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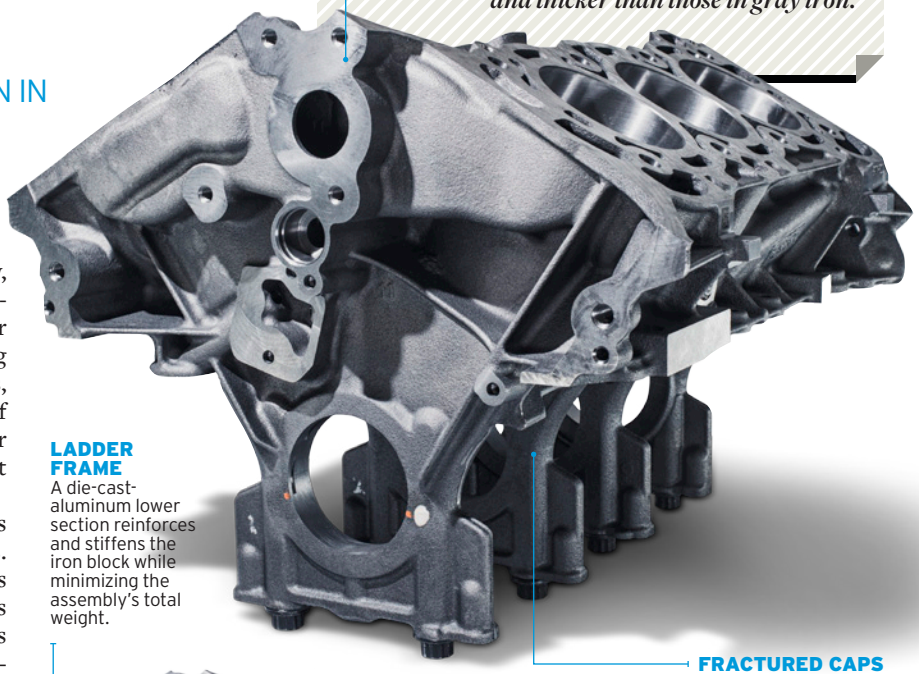
Leave the Iron On

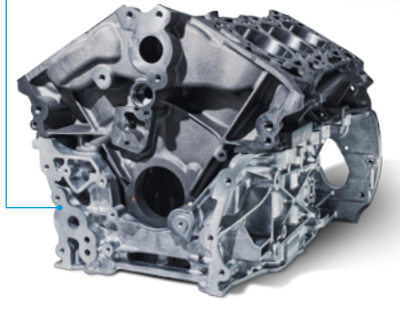
FORD BURIES NEW-AGE IRON IN ITS ALUMINUM-INTENSIVE 2015 F-150. *by Don Sherman*

UNDER THE MICROSCOPE
Graphite particles in CGI are shorter and thicker than those in gray iron.



LADDER FRAME
A die-cast-aluminum lower section reinforces and stiffens the iron block while minimizing the assembly's total weight.

FRACTURED CAPS
Breaking the main bearing caps off the cylinder-block casting results in an uneven mating surface and more stable support for the twin-turbo 2.7-liter V-6's crankshaft.



AT THIS YEAR'S Detroit auto show, Ford's F-150 nabbed headlines with its courageous move from steel to aluminum for the entire cab and bed, potentially saving hundreds of pounds. Equally courageous, but less reported, is Ford's choice of materials for the 2015 F-150's 2.7-liter twin-turbocharged "Nano" V-6 engine: It has a cast-iron cylinder block.

Conventional wisdom says that iron is too heavy for modern cars and trucks. Ford's first manufacturing genius, Charles "Cast-Iron Charlie" Sorensen, earned his nickname by integrating the Model T's major engine and transmission components into just a few castings. But during the past two decades, engineers have systematically switched blocks and heads from iron to aluminum to save weight.

So why the seemingly retrograde move to an iron block for the F-150's 2.7-liter V-6, especially when this truck's three optional engines all have aluminum blocks and heads? Because iron makes the most sense from an engineering perspective, and the most cents for the Ford Motor Company.

In the 1950s, metallurgists began developing cast iron vastly superior to the Model T stuff. All cast iron is a mix of iron and graphite (carbon) with smidgens of other elements to fine-tune its physical properties. Basic gray iron is great for frying pans. Stronger malleable iron makes excellent crankshafts. Nodular iron has higher tensile strength and hardness, ideal for gears and camshafts. The best stuff is compacted graphite iron (CGI), which falls between gray and nodular iron in strength and stiffness while providing greater resistance to fatigue cracks.

Under the gaze of an electron microscope, the graphite clusters in CGI look like coral tentacles. These entangled curlicues grip the surrounding iron matrix, in contrast to gray iron's thin flakes and nodular iron's spherical clumps. CGI also excels in thermal conductivity and internal-damping characteristics. The intrinsic damping helps minimize engine noise and vibration.

When European high-speed trains suffered brake-rotor heat-checking and cracking, CGI saved the day. It's the material of choice for exhaust manifolds, turbocharger housings, and flywheels. Hardworking turbo-diesel engines and NASCAR racers have had CGI blocks for years.

Since iron is three times denser than aluminum, the F-150's engine block is inevitably heavier than if it were cast from recycled beer cans, but there are offsets to consider. Since CGI is stronger and tougher, block walls can be thinner and main bearing saddles narrower, trimming overall engine length and weight. Engineers cleverly designed what Ford calls a two-piece block with the iron sandwiched between aluminum heads and a thick die-cast-aluminum "ladder frame." The oil pan is molded plastic. No cylinder liners or expensive bore-surface treatments are needed inside the strong CGI, a significant cost savings.

Because Ford is using CGI, its new V-6 is tougher, more compact, and less expensive than the all-aluminum alternative. In other words, this is an excellent way to counterbalance the extra cost of the F-150's aluminum cab and bed. Cast-Iron Charlie would definitely approve.

photograph by **ROY RITCHIE**