

## GASOLINE ENGINES



Subaru has taken a big step up by taking fuel injection down into single-cylinder, recoil start industrial gasoline engines with the development of the EX21 EFI engine. The EFI system consists of a power coil, wire harness and the combined throttle body/ECU/fuel pump assembly shown here.

## A SINGLE BIG STEP DOWN FOR EFI

New Subaru single-cylinder recoil start industrial engine incorporates electronic fuel injection system

BY MIKE BREZONICK

Over the last year or so, electronic fuel injection has come in force to the small air-cooled industrial gasoline engine markets, as virtually all of the major engine suppliers have launched EFI V-twins into North America. Thus it was no surprise when Subaru launched two new EFI models, the EH72 and EH72 UTV V-twin engines, at the World of Concrete trade show in Las Vegas early this year.

But that was only a prelude to a smaller — yet much more significant — development from Subaru Industrial Engines. Just last month the Illinois-based subsidiary of Fuji Heavy Industries went into production with a new EFI engine, this one a new version of its single-cylinder EX21 gasoline engine.

It is believed to be the first time that EFI has been used in a mass-produced, single-cylinder, recoil start industrial engine. As such, despite the small size of the engine, it's a pretty big deal.

"Anybody can do EFI on a V-twin,"

quipped Brad Murphy, vice president of sales and marketing for Robin America, the Fuji Heavy Industries subsidiary that sells and supports Subaru industrial engines in North America. "The trick with getting EFI into a single is to be able to reduce the cost and make it something that seems more affordable, to make it something that people can actually buy."

Of course that's the trick to nearly any technology in any market, but it's especially true in the volume small gasoline engine business, where the economics might be the toughest in any segment of the engine-powered equipment industry.

"What's been a problem has always been all the things you had to have in a typical EFI system," said Murphy. "Generally, those have included a battery, an electric fuel pump and a regulator, and wiring for those to the ECU, which is a separate unit that also requires a wiring harness.

"You need an intake air temperature

sensor and wires to that; you need a sensor for the head temperature and wiring for that; you need a flywheel position sensor and wires to that; and you need an O<sub>2</sub> sensor and wires to that. If you're going to have a closed-loop system, you need a throttle body and a throttle position sensor and all of the bracketing and wiring that go with that.

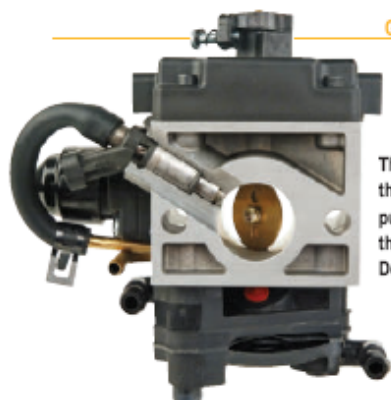
"Just the cost of the parts and the wiring harnesses is one thing, then there's also the associated labor of putting all of that on the engine. It makes it a very long and complicated thing. That's why typically you saw EFI only on expensive things like cars and motorcycles and then on liquid-cooled industrial engines and then only recently on V-twin air-cooled engines. The costs of the systems have come down from thousands of dollars per engine to maybe \$150 or \$200 for some of the systems that are out there.

"That's great for an engine that may cost several hundred dollars and if you're adding another \$200, it's doable if the performance is increased in any kind of significant way. But that doesn't cut it on single-cylinder engines. Those engines are all horizontal shaft, they need to run without a battery and they have to be dead-on simple to operate and maintain.

"That's the difference between our system and anything else we've seen out there. We've integrated it into the engine as much as possible to eliminate all the bracketing, the wiring harnesses and the complexity. We've been able to make it about as simple as it could be."

The EX21 engine is already among Subaru's most advanced air-cooled industrial engines, incorporating several technical aspects derived from Subaru's automotive experience, such as a chain-driven overhead cam system, along with a redesigned combustion chamber and optimized intake and exhaust ports.

Adding EFI was a case of basically adding three components to the existing 211 cc engine, Murphy said — a combined throttle body/ECU/fuel pump assembly, a power coil and a wire har-



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This cutaway look at the throttle body/ECU/fuel pump assembly shows the position of the Delphi fuel injector.

ness. "There are only three parts to it when you break out what we have to assemble onto the engine," he said.

"We don't have a battery, we have a power coil that looks like a charging coil and is underneath the flywheel and has electronics integrated into it to control the voltage. Then we have a wiring harness going up to the ECU, which is mounted on top of the throttle body, which eliminates an extra box, and the wiring that would be required on that.

"We used our existing ignition coil as our flywheel position sensor and so we have the same wiring harness that's on the charging coil which goes over the ignition coil and then we have a heat sensor that's on the head that will pick up the engine head temperature."

The fuel pump is a diaphragm-type pump that's integral to the lower end of the throttle body, which eliminates some bracketing and hosing. A connection to the head senses pressure changes in the crankcase, which operates the fuel pump, increasing pressure on the fuel while reducing the fuel volume. "We need about 3.2 psi fuel pressure to operate the engine, so it's a low-pressure fuel injection system," Murphy noted.

The fuel from the fuel pump goes up through a passage-way within the pump and into a throttle body/diaphragm pressure regulator assembly. From there, the fuel is delivered into the cylinder by a Delphi injector. "We chose to use a Delphi injector because it eliminated one big variable from the system," said Murphy. "Delphi is a leader in the world in injectors and this injector has millions of car miles on it in a slightly different version. We don't have to worry about whether it's going to be reliable or not, or waste a lot of time on testing."

When the recoil start cord is pulled, it turns the charging coil that brings the ECU and fuel pump to operation in a matter of milliseconds, Murphy said. Along with the expected benefits of improved performance — the engine has gained about 0.5 hp from its carbureted 7 hp rating — easier starting and improved response, the new EFI EX21 engine also offers additional features such as auto idle down and low oil level alarm/shutdowns. Maintenance issues are all expected to be reduced, since, as Murphy pointed out, "the number-one service item in small gasoline engines continues to be carburetors.

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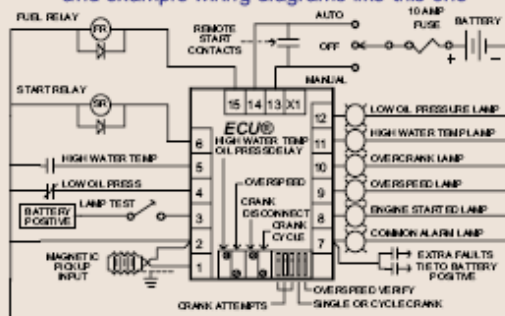
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