

## Technical Topic

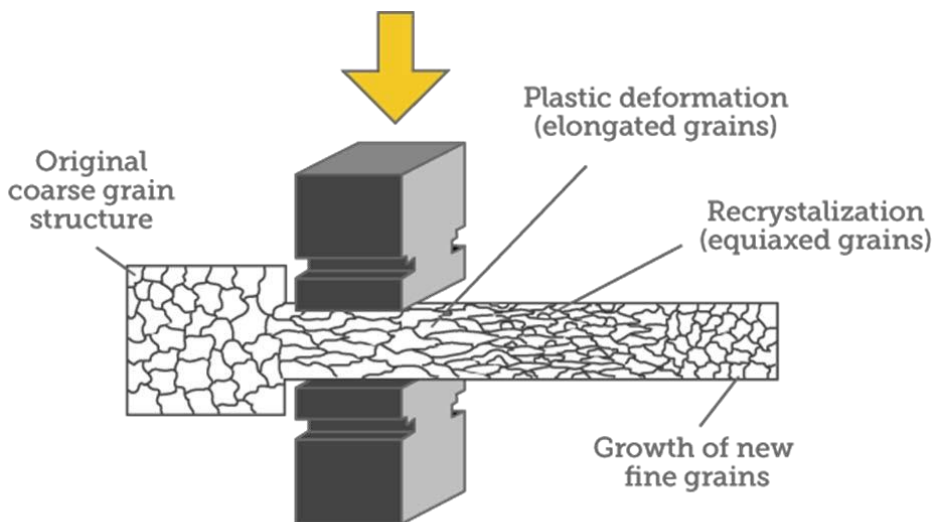
Number	Date	Application	Topic
TB-1	October 2016	General	Forged vs Cast Steel

Many engine components are made of various materials and manufacturing processes. This topic will focus on the basics of the forging and casting of steel with reference to piston manufacture.

The forging process dates back to 4000BC. Early man utilized bronze and wrought iron to produce tools and weapons. Early forging was done manually with a hammer and an anvil. The following is a general definition of a forge and the forging process.

**Forge** - a furnace or a workshop with its furnace where metal is heated and wrought

**Forging** - a manufacturing process involving the shaping of metal using localized compressive forces. The blows are delivered with a hammer or a die.

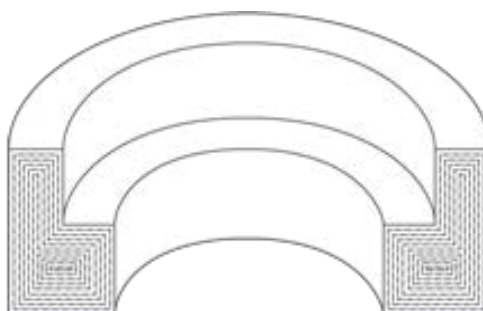


### How the open die forging process affects the crystal structure.

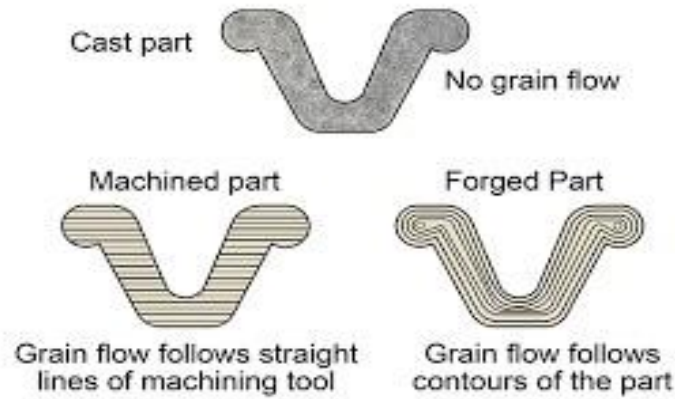
One of the biggest advancements in forging production began in the mid-nineteenth century with the invention of the Bessemer steel making process. The forging industry now had a plentiful supply of lower cost and higher quality steel.

Forging also provides a degree of structural integrity that is unmatched by other metalworking processes. Forging eliminates internal voids and gas pockets that can weaken metal parts. By dispersing segregation of alloys or non-metallics, forging provides superior chemical uniformity. Predictable structural integrity simplifies heat treating and machining, and ensures optimum part performance under field-load conditions.

### Structural strength & integrity

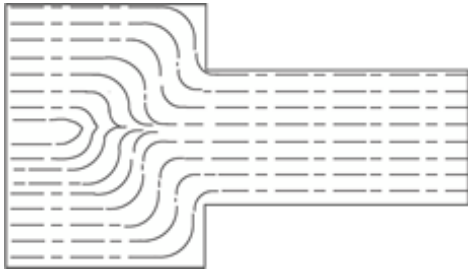


As more engine models are developed using the strength and durability benefits of forged steel pistons, product lines of forged pistons will expand. The illustrations below show the main benefits of forged steel pistons versus the cast steel counterparts.



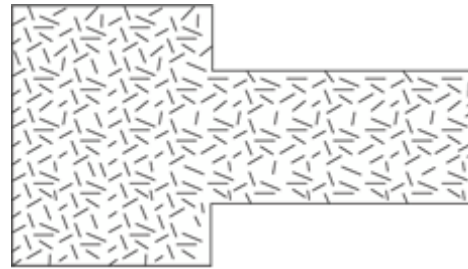
### Forged Steel Piston

Directional strength grain flow:



### Cast Steel Piston

Little or no grain flow:



Forging stock steel blank is typically preformed to refine the structure and remove porosity in the ingot (blank). By mechanically deforming the heated steel piston blank under tightly controlled conditions, the forging operation produces uniform grain sizes and flow characteristics in the piston. The piston forging process produces superior metallurgical and mechanical qualities in the forged piston body. The basic process is illustrated here.

Heated blank;





Forged steel pistons and cast steel pistons appear to look alike. The strength and durability benefits come from the forging process.

**Summary:**

**Cast steel**

Cast Steel is steel that is cast in molds. The steel is melted in electric arc and induction furnaces - at far higher temperatures than is the case for cast iron. The relevant melting and molding technology is therefore subject to high demands. Steel castings have a high shrinkage level of six to eight percent, which means contraction cavities are more likely to form. As they slowly cool, the castings solidify in a brittle, coarse-grained state.

**Forging versus Casting**

Forged Steel	Cast Steel
Stronger	Casting cannot obtain the strengthening effects of hot and cold working. Whether open or closed die forging is used, the forging process surpasses casting in predictable strength properties - producing superior strength.
Fewer Metallurgical Defects	A casting has neither grain flow nor directional strength and the process cannot prevent formation of certain metallurgical defects. Pre-working forge stock produces a grain flow oriented in directions requiring maximum strength. Dendritic structures, alloy segregations and like imperfections are refined in forging.
More Reliable	Castings defects occur in a variety of forms. Because hot forging refines grain pattern and imparts high strength, ductility and resistance properties, forged products are more reliable.
More Stable	Castings require close control of melting and cooling processes because alloy segregation may occur. This results in non-uniform heat-treatment response that can affect straightness of finished parts. Forgings respond more predictably to heat treatment and offer better dimensional stability.