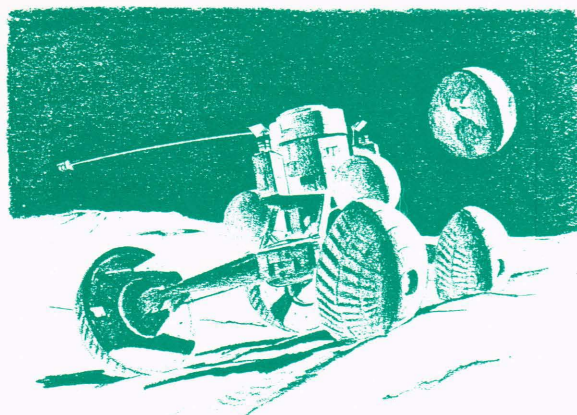


the spherical surface of the cap so that adjustment of support angle does not tilt the vehicle platform. Supports in the prototype are pivotally connected to the vehicle frame in a way that permits tilting them in one or more planes of motion by means of properly protected reversible DC motors and a worm gear drive. Other methods of tilting may be required for different vehicle configurations or for peculiar terrain conditions; these include hydraulic motors, hydraulic actuators, and mechanical linkages.

Direction and speed of travel are controlled by varying the tilt angles of all supports simultaneously while the caps are engaged to rotate. Independent cap control can also be provided but is not required for obtaining a maximum range of speeds in one direction or for altering direction or vehicle attitude. Total control is afforded when the vehicle utilizes pairs of caps or groups of pairs. If only one pair is employed, however, outrigger supports are essential for vehicle stability.

Maneuverability of a tilted-disc vehicle is far greater than that of one equipped conventionally with wheels or tracks. With caps rotating, movement of the vehicle in any direction from a starting position is simply a result of tilting the supports properly. Reversal of direction of motion without rotation of the vehicle can be readily achieved by simultaneously changing the tilt angle of the supports to the opposite side of the



Artist's concept of a lunar-terrain vehicle showing an application of the tilted-disc device with hemispherical caps in maximum speed attitude (nearly perpendicular to the vehicle axis).

vertical. Turns of any desired degree can be made, from spinning on the vehicle's axis to an infinite-radius turn, by changing tilt angles in the appropriate supports.

Operation of the vehicle may, therefore, be controlled by a single control mechanism rather than a maze of levers and pedals. Similar to the cyclic control stick used on some remote-controlled, experimental helicopters, displacement and rotation of a single control stick determines both speed and direction of a tilted-disc vehicle. This simplified control assures smooth operation and maximum maneuverability.

JOURNAL PUBLICATIONS

The following list is a compilation of recently published books and technical articles written by APL staff members.

F. F. Hiltz, "Analog Computer Simulation of a Neural Element," *IRE Trans. on Bio-Med. Electronics*, **BME-9**, 1, Jan. 1962, 12-20.

D. W. Fox and N. W. Bazley (National Bureau of Standards), "Error Bounds for Eigenvectors of Self-Adjoint Operators," *J. Research Nat. Bur. Standards*, **66B**, 1, Jan.-Mar. 1962, 1-4.

E. P. Gray and D. E. Kerr (The Johns Hopkins University), "The Diffusion Equation with a Quadratic Loss Term Applied to Electron-Ion Volume Recombination in

a Plasma," *Ann. Phys.*, **17**, 2, Feb. 1962, 276-300.

M. L. Peller and L. M. Herman (Library of Congress), "Soviet Chemical Ambitions at Home and Abroad," *Chem. Eng. Prog.*, **58**, 2, Feb. 1962, 31-33.

G. F. Pieper, C. O. Bostrom, and A. J. Zmuda, and B. J. O'Brien (State University of Iowa), "Detection of Solar and Van Allen Belt Protons by Injun Satellite in July 1961," *Bull. Am. Phys. Soc.*, **II**, 7, 1962, 62-

F. T. McClure, "Rockets, Resonance,

and Physical Chemistry," *Science*, **135**, 3506, Mar. 9, 1962, 771-776.

A. A. Westenberg and N. de Haas, "Gas Thermal-Conductivity Studies at High Temperature. Line-Source Technique and Results in N₂, CO₂, and N₂-CO₂ Mixtures," *The Phys. of Fluids*, **5**, 3, Mar. 1962-, 266-273.

O. Deters, "Effects of Gas Phase and Solid Phase Damping on Instability of Low Frequency Modes in Solid Propellant Rockets," pp. 378-384;

and

F. T. McClure, J. F. Bird, and R. W. Hart, "An Erosion Mechanism for Non-Linear Instability in the Axial Modes of Solid Propellant Rocket Motors," pp. 374-378, *J. Am. Rocket Soc.*, **32**, 3, Mar. 1962.

M. L. Hill, "Hydrogen Embrittlement of Metal Finishing," Chap. 3 of "The Behavior of Hydrogen in Iron and Steel," ed. by H. J. Read, Reinhold Publishing Corp., 1961, 46-80.

A. M. Stone and G. C. Weiffenbach, "Radio Doppler Method of Using Satellites for Geodesy, Navigation and Geophysics," Chap. III of "Progress in the Astronautical Sciences," I, ed. by S. F. Singer, North-Holland Publishing Co., Amsterdam, 1962, 93-144.

PATENTS

D. A. Washburn—*Sustained Operation Igniter for Ramjet Missiles*, Patent No. 3,024,607.

C. W. Brown, I. J. Sheppard et al—*Automatic Radio Navigation System*, Patent No. 3,025,519.

G. J. Pietrangeli et al—*Cascade Diffruser*, Patent No. 3,023,571.

APPOINTMENTS

Appointments of APL staff members to professional organizations and committees outside the Laboratory.

Walter G. Berl, Supervisor of the APL Fuels and Propellants Project of the Flight Research Group, has been appointed an Associate Editor of the *Journal of the American Rocket Society*.

Albert M. Stone, Technical Assistant to the Director, APL, has been elected a Fellow Member of the Hudson Institute, White Plains, N.Y., recently founded for studies on national security and international order.

George L. Seielstad, Supervisor of the APL Technical Reports Group, has been elected a Vice President of the American Association for the Advancement of Science and Chairman of the A.A.A.S. Section on Information and Communication.

Chih Kung Jen, Vice-Chairman of the APL Research Center, was recently elected to membership in the Academia Sinica, internationally recognized Chinese institution of higher learning in Taiwan, Formosa.

Lee M. Spetner, Research Center physicist, has been named by the President of The Johns Hopkins University as the 1962-63 recipient of the William S. Parsons Fellowship, the ninth to be awarded, to conduct research on deoxyribonucleic acid.

John B. Garrison, Richard B. Kershner, and Charles F. Meyer have been appointed to "Project Starlight," a study program on the status of the Navy in relation to technical developments in the field of astronautics.

APL COLLOQUIA SUMMARIES

Steps leading to identification of a new atomic particle were described by Dr. W. B. Fowler of the Brookhaven National Laboratory at the March 30 Colloquium. Called the positively-charged anti-xi (or anti-cascade) particle, the new bit of matter was detected after an exhaustive study of interactions in a bubble chamber designed and built by Dr. Fowler and his co-workers. The Brookhaven scientists were attempting to detect anti-hyperons, the anti-particles that are predicted by the Dirac theory.

The rectangular bubble chamber itself has inside dimensions of 10 x 10 x 20 in. The charged-particle stream entering the chamber is produced when the protons, having been accelerated to an energy of 30 Bev in the 2 x 5-cm, 4000-yd-long circular acceleration tube, strike a target. The beam is then purified and focused by a series of slits and bending magnets until it consists almost exclusively of anti-protons. When these interact with the hydrogen—the working fluid of the bubble chamber—

a xi-anti-xi hyperon pair is occasionally formed. Such an event can be spotted by its "signature," the unique configuration of the bubble tracks left in the wake of all charged particles which result from the decay of the hyperon pair.

The beam enters the chamber at the rate of a pulse of 10^{11} protons every 5 sec. All of the nearly 500,000 photographs taken of the chamber were searched for this characteristic "signature." Some 6000 proved interesting enough for further analysis. This was done by following all tracks, projected onto a screen, with a light spot controlled by a "joy stick" and thus automatically feeding the coordinates of all tracks into a "7090" computer. The computer is coded to identify the event by trying out all possibilities and determining which one fits the facts. The first anti-xi particle was found after scanning about 34,000 of the 500,000 pictures.

Other Colloquia held during the period were the following:

Feb. 23—"Magnetic Disturbances in the Far Exosphere," by Dr. C. P. Sonett, National Aeronautics and Space Administration.

Mar. 2—"Some Experiments on Spin-Lattice Relaxation in Rare Earth Salts," by Dr. R. P. Hudson, National Bureau of Standards.

Mar. 9—"Some Problems in the Dynamics of Planetary Atmospheres," by Prof. J. Charney, Massachusetts Institute of Technology.

Mar. 16—"Sensory Communication for the Blind," by Prof. S. Mason, Massachusetts Institute of Technology.

Mar. 23—"Collective Oscillations of Normal and Superconducting Electrons," by Prof. R. Ferrell, University of Maryland.

April 6—"Classical Radiation from Uniformly Accelerated Electrons," by Prof. T. Fulton, The Johns Hopkins University.

ADDRESSES

Principal recent addresses made by APL staff members to groups and organizations outside the Laboratory.

- R. E. Fischell, "Passive Magnetic Attitude Control for Earth Satellites," *American Astronautical Society*, Washington, D. C., Jan. 16-18, 1962.
- S. N. Foner, "Mass Spectrometry of Free Radicals and Excited Molecules," *Ninth Annual Conference, Western Spectroscopy Association*, Asilomar, Calif., Jan. 25, 1962.
- N. H. Choksy, "Lyapunov's Method and the Stability of Control Systems," *Electrical Engineering Seminar*, The Johns Hopkins University, Feb. 7, 1962.
- R. B. Kershner, "Geodesy in the Transit Program," *IRE National Winter Convention on Military Electronics, Navigation Session*, Los Angeles, Feb. 8, 1962.
- M. A. Schreiber, "Transit Navigational Satellites," *The Astronomy Club*, Gilman School, Baltimore, Feb. 16, 1962.
- T. Wyatt, "The Design, Development, and Operation of the Transit Satellite System," *U. S. Naval Reserve (WEPTU 662)*, Washington, D. C., Feb. 17, 1962.
- R. E. Fischell, "Solar Cell Experiments on the Transit and TRAAC Satellites," *NASA Interagency Advanced Power Group Meeting*, Washington, D. C., Feb. 27-28, 1962.
- R. B. Kershner, "Transit Program," *American Rocket Society, Maryland Section*, Baltimore, Mar. 5, 1962.
- G. F. Pieper, "Detection of Nuclear Particles in Space," *Experimental Nuclear Physics Seminar*, Yale University, Mar. 5, 1962.
- A. J. Zmuda, "Magnetic Storms and Solar Protons," *Symposium on Geomagnetism*, University of Pittsburgh, Mar. 12, 1962.
- G. F. Pieper, "Some Research Results from the Injun Satellite," *Seminar on Cosmic Rays and Astrophysics*, University of Maryland, Mar. 13, 1962.
- G. H. Albrecht, "Seeking Employment in the Chemical Industry—Interview Techniques and Ethics," *Senior Class*, Trinity College, Mar. 14, 1962.
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- A. I. Mahan and S. M. Cannon, "Fraunhofer Diffraction Patterns of Sections of Annular Ring-Type Apertures Contained Within Concentric Pie-Type Sections," *Optical Society of America, Physical Optics Section*, Washington, D. C., Mar. 14-17, 1962.
- T. K. Sen and G. H. Mowbray, "The Influence of Size and Brightness Parameters on the Differential Sensitivity of the Central Retina to Photic Flicker," *Optical Society of America, Vision and Color Section*, Washington, D. C., Mar. 14-17, 1962.
- G. C. Weiffenbach, "Transit," *IRE Professional Group on Aeronautical and Navigational Electronics*, Massachusetts, Institute of Technology, Mar. 15, 1962.
- A. G. Carlton, "Linear Estimation in Stochastic Processes," *Advanced Mathematical Statistics Seminar*, Columbia University, Mar. 23, 1962.
- R. B. Kershner, "Geodesy in the Transit Program," *1962 Lectures on Engineering Science*, University of Texas, Mar. 23, 1962.
- D. W. Fox, "Lower Bounds to Eigenvalues Using Operator Decompositions of the Form B^*B ," *Mathematics Colloquium*, The Naval Ordnance Laboratory, White Oak, Md., Mar. 26, 1962.
- J. O. Artman and J. C. Murphy, "Role of the Hemihedral Field in the Spectrum of Ruby," *American Physical Society, Masers and Non-linear Dielectric Session*, Baltimore, Mar. 26-29, 1962.
- G. C. Weiffenbach, "ANNA," *Starlight Committee*, The Naval Ordnance Laboratory, White Oak, Md., Mar. 27, 1962.
- G. F. Pieper, "Recent Measurements of Particle Radiation in Space," *Scientific Staff Meeting*, Nat. Bur. Standards, Mar. 30, 1962.
- M. L. Hill, "Interaction of Dissolved Hydrogen with Crystalline Imperfections in Iron and Steel," *43rd Annual Convention of the American Welding Society, Joint Meeting of the Metals Engineering Divisions of A.S.M.E. and A.W.S.*, Cleveland, April 9-11, 1962.
- J. O. Artman, "Electric Field Effects and the Spectrum of Ruby," *Applied Physics Dept. Colloquium*, The Naval Ordnance Laboratory, White Oak, Md., April 12, 1962.

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A. A. Westenberg, co-author of "High-Temperature Gas Transport Property Measurements by the Source-in-Flow Method," was co-author of "Fundamental Processes and Laminar Flame Structure" in the January-February 1962 issue of the *Digest*.

N. de Haas, co-author of "High-Temperature Gas Transport Property Measurements by the Source-in-Flow Method," is a member of the High Temperature Physics and Chemistry Project of the Flight Research Group. Born in Harrison, Arkansas, his education has included a B.S. degree in physics from Iowa State University (1950), graduate work at

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(continued)



the State University of Iowa, and an M.S. degree in physics from The University of Maryland in 1956. Mr. de Haas came to APL in 1951 and worked initially on the properties of shock waves as formed both by shock tubes and high explosives, and later on the trapping of free radicals at liquid helium temperatures. In his current work, he is conducting research in the field of high-temperature gas transport properties.

Author of "The Frog and the Radar Display," *A. J. Cote, Jr.* came to APL in 1955, following his employment at Davies Laboratories, Riverdale, Md. He was born in Providence, R.I., and received a B.S. degree in electrical engineering from

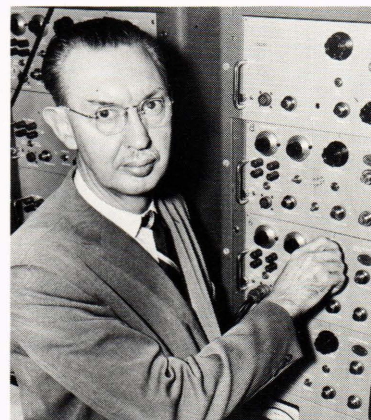
the University of Maryland in 1952. Mr. Cote is a specialist in circuit research and development as well as in bionics—the development of analog data-processing systems and components based on biological systems.



He is Supervisor of the System Design Applications Project of the Microelectronics Group. Mr. Cote is a member of the Institute of Radio Engineers professional groups on circuit theory, electronic computers, and information theory.

H. J. Unger, author of "Development of Infrared Spectrometer for Rocket Gas Analysis," is a physicist in the Fluid Mechanics Group of the APL Research Center. From Albany, New York, Dr. Unger received a B.A.

degree from Reed College, Portland, Oregon, and M.A. and Ph.D. degrees from the University of Oregon in 1930 and 1932, respectively. After two years as a research assistant in physics at the University of Oregon, he was associate professor of physics at the University of Idaho until 1938. He was then affiliated with the U. S. Treasury Department, Bureau of Engraving, as a research physicist until he came to the Laboratory in



1942. Dr. Unger is a specialist in infrared spectroscopy and has been concerned at APL with several phases of proximity fuze design, research, and analysis, and with test recovery analysis. He is a member of the Optical Society of America and the American Physical Society.