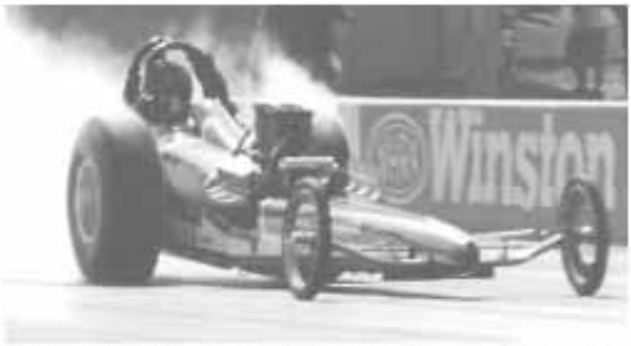
A BRIEF HISTORY OF FUEL INJECTION

CARBS TO CONSTANT FLOW, TO LUCAS MECHANICAL, AND FINALLY ELECTRONIC

CARBS TO CONSTANT FLOW

Back in the fifties it was either carbs or constant flow fuel injection. The basic cost for an out of the box carb was quite cheap compared to injection. However, to get the mixture distribution right with the carb took a pretty smart person a lot of time, as both the air distribution and the fuel distribution were tough to get right, and they changed with engine RPM and load. A really good running set of carbs would wind up costing a lot more than the injection, and even then carbs did poorly with combinations of both straightaway acceleration and cornering as the floats and bowls hadn't been developed far enough. Even today's carbs don't handle boating through rough waters well, as it's impossible to meter the fuel if it is bouncing off the top of the float bowl. Don't get us wrong — we're not knocking carbs, as tens of millions of them have done an admirable job for many years when used on the application they were designed for.



Walt Kolodziej's 'Blue Meanie' front engine dragster with Kinsler small block Chevrolet injection system

If you bought a good set of individual runner injection, the air distribution was just about perfect right out of the box, since all of the runners are cast the same and have a radiused bell at each entrance. If your unit had a properly matched set of nozzles the fuel distribution had to be good, since there was one nozzle in each runner. Other advantages of the injection was that you could change the fuel mixture quickly by just changing one jet (even from the dashboard while driving), and you could run alcohol and nitro. There were no carbs at the time that did a good job with these fuels.

Most all of the early injection was of the constant flow design, which to this day is the most rugged and dependable system. The basic fuel metering is done by sensing throttle angle and engine speed. The throttle rotates a spool with a tapered ramp inside a metering block. Engine speed is sensed by using a positive displacement fuel pump coupled to the engine, so when the engine speed doubles, the output of the pump doubles. A problem lies in the fact that the fuel pump doesn't draw in all the fuel it should, especially with gasoline, which causes a lean out condition. This happens because the light ends in gasoline boil at about room temperature, or even lower if you have any vacuum at the inlet of the pump caused by a restriction in the inlet line from the tank. While alcohol doesn't boil as easily, it still requires a carefully plumbed inlet to prevent the lean-out, especially in round track or road racing. The car will seem to run just great early in the race, but after a while it gets 'lazy'...the power and response fall off, and you may even burn a piston. The solution is to pressurize the pump inlet line so the fuel can't boil. Our vapor separator tank is the heart of an excellent off-the-shelf system that takes care of this. An especially nice feature of the constant flow system is that you can precisely tailor just about any fuel curve, even with bumps and dips in it, using special metering pieces that we have available.

LUCAS AND BOSCH MECHANICAL

The first injection on a passenger car was Bosch on the 1954 Mercedes 300SL. In the early sixties both Lucas and Bosch mechanical timed injection became popular for racing, as they have several nice features. The fact that they are timed allows you to inject the fuel at just the right instant to avoid letting any go through during valve overlap, thus giving better potential fuel economy. These systems also meter the fuel well during engine starting which prevents washing off the upper cylinder lube. The nozzles are of a valve-and-seat design, so there is no dripping of the fuel into the engine on shutdown, even without a fuel shut-off valve. The throttle response is very crisp, as you get the new fuel rate within two revolutions of the engine after moving the throttle pedal. Finally, the output of the pump is not a basic part of the metering system, so if the pump were to cavitate say 10%, it would have no effect on the mixture at all.

1963 Maserati Mistral
Lucas fuel metering system

A drawback of both the Lucas and Bosch is that to get more than a simple straight line fuel curve you have to make a complex three dimensional fuel cam. Even today, a Lucas mechanical system with the simple straight line fuel curve is close to the ultimate mechanical injection. Why? Because the internal combustion engine is so beautifully forgiving...it puts out almost full power from about three percent lean to about six percent rich.

ON TO ELECTRONIC

In the late sixties various auto companies started serious electronic fuel injection (EFI) programs for better economy, driveability, and emissions. What needed to be done was obvious, but the progress was slow because of the difficulty of developing good low cost injectors and electronic bits. The exciting thing about using electronics is that you could look at as many inputs as you wanted to for very little money. Why? With any mechanical device, either carbs or injection, it is quite cumbersome and expensive to sum more than a few inputs. With electronics it is easy and cheap to sum as many as you want. So while only throttle angle or intake vacuum combined with engine speed had been used in most mechanical systems, now you could sense air, water, oil, and fuel temperature, barometer, rate of throttle opening, etc. With computing ability, it became easy to have complex maps of fuel mixture vs. RPM for various throttle angles, acceleration enrichment, controlled enrichment from cold starting to hot running, etc. Bosch was the clear leader in the early EFI work, introducing the system on the 1967 Volkswagen.

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