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NASA TECH BRIEF



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Silver-Base Ternary Alloy Proves Superior For Slip Ring Lead Wires

The problem:

Slip ring lead wires used in the guidance and control systems in the Saturn rocket must have high electrical conductivity, a tensile strength of at least 30,000 psi, high ductility, and be solderable and weldable. Teflon-coated silver-plated copper wire has been used because of the superior dielectric and high temperature properties of the teflon. Silver plating is needed to protect the copper from oxidation during the necessary 650°F curing of the teflon. The lead wires presently used are twisted from at least 19 strands of 0.0025-inch diameter wire, which invariably causes rupture of the silver plating. Plating cracks also occur when the finished lead wires are wound on spools. Since moisture and air are sometimes present within the wires, galvanic corrosion cells can become active at the breaks in the silver plating, and attack the copper. Corrosion of the copper wire can cause opened circuits and structural failures.

The solution:

A wire composed of ternary alloys of silver, which include less than 5% copper plus a minor addition of a third element, to provide the following properties:

- (1) Minimum electrical conductivity of 90%; maximum specific resistivity of 1.92 microhm-cm.
- (2) Minimum tensile strength of 30,000 psi.
- (3) Ability (of 42-gage wire) to withstand at least 400 bends of 90 degrees or more over a 0.025-inch radius, while supporting a tensile stress of 6,000 psi.
- (4) Ability to withstand corrosion in fluorine moisture environment, oxidation, soldering, or welding.

How it's done:

A satisfactory composition is silver with 1.0% copper and 0.2% nickel. The copper serves primarily

to increase strength at only a minor sacrifice in electrical conductivity. The desired range of copper falls between 0.25% and 5.0%, depending on the strength desired. Generally all the copper is in solid solution, the greater amounts being kept in solution by appropriate heat treatment.

The minor ternary addition serves to increase resistance to heat softening and to raise the recrystallization temperature without significantly decreasing conductivity. In addition to nickel, beryllium was found to be a satisfactory ternary addition. These elements, acting as a dispersed phase, have only slight solubility in solid silver. Ternary element content will range from 0.1% to 1.0%.

These new alloys are made by melting under hydrogen or by melting with suitable deoxidation, and are readily drawn to wire by conventional drawing methods, using intermittent heat-treatment steps. An unexpected advantage of these alloys is their resistance to discoloration on heating in air.

Notes:

1. Titanium was found to be unsatisfactory as a ternary addition because it drastically lowers the conductivity of the alloy.
2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B66-10540

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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