

that at the outer surface the transpirant flow rate increases away from the stagnation line and that there is very little temperature gradient at the outer surface of the porous matrix. This indicates that two-dimensional internal crossflow of the coolant had relatively little influence on the measured surface temperature.

Summary

A computer program has been written to predict temperature, pressure, and mass flow in a compact transpiration cooling system. It is a complex program including: conduction, radiation, aerodynamic heating, material properties as functions of temperature, friction losses, conduction to the plenum gas, suction effects, blowing effects, and transpiration cooling.

To verify results obtained from this program, a completely instrumented compact transpiration-cooled leading-edge model was constructed. The data from these tests were compared with analytical values and showed good agreement for absolute pressure in the compact plenum. Measured and computed surface temperatures had the same

general trends and were in good agreement everywhere except in the stagnation region, where it was felt that free-stream turbulence may have caused experimental temperatures to be higher than predicted.

A second computer program has been written to predict three-dimensional temperature, pressure, and mass flow in a porous matrix of general geometry. The program accounts for three-dimensional mass flow of transpirant within a matrix of spatially varying porosity. It is of general form and can be used in other transpiration cooling applications besides the compact plenum application.

Acknowledgment

This work was carried out under sponsorship of the Naval Air Systems Command, specifically, AIR-320B, Lt. Cdr. F. Cundari. Thanks are extended to L. B. Weckesser for his continued guidance throughout this program, and to J. L. Rice for his contribution in carrying out the free-jet tests.

HONORS AND AWARDS

R. E. Gibson, Director Emeritus of the Applied Physics Laboratory and Professor of Biochemical Engineering at The Johns Hopkins University School of Medicine, was awarded the honorary degree of Doctor of Medicine by The Johns Hopkins University on May 26, 1972.

A. Kossiakoff, Director of the Applied Physics Laboratory, has been named a trustee of the Chesapeake Research Consortium. This is an association of academic institutions consisting of The Johns Hopkins University, the University of Maryland, the Virginia Institute of Marine Science, and the Smithsonian Institution. Chartered in January 1972, its mission is "to conduct an integrated and collaborative research program which will contribute to better management of the Chesapeake Bay."

The *APL Technical Digest* won a Certificate of Achievement in the Corporate Research Journal category at the Third International Publications Competition sponsored by the Society for Technical Communications. Accepting the award during the Society's Nineteenth Annual Conference, held May 10-13, 1972, at the Statler Hilton Hotel in Boston, were the *Digest's* Managing Editor P. E. Clark and Staff Artist J. H. Hartle. The winning entry (January-February 1970 issue) was the same one that won the Award of Distinction last year in local competition of the Washington area chapter of the Society.

In a recent contest held by the Washington, D.C. Chapter of the Society for Technical Communications, *APL* publications won an award in each of the five categories. In addition, a special award was

given *APL* in recognition of its high performance as a multiple winner for two consecutive years. The awards were presented at a dinner on June 23, 1972.

An Award of Excellence was received in the Technical Reports category for *Heat-Engine/Mechanical-Energy-Storage Hybrid Propulsion Systems for Vehicles—Final Report*; editor R. T. Kroll and authors G. L. Dugger, A. Brandt, J. F. George, L. L. Perini, D. W. Rabenhorst, T. R. Small, R. O. Weiss. An Award of Excellence was also received in the House Organ category for the *APL Technical Digest*, Vol. 10, Nos. 4/5; Managing Editor P. E. Clark and Chairman of the Editorial Board S. N. Foner; authors H. B. Riblet, M. R. Peterson, D. L. Zitterkopf, E. J. Hoffman, A. L. Lew, F. F. Mobley, B. E. Tossman, G. H. Fountain.

HONORS AND AWARDS *(continued)*

Three Awards of Merit were received. One was received for Technical Brochures, *The Evolution of the Computer from the Abacus to the ENIAC*; editor V. M. Root, author Jeanne V. Von Schulz and designer S. G. Smith. Another was received for the Technical Manual

The Motion of Ballistic Missiles; editor Adele L. Machurek, authors L. S. Glover, J. C. Hagan. The third Award of Merit was received for the Journal Article "The Effect of Hyperbaric Oxygenation on Retinal Ischemia," authors R. W. Flower and Arnall Patz, M. D.

The two publications that received Awards of Excellence will be submitted by the local Chapter as entries in next year's national contest. Winners will be announced at the International Technical Communications Conference to be held in Houston in May 1973.

PUBLICATIONS

Compilation of principal recently published books and technical articles written by APL staff members.

- D. M. Silver, "Gaussian Expansions for Polyatomic Molecules," *Mol. Phys.* **22**, No. 6, 1971, 1069-1080.
- D. M. Silver, "Reaction Paths for Bimolecular Hydrogen Exchange," *Chem. Phys. Letters* **14**, No. 1, May 1, 1972, 105-107.
- R. A. Farrell (APL) and P. H. E. Meijer (The Catholic Univ. of America), "Compressibility Exponent γ from Ising to Mean-Field Theories," *Phys. Rev. B* **5**, No. 9, May 1, 1972, 3747-3750.
- J. G. Parker and D. N. Ritke, "Vibrational Relaxation Times of Oxygen and Oxygen Mixed with Several Light Gases," *J. Chem. Phys.* **56**, No. 10, May 15, 1972, 4834-4839.
- A. A. Westenberg and N. deHaas, "Steady-State Intermediate Concentrations and Rate Constants. Some HO₂ Results," *J. Phys. Chem.* **76**, No. 11, May 25, 1972, 1586-1593.
- J. C. Pirkle and V. G. Sigillito, "Calculation of Coefficients in Certain Eigenfunction Expansions," *Appl. Sci. Res.* **26**, No. 1/2, May 1972, 105-107.
- J. C. Pirkle and V. G. Sigillito, "Laminar Heat Transfer with Axial Conduction," *Appl. Sci. Res.* **26**, No. 1/2, May 1972, 108-112.
- T. A. Potemra, "The Empirical Connection of Riometer Absorption to Solar Protons during PCA Events," *Radio Sci.* **7**, No. 5, May 1972, 571-577.
- A. N. Jette, "Hyperfine and Zeeman Interactions in the Metastable, $c^3 \pi_u$, State of H₂," *Phys. Rev. A*, **5**, No. 5, May 1972, 2009-2013.
- R. E. Walker, T. L. Litovitz (APL) and M. E. Langham (JHU School of Medicine), "Pneumatic Applanation Tonometry Studies. II. Rabbit Cornea Data," *Exp. Eye Res.* **13**, No. 3, May 1972, 187-193.
- D. K. Anand and J. M. Whisnant, "Attitude Stability and Performance of a Dual-Spin Satellite with Nutation Damping," *J. Astronaut. Sci.* **19**, No. 6, May-June 1972, 462-469.
- F. J. Adrian, E. L. Cochran, and V. M. Bowers, "Electron Spin Resonance Spectra of ClCO and ClOO," *J. Chem. Phys.* **56**, No. 12, June 15, 1972, 6251-6255.
- C. Nyeland (Univ. Copenhagen) and E. A. Mason (Brown Univ.), and L. Monchick (APL), "Thermal Conductivity and Resonant Multipole Interactions," *J. Chem. Phys.* **56**, No. 12, June 15, 1972, 6180-6192.
- J. E. Creeden, R. M. Fristrom, C. Grunfelder (APL) and F. J. Weinberg (Imperial Coll., London), "A Large-Area Differential Laser Interferometer for Fire Research," *J. Phys. D: Appl. Phys.* **5**, No. 6, June 1972, 1063-1067.
- J. C. Pirkle, Jr. and V. G. Sigillito, "Variational Treatment of Chemical Reaction and Diffusion in a Catalytic Tubular Reactor," *Int. J. Eng. Sci.* **10**, No. 6, June 1972, 553-559.
- T. O. Poehler, M. Shandor, and R. E. Walker, "High-Pressure Pulsed CO₂ Chemical Transfer Laser," *Appl. Phys. Letters* **20**, No. 12, June 1972, 497-499.
- H. M. Stainer, "Cooperative Enhanced Scattering from Nonthermal Theta-Pinch Plasmas," *Phys. Fluids* **15**, No. 6, June 1972, 1109-1116.
- M. H. Friedman, "A Quantitative Description of Equilibrium and Homeostatic Thickness Regulation in the In Vivo Cornea. I. Normal Cornea," *Biophys. J.* **12**, No. 6, June 1972, 648-665.
- M. H. Friedman, "A Quantitative Description of Equilibrium and Homeostatic Thickness Regulation in the In Vivo Cornea. II. Variations from the Normal State," *Biophys. J.* **12**, No. 6, June 1972, 666-682.
- M. H. Friedman, J. P. Kearns (APL) and C. J. Michenfelder, K. Green (Johns Hopkins University School of Medicine), "Contribution of the Donnan Pressure to the Swelling Pressure of Corneal Stroma," *Amer. J. Physiol.* **222**, No. 6, June 1972, 1565-1570.
- C. C. Kilgus (APL) and W. C. Gore (The Johns Hopkins Univ.), "Root-Mean-Square Error in Encoded Digital Telemetry," *IEEE Trans. Comm.* **COM-20**, No. 3, June 1972, 315-320.

ADDRESSES

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

R. E. Walker and T. L. Litovitz (APL), and M. E. Langham (JHMI), "Fundamental Investigations into the Principles of Pneumatic Applanation Tonometry," *Wilmer Residents Association, 31st Clinical Meeting, Glaucoma Symposium*, Baltimore, April 14, 1972.

The following two addresses were presented at the *Washington-Baltimore Colloquium on Atomic and Molecular Collisions*, APL Howard County, April 17, 1972:

F. J. Adrian, "Chemically Induced Electron and Nuclear Spin Polarization;"

R. E. Walker, "Laser Experiments on Vibrational Relaxation and Chemical Kinetics Involving Sodium."

The three following papers were presented at the *American Geophysical Union*, Washington, D. C., April 17-21, 1972:

Ella B. Dobson and J. H. Meyer, "A Case Study of a Clear Air Layer Using Doppler Radar;"

Helen S. Hopfield, "Tropospheric Range Error Parameters: Further Studies;"

T. G. Konrad and J. C. Howard, "A Rare Case of Contrail Streamers Observed by Radar."

I. Katz, "The Detection and Study of Gravity Waves with Microwave Radar," *NATO Meeting on the Effects of Atmospheric Gravity Waves on Electromagnetic Propagation*, Wiesbaden, West Germany, April 19, 1972.

The following two addresses were presented at the *American Physical Society*, Washington, D. C., April 24-27, 1972:

R. A. Farrell (APL) and P. H. E. Meijer (Catholic U. of America), "Compressibility Exponent γ in the Higher Neighbor Ising Model;" Vivian O'Brien and L. W. Ehrlich, "Oscillation-forced Viscous Circulation."

M. I. Farber, "An Editing Routine

for Noisy Data," *Operations Research Society of America*, New Orleans, April 26-28, 1972.

The following six addresses were presented at the *Association for Research in Vision and Ophthalmology*, Sarasota, Florida, April 24-28, 1972:

R. A. Farrell, "Light Scattering in Swollen Rabbit Cornea;"

R. W. Flower, "Infrared Absorption Angiography of the Choroid at Elevated Intraocular Pressures;"

M. H. Friedman, "Unsteady-state Theory of Corneal Thickness Control;"

R. W. Hart and M. E. Langham (JHMI), "Physiological Changes Associated with the Development of Open-angled Glaucoma;"

M. E. Langham (JHMI) and R. E. Walker, "Measurement of Intraocular Pressure, Intraocular Pulse and Aqueous Dynamics Using a Pneumatic Applanating Tonometer;"

R. E. Walker and M. E. Langham, "Theoretical and Experimental Studies on a New Continuous Recording Pneumatic Applanating Tonometer."

F. J. Adrian, "Chemically Induced Electron and Nuclear Spin Polarization," *Greater Washington ESR Group*, Washington, D. C., April 25, 1972.

R. G. King, "Computers," *9465th Air Reserve Squadron, Washington National Airport*, Washington, D.C., May 1, 1972.

T. O. Poehler, "Chemical and Thermal Lasers," *The Johns Hopkins University Seminar*, Baltimore, May 1, 1972.

The following two addresses were presented at the *3rd Conference on Chemical and Molecular Lasers*, St. Louis, Missouri, May 1-3, 1972:

T. O. Poehler, M. Shandor, and R. E. Walker, "A High Pressure Pulsed CO₂ Chemical Transfer Laser;"

R. E. Walker, J. C. Pirkle, C. B. Barger, and H. L. Olsen, "Experimental Studies of a Pure

Chemical CO₂ Laser."

S. E. Anderson, "The Scientific Uses of Computer Animation," *21st Annual National Microfilm Convention*, New York, May 9, 1972.

B. B. Holland, "Uses of Geociever as a Geodetic Instrument," *15th COSPAR Meeting*, Madrid, Spain, May 10-12, 1972.

A. Michelsen, "Dose Measurements and Interpretation of Radiation Effects in Non-Uniform Field Pulsed Beam Experiments," *20th Annual Meeting of the Radiation Research Society*, Portland, Oregon, May 14-18, 1972.

APL COLLOQUIA

Mar. 10—"Interactive Computer Graphics in Molecular Biology," by R. Langridge, Princeton University.

Mar. 17—"Regional Environmental Quality Modeling," by C. S. Russell, W. O. Spofford, Jr., and R. A. Kelly, Resources of the Future.

Mar. 24—"Uses and Misuses of Urban Growth Models," by L. P. Kadanoff, Brown University.

Mar. 31—"A Systems Dynamics Study of Nonrenewable Natural Resources," by R. F. Naill, Massachusetts Institute of Technology.

Apr. 7—"Early Cratering History of the Solar System," by W. K. Hartmann, Illinois Institute of Technology.

Apr. 14—"Black Holes in Our Galaxy," by R. Ruffini, Princeton University.

Apr. 21—"Transparency and Structure of the Cornea," by R. A. Farrell, Applied Physics Laboratory.

Apr. 28—"Saturation Spectroscopy with Tunable Dye Lasers," by T. W. Hansch, Stanford University.

May 5—"The Global Atmospheric Circulation," by J. Smogorinsky, NOAA Geophysical Fluid Dynamics Laboratory.

May 19—"Early Ice-Age Intelligence as Revealed by Notation and Art," by A. Marshack, Harvard University Peabody Museum.

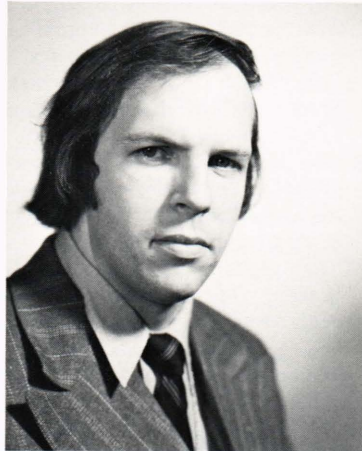
June 2—"The National Income and the Quality of Life," by M. Olson, University of Maryland.

WITH THE AUTHORS



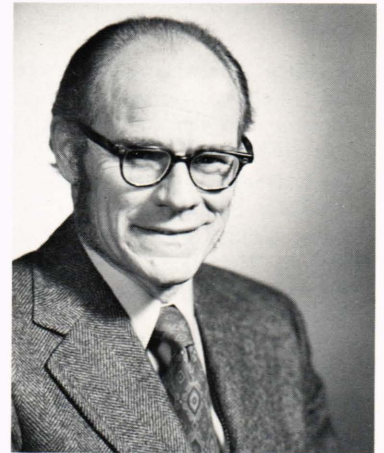
David W. Rabenhorst, author of "The Applicability of Wood Technology to Kinetic Energy Storage," is an earlier contributor to the *Digest*, having been the author of "A Simplified Passive Spacecraft Separation System," which was published in the November-December 1966 issue. A native of Washington, D.C., Mr. Rabenhorst received the B. E. degree in aeronautical engineering from The Catholic University. He came to APL in 1945 as a specialist in missile composite design coordination, with emphasis on aeronautical and mechanical engineering aspects. At APL he has participated in various supersonic and hypersonic wind-tunnel studies, and was active in the composite design of the Terrier and Tartar missiles as well as in the design coordination of the Polaris missile; he was also Co-Project Engineer of the Eyes in the Sky System. Since 1966, as Supervisor of the Special Projects Office of the Space Development Department, Mr. Rabenhorst has been responsible for coordinating several launch

facilities and operations, as well as launch vehicle coordination, preliminary spacecraft design, and spacecraft contractor liaison. For the past several years, his chief interest has been as inventor and consultant for the Laboratory's work on the Superflywheel and other government oriented inventions.



R. W. Newman, co-author of "Compact Transpiration Cooling Systems," is a native of upstate New York, where he received a B.S. degree in mechanical engineering at Cornell University. During the summer of 1965 Mr. Newman worked at Bell Aerosystems performing thermal studies in the LEM ascent engine. In the fall of 1965 he joined APL as an associate engineer specializing in mechanical engineering and heat transfer. Mr. Newman has conducted experiments and performed development work on a transpiration computer program, and is currently developing a similar program for analyzing laser irradiated surfaces.

R. W. Allen, co-author of "Compact Transpiration Cooling Systems," is a native of Washington, D.C. He received the B.S. and M.S. degrees in mechanical engineering from the University of Maryland and the Ph.D. in the same field from the University of Minnesota. Since 1946, Dr. Allen has been a member of the mechanical engineering faculty of the University of Maryland, where he is now a full professor. He was employed by APL in 1960 as a consultant, specializing in mechanical engineering, heat transfer, fluid mechanics, thermodynamics, and auxiliary or powerplant analysis. Since 1966, he has been full-time at APL in the summers and part-time during the academic years. A mem-



ber of the staff of the Laboratory's Engineering Group, Dr. Allen has conducted basic investigations into thermal conductivity theory and ablation and transpiration thermal analysis. He is a member of the American Society of Mechanical Engineers.