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Improved Iridium Alloy Welds

FOUR-POLE OSCILLATION REDUCES HOT-SHORT CRACKING

The use of platinum group alloys to encapsulate radioactive heat sources in the thermoelectric generators that are used to provide electric power for instruments on unmanned spacecraft has been reported in this journal previously (1,2). Heat released by the decay of an isotopic fuel, generally plutonium dioxide ($^{238}PuO_2$), is converted into electrical power by its action on a collection of thermocouple elements. The plutonium dioxide must be safely contained under both normal operating conditions and those that could be encountered in the unlikely event of an aborted launch or later re-entry into the Earth's atmosphere.

Currently the radioactive pellets are encapsulated by welding together two 0.6mm thick iridium alloy cups. In addition to iridium, the alloy contains 0.3wt. per cent tungsten, 60±30ppm thorium and 50±30ppm aluminium, while welding is performed in a protective atmosphere of helium–25 per cent argon. Two-pole magnetic arc oscillation has been used to give the required grain structure. However, it is well known that iridium alloys suffer from hot-short cracking when the thorium concentration approaches 100ppm, and in practice approximately one equatorial weld in five exhibits underbead cracking in the arc taper area. Ultrasonic inspection results in a seven per cent rejection rate, although in some batches of alloy this can rise to 26 per cent, an unacceptable level.

Now J. D. Scarbrough of E. I. du Pont's Savannah River Plant and C. E. Burgan of the Monsanto Research Corporation have reported that the frequency and severity of the weld cracking problem can be significantly reduced by the use of a four-pole magnetic arc oscillator (*Welding J.*, 1984, **63**, (6), 54–56). In their paper typical microstructures of the welds produced by the two methods are shown. Grain growth patterns are very similar but a 17 per cent reduction in grain size results from the use of the four-pole oscillator. Using given parameters, the overall production reject rate fell from 7 to 2 per cent, while batches of alloy that had previously suffered a 26 per cent rejection with the two-pole oscillator also had this rate reduced to 2 per cent when the four-pole oscillator was employed. Two primary causes are postulated for this improvement in the production reject rates.

The two authors suggest that the use of four-pole oscillation may also be beneficial when welding other alloys which are prone to hot-short cracking.

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Rhodium-Iron Thermometers

Over the past ten years the platinum-sheathed rhodium-iron resistance thermometer (RIRT) has proved its reliability at temperatures between 0.5 and 20K. Now smaller, more rugged versions of the RIRT have become available. In one, designed for use up to 700°C as well as for cryogenic conditions, the resistance coil is mounted in an alumina and glass body. A recent report on the thermometric properties and stability of these ceramic RIRTs by L. M. Besley of CSIRO, Division of Physics, Sydney (*J. Phy.E: Sci. Instrum.*, 1984, **17**, (9), 778–781) concludes that despite small changes in resistance on handling the remarkable stability of these thermometers on thermal cycling together with their low self heating and reasonable sensitivity will make them useful for many low temperature applications.