Kawasaki Fuel Injection Simplified, Part 1 Why Fuel Injection?

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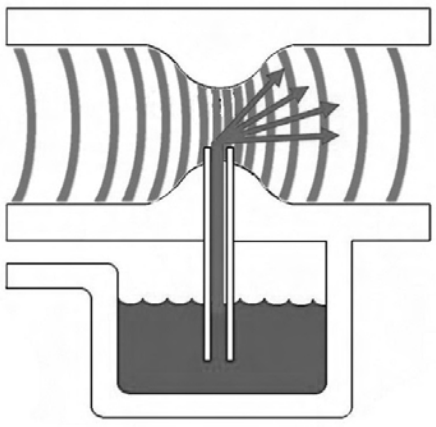
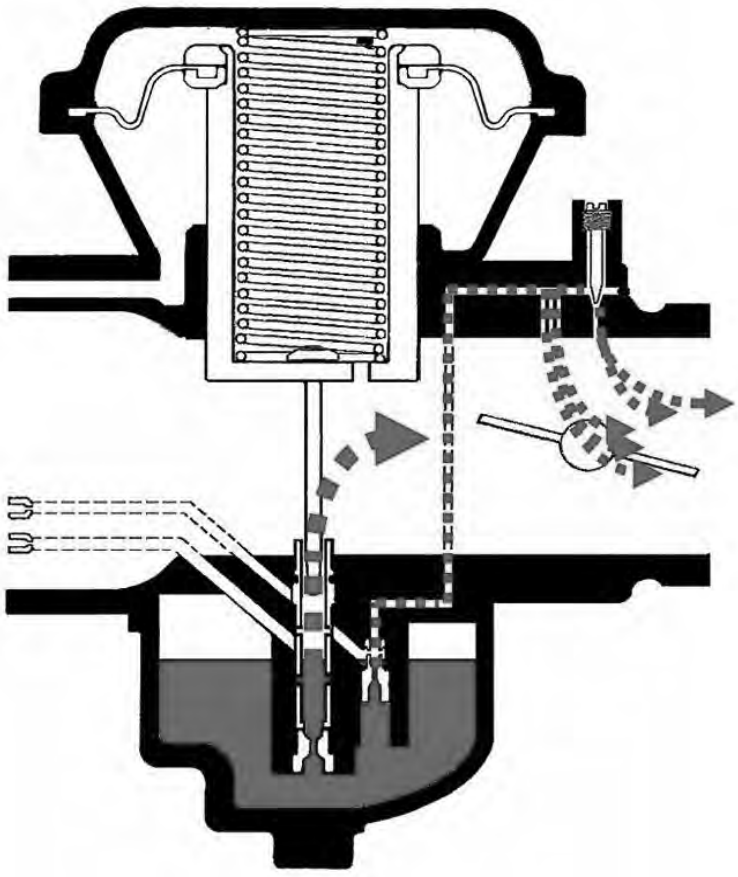
Why fuel injection? Air rushing through the carburetor on its way into the engine is forced to accelerate through a narrowed part of the carburetor called the venturi. This creates a low pressure pocket, and from this point is found a tube suspended into a cavity of fuel. The difference between the fuel at atmospheric pressure and the venturi at-less-than atmospheric pressure causes the fuel inside the tube to be coaxed upward into the intake manifold. Under normal conditions, throttle-operation-induced changes in the carburetor's airflow bring proportional changes in venturi pressure, resulting in proportionally sized splashes of fuel into the intake airstream. It all works rather well.

However, an irregular condition such as cold starting requires the manual override of a hand choke, because the carburetor cannot sense the engine's temperature and its reduced ability to vaporize the fuel. And more significant variations such as changes in altitude or air temperature overcome the carburetor's capabilities completely. They cannot be overridden at all and must be endured because the carburetor has no means of monitoring them.



Proportional changes in venturi air pressure draw corresponding splashes of fuel into the airstream.



The carburetor's various jet circuits help atomize the fuel, but cannot compensate for any change from baseline conditions.

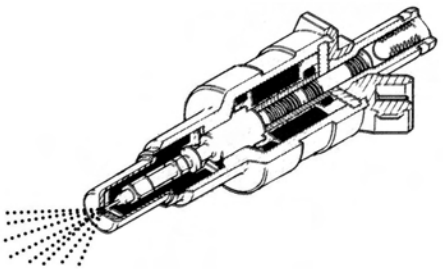
We have just described the carburetor's two main handicaps. First, that it depends on forces completely outside itself (air pressures) to produce fuel discharge. Second, that it offers no means of compensation (other than disassembly and recalibration) for any change from baseline conditions.

There is a third carburetor short coming that is actually related to the first, and that is atomization. Atomization, the breaking of fuel into a fine mist, is at best incomplete with a carburetor due to the fuel being under merely atmospheric pressure. The mist is not as fine as would be ideal, which means it will not as readily be vaporized by the engine.

The "big deal" about fuel injection is that, first, fuel injection adjusts to all those little things that the carburetor cannot sense: the engine's temperature and load, for example, resulting in improved engine operation under varying conditions. Second, and not at all least, fuel injection's external fuel pressurization results in the fuel being broken into much finer particles upon discharge than happens in a carburetor.

Atomization is important because it is the first step in combustion. The better the fuel is atomized, the more evenly it is distributed in the cylinder, the more readily it vaporizes, and the easier it burns. The bottom line is improved throttle response, increased torque, and fewer exhaust emissions.

Almost 30 years ago, in 1980, Kawasaki introduced motorcycling's first mass-produced electronic fuel injection (EFI) system. This L-Jetronic (Bosch) patterned EFI system relied on a swinging air flow flapper valve plus engine rpm inputs into the electronic control unit (ECU) to calculate basic fuel discharge. The cylinder head mounted engine temp sensor and the air pressure sensor then added information for final lean/rich adjustment immediately before injector operation. This 360-degree system's injectors redundantly squirted with each crankshaft ▶



Early-style fuel injector.

revolution, an inexpensive design that also offered increased fuel vaporization in the intake manifold. Two years later the airflow flapper was replaced with a throttle sensing switch, and Kawasaki began calling this system digital fuel injection, or DFI, the name still used for its fuel injection systems today.

Fuel injection offers benefits beyond enhanced power and lowered emissions: minimal maintenance; especially in regard to vehicle storage; less susceptibility to environmental conditions; especially vehicle motion and attitude; and better compatibility with low-energy ignition systems, to begin with. In addition to these universal benefits, certain Kawasaki models shift better (Brute Force® 750, Teryx RUV) and start better (Mule™ Utility Vehicles), and the KX450F motocrosser starts and idles better and is easily tuned at the track with a laptop computer.

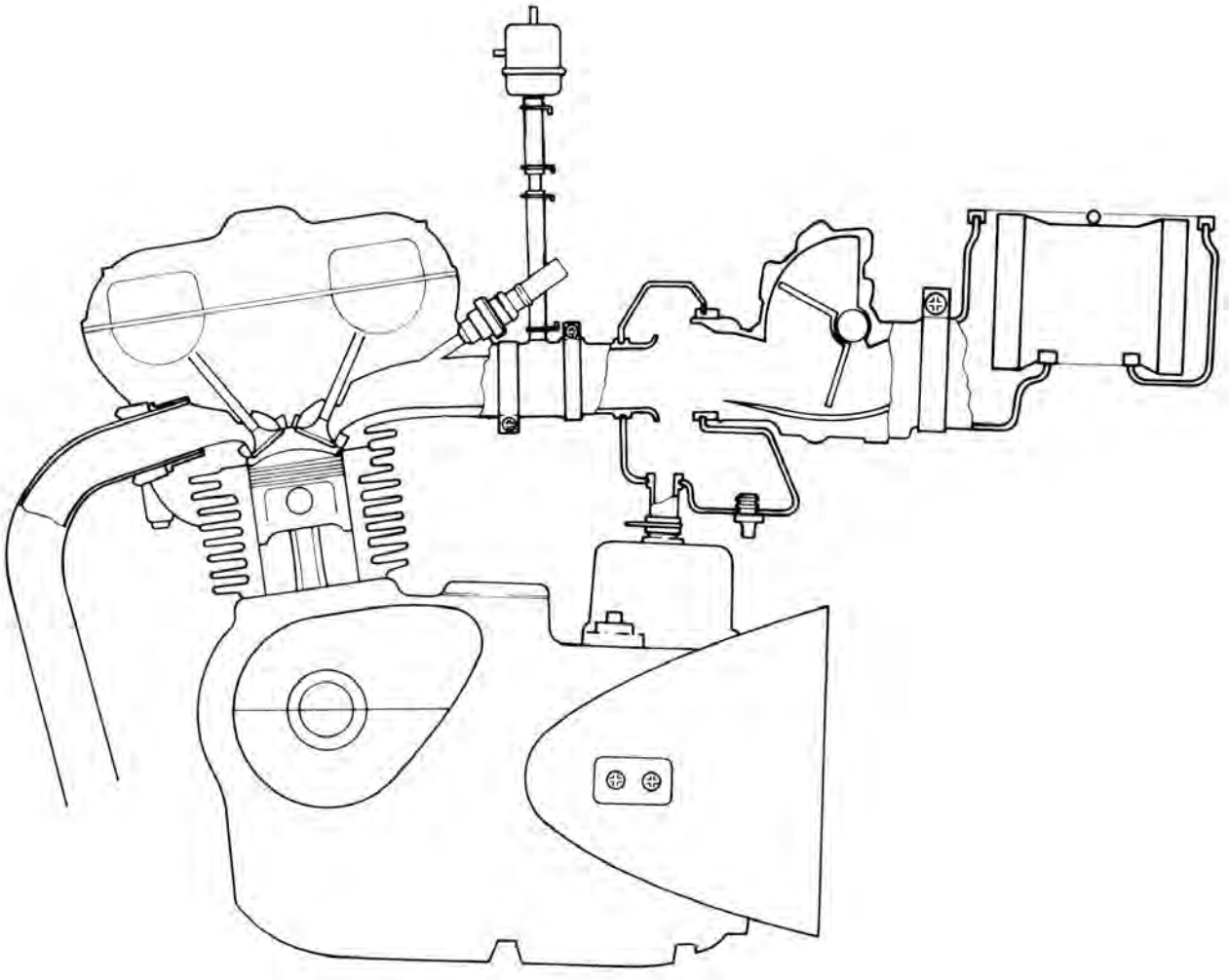
Fault modes for when parts fail is programmed into all Kawasaki DFI systems, allowing them to keep operating until the keyswitch is turned off. DFI also connects the fuel and ignition systems together, bringing integration to these two major engine systems: independent ignition timing in each cylinder is common, for example. Also, DFI systems include rpm limiting, which protects the engine, not by simply cutting off ignition or fuel but through feathering them for smooth engine control.

Maximum speed control is present on Mule™ utility vehicles and on the largest supersport model, the Ninja® ZX™-14. Similarly sophisticated engine management in the form of torque control, that is, active adjustment of ignition and fuel to fit the amount of engine torque production to the conditions, is found on a few products. DFI also offers the perfect platform for electronic cruise control, as demonstrated on the Vulcan® 1700 Nomad™ and Voyager® models.

Even exhaust system valves come under ECU control. And, with a few models there is also the ability to manually reshape the power output to optimally match it to conditions using a laptop computer. All of these features and benefits are outcomes of the Kawasaki digital fuel injection (DFI) system.

The carburetor couldn't do it, but DFI can, and Kawasaki brings the best technology to play in its application of DFI to its high performing products.

Next Issue: Part 2: DFI Parts Explained◆



Kawasaki's first fuel injection system was introduced nearly 30 years ago.