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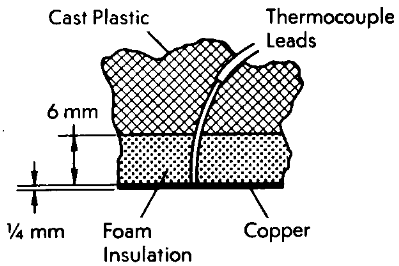
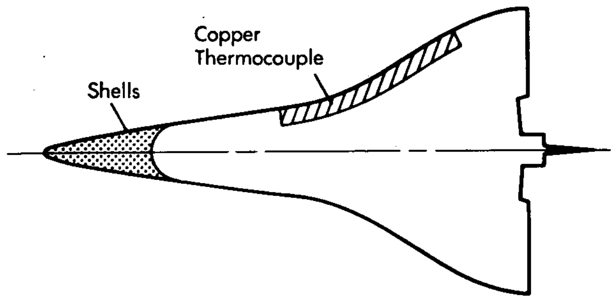
Technique for Producing Wind-Tunnel Heat-Transfer Models

Thermocouples are generally used to obtain aerodynamic heat transfer measurements in wind tunnels because they yield definite point-by-point measurements; however, the thermocouples must be mounted





on thin-skinned surfaces in order to obtain accurate measurements. Construction of structurally rigid and accurately duplicated models which have thin skins at measurement points by conventional model-shop techniques is difficult and expensive. The improved technique described below makes possible the fabrication of inexpensive wind tunnel models which have thin-skin shells and thermocouples at specific areas on their surfaces.

An accurately constructed model is used to form a mold of the area to be instrumented; then the surface of the mold is heavily electroplated to form a shell. After thermocouples have been mounted, the shell is returned to the appropriate location in a mold of the entire model. The mold is filled with plastic to form a solid, rigid model.

The model which is to be copied can be made of nearly any material that has dimensional stability up to a temperature of approximately 150°C (300°F). Quite often, the cost of producing a model can be saved if it is permissible to use a force-test model of the desired configuration. The master model (or its copy) is needed only temporarily to make female molds; the model should be waxed to produce smooth impressions. The molds are then used to generate the completed thin-skinned model.

The portions of the master model (or its copy) which are to be duplicated as thin-skinned surfaces equipped with thermocouples are dipped into molten bismuth-lead alloy (M.P., 124°C) that is at just above its melting point. The alloy melt freezes immediately on the cold surfaces of the model and forms a thin shell which is, in fact, a female mold with a smooth and true inside surface; while the shell mold is on the model, it can be strengthened by additional dippings in the alloy melt. Then the shell is removed and the rough outer surface is masked off by a lacquer or paint; the inner surface of the bismuth-lead alloy shell is electroplated with copper (or nickel) to produce an electroplate sheath of a desired thickness. The bismuth-lead alloy is melted away from the electroplate sheath (hot water bath) and the sheath is

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trimmed, cleaned, and marked for thermocouple locations. The sheath thickness is measured at each location; thermocouples are installed, and the junctions are insulated and anchored by foamed-in-place polyurethane plastic. The plastic foam also provides a dead air space which prevents unwanted conduction from the thin skin into the body of the completed model.

The instrumented copper sheath is then located and fixed in the model mold; a metal-filled epoxy plastic is poured into the mold to form the completed test model. Since the electroplate sheath has been made from the same mold, no measurable joints will be evident at the juncture of the sheath and the epoxy plastic.

Note:

Requests for additional information may be directed to:

Technology Utilization Officer
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Reference: TSP 72-10349

Patent status:

NASA has decided not to apply for a patent.

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