New COAXIAL CABLE Design

The AN/SPG-59 radar designed at APL incorporates approximately 40 miles of ⅜-in. and ½-in. coaxial cable for the transmission of microwave energy. Analyses of designs of existing cabling for this application indicated that a new approach was required to insure complete reliability and long life under the conditions peculiar to the operation of the SPG-59. These conditions include high temperatures and temperature cycling, sharp bends in the cabling, shipboard environment (vibration, humidity, temperature, etc.), and the transmission of high levels of microwave power. Further, there is a fundamental requirement that the coaxial cable have a low loss and be homogeneous from segment to segment along its length to avoid reflections from discontinuities. It must be light in weight and low in cost because of the large quantities required. Since available cabling could not meet these combined standards, a new coaxial cable was developed at APL by T. C. Cheston and A. B. Carver.*

Figure 1 illustrates the construction of the cable, its most prominent feature being the Teflon† five-spline dielectric. Teflon was selected for its low-loss and high-temperature-resistance characteristics. Because it is a continuous extrusion, it cannot be moved, displaced, or bunched as a result of heat cycling, vibration, and bending.

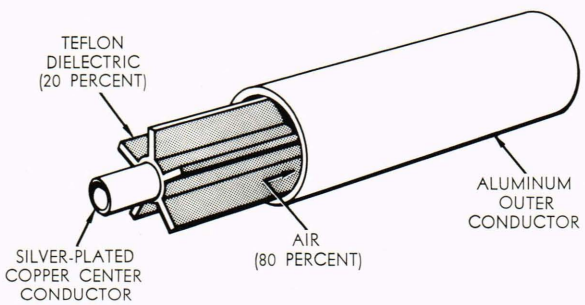

Fig. 1—Schematic diagram of the five-spline coaxial cable with 68-Ω characteristic impedance.

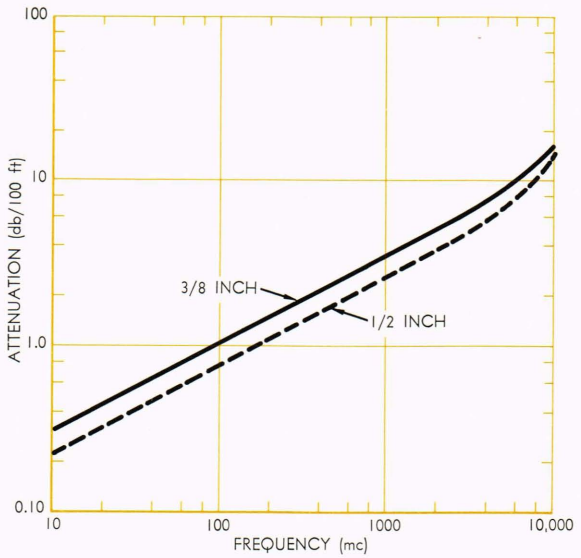

Fig. 2—Plot of attenuation versus frequency for ⅜-in. and ½-in.-diameter, 68-Ω, five-spline coaxial cable.

The five splines firmly support the hollow, soft-copper inner conductor. (The inner conductor is silver plated to prevent corrosion during the process of extruding the dielectric over it.) Finally, since there is no air in contact with the inner conductor, long and corrosion-free life is assured. This design has the further advantage of permitting bend radii as small as twice the total diameter of the cable, with no resulting discontinuities or reductions in power-carrying capacity.

The quantity of dielectric in the five-spline cable is kept as small as possible commensurate with the need for adequate support of the inner conductor. In this configuration, the dielectric is only 20% of the volume. This, together with

*Mr. Cheston is supervisor of a project engaged in antenna development and Mr. Carver is supervisor of a mechanical design project.

† Trade name of polytetrafluoroethylene, manufactured by E. I. Dupont de Nemours & Co., Inc.

the near-optimum ratio of inner to outer cable diameters (3.6:1) results in low losses, as shown by Fig. 2. The thin aluminum outer conductor is drawn over the plastic dielectric by ordinary tube manufacturing techniques.

The small amount of low-loss dielectric and the favorable (low-loss) ratio of diameters gives the five-spline cable an impedance of approximately 68 Ω. Highest power-carrying capacity in a cable is achieved when the cable impedance is about 50 Ω, and for that reason most common standard cables have that impedance. The favorable geometry of the dielectric of the five-spline cable, however, permits it to transmit at least as much power as most conventional cables of equal size having a 50-Ω impedance.

To summarize, the new coaxial cable is reliable, has low losses, is pliable, and is comparatively inexpensive to manufacture. Its five splines are, relative to air, good conductors of heat and allow cooling of the center conductor. In conjunction with the new cable, simple, solderless, press-fit connectors were developed that are both air- and moisture-proof, and that do not cause any discontinuities.

PUBLICATIONS

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

G. L. Dugger, "Comments on High Performance Combustion Systems," *Proc. Twelfth International Astronautical Congress*, Academic Press, New York, 1963, 715–727.

S. D. Bruck, "New Polyoxamidation Catalysts," *Ind. Eng. Chem.—Product and Research Development*, **2,** May–June 1963, 119–121.

F. F. Hiltz, "Artificial Neuron," *Kybernetik*, Berlin, May 1963, 231–236.

A. A. Westenberg and N. de Haas, "Gas Thermal Conductivity Studies at High Temperature," *Phys. Fluids*, **6,** May 1963, 617–620.

Catherine Britton (APL) and I. F. Wagner (Minneapolis-Honeywell), "A Computer Program for Analysis of Variance for a Two-Level Factorial Design," *Commun. Assoc. Computing Machinery*, **6,** June 1963, 308–309.

N. H. Choksy, "A New Analytic Stability Criterion for Use With Describing Functions," *Fourth Joint Automatic Control Conference*, University of Minnesota, June 1963, 481–484.

R. H. Cantrell, "Gas Film Effects in the Linear Pyrolysis of Solids," *J. Am. Inst. of Aeronautics and Astronautics*, **1,** July 1963, 1544–1550.

J. Dassoulas, "Transit/ANNA Flight-Test Operations," *Astronautics and Aerospace Engineering*, **1,** July 1963, 44–50.

A. J. Zmuda, B. W. Shaw, and C. R. Haave, "VLF Disturbances Caused by the Nuclear Detonation of October 26, 1962," *J. Geophys. Res.*, **68,** July 1, 1963, 4105–4114.

PATENTS

Listed below are U. S. Government patents recently issued to Laboratory staff members for inventions produced in support of APL objectives.

J. H. Walker—*Airplane*, Patent No. Des 194,445.

R. O. Robinson, Jr.—*Radome Structure*, Patent No. 3,081,051.

J. F. R. Floyd and R. H. Lapp—*Fire Extinguisher for a Rocket Motor*, Patent No. 3,084,506.

E. Donato and R. E. Kemelhor—*Ohmmeter for Power Source Isolating Transducers for Testing Hazardous or Sensitive Circuits*, Patent No. 3,086,170.

R. O. Robinson, Jr.—*Toroidal Coil Influence Oscillator*, Patent No. 3,089,421.

R. H. Lapp and A. F. Hogrefe—*Inductive Link Infrared Fire Detection and Water Injection System*, Patent No. 3,090,197.

J. H. Kuck and B. W. Bullock—*Transmitter for Radio-Sonde Battery Potential Indications*, Patent No. 3,090,917.

J. H. Kuck—*Target Discriminator*, Patent No. 3,090,952.

HONORS

Maynard L. Hill, supervisor of the High Temperature Materials Project of the Bumblebee Flight Research Group, recently set a world altitude record for radio-controlled model airplanes. Nearly doubling the previous record held by Russia's V. Malenkov, the seven-pound *Skyrocket* reached 13,320 feet on its castor-oil-and-alcohol fuel. Mr. Hill is vice-president of the U. S. Academy of Model Aeronautics and current president of the Washington, D.C. Radio Control Club. *Dr. Walter A. Good*, whose "A Scientist and His Hobby" appeared in the January-February 1963 *Digest*, also surpassed the Russian record, with his radio-controlled model reaching an altitude of 10,080 feet.

ADDRESSES

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

F. H. Esch, "Transit and ANNA Satellite Lubrication Problems," *American Society of Lubricating Engineers*, New York, May 3, 1963.

F. T. McClure, "Acoustic Resonance in Combustion Systems," *Acoustical Society of America*, May 15–18, 1963.

(*continued*)