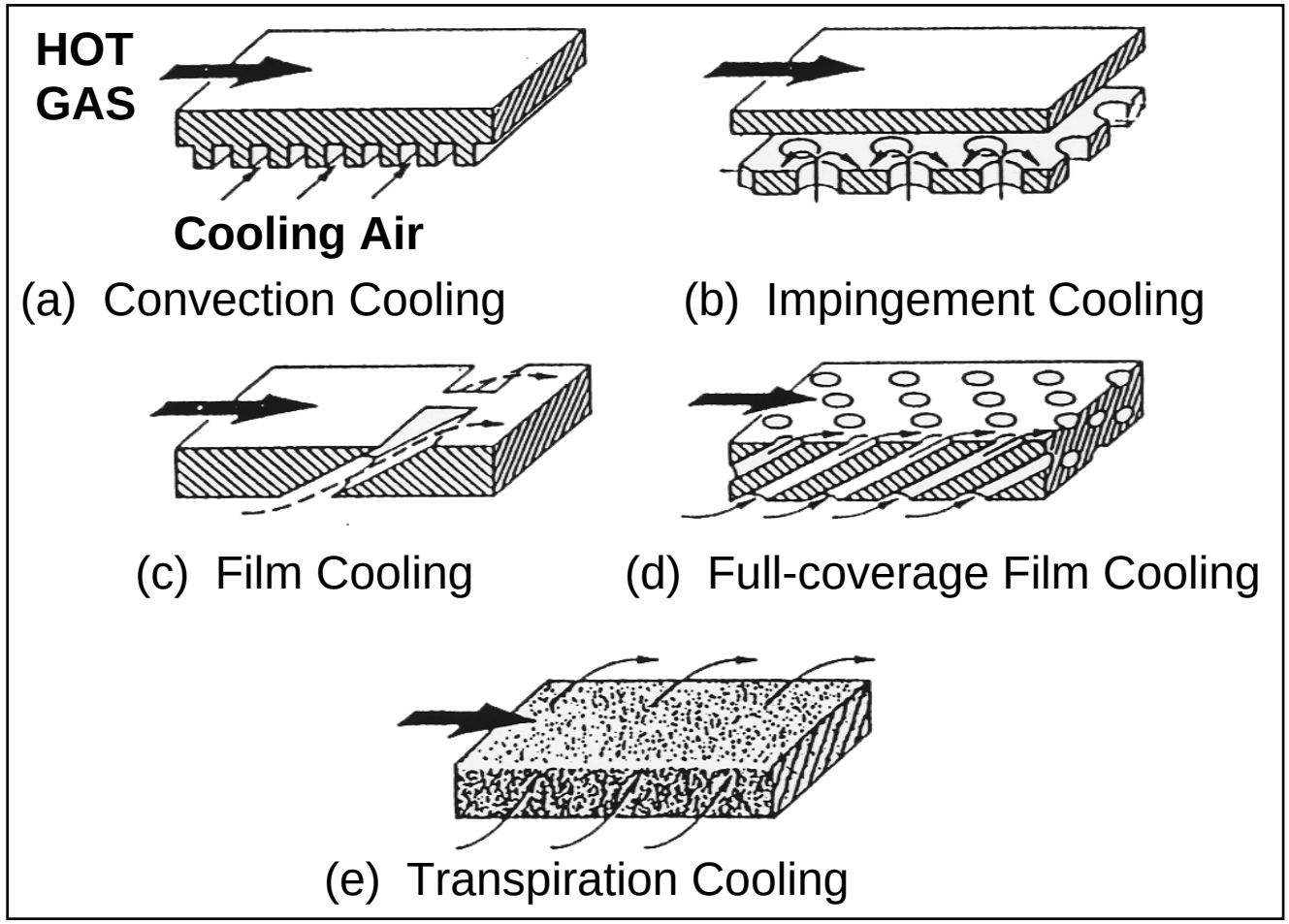
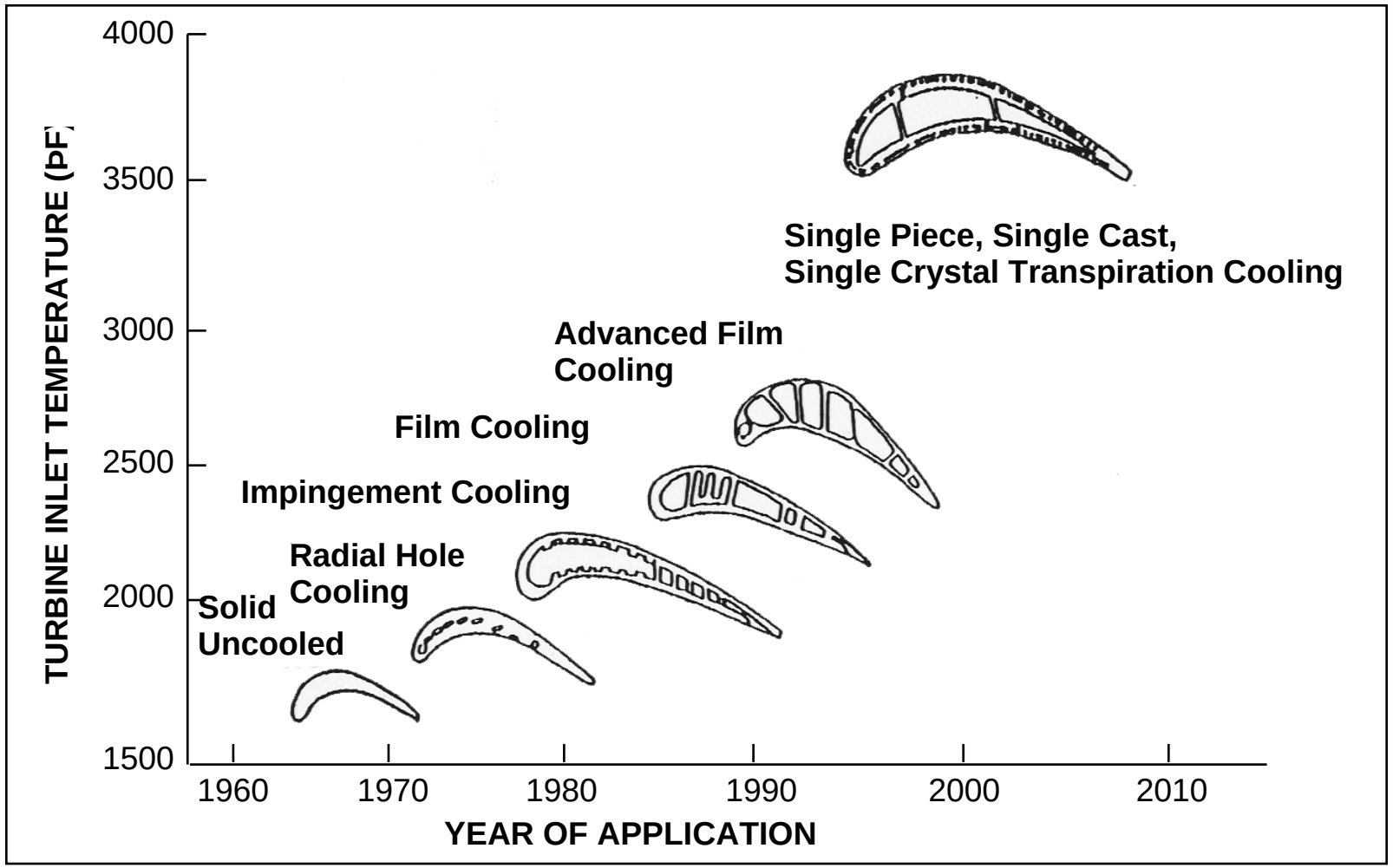
Advances in Turbine Airfoil Cooling Designs Enabled by Improvements in Core Manufacture & Casting Capability

TURBINE BLADE COOLING METHODS

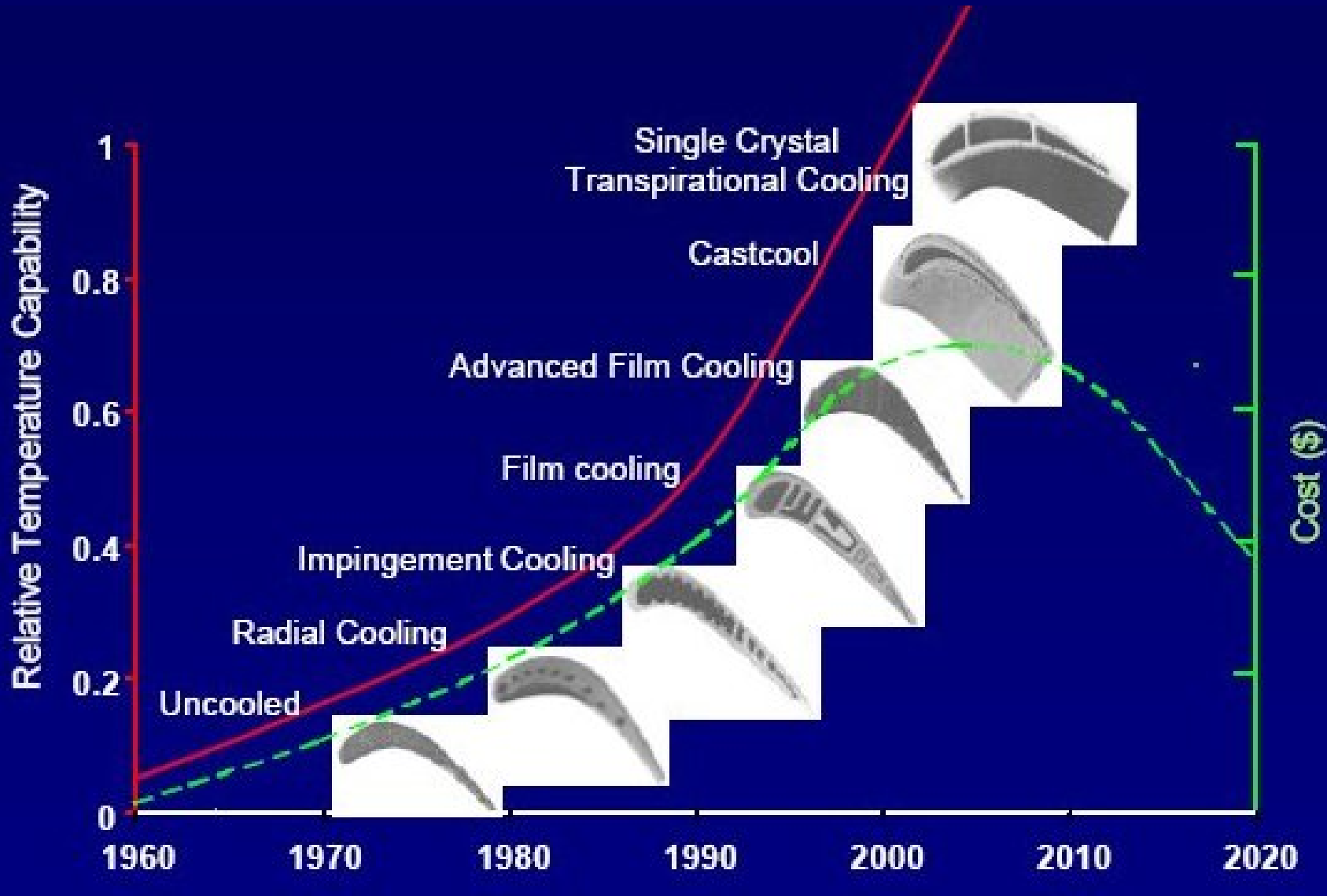


ADVANCES IN TURBINE BLADE COOLING



After Frasier US Patent 5295530

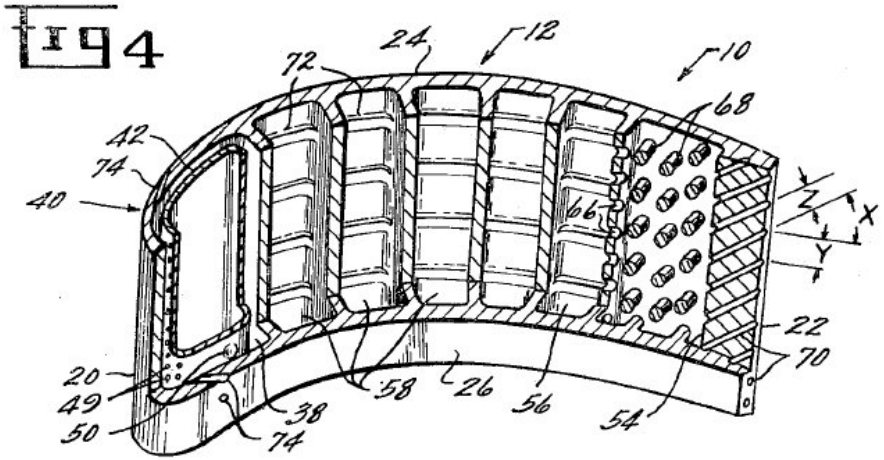
Airfoil Cooling Technology Trends

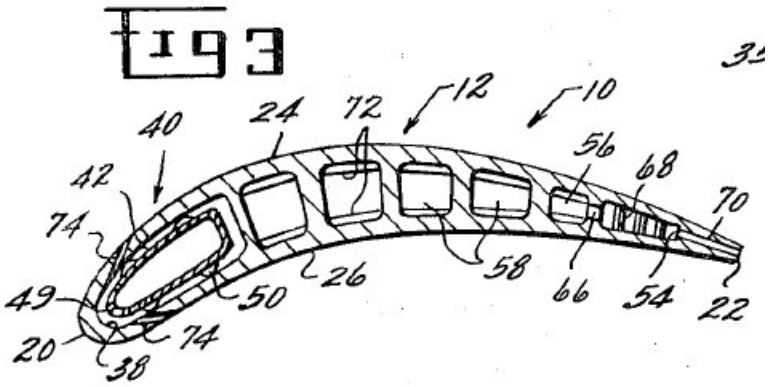


After Philip.Haley-RR-2000-Gas Turbine of the Future

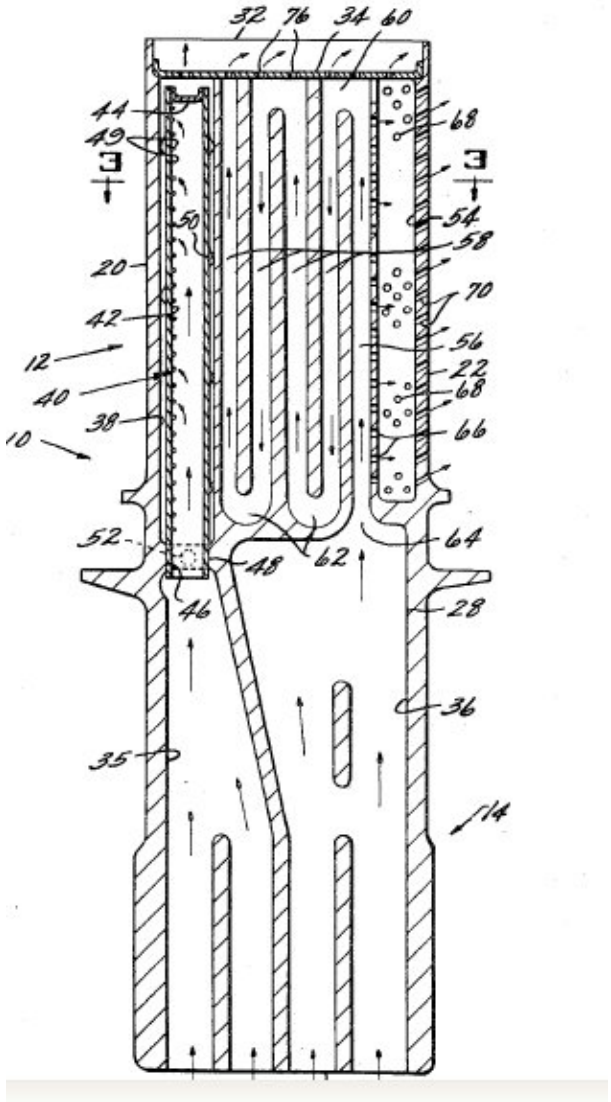
GE Aero Serpentine Design Circa 1971

US patent 3,628,885





Note impingement cooling sheet metal insert at Leading Edge



IGT Vane Impingement Cooling Design

US Patent 04297077

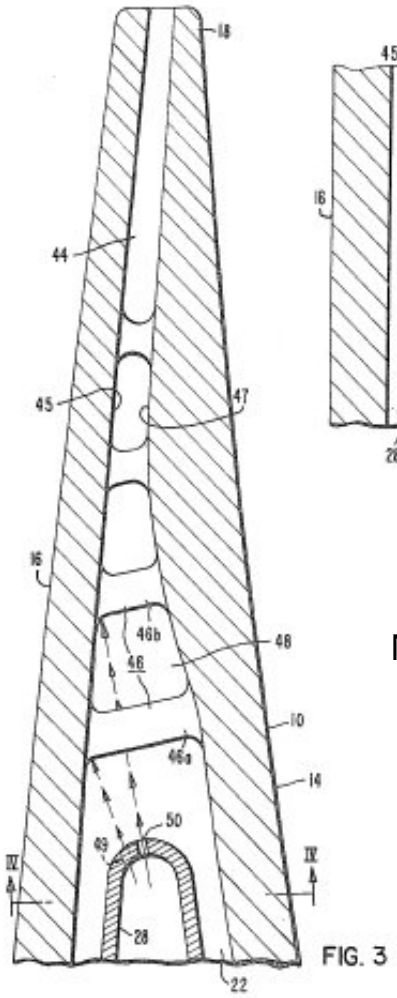


FIG. 3

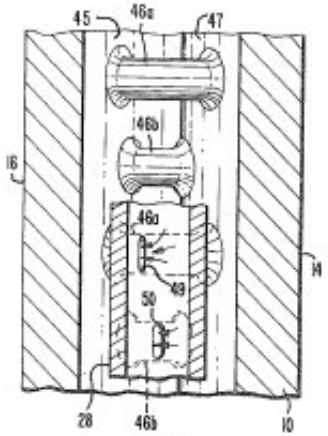
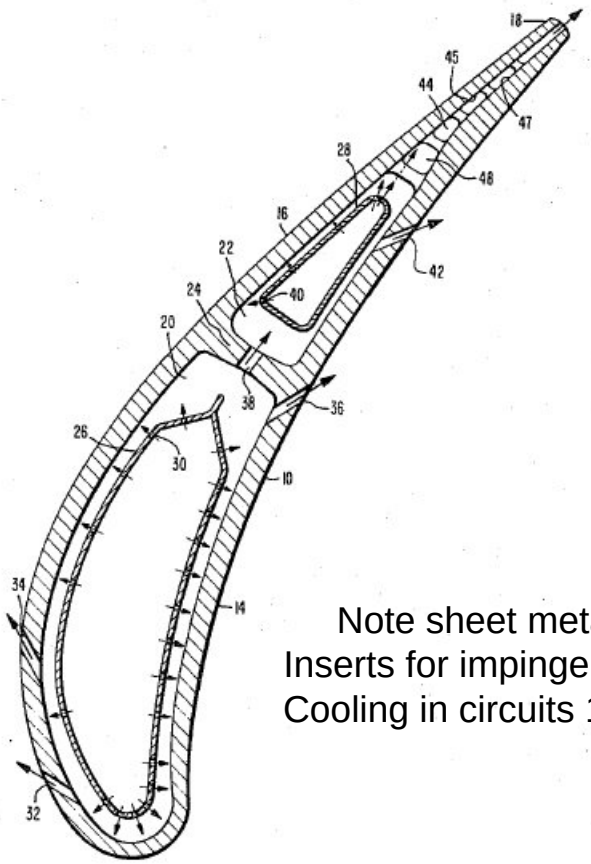


FIG. 4

Note trailing edge
pin fin design



Note sheet metal
Inserts for impingement
Cooling in circuits 1 & 2

GE-Aero Multiwall-Cooling Circuit Design Circa 1992

US Patent 5660524

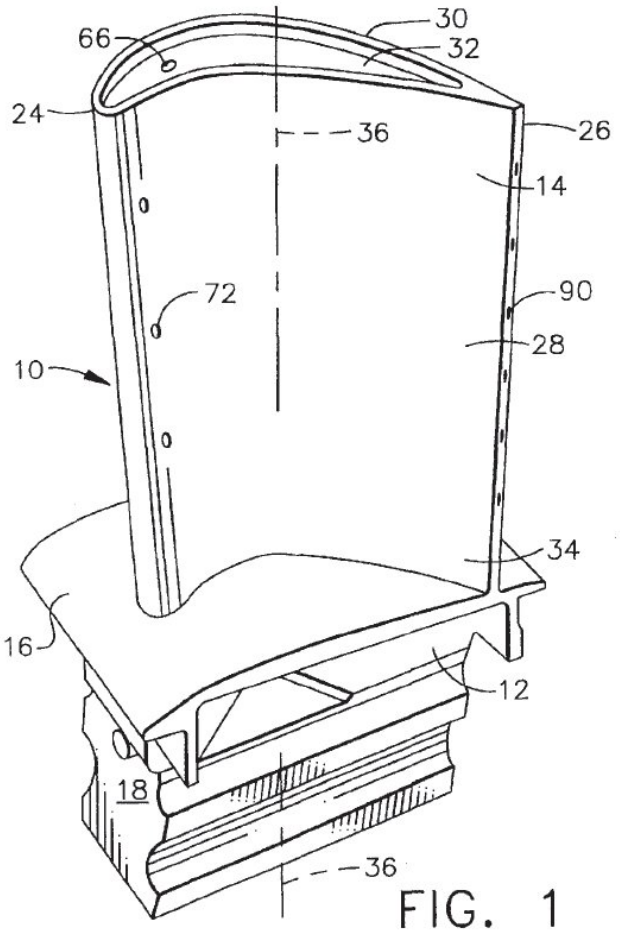


FIG. 1

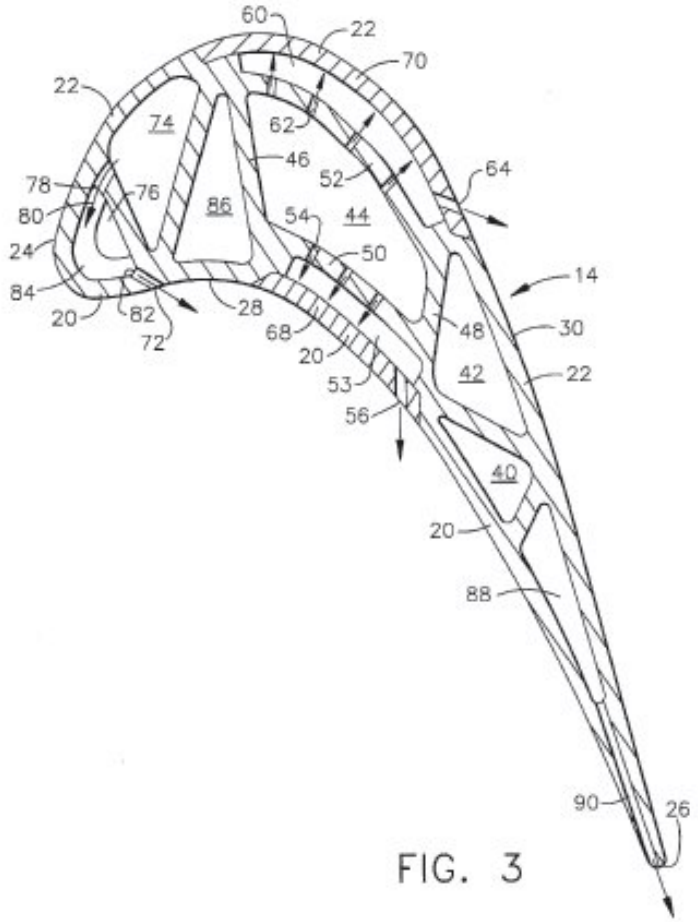


FIG. 3

ADVANCES IN TURBINE BLADE COOLING

Rolls Royce Cast Cool Quasi-Transpiration Cooling

RR-Patent 5924483

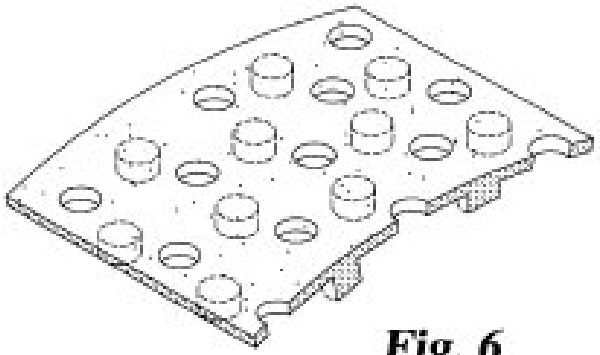
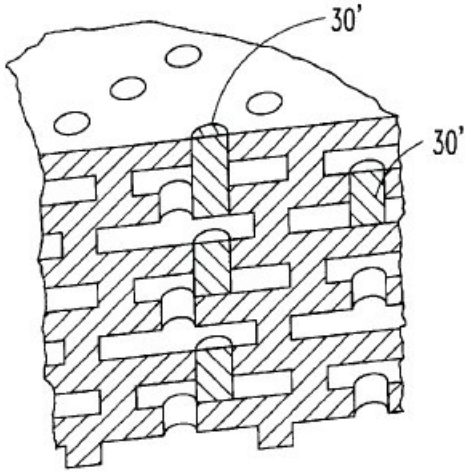


Fig. 6



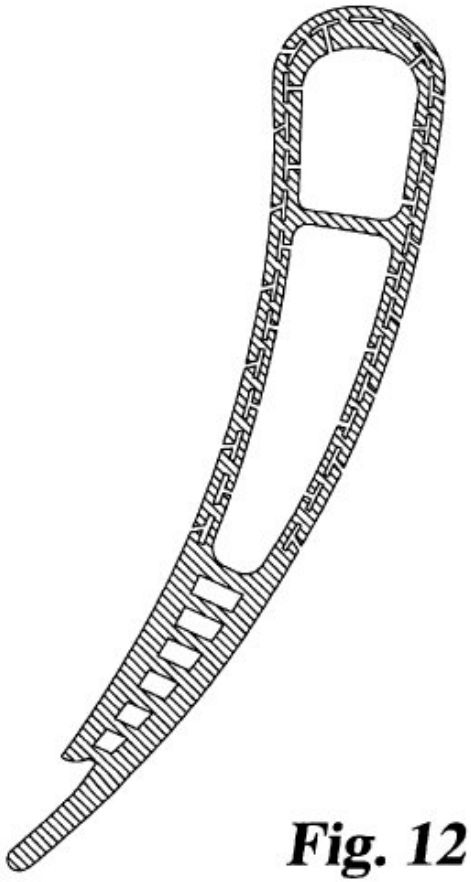
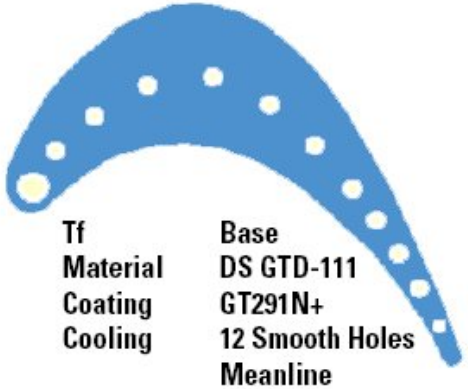


Fig. 12

IGT Bucket Radial Cooling Design

GE 6B 1st Bucket STEM Drilled Holes

BLUNT LEADING EDGE



Tf	Base
Material	DS GTD-111
Coating	GT291N+
Cooling	12 Smooth Holes
	Meanline
Shank	Radial ECM

PERIMETER COOLED

Base +35F
DS GTD-111
GT331N+
3 Smooth/13 Turb Holes
Perimeter
Hollow Core

Cooling circuits produced by STEM drilling radial holes in solid airfoil

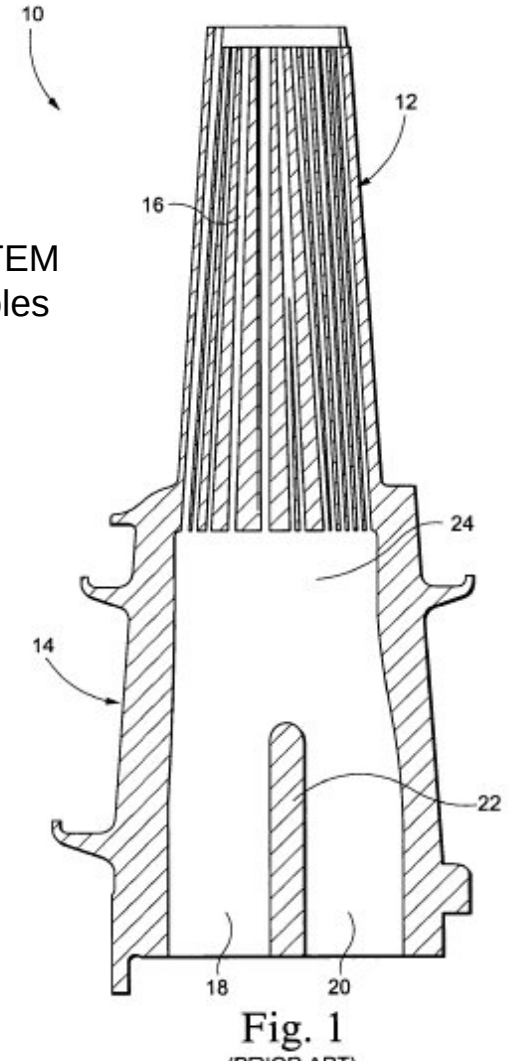


Fig. 1

GE GER-4217A

IGT F-Class Bucket Serpentine Cooling Design

US Patent 6,672,836

FIG.4

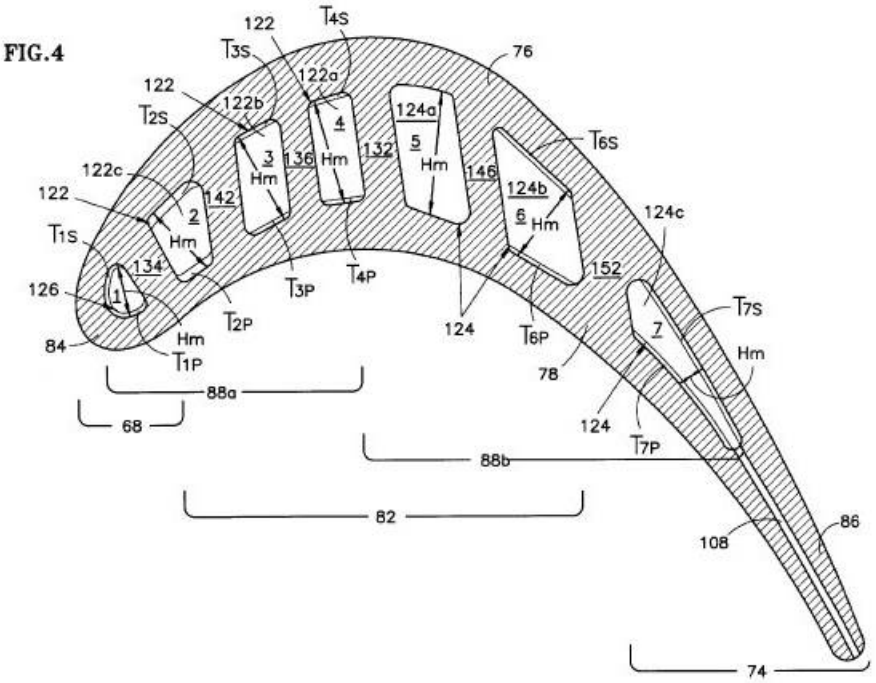
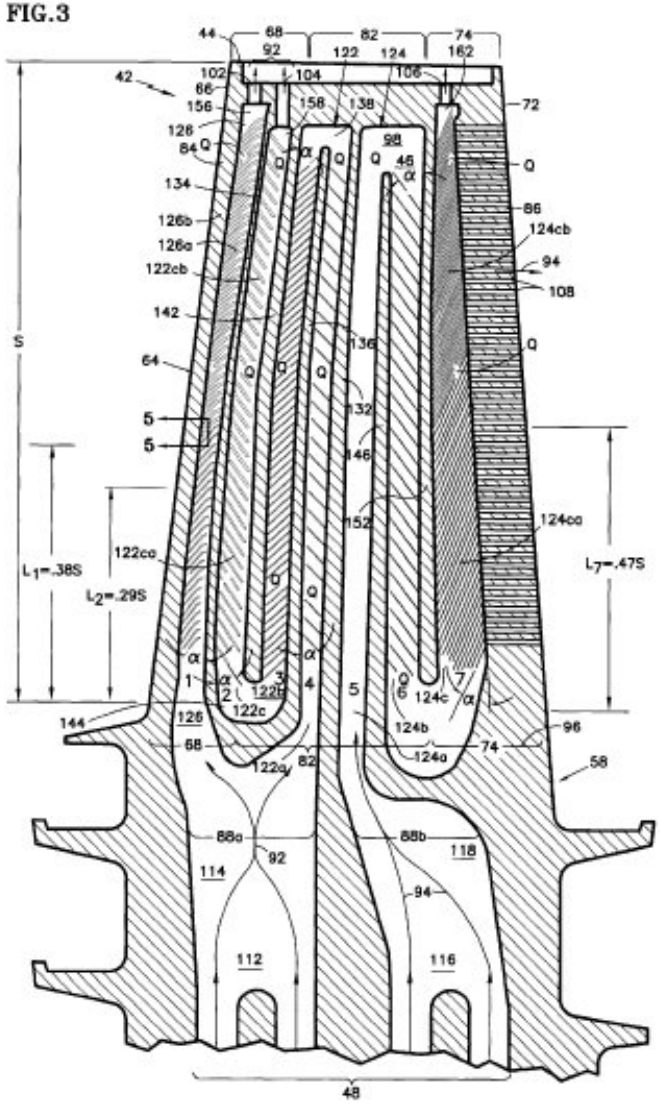


FIG.3



IGT Blade Cooling Radial STEM Drilled v Cored Cast Serpentine Designs

US Patent 6966756

Cooling circuits produced by STEM drilling radial holes

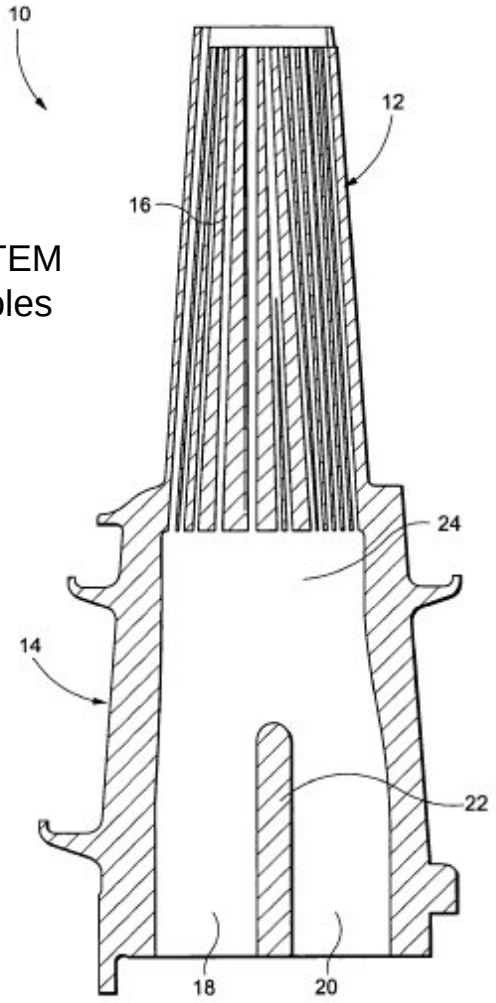


Fig. 1
(PRIOR ART)

Cooling circuits produced by complex ceramic core during casting process

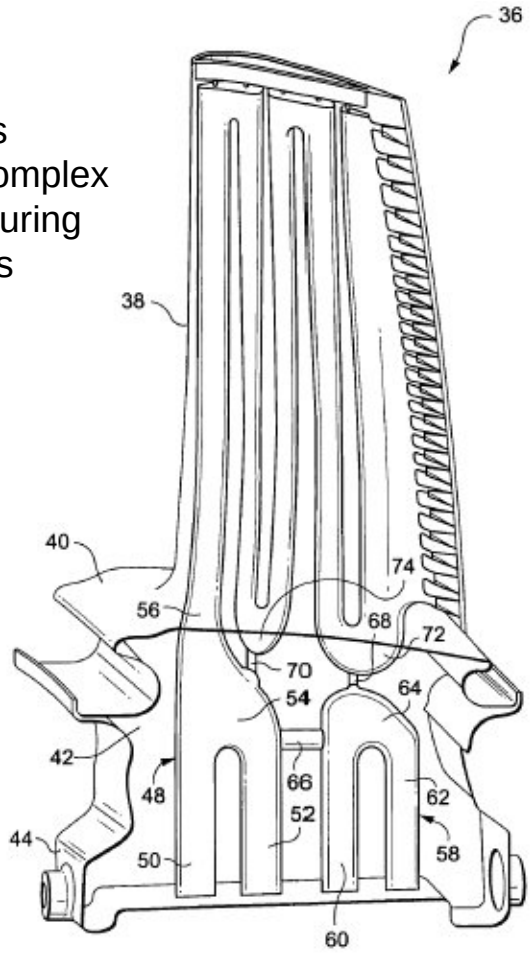


Fig. 3

GE-Aero Multiwall-Cooling Circuit Design

US Patent 7296973

Note details of crossover holes between some circuits increasing the complexity of the ceramic core

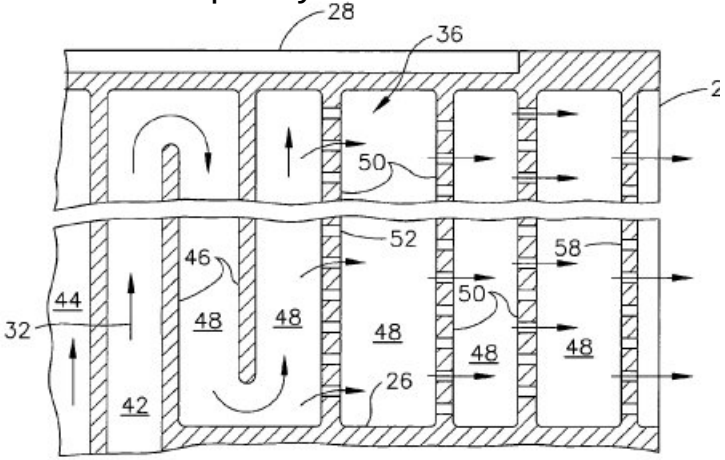


FIG. 5

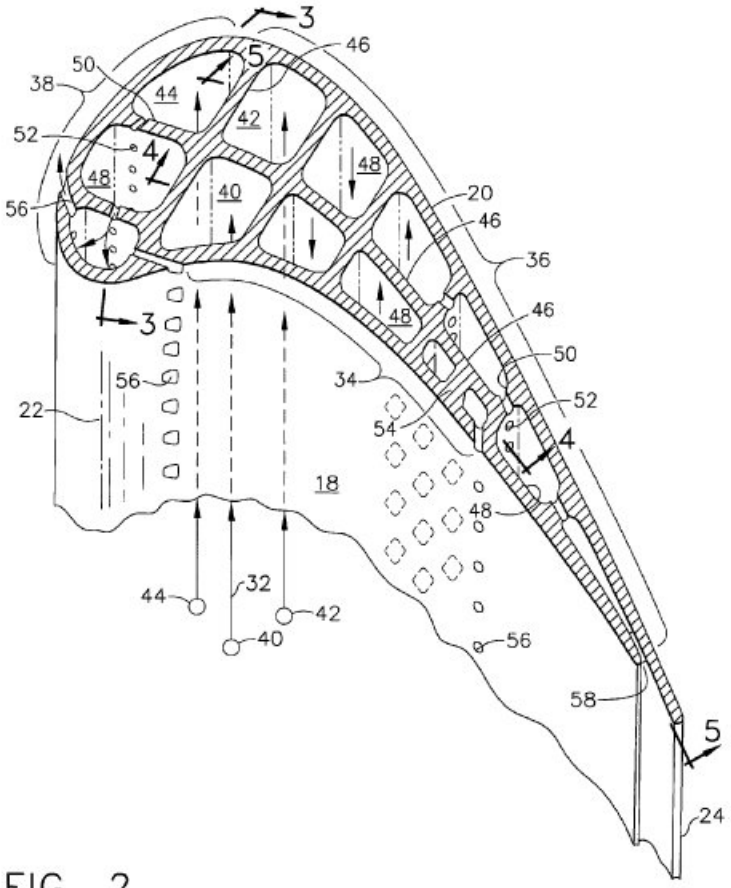


FIG. 2

ADVANCES IN TURBINE BLADE COOLING
IGT Turbines – Siemens Adv. Multiwall
US Patent Appl. Pub # 2006-0222495

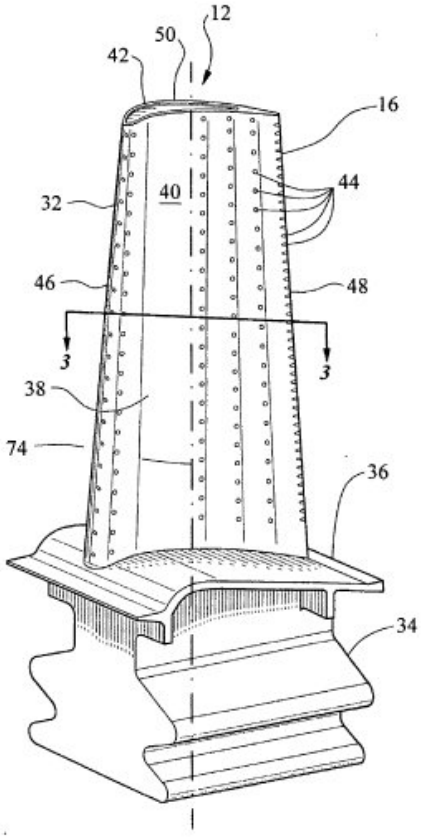
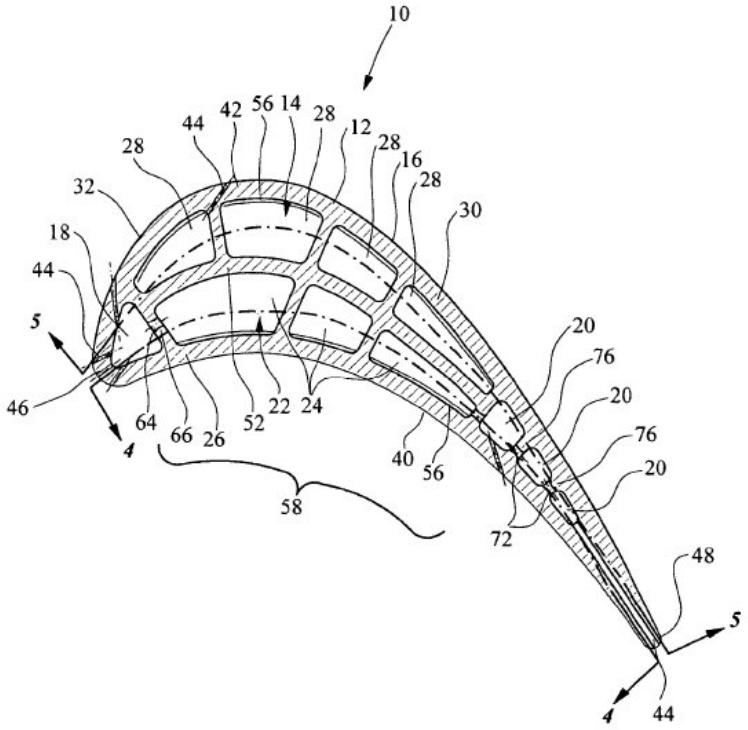


FIG. 2



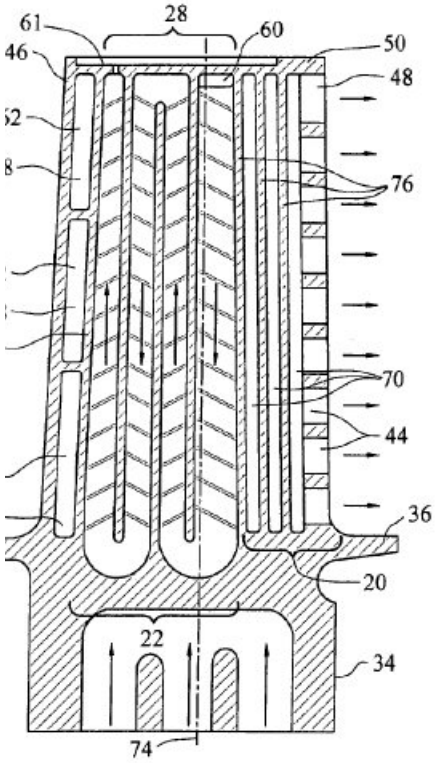
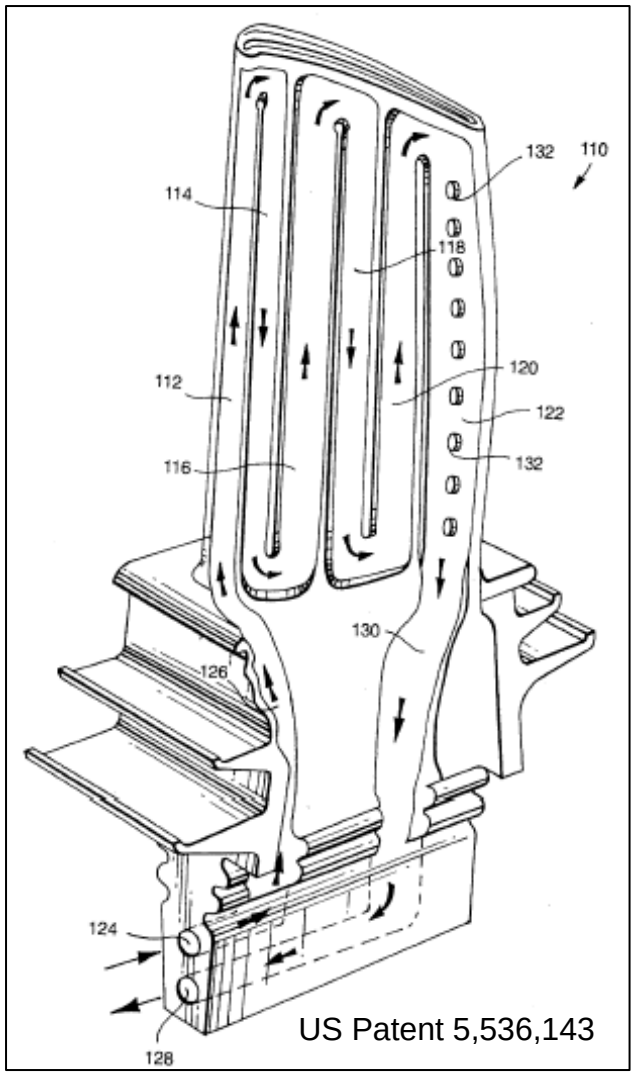
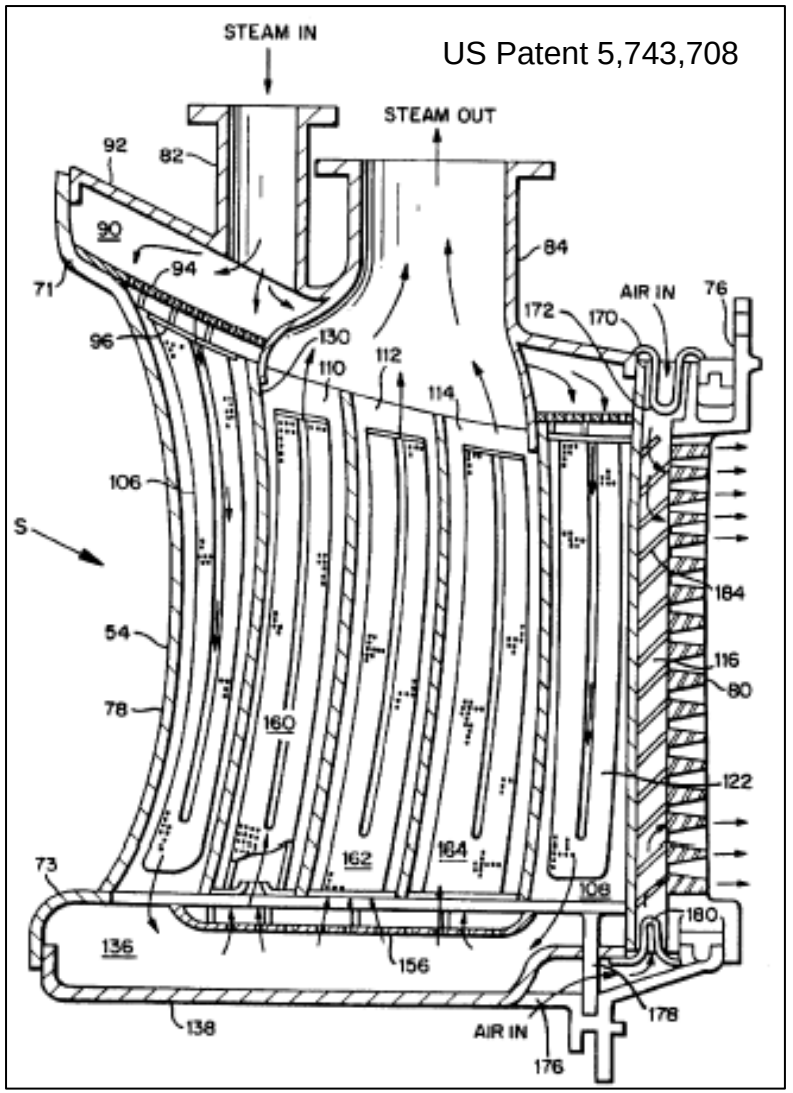


FIG. 5

ADVANCES IN TURBINE BLADE COOLING
IGT H Class Turbines – Closed Loop Steam Cooling



US Patent 5,536,143



US Patent 5,743,708