder and symbol synchronizer assemblies, and includes information on the telemetry and command data-handling subsystem, the MMT test rack, subcarrier demodulator assemblies, the new high-speed data wide-band data input–output assembly, and mission-independent software.

FRIESEMA, S.

F04 DSIF Multiple-Mission Command System
R Crow, S Friesema, J. Wilcher, and J. Woo

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 77–94, May 31, 1970

For abstract, see Crow, R.

FUZIE, R. E.

F05 DSIF Network Maintenance Facility: Reference Standards Frequency and Timing Laboratory

R. E. Fuzie

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 101–107, May 31, 1970

The Reference Standards Laboratory of the Deep Space Instrumentation Facility (DSIF) Network Maintenance Facility operates a Frequency and Timing Laboratory for the DSIF that provides precise frequency and time references to the National Bureau of Standards and the United States Naval Observatory. The Frequency and Timing Laboratory is comprised of (1) the laboratory measurement chain, (2) the very low frequency monitoring and measuring system, and (3) the DSIF tick generation and distribution system. This article describes the operation of the Frequency and Timing Laboratory including equipment configuration and the role of each of its major sections in furnishing precision frequency and time to the DSIF.

GLUCKLICH, J.

G01 Strain-Energy Size Effect

J. Glucklich

Technical Report 32-1438, August 15, 1970

The effect of the physical size of a specimen upon the *initiation* of fracture of materials is in accordance with statistics of flaw distribution. The effect of size upon *total* fracture is as above, plus the effect during stable crack propagation Stability of cracking can be because of (1) energy dissipation, (2) load relaxation, or (3) crack orientation. Only (1) reflects a material property. The *energy-dissipation stability* is affected by the strain-energy content (and therefore by size) in such a way that the higher the energy, the earlier this stability transforms to instability. Consequently, the larger the specimen, the lower the breaking stress and the ductility that accompanies the cracking. A possible explanation is presented in terms of dynamic effects caused by an excess in the energy released over the energy absorbed. These dynamic effects influence the stability of the propagating crack in a manner in which the size of the specimen plays a dominant part.

The behavior of three broad groups of materials is examined from the viewpoint of crack stability. These are *ductile* (mainly soft metals), *semiductile* (materials such as concrete and gypsum), and *brittle*

(glass). The conditions favoring instability are listed, and the various materials are classified in accordance with their position relative to a transition size. Examples of the effects of size in various materials are cited, and it is shown that existing theories are unable to explain all of the observations, either qualitatively or quantitatively. The proposed theory of a strain-energy size effect seems to fill these gaps satisfactorily.

It is speculated that, in general, every material has two constants that fully describe its resistance to fracture: γ' and G_i. These involve the critical strain-energy release rate G_c. Here, γ' is the limiting value of $\frac{1}{2} G_c$ when size increases to infinity; G_i is the limiting value of G_c when size decreases to zero. In practice, γ' controls the initiation of cracking and G_c (not G_i) controls the onset of instability. Whereas γ' is independent of specimen size, a study should be made of the size dependence of G_c. Evidently γ' is also the true design criterion for very large, ductile members, and G_i is the design criterion for very small, brittle elements.

Transition–size curves are proposed (in analogy to transition–temperature curves), and the positions of the transition for some materials are roughly indicated.

GOSLINE, R. M.

G02 DSS 13 Operations
E. B. Jackson and R. M. Gosline
The Deep Space Network, Space Programs Summary 37-63, Vol. II, p. 42, May 31, 1970

For abstract, see Jackson, E. B.

GOSS, W. C.

G03 Advanced Development Electrostatic Image Dissector
W. C. Goss
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 114–115, June 30, 1970

A second-generation electrostatic image dissector is being developed for use in the *Mariner* spacecraft attitude-control star tracker. Major improvements are planned in the areas of fabrication yield ratio, dimensional control, leakage currents, temperature tolerance, and tolerance of low-pressure gas environments.

GREENBERG, R.

G04 Multiple Mission Telemetry 1971 Configuration
W. Frey, R. Petrie, R. Greenberg, J. McInnis, and R. Wengert

The Deep Space Network, Space Programs Summary 37-63, Vol II, pp. 63–77, May 31, 1970

For abstract, see Frey, W.

GRONROOS, H.

G05 Reactor Simulator Runs With Thermionic Diode Kinetics Experiment
H. Gronroos
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 215–222, June 30, 1970

The operation of the thermionic diode kinetics experiment with a nuclear reactor simulator in the loop is described Two cases from the most recent series of runs are discussed and their response trajectories are shown. A brief account of the modifications presently being incorporated into the experiment is also given. One of the two cases discussed illustrates the open-loop (i.e., no reactor controller) response to an electric load change. The other case shows the event during a simulated reactor start-up run.

HAND, P. J.

H01 TOPS Inertial Reference Unit
P. J. Hand
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp 122–123, June 30, 1970

The Thermoelectric Outer-Planet Spacecraft (TOPS) attitude-control system baseline is to be all digital. An all digital inertial reference unit (IRU) is therefore being designed which will employ gyros requiring active temperature control. To minimize the power consumption resulting from this approach, a low-thermal-loss IRU design concept is being evaluated. Tests indicate that a controlled-thermal-loss design rather than a minimum-loss design is required. These tests are discussed and plots of gyro input power versus temperature are shown for both atmospheric and vacuum conditions

HARDY, J.

H02 Spacecraft Antenna Research: Preliminary RF Test of Conical Gregorian Antenna
A. C. Ludwig and J. Hardy
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 42–46, June 30, 1970

For abstract, see Ludwig, A. C.

HARRISON, B. K.

H03 General Relativistic Axially Symmetric Rotating Perfect Fluids

B. K. Harrison

Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, p. 14,
June 30, 1970

New formulations and simplifications of the equations for general relativistic axially symmetric rotating perfect fluids have been found.

HEIDENREICH, A.

H04 TOPS Trajectory Correction Engine

A. Heidenreich

Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 227–235,
June 30, 1970

Future unmanned space missions, such as the Grand Tour of the outer planets, will require up to nine separate trajectory course corrections with a total burn time of 1500 s. A pressure-fed blowdown system using a monopropellant blend of hydrazine in a catalytic decomposition chamber producing 25-lbf thrust has been chosen as the baseline propulsion system for the Thermoelectric Outer-Planet Spacecraft (TOPS). A series of tests were conducted to determine the effects of multiple cold starts, long-duration (up to 800 s) steady-state burns, and low-temperature incoming propellant. Some preliminary tests were also conducted with a blend of 76% N_2H_4, 24% $N_2H_5NO_3$. The tests to date indicate that the duty cycle envisioned can be met with state-of-the-art technology using neat hydrazine as the propellant. However, extreme care must be given to both design and testing to insure a high degree of confidence and reliability, since catalytic performance and life is limited. It is determined that considerable development effort will be needed before a higher performing monopropellant can be utilized. Several known problems requiring future investigation are discussed.

HOFFMAN, J. K.

H05 Evaluation of Recording Tapes for Use in Spacecraft Magnetic Tape Recorders

J. K. Hoffman, S. H. Kalfayan, and R. H. Silver

Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, p. 160,
June 30, 1970

Efforts to solve problems related to reliability of magnetic tape in typical spacecraft recorder applications continue. Tape to magnetic head frictional drag

characteristics were investigated under certain environmental conditions. Further evaluation of data and additional testing is in progress.

H06 Evaluation of Spacecraft Magnetic Recording Tapes

S. H. Kalfayan, R. H. Silver, and J. K. Hoffman
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 209–214,
June 30, 1970

For abstract, see Kalfayan, S. H.

HOLMES, J.

H07 Coding and Synchronization Research: Performance of a First-Order Digital Phase-Locked Loop

J. Holmes
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 28–34,
June 30, 1970

This article develops the exact analysis of an unmodulated digital phase-locked loop for the (modulo 2π reduced) steady-state phase error variance and for the first passage time problem. Also the bit error probability is obtained for the modulated case. The results have been applied to the operation of the newly proposed all-digital, single-channel command system being developed as part of the Thermoelectric Outer-Planet Spacecraft Project.

HONG, J. P.

H08 Pattern Recognition: Invariant Stochastic Feature Extraction and Classification by the Sequential Probability Ratio Test—Theory and Experimental Results for the Two-Class Problem

J. P. Hong
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol III, pp. 153–159,
June 30, 1970

Random lines are used to obtain a feature extraction algorithm in which the extracted features are insensitive to rotation and translation of the pattern within the retina. It is shown that the statistics of the total intersection length of the random line of the pattern is such an invariant feature. The choice of random line intersection length as a feature extractor is an arbitrary one. It is hypothesized that the statistics of the number of intersections which a random line makes with a pattern is also such an invariant feature. Futhermore, it may be less sensitive to the font. This article presents the mechanics necessary to predict the average number of observations that are needed

to properly classify unknown letters. The theory presented also allows one to make a tradeoff between the number of required samples and the accuracy of the classification. Experimental results are included which verify the theory.

HORTTOR, R. L.

H09 Cyclic Search Algorithms for Synchronizing Maximal Length Linear Shift Register Sequences
R. L. Horttor
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 58–63, June 30, 1970

This article compares two algorithms for synchronizing one maximal length linear shift register sequence with another one biphase-modulated onto a carrier. A phase-locked loop is used to acquire and track the carrier. One algorithm is the Maximum Likelihood Receiver which examines all possible synchronization times before making a decision. The second is a sequential algorithm which does not always require a complete search before making a decision. The mean and variance of the search times are calculated from the respective generating functions.

JACKSON, E. B.

J01 DSS 13 Operations
E. B. Jackson and R. M. Gosline
The Deep Space Network, Space Programs Summary 37-63, Vol. II, p. 42, May 31, 1970

During the period February 16 through April 15, 1970, DSS 13 (Venus Deep Space Station) was fully operational for only two 1-wk periods. The non-operational period was devoted mainly to maintenance and support of the Mars Tri-Cone installation and testing. During the operational period, a mono-static and bi-static planetary radar track was performed on Venus. Frequent pulsar tracks, noise-adding radiometer tests, and clock synchronization transmissions were performed during both operational periods.

JET PROPULSION LABORATORY: DATA SYSTEMS DIVISION

J02 *Mariner* Mars 1971: Data Systems [March–April 1970]
Jet Propulsion Laboratory Data Systems Division
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 4–10, May 31, 1970

The development of the mission and test computer system is described in this article. The higher data rates required for *Mariner* Mars 1971 and the need for

handle and process as much as possible of the data in real time necessitated additional computing capability to supplement that of the existing two UNIVAC 1219 systems. A dual high-rate data proprocessor consisting of a UNIVAC 1230 computer and peripheral equipment was leased to receive, block decode as necessary, decommutate, and perform all input processing functions on all high-rate data streams A full UNIVAC 1230/dual UNIVAC 1219 configuration to accommodate the simultaneous testing of two flight spacecraft and the system test complex data streams available to the mission and test computer system are illustrated.

The Mission Operations System is responsible for development of the mission-dependent computer programs required for mission operations, simulation, and spacecraft checkout, except for the mission-dependent software in the Deep Space Instrumentation Facility telemetry and command processor. The *Mariner* Mars 1971 Mission Operations System software system operates in the UNIVAC 1108 or IBM 360/75 Space Flight Operations Facility computers. The presently defined programs, the program functions, and the computer in which each program is currently planned to operate are also described here.

JET PROPULSION LABORATORY: ENGINEERING MECHANICS DIVISION

J03 *Mariner* Mars 1971: Engineering Mechanics [March–April 1970]

Jet Propulsion Laboratory: Engineering Mechanics Division
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 24–34, May 31, 1970

Most of the structure, cabling, and mechanical devices subsystem equipment for the *Mariner* Mars 1971 proof test model has been delivered to the Spacecraft Assembly Facility. Engineering mechanics activities are now concentrated on the completion of flight equipment and the support of efforts to eliminate problem areas in the subsystems Reported here are the procurement of integrated circuits, design and fabrication of the solar panel deployment and damper mechanism, vibration testing of the development test model, and space simulator testing of the temperature control model.

JET PROPULSION LABORATORY: GUIDANCE AND CONTROL DIVISION

J04 *Mariner* Mars 1971: Guidance and Control [March–April 1970]

Jet Propulsion Laboratory· Guidance and Control Division
Flight Projects, Space Programs Summary 37-63, Vol I, pp 10–24, May 31, 1970

During the *Mariner* Mars 1971 solar panel shadow analysis program, a shadow-casting computer program was used to provide a set of plots at 5-deg increments in both directions of yaw, and an initial analysis was made of the effect on the solar panel output power. The first portion of this article describes a follow-up effort wherein photographs were taken of a spacecraft model to help confirm the initial data obtained and to determine what additional points might be necessary to more accurately define the geometry of the shadows cast.

Under the constraint for satisfactory television picture-taking, only two or three scan platform position changes are required. During these, disturbing torques are applied to the spacecraft as a result of the law of conservation of momentum. The effects of these disturbing torques on the *Mariner* Mars 1971 attitude-control subsystem are determined. Also described are the results of an analysis to determine the effects on attitude-control gas consumption from scan platform motion during the orbital phase of the mission. Gas storage requirements based on the most current definition of the vehicle configuration and the mission requirements that affect gas consumption are also examined.

Illustrations are provided for the initial and modified Canopus-sensor/attitude-control-electronics circuitry. Recently conducted integration tests of the attitude-control subsystem, which are also described in this article, revealed an anomalous logic state of the subsystem not anticipated during the design phase. The logic equations were thus modified to correct this condition, and the hardware was reworked to reflect the changes to the logic.

The final portion of the article describes a circuit incorporated into the laboratory and system test sets to stabilize the autopilot for test purposes and to prevent driving the engine gimbal actuators to their mechanical stops.

J05 *Mariner* Venus–Mercury 1973: Guidance and Control [March–April 1970]

Jet Propulsion Laboratory. Guidance and Control Division

Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 40–44, May 31, 1970

The *Mariner* Venus–Mercury 1973 power subsystem is planned to be of *Mariner* Mars 1971 design, modified for operation in the vicinity of Mercury and for a revised power profile. The reasons for these changes and a preliminary description of the overall power

subsystem, including a functional block diagram and a weight breakdown, are presented in this article

J06 *Viking*, Orbiter System: Guidance and Control [March–April 1970]

Jet Propulsion Laboratory Guidance and Control Division
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 61–65, May 31, 1970

An improvement in the functional sequence associated with roll axis control has been designed for incorporation on the *Viking* attitude-control subsystem. The proposed sequence eliminates some unnecessary roll search modes. The attitude-control subsystem does not immediately initiate a spacecraft roll search mode upon loss of Canopus, thus affording ground controllers time to override the automatic features of the sequence if circumstances call for it. This article describes the attitude-control sequence for Canopus reacquisition.

Also described are the attitude-control subsystem status register and the scan subsystem mechanization. The status register replaces the event register of the *Mariner*-type spacecraft. The scan subsystem mechanization involves a proposed modification to the *Mariner* Mars 1971 scan control that results in some hardware economies and in improved operational flexibility.

JET PROPULSION LABORATORY: MARINER MARS 1971 PROJECT

J07 *Mariner* Mars 1971: Project Description and Status [March–April 1970]

Jet Propulsion Laboratory: *Mariner* Mars 1971 Project
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 1–3, May 31, 1970

The primary objective of the *Mariner* Mars 1971 Project is to place two spacecraft in orbit around Mars that will be used to perform scientific experiments directed toward achieving a better understanding of the physical characteristics of that planet. An engineering objective is to demonstrate the ability of the spacecraft to perform orbital operations in an adaptive mode wherein information from one orbital pass is used to develop the operations plan for subsequent orbital passes. Specific mission objectives, the spacecraft, its scientific experiments, and management responsibilities for the project are briefly described. Status information includes documentation, computer program completions, and proof-test-model, temperature-control-model, and propulsion-engineering-test-model operations. The television team matrix is illustrated.

JET PROPULSION LABORATORY: MARINER VENUS–MERCURY 1973 PROJECT

J08 *Mariner* Venus–Mercury 1973: Project Description and Status [March–April 1970]

Jet Propulsion Laboratory: *Mariner* Venus–Mercury 1973 Project

Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 39–40, May 31, 1970

The primary objective of the *Mariner* Venus–Mercury 1973 Project is to launch one spacecraft to conduct exploratory investigations of the planet Mercury's environment, atmosphere, surface, and body characteristics and to obtain environmental and atmospheric data on the planet Venus, with first priority assigned to the Mercury investigations. The secondary objectives are to perform interplanetary experiments enroute to Mercury and to obtain experience with the gravity-assist mission mode. Preliminary project planning is described.

JET PROPULSION LABORATORY: PROPULSION DIVISION

J09 *Mariner* Mars 1971: Propulsion [March–April 1970]

Jet Propulsion Laboratory: Propulsion Division

Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 34–38, May 31, 1970

The *Mariner* Mars 1971 propulsion subsystem must perform a midcourse maneuver near earth and four or more maneuvers near Mars. An electrically operated bipropellant valve and a gaseous nitrogen pressure regulator will nominally prevent fluid leakage during non-firing periods. Concern over the possible leakage of these components during the 6-mo duty cycle resulted in the incorporation of three groups of pyrotechnic-actuated valves in the system. For a nominal sequence, the first midcourse maneuver and the four maneuvers near Mars are treated as two maneuver sets. The pressurant and propellant lines will nominally be opened and closed before and after each set. A fifth valve in each line provides redundancy and/or extended mission capability. A failure-mode analysis of the propulsion-subsystem sequence is described in this article.

JET PROPULSION LABORATORY: SPACE SCIENCES DIVISION

J10 *Viking*, Orbiter System: Space Sciences [March–April 1970]

Jet Propulsion Laboratory: Space Sciences Division

Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 46–48, May 31, 1970

A high-resolution spectrometer has been selected for the *Viking* orbiter system science package to determine the amount and distribution of water vapor in the Martian atmosphere. The instrument is to operate in the 1.4-μ region with a spectral resolution of no more than 0.5 cm^{-1}. As described in this article, ray-trace analyses were performed on nine monochromator configurations. The configuration selected was a Littrow double-pass with parabolic collimating mirror and corner return prism. Illustrations of the instrument are provided.

JET PROPULSION LABORATORY: TELECOMMUNICATIONS DIVISION

J11 *Viking*, Orbiter System: Telecommunications [March–April 1970]

Jet Propulsion Laboratory. Telecommunications Division
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 48–61, May 31, 1970

The *Viking* orbiter radio frequency subsystem will be of *Mariner* Mars 1971 design, with the incorporation of a redundant receiver proposed as the only major change. As with the *Mariner* radio subsystems, this subsystem will provide the communications and tracking link between the orbiter and the Deep Space Instrumentation Facility. The receiver and diplexer subassemblies, exciter subassembly, control unit, traveling-wave-tube amplifiers, microwave components, S-/X-band experiment interface, and redundant receivers are discussed in this article, and a block diagram of the radio frequency subsystem is provided.

Also described in this article is the *Viking* orbiter relay system, which will provide receiving and detection capability for communications via a UHF lander-to-orbiter link. The relay system includes the relay radio subsystem, telemetry subsystem, and antenna subsystem. Discussions are included for each of these subsystems, as well as for relay link requirements, performance estimates, and beacon considerations.

JET PROPULSION LABORATORY: VIKING PROJECT

J12 *Viking*: Project Description and Status [March–April 1970]

Jet Propulsion Laboratory *Viking* Project
Flight Projects, Space Programs Summary 37-63, Vol. I, pp. 45–46, May 31, 1970

The primary objective of the *Viking* Project is to send two vehicles to the planet Mars to perform scientific experiments directed toward enhancing current knowledge about the physical characteristics of the planet, particularly its capability for supporting life and

possible evidence of life. The launches are currently anticipated during 1975 Each vehicle will consist of an orbiter system being developed by JPL and a lander system being developed by the Martin-Marietta Corp A gas chromatograph/mass spectrometer for the lander system is being developed by JPL. Langley Research Center has overall management responsibility for the project. The specific objectives for the orbiter system and the lander system are described. Status information includes commonality studies with the *Mariner* Venus–Mercury 1973 Project Office and navigation studies.

JONES, D. E.

J13 Spectral Observations of Jupiter in the Frequency Interval 18.5–24.0 GHz: 1968

D. E. Jones (Brigham Young University), B. L. Meredith, and E. Arthur

Pub. Astron. Soc. Pacific, Vol. 82, No 484, pp. 122–125, February 1970

There is continuing interest in observations of Jupiter that pertain to the composition and structure of the upper regions of the Jovian atmosphere. This article reports the results of observations in the frequency range 18.5–24 0 GHz near the opposition of 1968. The observations were made with the 30-ft cassegrain radio telescope at the Venus Deep Space Station. The results are in excellent agreement with those of Law and Staelin obtained during the opposition of 1966, suggesting the reality of the previously observed discrepancy between predicted and measured brightness temperatures for this frequency interval.

KALFAYAN, S. H.

K01 Evaluation of Recording Tapes for Use in Spacecraft Magnetic Tape Recorders

J. K. Hoffman, S. H. Kalfayan, and R. H. Silver

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, p. 160, June 30, 1970

For abstract, see Hoffman, J K.

K02 Evaluation of Spacecraft Magnetic Recording Tapes

S. H Kalfayan, R H. Silver, and J. K. Hoffman

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 209–214, June 30, 1970

The values of the dynamic frictional forces between magnetic recording tapes and magnetic heads were determined under various conditions. Three tapes

(3M 990, 3M 20250, and CEC W-4) were evaluated at 25 and 55°C and at speeds of 0.133 and 0.333 in./s under dry and humid conditions. The performance of these tapes under such conditions is discussed. The object of the investigation is to explain the stick-slip and seizure phenomenon observed in magnetic tape recorders used in spacecraft.

K03 **Effects of Simulated Venusian Atmosphere on Polymeric Materials**
S. H. Kalfayan and R. H. Silver
J. Spacecraft Rockets, Vol. 7, No. 5, pp. 634–636, May 1970

Polymeric materials (plastics and rubbers) serve as electrical and thermal insulators, protective and structural materials, vibration dampeners, adhesives, etc., on spacecraft and planetary landing probes. In 1967, *Venera 4* entered the Venus atmosphere and sent back information about temperature, pressure, and atmospheric composition as it descended to the surface, and *Mariner V* flew by Venus and sent back atmospheric data, among other information. This article presents results of exposure of polymeric materials to a simulation of the Venusian atmosphere, which was reported to be composed as follows (in weight percentages): CO_2, 90 ± 10 (probably >90); O_2, 0.4–1.6 (probably ~1); N_2, <7 (probably <2.5); and H_2O, 0.1–0.7. The effects of the simulated "Venus" atmosphere are compared with those of air and nitrogen at 550°F and 18 atm.

KELLY, A. M.

K04 **Pyrolysis of Natural Products: Identification of Products From Nucleotide Pyrolysis by High Resolution Mass Spectrometry**
H. G. Boettger and A. M. Kelly
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 10–13, June 30, 1970

For abstract, see Boettger, H. G.

KLAUS, R. L.

K05 **Theoretical Arguments Supporting the Instantaneous Burning Rate Measurements for Solid Propellants During Depressurization Made at JPL**
R. L. Klaus
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 169–173, June 30, 1970

Measurements of the instantaneous burning rates of solid propellants during a depressurization transient have indicated that during the early part of the transient, the instantaneous burning rate is greater than that of a steadily burning propellant at the same pressure. This result contradicts former theoretical predictions. New theoretical arguments are advanced to support the observed phenomena by considering the effect of a finite step-function decrease in system pressure. It is shown that in this case the propellant always extinguishes and that in the early part of the transient, the surface temperature, and hence instantaneous burning rate, is always greater than the corresponding steady value. It is also shown how these results apply to finite depressurization rates.

K06 An Improved Newton–Raphson Algorithm for Finding the Roots of Equations for Solid Propellant Combustion Studies

R. L. Klaus and S. Wilson

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 173–175, June 30, 1970

An improved Newton–Raphson algorithm for finding roots of equations is described. If a root is present within a specified interval, the algorithm is guaranteed to find it regardless of the shape of the curve within the interval. Moreover, the method of interval shrinking which is used guarantees that the root will be found to within the specified tolerance. As the calculation proceeds, it is tested to determine whether convergence is being attained at least as fast as by the method of interval halving; if not, the algorithm shifts to interval halving until such time as the Newton–Raphson method converges more rapidly. The algorithm has been coded for a computer in FORTRAN and tested.

K07 Basic Equations in the Mathematical Modeling of the Gas Phase of a Burning Solid Propellant

R. L. Klaus

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 175–184, June 30, 1970

The basic equations that describe the gas phase of a burning solid propellant are derived and their behavior from both a mathematical and physical standpoint is discussed. In the case of a semi-infinite flame (which applies when no ignition stimulus is being applied at the edge of the flame), it is shown that boundary conditions at the solid–gas interface are themselves sufficient to completely determine the problem. An attempt to apply boundary conditions

at the gas side may result in an ill-posed problem. In order to consider ignition stimuli in the form of a heat flux to the flame on the gas side, a finite flame is also considered. This case permits the inclusion of two additional boundary conditions at the edge of the flame.

KURTZ, D. W.

K08 DSS 14 Antenna Wind Loading Measurements
D. W. Kurtz
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 35–37, May 31, 1970

In order to supplement existing design information, a test has been proposed to obtain direct wind load measurements from the 210-ft antenna at DSS 14 (Mars Deep Space Station). Strain gage instrumented force panels will be mounted in the antenna surface and local pressure across the disk will be obtained. Integration of these data will yield the aerodynamic coefficients for comparison and correlation with existing wind tunnel data. These results should help in resolving some of the problems and scaling effects involved in current wind load predictions.

K09 Compilation of Wind Tunnel Coefficients for Parabolic Reflectors
R. Levy and D. Kurtz
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 36–42, May 31, 1970

For abstract, see Levy, R.

LAESER, R. P.

L01 *Mariner* Mars 1971 Mission [Support, by DSN, March–April 1970]
R. P. Laeser
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 11–14, May 31, 1970

An operational system for support of the *Mariner* Mars 1971 S-band occultation experiment is being implemented by the Deep Space Network (DSN) and includes elements at three deep space stations and at the Space Flight Operations Facility. A functional description of the system is presented along with supporting information on the experiment itself.

LANDEL, R. F.

L02 A Generalization of the Boltzmann Superposition Principle
J. Maocanin, J. J. Aklonis, and R. F. Landel

Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 207–209,
June 30, 1970

For abstract, see Moacanin, J.

LEONARD, W. D.

L03 **Multi-Hundred-Watt Radioisotope Thermoelectric Generator Transient Performance**
W. D. Leonard and O. S. Merrill
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 80–86,
June 30, 1970

The transient performance of two possible multi-hundred-watt radioisotope thermoelectric generator (MHW-RTG) concepts has been evaluated over the critical period from launch to launch plus 5 h. The analysis considered the effect of radiation interchange factors for the RTG. One of the RTG concepts was found to be capable of supplying 100% of the power required during the entire launch phase. In the other concept, useful power was not delivered until approximately 45 min after launch, and 100% of the needed power was not delivered until about 85 min after launch. The latter system must be supplemented with 260 W-h of battery power until the RTGs can assume the full load.

LEVY, R.

L04 **Compilation of Wind Tunnel Coefficients for Parabolic Reflectors**
R. Levy and D. Kurtz
The Deep Space Network, Space Programs Summary 37-63,
Vol. II, pp. 36–42, May 31, 1970

Loading data from wind tunnel tests on parabolic reflectors are compiled and summarized in tabular and plotted format. Non-dimensional force and moment coefficients are provided over complete ranges of azimuth and elevation angles for four practical combinations of focal length/diameter, focal length/depth, and surface porosity ratios

LIN, H. S.

L05 **TOPS Attitude Control Reliability Study**
H. S. Lin
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 106–109,
June 30, 1970

The effects of imperfect sensing and switching on system reliability for the Thermoelectric Outer-Planet Spacecraft (TOPS) Attitude Control System are being studied. General formulas of the reliability function

are derived The reliability of the system is expressed in terms of the failure rate of the operating unit, the failure rate of the standby unit, and the probabilities of proper operation of failure detectors and switching mechanism. For the constant failure rates, special cases are solved.

LORELL, J.

L06 Celestial Mechanics Experiment for *Mariner* Mars 1971
J. Lorell, J. D. Anderson, and I. I. Shapiro (Massachusetts Institute of Technology)
Icarus. Int. J. Sol. Sys., Vol. 12, No. 1, pp. 78–81, January 1970

A spacecraft experiment is described. This experiment is expected to test the theory of general relativity, improve the Martian ephemeris, and provide new gravimetric data for Mars The anticipated measurements will be obtained from the radio tracking system used to navigate the *Mariner* Mars 1971 orbiter.

LOVELOCK, J. E.

L07 Palladium–Hydrogen System: Efficient Interface for Gas Chromatography–Mass Spectrometry
P G. Simmonds, G. R. Shoemake, and J. E Lovelock
Anal. Chem., Vol. 42, No 8, pp. 881–885, July 1970

For abstract, see Simmonds, P. G.

LUDWIG, A. C.

L08 Spacecraft Antenna Research: Preliminary RF Test of Conical Gregorian Antenna
A. C. Ludwig and J. Hardy
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 42–46, June 30, 1970

The design and RF test results of a prototype conical Gregorian antenna are presented. The test data demonstrate that the performance of the antenna is consistent with the optical principle assumed in the design. The antenna also performs well in monopulse mode of operation and when the subreflector is less than six wavelengths in diameter.

MACIE, T. W.

M01 Solar Electric Propulsion System Tests
E. V. Pawlik, E. N. Costogue, J D. Ferrera, and T. W. Macie
Technical Report 32-1480, August 15, 1970

For abstract, see Pawlik, E. V.

MARSH, E. L.

M02 The Nonlinear Equations of Motion for a Solar-Electric Powered Spacecraft

E. L. Marsh

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 115–122, June 30, 1970

The nonlinear equations of attitude motion are presented for a solar-electric spacecraft. Flexibility of the solar panels is accounted for in the equations. The hybrid coordinates method of Likins is used for analyzing the dynamic interaction of the flexible solar arrays. Also included are the dynamics associated with the translation of the solar-electric engine cluster.

MARSH, H. E., JR.

M03 Low-Modulus Propellant for Case-Bonded, End-Burning Motors

H. E. Marsh, Jr., and D. Udlock

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 184–188, June 30, 1970

A low-modulus propellant for use in fully case-bonded end-burning motors has been developed and demonstrated. This development was achieved by employing a new binder formulating technique based on polymer network theory. The low modulus was obtained by adjusting the network polymer formation within the propellant binder by means of chain termination. The chain termination was accomplished by the introduction of a monofunctional binder ingredient, which effectively lowers the polymer crosslink concentration, resulting in a highly extensible propellant binder.

The properties of this binder make possible propellants with controllable physical properties over a wide range. This has allowed the design of a fully case-bonded end-burning motor with a propellant which is elastic enough to withstand the triaxial strains imposed upon it and yet is rigid enough so that it will not deform under its own weight. Preliminary tests with a flight-weight motor containing 800 lb of propellant have been successful.

MATTICE, J. A.

M04 Study of the Effects of Heat Sterilization and Vacuum Storage on the Ignition of Solid Propellant Rockets

L. Strand, J. A. Mattice, and J. W. Behm

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 196–206, June 30, 1970

For abstract, see Strand, L.

McELIECE, R.

M05 Combinatorial Communication: Hide and Seek, Data Storage, and Entropy
R. McEliece and E. Posner
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 23–28, June 30, 1970

This article shows that the worst-case probability distribution on a compact data source typically forces a minimum average word length for storage within a given fidelity which is no better than what could be realized if no advantage were taken of the probability law whatever. This minimum turns out to be the logarithm of the reciprocal of the value of a hide and seek game played on the data source.

McGINNESS, H. D.

M06 New Cable Wrap-Up System for 210-ft-diam Antenna
H. D. McGinness
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 53–56, May 31, 1970

The installation of the structural components of the cable wrap-up system is described. A comparison between the actual configuration at full wrap-up and the predicted configuration is presented.

McINNIS, J.

M07 Multiple Mission Telemetry 1971 Configuration
W. Frey, R. Petrie, R. Greenberg, J. McInnis, and R. Wengert
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 63–77, May 31, 1970

For abstract, see Frey, W.

MENICHELLI, V. J.

M08 Initiation of Explosives by Laser Energy
V. J. Menichelli and L. C. Yang
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 167–169, June 30, 1970

Primary high explosives and some metal/metal-oxide mixtures are easily initiated by pulsed laser energy in the free running mode. Secondary high explosives

are not easily initiated except under very special conditions. The shock phenomenon, associated with Q-switched lasers, may be strong enough to start a detonation in the less sensitive secondary high explosives. This technique is being studied and some preliminary results are reported

MEREDITH, B. L.

M09 Spectral Observations of Jupiter in the Frequency Interval 18.5–24.0 GHz: 1968
D. E. Jones (Brigham Young University), B. L. Meredith, and E. Arthur
Pub. Astron. Soc. Pacific, Vol. 82, No. 484, pp. 122–125, February 1970

For abstract, see Jones, D. E.

MERRILL, O. S.

M10 Multi-Hundred-Watt Radioisotope Thermoelectric Generator Transient Performance
W. D. Leonard and O. S. Merrill
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 80–86, June 30, 1970

For abstract, see Leonard, W. D.

METZGER, A. E.

M11 Gamma Ray Spectroscopic Measurements of Mars
A. E. Metzger and J. R. Arnold (University of California, San Diego)
Appl. Opt., Vol. 9, No. 6, pp. 1289–1303, June 1970

A gamma ray spectrometer placed in orbit around Mars is expected to yield significant compositional data which can be related to the evolution of that planet. Components of the observable gamma ray flux come from the Martian surface, galactic and intergalactic space, and the spacecraft itself. The flux can be detected by a scintillation crystal or solid state detector, either of which combines efficiency of detection with energy resolution, and returns information to the earth as a pulse height distribution in order to detect characteristic energy line structure. The data will be evaluated for evidence of elemental differentiation with reference to terrestrial, meteoritic, solar, and lunar abundances. A lengthy mission will allow the surface of Mars to be mapped in a search for possible correlations between composition and topography or albedo

MILLER, C. G.

M12 Application of Imposed Magnetic Fields to Compact-Arc Lamps

C. G. Miller and R. E. Bartera

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 161–166, June 30, 1970

Sealed xenon compact-arc lamps are used as light sources for JPL solar simulators. The factors influencing arc lamp brightness and operation are given. To improve performance, some of these factors may be influenced by using magnetic fields imposed on the arc during operation. The use of imposed magnetic fields have resulted in improved lamp performance through. (1) increased anode heat-carrying capacity, (2) increased cathode current density during operation, (3) increased power delivered into the imaged area of the arc, and (4) increased stability of banks of lamps in operation.

MOACANIN, J.

M13 A Generalization of the Boltzmann Superposition Principle

J. Moacanin, J. J. Aklonis, and R. F. Landel

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 207–209, June 30, 1970

In previous work a mathematical representation was developed for the stress relaxation or creep behavior of an elastomer undergoing scission reactions. These results have been extended so that arbitrary time-dependent deformations could be treated. A convolution integral was derived. In absence of chemical reaction, this integral reduces to the classical statement of the Boltzmann superposition principle.

MUDGWAY, D. J.

M14 DSN Support for *Viking* [March–April 1970]

D. J. Mudgway

The Deep Space Network, Space Programs Summary 37-63, Vol. II, p. 14, May 31, 1970

The Deep Space Network (DSN) Interface Design Handbook has been released and is intended for use by all flight projects as a standard source of advanced technical information describing the DSN interfaces with the projects in telecommunications, data processing, and simulation. Telecommuncations interfaces are considered in the context of a full 210-ft subnet, together with the existing but enhanced 85-ft subnet. Data processing interfaces are considered in terms of the Mark III Space Flight Operations Facility

systems, subsystems, and assemblies, the simulation section introduces the concept of tracking, telemetry, and command mathematical software models.

NORMAN, R. A.

N01 Correction Factors for Near Field Horn Antenna Gain Measurements

R. A. Norman

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 34–35, May 31, 1970

Spherical wave function theory is used in the calculation of the near field gain variation of a dual-mode conical horn. The near field gain values are calculated for the two-horn insertion loss gain measurement technique.

ONDRASIK, V. J.

O01 A Solution for the Tropospheric Zenith Range Correction Using a Single Pass of Differenced Doppler Data

V. J. Ondrasik

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 16–22, May 31, 1970

The ability to solve for the tropospheric zenith range correction is analyzed using a single pass of differenced doppler data and a very simple tropospheric model. To improve upon the accuracy obtainable from surface weather measurements requires use of data below an elevation angle of 10 deg. However, the problems associated with using such low elevation angle data probably preclude the determination of zenith tropospheric corrections from differenced doppler data.

O02 The Effects of a Variable h_{max} on the Mapping of Zenith Ionospheric Corrections to Lower Elevation Angles

V. J. Ondrasik

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 21–24, May 31, 1970

Ionospheric corrections computed using elevation angle mappings based firstly on a Chapman model with constant parameters and secondly on a Chapman model with a variable h_{max} (height of maximum electron density) are compared. For the example considered, the corrections may differ by as much as 0.5 m in range and 1.4×10^{-3} Hz in doppler.

OTOSHI, T. Y.

O03 Improved RF Calibration Techniques: A Precision Compact Rotary Vane Attenuator

T. Y Otoshi
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 29–33, May 31, 1970

The results of radio frequency calibrations on a compact H-band rotary vane attenuator are presented. The calibrations consist of (1) 8448-MHz reflection coefficient measurements on the individual component parts of the compact attenuator, and (2) phase and attenuation characteristics of the overall attenuator over the frequency range of 8.0 to 10.0 GHz Comparison of measured and theoretical values indicate that the compact attenuator theory is valid over a broad band of frequencies

Sources of error causing deviation from theory have been analyzed. The results are presented in graphic form. It is concluded that when transitions having voltage standing-wave ratios of 1.02 or less are installed on the compact attenuator assembly, the attenuator will obey the modified law within the total probable error limits.

PAWLIK, E. V.

P01 Solar Electric Propulsion System Tests

E V. Pawlik, E. N. Costogue, J. D. Ferrera, and T. W. Macie
Technical Report 32-1480, August 15, 1970

The design and experimental evaluation of a solar electric primary propulsion system is described. The system consists of two electron-bombardment ion thrusters complete with the associated thrust vector aligning actuators, a switching network, controller, and a flight-type power conditioner. The system was operated over a 2:1 range in output power. System integration problems such as matching of thruster performance and response to arcing within the thruster and solutions to these problems are described. Short endurance tests of the system were undertaken. Noise within the system was the major lifetime-limiting factor for both the power conditioner and controller.

P02 Ion Thruster Control-Loop Sensitivity

E. V. Pawlik
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 223–226, June 30, 1970

Electrical parameters of a 20-cm diameter electron-bombardment ion thruster were varied from the nominal set points as the thruster output power and mercury propellant flowrate were regulated by control loops. The effect of variations in the fixed parameters on the indirectly controlled propellant flowrate was determined. It was found that about ±1% regulation

was required for the arc chamber current and voltage. A regulation of ±10% was found sufficient for all other parameters.

PETRIE, R.

P03 Multiple Mission Telemetry 1971 Configuration

W. Frey, R. Petrie, R. Greenberg, J. McInnis, and R. Wengert
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 63–77, May 31, 1970

For abstract, see Frey, W.

PHILLIPS, R. J.

P04 Dipole Antenna Radiation in a Compressible, Anisotropic Electron Plasma Overlying an Imperfectly Conducting Half-Space—Lunar Applications: 1. Formulation of the Solution; 2. Integration and Results

R. J. Phillips and S. H. Ward (University of California, Berkeley)
Radio Sci., Vol. 5, No. 5, pp. 821–839, May 1970

The problem of the electromagnetic response of infinitesimal electric and magnetic dipole sources in a compressible, anisotropic electron plasma overlying a lossy dielectric half-space is solved by integral transform and matrix techniques to assess antenna radiation in the lunar environment. In part 1, the solutions are formulated in terms of Fourier–Bessel integrals operating on matrix quantities. In particular, the field solutions are shown to linear combinations of classical plane-wave modes in a compressible, anisotropic plasma. The introduction of a lossy dielectric half-space yields uncoupled TE and TM modes propagating into the dielectric plus three reflected plasma modes. The modal reflection coefficients represent reflections coupled to all plasma modes.

In part 2, the Fourier–Bessel integrals of part 1 are evaluated by the saddle-point method. By utilizing the arguments of ray optics, an algorithm is devised to find the saddle points by a numerical search procedure on dispersion surfaces. Reflection coefficients show a strong oscillatory structure as a function of frequency in the vicinity of the plasma frequency. This phenomenon is caused by rapid changes in ray convergence and by constructive–destructive interference of reflected modes. Branch-cut contributions yield lateral waves traveling along the dielectric boundary. The dominant lateral wave species is the modified extraordinary (MEX) mode launched by an acoustic-acoustic reflection. Other lateral waves are less important, and, for these species, the position of the observer can go from the propagating zone to the

shadow zone as the frequency is increased upward from the plasma frequency.

POSNER, E.

P05 Combinatorial Communication: Hide and Seek, Data Storage, and Entropy
R. McEliece and E. Posner
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 23–28, June 30, 1970

For abstract, see McEliece, R.

QUADE, J. G.

Q01 Multispectral Remote Sensing of an Exposed Volcanic Province
J. G. Quade (University of Nevada), P. E. Chapman (University of Nevada), P. A. Brennan (University of Nevada), and J. C. Blinn III
Technical Memorandum 33-453, June 15, 1970

During July of 1968 a mission was flown, for a second year, over a volcanic province at Mt. Lassen National Park, in support of the NASA Earth Resources Program. Day and night flights were completed with the following instruments operating satisfactorily: two 9-in. by 9-in. metric cameras with black and white and color IR film, an 8-14 μm IR scanner, four microwave radiometers operating at 8.9, 15.8, 22.2, and 34.0 GHz and a 13.3-GHz radar scatterometer.

Four ground stations were manned during the flights to monitor ground temperatures and moistures. These data were used in conjunction with ground-based radiometers operating at 1.4, 9.3, 13.7, and 37.0 GHz. Prior to the overflights, extensive ground studies (terrametrics), utilizing standard geologic and geophysical techniques, were performed. Some of these studies were reported in greater detail in JPL Technical Memorandum 33-405, however, those pertinent to this report and studies completed this year are reported herein.

Data from the aircraft and ground-based sensors are presented with the relative merits of each sensor discussed along with recommendations for their application.

REICHHARDT, R. W.

R01 Synthesis of a Binary System
R. W. Reichhardt
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 94–97, May 31, 1970

A set of algorithms has been developed that define a computer program to extract and synthesize the logical structure of a record of binary data. The program, which has been coded in the basic language, is designed for interactive control through a remote terminal. Given a data record of sampled values of a set of binary-valued parameters, the program permits detection and representation of combinatorial relations among the parameters. Functional relations are expressed, in output, as lists of prime implicants.

REIER, M.

R02 Absolute Gamma Ray Intensity Measurements of a SNAP-15A Heat Source

M. Reier

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 97–102, June 30, 1970

A germanium crystal has been used to measure the absolute intensity of gamma rays from the decay of Pu^{238}, Pb^{212}, Bi^{212}, and Tl^{208} in a 1.5-W SNAP-15A (System for Nuclear Auxiliary Power 15A) heat source. In practically all cases, agreement with other measurements is excellent. In addition, the amount of Pu^{239} impurity originally present in the sample can be measured with an accuracy of 4%. It is estimated that the Pu^{239} content in a fuel sample that is several months old can easily be measured with an accuracy of 10%.

ROHR, J. A.

R03 STAR Computer Software

J. A. Rohr

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 150–152, June 30, 1970

Software for the STAR (self-testing and repairing) computer is comprised of three types of programs. The first type is used to prepare STAR computer programs. Two versions of the programming subsystem for the STAR computer have been completed: one for the IBM 7094 and one for the UNIVAC 1108. Each consists of an assembler, loader, simulator, and executive control program. An initial version of the second type of program, the operating system, is now being developed. Some programs of the third type, common subroutines and special-purpose applications programs, have already been written. In the future, the operating system will be developed further and more subroutines and applications programs will be written.

ROPER, W.

R04 Spacecraft Adhesives for Long Life and Extreme Environments
W. Roper
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol III, pp. 128–133,
June 30, 1970

The present state-of-the-art of high performance adhesives was reviewed to identify those newer adhesive materials which show promise for application in future spacecraft fabrication. The adhesives survey revealed several new polymeric materials which show considerable potential for spacecraft use when both elevated and cryogenic environments are encountered. These include the polyimide, polybenzimidazole, and the polyquinoxaline polymers.

ROSS, R. G., JR.

R05 Optimum Shell Design
A. E. Salama and R. G. Ross, Jr.
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 134–139,
June 30, 1970

For abstract, see Salama, A. E.

SALAMA, A. E.

S01 Optimum Shell Design
A. E. Salama and R. G. Ross, Jr.
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 134–139,
June 30, 1970

A unified approach for formulating the problem of optimum shell design satisfying certain design requirements is given and a means of transforming the constrained design problem to an unconstrained minimization problem is discussed. The resulting unconstrained function is simple in form and is devised such that a minimum amount of computational effort is required. The advantages of the form of the suggested function over others described in the literature are discussed.

Two algorithms for unconstrained minimizations are compared. These are the Simplex method of direct search and a gradient technique known as the variable metric method. For the two examples solved, the Simplex method was found to be superior over the variable metric technique.

SATO, T.

S02 **Radio Science Support [by DSN, March–April 1970]**
T. Sato and D. Spitzmesser
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 98–101, May 31, 1970

Three proposed experiments received earlier were evaluated and approved by the Radio Astronomy Experiment Selection Panel and three new proposals were received for consideration. Radio science experiments performed at Deep Space Network (DSN) facilities since July 1967 are summarized. Operating times of the 210-ft antenna facility in support of radio science activities during calendar year 1970 are also projected.

SAVAGE, J. E.

S03 **Coding and Synchronization Research: Decision Rules for a Two-Channel Deep-Space Telemetry System**
S. Butman, J. E. Savage, and U. Timor
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 38–41, June 30, 1970

For abstract, see Butman, S.

SCHAPER, P. W.

S04 **Results of the Near Infrared Multidetector Grating Spectrometer Study**
L. W. Carls and P. W. Schaper
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 1–5, June 30, 1970

For abstract, see Carls, L. W.

SHAFER, J. I.

S05 **Solid Propellant Spacecraft Motors**
J. I. Shafer
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 188–196, June 30, 1970

Successful static test firings in 60- and 800-lb flight-weight motors have now shown that the concept of case-bonded end-burning motors, without mechanical stress relief, is technically feasible when the case length-to-diameter ratio is about one. Motors utilized polyether polyurethane propellant zone cured at 140°F under a cure pressure as high as 275 psi (about 93% of the chamber proof pressure). Additional motor

processing and firing tests to help determine the boundaries for the concept indicate that the propellant should have unusually low modulus and exceptionally high elongation to avoid buckling in the thin wall case and pullaway at the propellant–insulation interface. A tentative range of values for propellant mechanical properties has been adopted.

SHAPIRO, I. I.

S06 Celestial Mechanics Experiment for *Mariner* Mars 1971

J. Lorell, J. D. Anderson, and I. I. Shapiro (Massachusetts Institute of Technology)

Icarus: Int. J. Sol. Sys., Vol. 12, No. 1, pp. 78–81, January 1970

For abstract, see Lorell, J.

SHOEMAKE, G. R.

S07 Palladium–Hydrogen System: Efficient Interface for Gas Chromatography–Mass Spectrometry

P. G. Simmonds, G. R. Shoemake, and J. E. Lovelock

Anal. Chem., Vol. 42, No. 8, pp. 881–885, July 1970

For abstract, see Simmonds, P. G.

SIEGMETH, A. J.

S08 *Pioneer* Mission Support [by DSN, March–April 1970]

A. J. Siegmeth

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 7–11, May 31, 1970

The Deep Space Network (DSN) is regularly furnishing tracking and data acquisition support for the still-active *Pioneer VI, VII, VIII,* and *IX* missions. The purpose of this support is to detect and collect telemetry data transmitted by the spacecraft, transmit commands to the spacecraft, and utilize the doppler shift of the two-way coherent S-band carrier for precision spacecraft trajectory determination. This article is concerned only with the telemetry support.

During more than four years of *Pioneer* support, the network has developed an advanced deep-space telecommunications capability encompassing a sizable segment of our solar system. Since 1966, the DSN has implemented several new subsystems in the network, all of which improved the threshold capabilities of the *Pioneer* telemetry support. Seven 85-ft-diam antenna stations were equipped with improved masers, efficient microwave plumbing, linear antenna polarizers, 3-Hz carrier tracking loops, advanced demodulation hardware, and equipment to support the

onboard convolutional coding of *Pioneer IX*. Total telemetry signal-to-noise improvements of 8.5 to 10.1 dB were achieved. Both the 85-ft antenna network's *Pioneer* support range and, in a broad sense, the data return from the spacecraft have been almost doubled.

SILVER, R. H.

S09 Evaluation of Recording Tapes for Use in Spacecraft Magnetic Tape Recorders
J. K. Hoffman, S. H. Kalfayan, and R. H. Silver
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, p. 160, June 30, 1970

For abstract, see Hoffman, J. K.

S10 Evaluation of Spacecraft Magnetic Recording Tapes
S. H. Kalfayan, R. H. Silver, and J. K. Hoffman
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 209–214, June 30, 1970

For abstract, see Kalfayan, S. H.

S11 Effects of Simulated Venusian Atmosphere on Polymeric Materials
S. H. Kalfayan and R. H. Silver
J. Spacecraft Rockets, Vol. 7, No. 5, pp. 634–636, May 1970

For abstract, see Kalfayan, S. H.

SIMMONDS, P. G.

S12 Palladium–Hydrogen System: Efficient Interface for Gas Chromatography–Mass Spectrometry
P. G. Simmonds, G. R. Shoemake, and J. E. Lovelock
Anal. Chem., Vol. 42, No. 8, pp. 881–885, July 1970

The property of palladium–silver (25%) tubing to selectively diffuse hydrogen has been used to develop a new type of interface for gas chromatography–mass spectrometry. Optimum efficiency can be maintained at temperatures in excess of 200°C when the separator is placed in an oxidizing atmosphere such as laboratory air. Catalytic reduction which was anticipated to be a potential handicap of the palladium–silver interface has been investigated and found to be specific for compounds with conjugated unsaturation such as dienes, α,β-unsaturated aldehydes, ketones, and nitriles. The palladium–silver separator was developed for a gas chromatograph–mass spectrometer instrument specifically intended for spaceflight experiments. However, its advantages of possessing a simple and rugged construction, near 100% efficiency,

and a quantitative delivery of most sample substances make it attractive for more general use.

SIMON, M. K.

S13 Optimum Modulation Index for a Data-Aided, Phase-Coherent Communication System

M. K. Simon

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 63–66, June 30, 1970

The choice of a modulation index which minimizes error probability in a single-channel phase-coherent communication system employing a data-aided tracking loop is considered in this article. It is shown that for a fixed total energy-to-noise ratio and loop bandwidth-symbol time product, a value of modulation factor does indeed exist which minimizes the data detector's probability of error. This minimum error probability preformance compares favorably with the case of ideal detection.

S14 The Effect of Limiter Suppression on Command Detection Performance

M. K. Simon

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol III, pp. 66–70, June 30, 1970

This article evaluates the error probability penalty paid in the design of present-day vehicle transponders due to passage of the command modulation through a bandpass limiter. Based upon recent theoretical developments relative to bandpass limiters and second-order phase-locked loops, analytical results are given which enable one to compare the performance of the present design with a system which removes the command modulation prior to transmission through the limiter Also considered is the effect of the bandpass limiter input filter bandwidth on the resulting data detector preformance

S15 An Analysis of the Phase Coherent–Incoherent Output of the Bandpass Limiter

J. C. Springett and M K. Simon

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 70–79, June 30, 1970

For abstract, see Springett, J C.

SMITH, L. S.

S16 TOPS Attitude-Control Single-Axis Simulator Momentum-Wheel Tachometer Circuit

L. S. Smith
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 109–111,
June 30, 1970

The characteristics of a Bendix momentum wheel tachometer output are presented. The interfacing logic between the tachometer and the Thermoelectric Outer-Planet Spacecraft (TOPS) attitude-control single-axis simulator digital circuits is discussed.

SPITZMESSER, D.

S17 **Radio Science Support [by DSN, March–April 1970]**
T. Sato and D. Spitzmesser
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 98–101, May 31, 1970

For abstract, see Sato, T.

SPRINGETT, J. C.

S18 **An Analysis of the Phase Coherent–Incoherent Output of the Bandpass Limiter**
J. C. Springett and M. K. Simon
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 70–79,
June 30, 1970

Many applications of the bandpass limiter involve coherent demodulation following the limiter. It is shown that as a result of demodulation the signal mean and the noise variance are direct functions of the phase angle between the signal component passed by the bandpass limiter and the coherent reference. As a result, the relationship between the output and input signal-to-noise ratio may be significantly different than that obtained by Davenport for incoherent limiters. A study is also made of the output noise spectral density, and an approximate expression is derived as a function of the input signal-to-noise ratio, reference phase angle, and the characteristics of the input bandpass filter to the limiter. Also discussed is the first-order signal-plus-noise probability density following coherent demodulation.

STAVRO, W.

S19 **Possible 1975 Jupiter–Pluto Gravity Assist Trajectories**
W. Stavro
Supporting Research and Advanced Development,
Space Programs Summary 37-63, Vol. III, pp. 236–239,
June 30, 1970

A preliminary analysis of a 1975 Jupiter–Pluto mission was performed. A patched conic computer program SPARC was used to search for any possible trajectories. Two kinds of trajectories were found to be possible: (1) those with very high injection energy C_3 and very short launch period (ridge), and (2) those that have Type II Earth–Jupiter legs with very long flight times. Characteristics and plots of these trajectories are given. It is concluded that even though the trajectories are possible the mission is not feasible.

STELZRIED, C. T.

S20 A Faraday Rotation Measurement of a 13-cm Signal in the Solar Corona

C. T. Stelzried

Technical Report 32-1401, July 15, 1970

The goal of this experiment was to further the scientific knowledge of the solar corona by measuring the Faraday rotation of a 2292-MHz continuous wave signal in this plasma.

The *Pioneer VI* spacecraft was launched into a circumsolar orbit on December 16, 1965, and was occulted by the sun in the last half of November, 1968. During the occultation period, the 2292-MHz S-band telemetry carrier wave underwent Faraday rotation due to the interaction of this signal with the plasma and magnetic field in the solar corona. The 210-ft-diam Goldstone Mars station antenna of the Deep Space Network located near Barstow, Calif. was used for the measurement. The antenna feed was modified for automatic polarization tracking for this experiment. This modification is described and the performance evaluated.

Three large-scale transient Faraday rotation phenomena were observed on November 4, 8, and 12. These phenomena typically lasted about 2 h and produced Faraday rotations on the order of 40 deg. Correlation with dekametric solar radio bursts was noted and the implied solar wind velocity estimated.

A steady-state Faraday rotation was observed, commencing at about 10 solar radii on the west limb of the sun. The rotation increased steadily as the ray path approached the sun At 4 solar radii polarization had rotated over 125 deg. The signal could not be tracked closer to the sun because of the loss in receiver sensitivity caused primarily by the increased system noise temperature. The increase in system noise temperature was due to the antenna side lobes "seeing" the sun. Further loss in sensitivity was due to the spectral broadening of the signal caused by highly random motion of the excited plasma close to

the sun The rotation was of nearly equal magnitude upon exit on the east limb of the sun but of opposite sense in the outer region.

The steady-state measurement is compared with a theoretical model of the solar corona using a modified Allen–Baumbach electron density and the coronal magnetic field as derived from the Mount Wilson optical solar magnetograph and the *Explorer 33* satellite magnetometer. Although the calculated rotation and the experimental data show general agreement with respect to the magnitude, sense, and timing of the rotation, an improved fit is obtained with an assumed equatorial electron density (in m^{-3})

$$N = 10^{14}\left(\frac{6000}{R^{10}} + \frac{0.002}{R^2}\right), \qquad (4 < R < 12)$$

with R in solar radii.

STRAND, L.

S21 Study of the Effects of Heat Sterilization and Vacuum Storage on the Ignition of Solid Propellant Rockets

L. Strand, J. A. Mattice, and J. W. Behm

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 196–206, June 30, 1970

A program was conducted to determine the effects of heat sterilization and vacuum storage on the ignition characteristics and performance of typical state-of-the-art solid propellant igniters and igniter materials The ignition characteristics of a JPL propellant specifically developed to survive heat sterilization cycling were also investigated. The results of various measurements and tests conducted on heat-cycled (three and six heat cycles: 56 h at 275°F per cycle) and vacuum-stored (6 mo at 10^{-7} torr) samples were compared with those for control samples of the same materials. Heat sterilization was found to have small, but measurable, effects on the ignition characteristics of the materials tested. Similar tests on the materials that had undergone vacuum storage did not reveal any distinct effects of the exposure.

TIMOR, U.

T01 Coding and Synchronization Research: Efficient Multichannel Space Telemetry

S. Butman and U. Timor

Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 34–37, June 30, 1970

For abstract, see Butman, S.

T02 **Coding and Synchronization Research: Decision Rules for a Two-Channel Deep-Space Telemetry System**
S. Butman, J. E. Savage, and U. Timor
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 38–41, June 30, 1970

For abstract, see Butman, S.

UDLOCK, D.

U01 **Low-Modulus Propellant for Case-Bonded, End-Burning Motors**
H. E. Marsh, Jr., and D. Udlock
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 184–188, June 30, 1970

For abstract, see Marsh, H. E., Jr.

URECH, J. M.

U02 **Telemetry Improvement Proposal for the 85-ft Antenna Network**
J. M. Urech
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 116–120, May 31, 1970

Since most of the spacecraft currently being tracked at the Madrid stations are either near or below the telemetry threshold, studies and tests have been carried out to ascertain the possibility of combining two or more stations to improve telemetry performance. The studies show that telemetry performance can be improved by several decibels, depending on which of the proposed methods of combination is selected. An increase of 3 dB over a normal two-way tracking station can be obtained with the combined tracking of two identical stations—one in normal two-way (acting as prime) and the other in three-way (acting as booster). With the configuration of one station in a *receive only* mode (with diplexer bypass) acting as the "booster station," a 4.75-dB improvement may be obtained.

VOLKOFF, J. J.

V01 **Irradiance Required to Cause Damage to Developed Photographic Film**
J. J. Volkoff
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 47–52, May 31, 1970

A noticeable change in the photometric and physical properties of a developed photographic film is found to be a function of the irradiance level and the period

of exposure imposed upon the film. Results show that developed black and white film may be irradiated up to an energy density of 10^5 W-s/cm^2 without causing an apparent photometric degradation.

WARD, S. C.

W01 A Time-Synchronized VLF Phase-Tracking Receiver

S. C. Ward

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 108–112, May 31, 1970

Frequency offset and stability information is achieved directly through the phase tracking of very low frequency (VLF) transmissions. Time synchronization is indirectly maintained using these data. At present, keyed VLF transmissions contain both primary time and frequency information; however the VLF receiver presently used by the Deep Space Network cannot be used on keyed broadcasts in areas of high interference or low signal level. More meaningful time data and a great improvement in signal-to-noise ratio of primary frequency data can be achieved by time-code-keying the VLF receiver while tracking WWVL transmissions. This article discusses the exploitation of WWVL as a worldwide source of a frequency reference.

WARD, S. H.

W02 Dipole Antenna Radiation in a Compressible, Anisotropic Electron Plasma Overlying an Imperfectly Conducting Half-Space—Lunar Applications: 1. Formulation of the Solution; 2. Integration and Results

R. J. Phillips and S. H. Ward (University of California, Berkeley)

Radio Sci., Vol. 5, No. 5, pp. 821–839, May 1970

For abstract, see Phillips, R. J.

WEBER, R. L.

W03 Canberra Microwave Link Relocation

R. L. Weber

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 61–63, May 31, 1970

Construction of the new 210-ft antenna at the Tidbinbilla Deep Space Station (Australia) has caused blockage of the radio frequency path of the Manned Space Flight Network (MSFN) backup wing to the prime site microwave link. MSFN backup wing tracking commitments for future *Apollo* missions, such as *Apollo* 13 in mid-April, presented an urgent need to

replace or relocate the existing microwave link. The link relocation was completed in the required time-span by relocating the equipment at the Tidbinbilla Deep Space Station end of the microwave link.

WENGERT, R.

W04 Multiple Mission Telemetry 1971 Configuration
W. Frey, R. Petrie, R Greenberg, J. McInnis, and R. Wengert
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 63–77, May 31, 1970

For abstract, see Frey, W.

WILCHER, J.

W05 DSIF Multiple-Mission Command System
R Crow, S. Friesema, J. Wilcher, and J. Woo
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 77–94, May 31, 1970

For abstract, see Crow, R.

WILSON, S.

W06 An Improved Newton–Raphson Algorithm for Finding the Roots of Equations for Solid Propellant Combustion Studies
R L Klaus and S. Wilson
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 173–175, June 30, 1970

For abstract, see Klaus, R. L.

WOO, J.

W07 DSIF Multiple-Mission Command System
R. Crow, S. Friesema, J. Wilcher, and J. Woo
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 77–94, May 31, 1970

For abstract, see Crow, R.

WOO, K.

W08 Spacecraft Antenna Research: Further RF Test Results of Reflector Surface Materials for Spacecraft Antennas
K. Woo
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 46–47, June 30, 1970

Radio frequency test results of reflector surface materials for spacecraft antennas are presented. The RF reflectivity loss of an improved gold-plated Chromel-R

mesh is found to be of the order of 0.07 dB or better at 8448 MHz; the RF reflectivity loss of Emfoil (copper-clad glass epoxy laminate) is of the order of 0.04 dB or better at the same frequency.

WOO, R.

W09 Spacecraft Antenna Research: Voltage Breakdown in Monopole Antennas at S-band
R. Woo
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 47–50, June 30, 1970

Voltage breakdown in $\lambda/4$ monopole antennas has been studied. The breakdown power levels are found to increase rapidly when either monopole diameter or frequency is increased. When voltage breakdown is a problem, dielectrics may be used to significantly improve the power-handling capability of monopole antennas.

WYATT, M. E.

W10 DSS Control Room Reconfiguration in Support of Future Project Requirements
M. E. Wyatt
The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp 60–61, May 31, 1970

The Deep Space Instrumentation Facility (DSIF), in 1970, will greatly increase its capabilities to meet the requirements of future spacecraft projects. Consequently, the DSIF will realize a significant increase in the amount of equipment located within the deep space station (DSS) control rooms throughout the DSIF. This article describes the new equipment and the philosophy utilized in location of the new equipment within the control rooms.

YANG, L. C.

Y01 Initiation of Explosives by Laser Energy
V. J. Menichelli and L. C. Yang
Supporting Research and Advanced Development, Space Programs Summary 37-63, Vol. III, pp. 167–169, June 30, 1970

For abstract, see Menichelli, V. J.

ZANTESON, R.

Z01 Multiple Primary Feed Cone Installation and Alignment
R. Zanteson

The Deep Space Network, Space Programs Summary 37-63, Vol. II, pp. 56–60, May 31, 1970

The installation and alignment phases of the multiple primary feed system have been completed at the Mars Deep Space Station. This involved removal of the original single cone system, structural modifications to accept larger and heavier components, and the installation of new structure. Subsequent alignment and gravity deflection testing phases indicate that design criteria have been met or exceeded.

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