

## U. S. Patents

- [Patent 5,353,865](#) describes a way to greatly increase impingement heat transfer with negligible increase in coolant pressure drop. The method involves casting the impinged surface with a close-packed array of small diameter hemispheres. The hemispheres increase the heat transfer area. They also add thermal resistance, but the additional resistance is minimized by making the hemisphere diameters very small.
- [Patent 5,269,468](#) describes a fuel nozzle design that eliminates or minimizes the vaporization of fuel as it passes through the nozzle. The minimization of fuel vaporization results from a heat shield consisting of an air gap with gold plated surfaces. The immediate application was gas turbine fuel nozzles.
- [Patent 4,978,230](#) describes an apparatus and method for determining heat transfer coefficient based on testing actual hardware rather than simplistic scale models of such hardware. The immediate application was gas turbine airfoils.
- [Patent 4,916,715](#) describes a method and apparatus for measuring the distribution of heat flux and heat transfer coefficients on the surface of a cooled component used in a high temperature environment. The immediate application was gas turbine blades and vanes undergoing engine test programs.
- [Patent 4,902,139](#) describes “thermal check”, a bench test for measuring the thermal performance of heating or cooling circuits. (Thermal check is the thermal analog of “flow check”, a bench test for measuring the flow performance of heating or cooling circuits.) The immediate application was cooling circuits in gas turbine components.

Thermal check is also described in [Thermal Check--A Simple and Accurate Bench Test for Measuring the As-built Heat Transfer Performance of Cooling or Heating Circuits in Gas Turbine Components](#), ASME HTD-Vol. 226, p.17, presented at ASME 1992 Winter Annual Meeting, November, Anaheim, CA.

- [Patent 3,901,081](#) simply adds more claims to Patent 3,827,102.
- [Patent 3,827,102](#) describes how to use a soot blower as a Pneumatic Temperature Detector to measure the temperature of the coolant as it exits the soot blower, and to measure the heat flow rate and the heat flux into the soot blower. Also

describes how to use the measurements to control a water-cooled soot blower so that most of the water is vaporized before it is expelled from the soot blower.

- [Patent 3,542,486](#) describes an impingement insert—ie a hollow insert to be placed within a hollow component, and which has an array of close-packed holes through which coolant is passed, and which then impinges on the surface to be cooled or heated. The immediate application was gas turbine vanes and blades.
- [Patent 3,388,888](#) describes a thermally effective cooling circuit for a gas turbine blade. Prior to this design, blade cooling was generally accomplished by passing coolant through radial holes, a method that resulted in poor thermal effectiveness.