

**6.7 Case Study No. 7
Crankshaft for High
Performance V-6
Engine**

Component name:	Crankshaft for High Performance V-6 Engine
Forging Process:	Hot impression die
Length, mm (in.):	510 (20)
Weight, kg (lb):	26 (58)
Alloy:	Vanadium modified microalloy steel
Tensile strength, MPa (psi):	825 (120,000)
Yield strength, MPa (psi):	495 (72,000)
Fatigue strength MPa (psi):	380 (55,000) (estimated)
Secondary Operations:	Finish machining, shot peening of journals
Heat treatment:	None
Alternate process:	Austempered ductile iron

The crankshaft for a 3.8 liter supercharged engine, shown in Figure 6-7, utilizes the properties of microalloyed steel with the advantageous grain flow developed in the impression die forging process. The original design specified austempered ductile iron; however the material was not capable of achieving engineering targets for consistency of properties and machinability.

The combination of microalloy steel and impression die forging generates a 31 % increase in yield strength and 41 % increase in tensile strength compared with nodular cast iron, which is specified for conventional crankshafts. More important for the application, fatigue strength was increased by an estimated 57% and stiffness by as much as 36%. Stiffness, which is critical at higher engine speeds, is proportional to the modulus of elasticity, which is 207 GPa (30,000 ksi) for steel versus 152 GPa (22,000 ksi) minimum for nodular iron. The selection of microalloyed steel allowed the strength properties to be generated as forged, without the quenching and tempering operations that are usually required for carbon steel cranks.

Fatigue strength was further enhanced by shot peening the fillets on main and rod journals. Shot peening induces compressive stresses at and near the surface, which subtract from the tensile stresses imposed in those areas. Usually a deep rolling process is performed on main journals only.

With this combination of material and processes, designers anticipated very long service life, with possibly no failures in service.

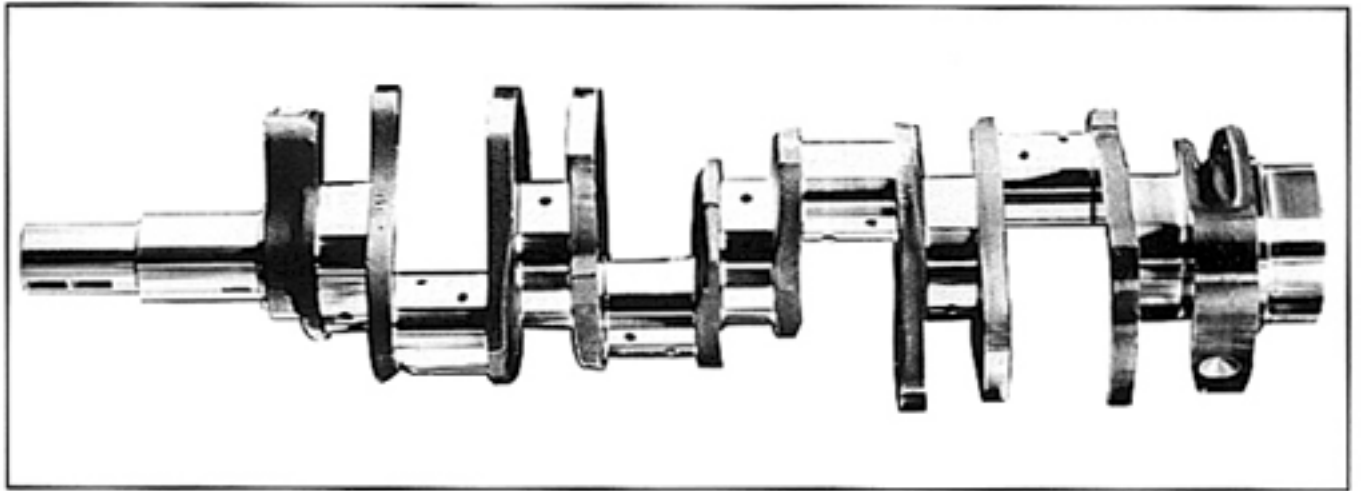


Figure 6-7 Crankshaft shown is the cast version, which was replaced by a forging.