SUBARU FB ENGINES

BY **DAVE HAGEN**

Subaru FB16

From Tokyo Japan at the Fuji Heavy Industries Ltd. (FHI) manufacturing facility, a new Subaru FB 4 cylinder Boxer engine has been introduced to replace the EJ 4 cylinder engine over a period of time. An entirely new generation of boxer engine was announced in September 2010 and has already found its way into approximately 2011-2015 Subaru vehicles. This next-generation boxer engine that combines the technology and know-how used in Horizontally-Opposed Boxer engines, the core technology that has supported Subaru's unique driving since it was first employed in the Subaru 1000 in 1966. This overall renewal is the first in 21 years, since the second generation boxer engine were introduced in the first Legacy models in 1989. By increasing piston stroke and decreasing piston bore, Subaru aims to reduce emissions and improve fuel economy while increasing and broadening torque output over the previous generation engine.

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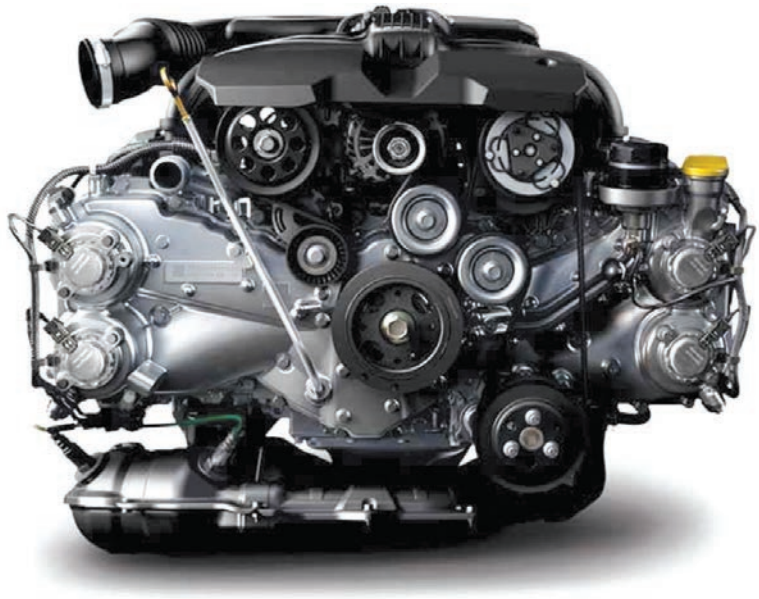

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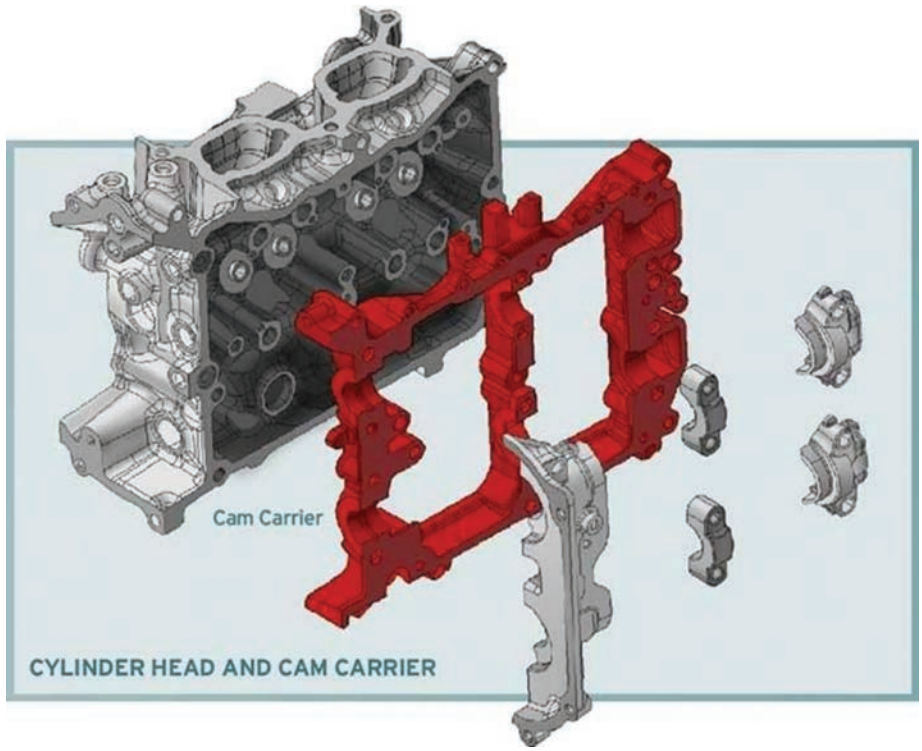

The cylinder heads and the camshaft carriers consist of separate pieces instead of one metal casting, which allows a reduction in metal thickness, simplification of the engine's structure, and reduction in weight.

The all new FB Cylinder Head

92) allow for more compact combustion chambers, and is now "under" square. The trick was to increase the stroke of the crankshaft (now 90 mm versus 75), yet not increase the width of the longitudinally mounted engine allowing it to fit into the present Subaru vehicles. The solution was swapping the camshafts' belt drive for chain drive (and consequently, bulkier pulleys for smaller sprockets). The valve angle was reduced too, from 41 degrees to 27—further shrinking the size of the combustion chamber. For lower friction, cam lobes now ride on roller tappets and cylinder-bore roundness was improved, allowing for lower-tension piston rings. The intake system has been totally reworked to include a plastic plenum/runners assembly and four butterfly valves (in addition to the single throttle body) to enhance cylinder filling or promote tumble when needed. The resulting Upshot? It's about the same power as before in both 2.0- and 2.5-liter iterations, but slightly more midrange torque, sweeter air out the tailpipe and, on average, about 10 percent better fuel economy which is a win-win for everyone.

The FB has an all new block and cylinder heads featuring dual overhead cams with intake and exhaust variable valve timing (AVCS - Active Valve Control System), and a timing chain that replaced the timing belt. Moving to chain-driven cams is said to allow the valves to be placed at a narrower angle to each other and shrink the bore of cylinder from 99.5 mm to 94. It results in less unburned fuel during cold starts, thereby reducing emissions. Subaru is able to maintain the exterior dimension substantially unchanged by asymmetrical connecting rods like those in EZ36. The FB is only marginally heavier. Subaru claims a 28-percent reduction in friction losses, mainly due to lighter pistons and connecting rods. The FB has a 10% improvement in fuel economy with the power coming on sooner and the torque band being broader and it's no doubt direct injected fuel is planned soon.

Despite the longer stroke, engineers were able to maintain the dimensions of the EJ engine with revisions to connecting rods and valve train components. Maintaining engine width was a concern in designing the FB power plant. The new engine was required to fit in the same-sized engine bay as its predecessor. The change in the combustion chamber's displacement and surface area helps to reduce engine knock.

CYLINDER HEADS/CAM CARRIERS

The cylinder heads and the camshaft carriers consist of separate pieces instead of one metal casting. That allows a reduction in metal thickness, simplification of the engine's structure, and reduction in weight.

Revisions to the valve train include the use of roller rocker arms instead of lifters to actuate valves. These components and their layout contribute to reducing the width of the cylinder heads and overall engine width.

The fuel injectors were moved to the cylinder heads. In the EJ engine, they were mounted in the intake manifolds. The relocation enhances the flow of atomized fuel, helping to improve fuel efficiency and reduce exhaust gas emissions.

INTAKE AND EXHAUST

Both intake and exhaust systems are designed to optimize the flow of gases and improve performance.

In the intake system, the intake manifold no longer requires a large intake chamber, which reduces the number of parts in the engine. The size and shape of the large and small resonators along the intake manifold are streamlined. These revisions help reduce overall engine weight as well as manufacturing costs.

Another modification resulting in the elimination of parts is the addition of a cooling function to the exhaust gas recirculation system.

Intake and exhaust ports and valves have been revised, too. Valves have been engineered to reduce drops in pressure when they're open, which helps improve performance. Their design increases tumbling (keeping fuel mixed with air) when closed, which improves fuel efficiency and helps reduce exhaust gas emissions.

The exhaust system features improved tuning. The diameters and lengths of the separate tubes have been modified to improve catalytic converter warm-up (reducing emissions) and to increase power output.

LIGHTWEIGHT COMPONENTS

Among the components redesigned to weigh less in the FB engine are:

- Connecting rods shaped to help keep engine width the same as the EJ while allowing longer stroke
- Pistons with a smaller bore, requiring less material and having less reciprocating mass
- Wrist pins with smaller diameters, requiring less material

Along with an efficient and compact oil pump, the lightweight components reduce friction loss by approximately 30 percent, improving fuel efficiency and engine response.

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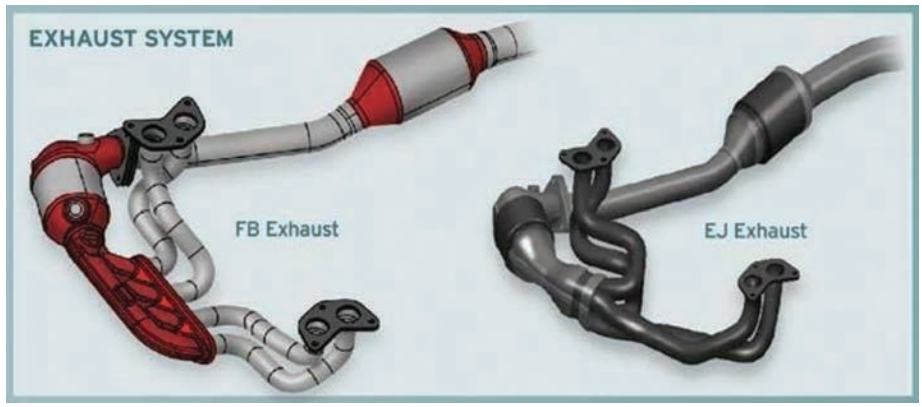

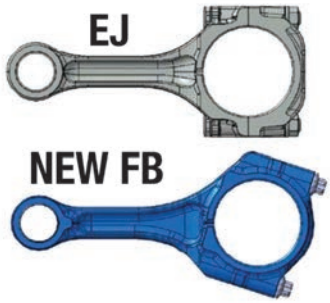

ABOVE: FB vs. EJ Exhaust Systems — The FB exhaust system features improved tuning. The diameters and lengths of the separate tubes have been modified to improve catalytic converter warm-up (reducing emissions) and to increase power output.

LEFT: FB vs. EJ Connecting Rods — Connecting rods for the FB engine have been redesigned to weigh less and are shaped to help keep engine width the same as the EJ while allowing longer stroke.

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CHAIN DRIVE

The double overhead camshafts are driven by chains rather than toothed belts. The chains are maintenance free and do not require replacement, helping to lower the cost of ownership.

The use of chain drive allows smaller sprocket diameters at the crankshaft and camshafts. That helps to keep engine width within convenient dimensions.

FB VERSUS EJ

As compared with the previous non-turbocharged EJ25 engine, the FB25 produces:

- The same horsepower, but at lower rpm
- Slightly higher torque at lower rpm
- Improved fuel economy

That makes the Forester's new FB SUBARU BOXER engine more responsive, especially at lower engine speeds, while allowing the vehicle to travel farther on the same amount of fuel.

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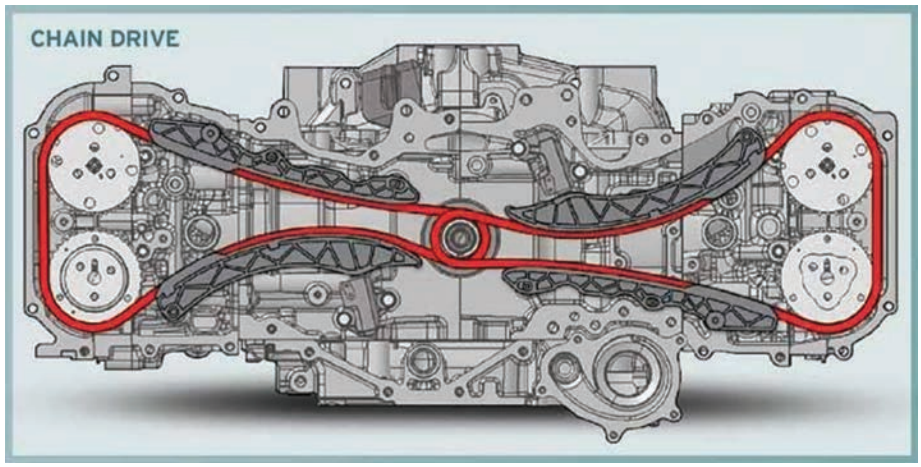

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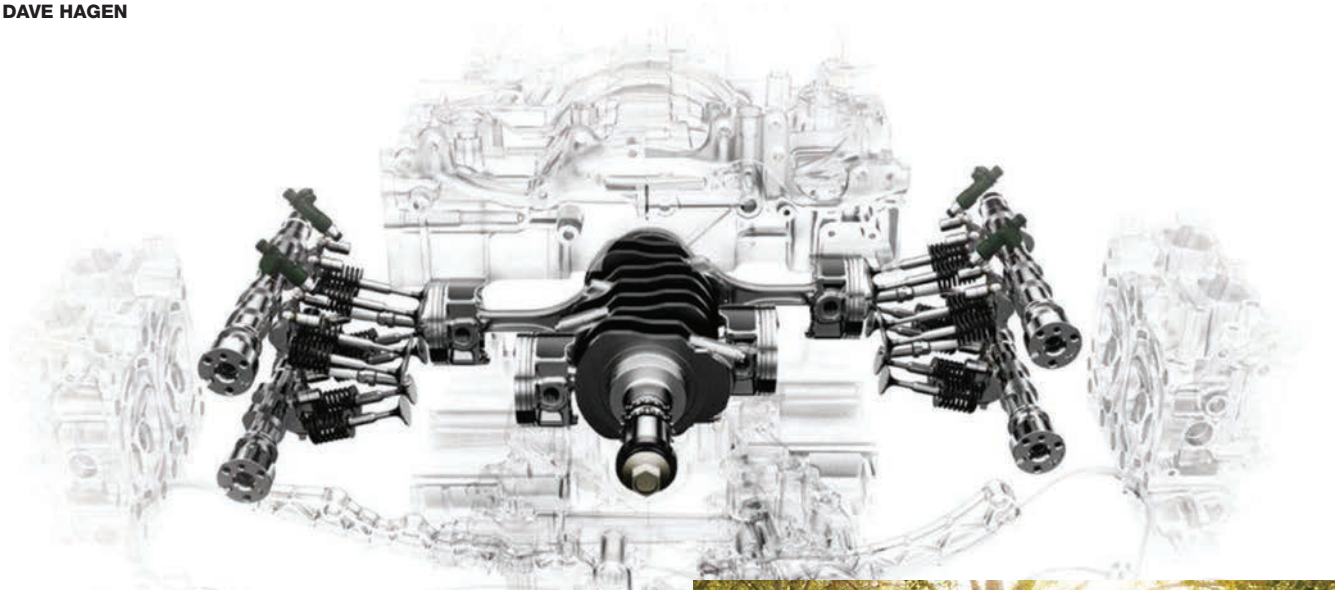

As compared with the previous non-turbocharged EJ25 engine, the FB25 produces the same horsepower, but at lower rpm, slightly higher torque at lower rpm and improved fuel economy. That makes the Forester's new FB SUBARU BOXER engine more responsive, especially at lower engine speeds, while allowing the vehicle to travel farther on the same amount of fuel.

FB VERSUS EJ

	2011 FB	2010 EJ
Displacement, cc (cu in)	2,498 (152)	2,457 (150)
Bore/stroke, mm (in)	94.0/90.0 (3.70/3.54)	99.5/79.0 (3.92/3.11)
Peak horsepower, @ rpm	170 @ 5,800 rpm	170 @ 6,000 rpm
Peak torque, lb-ft @ rpm	174 @ 4,100 rpm	170 @ 4,400 rpm
Compression ratio, :1	10.5	10.0
Fuel requirement	Unleaded gasoline (87 octane)	Unleaded gasoline (87 octane)
Valve train configuration	16-valve, double overhead camshaft	16-valve, single overhead camshaft

The FB engine is currently offered in three displacements with room for more options in the future.

- **FB16:** 1,600 cc, DOHC, 78.8 mm bore x 82 mm stroke, 10.5:1 Compression Ratio, Rated at: 84 kW (115PS) @5,600 rpm, 150 Nm (15.3 kgm) @4,000 rpm in (2012+ EUDM Impreza XV 1.6i)
- **FB20B:** 1,995 cc, DOHC, 84 mm bore x 90 mm stroke, 10.5:1 Compression Ratio, Rated at: 109 kW (148PS) @6,000 rpm, 196 Nm (20 kgm) @4,200 rpm in (2011+ JDM Subaru Forester) Rated at: 148 hp, 145 lb·ft (2012+ Subaru Impreza and Subaru XV)
- **FB20X:** 1,995 cc, DOHC, 84 mm bore x 90 mm stroke, 10.5:1 Compression Ratio Rated at: 148 hp, 145 lb·ft (2014+ Subaru XV Hybrid)
- **FB25B:** 2,498 cc, DOHC, 94 mm bore x 90 mm stroke, 10.0:1 Compression Ratio. Rated at: 170 hp, 174 lb·ft @ 4,100 rpm (2011+ North American Subaru Forester, 2012+ North American Subaru Legacy)

Every new engine comes with some issues after their launch into the real world of reality and these engines will offer continued service work for technicians worldwide and there's been some problems with oil ring seal for select models. Subaru is handling the concerns on an individual basis and has a genuine goal of maintaining customer satisfaction for a well-respected vehicle brand. Head gasket issues are starting to occur as the mileages are starting to get up near or beyond the 100,000 mark which offers more opportunities form machine shops. Performance parts for these engines are also very limited at the time of this article, but, I'm sure they're in the planning stages somewhere. The next improvement for this engine could very well be direct injection as Subaru has been developing GDI for the past few years. ■

AERA Technical Specialist Dave Hagen has over 41 years of experience in our industry. As an ASE-certified Master Machinist, Dave specialized in cylinder head work and complete engine assembly for the first 17 years of his career.