TomcoTechtips

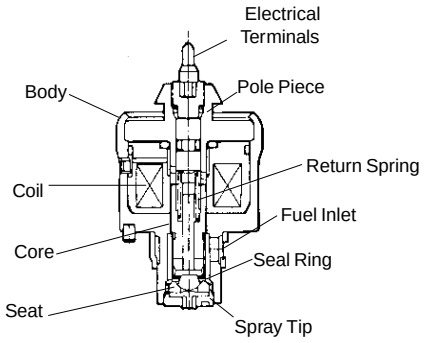
TM

ISSUE 37

FUEL INJECTORS

This issue we will begin a study on fuel injectors. Fuel injectors are electro-mechanical devices that are used to meter fuel. These can be either bottom feed or top feed injectors.

Bottom feed injectors receive their fuel supply near the bottom of the injector (Fig. 1). These were typically used on throttle body injection units, however some manufacturers are beginning to use them on port fuel applications.



Bottom Feed Injectors

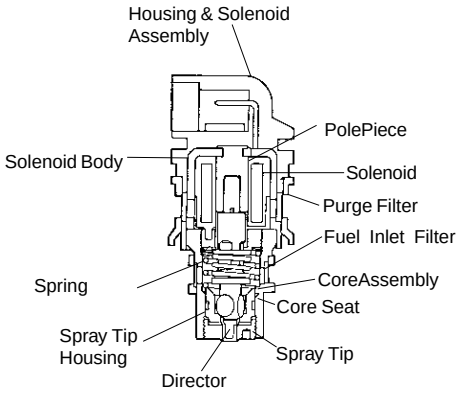


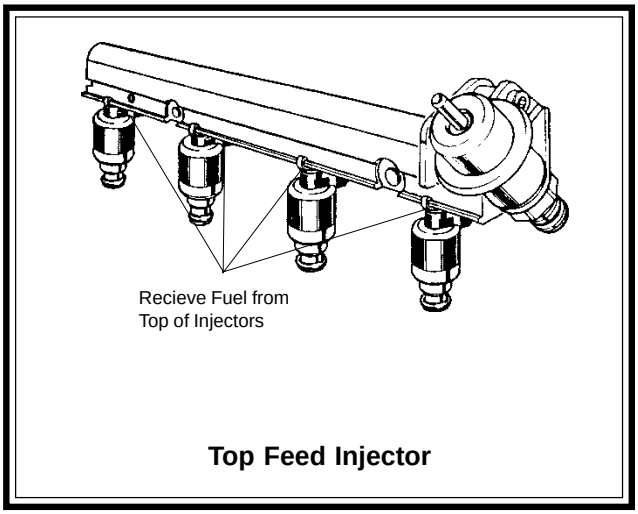
Figure 1

The benefit of a bottom feed injector is that it contains a path to purge vapors from the injector. Since the fuel comes in the bottom, the vapors can be directed out of an upper portion of the injector allowing vapors to escape easily. (See Fig. 1). This helps reduce vapor problems during hot fuel conditions.

Top feed injectors receive their fuel supply from the top of the injector and the fuel flows vertically through the injector (Fig. 2).

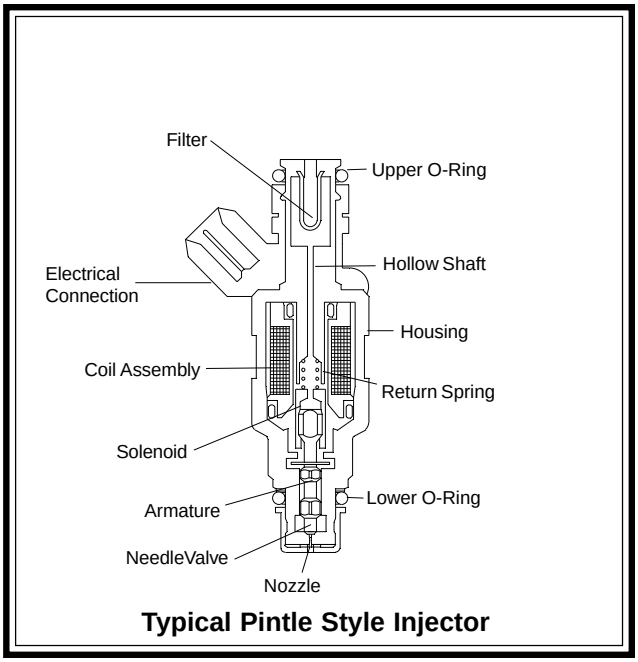
Since the fuel comes in from the top, it is hard for the vapors to escape and be purged. For this reason the pressure must be higher on this style injectors to help prevent hot fuel vapor problems.

An injector typically consists of a filter, a hollow shaft, a coil assembly, a return spring, an armature, a nozzle, and a housing (Fig. 3)



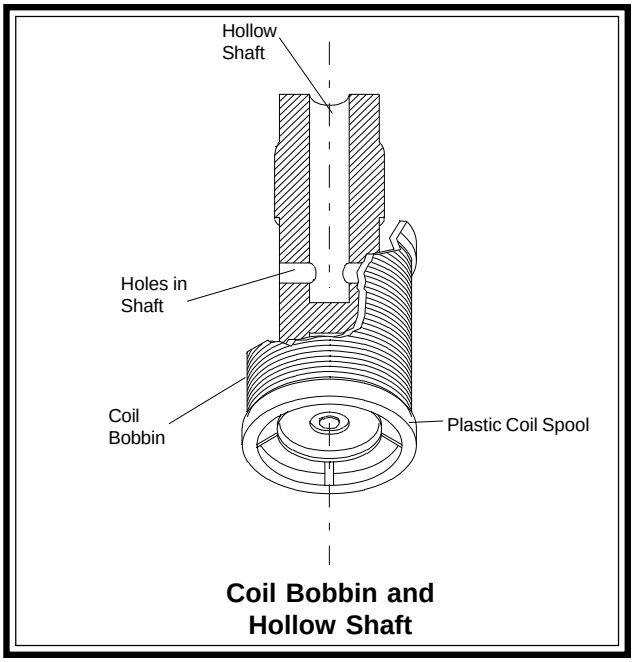
Top Feed Injector

Figure 2



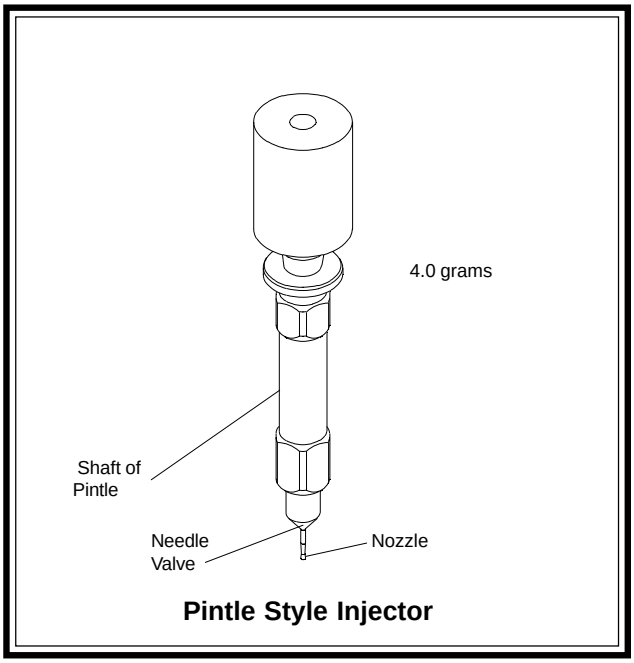
Typical Pintle Style Injector

Figure 3



Coil Bobbin and Hollow Shaft

Figure 4



Pintle Style Injector

Figure 5

As we know, the injector filter, sometimes called a basket, is not the main filter of the system. Its purpose is to keep out initial fuel line and rail contaminants, protect from contaminants during testing and system service and from contaminants in the fuel that may get by the fuel filter. This is much like the screens added to some fuel pressure regulators on the inlet side.

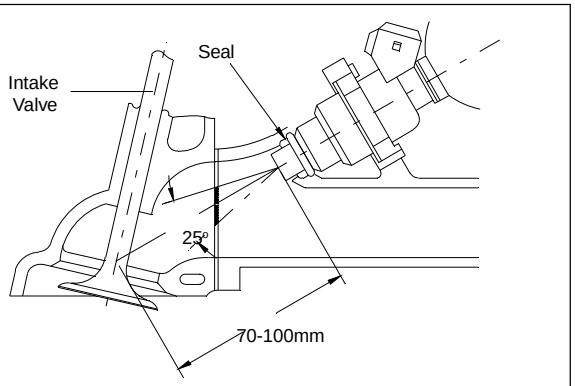
The injector basket is set in a hollow shaft or tube that goes through the coil bobbin. The shape of this shaft varies between manufacturers (Fig. 4). In some cases the shaft has a number of small holes drilled in it. This allows fuel to contact the inside plastic of the coil bobbin not the coil wire itself, thereby helping to cool the coil. Not all manufacturers use this method of holes drilled in the shaft, but the fuel moving through the tube will still have some cooling effect.

The injector coil has a certain number of wire turns wrapped around a plastic bobbin. The material and the size of the wire chosen is dependent on the resistance required to be compatible with the injector driver being used and the strength of the magnetic field needed.

The total resistance of the coil is dependent on the length of the wire, resistivity of the wire and the type of terminals used. Brass wire is typically used for the high resistance injectors and copper is used for the low resistance injectors.

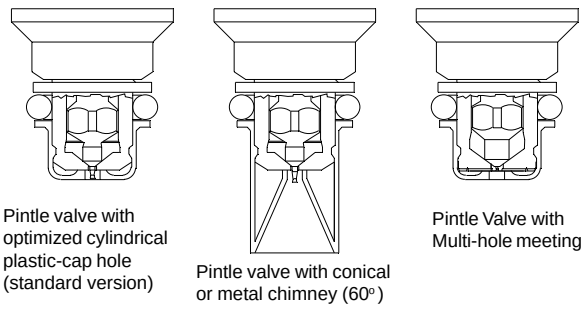
The coil's plastic bobbin has an o-ring on the top and bottom, which acts as a seal to prevent fuel from leaking into the coil area, causing damage to the coil.

When it comes to the lower portions of



Heat Rises Past Open Intake Valve to Injector Tip

Figure 6



Pintle Cap Variations

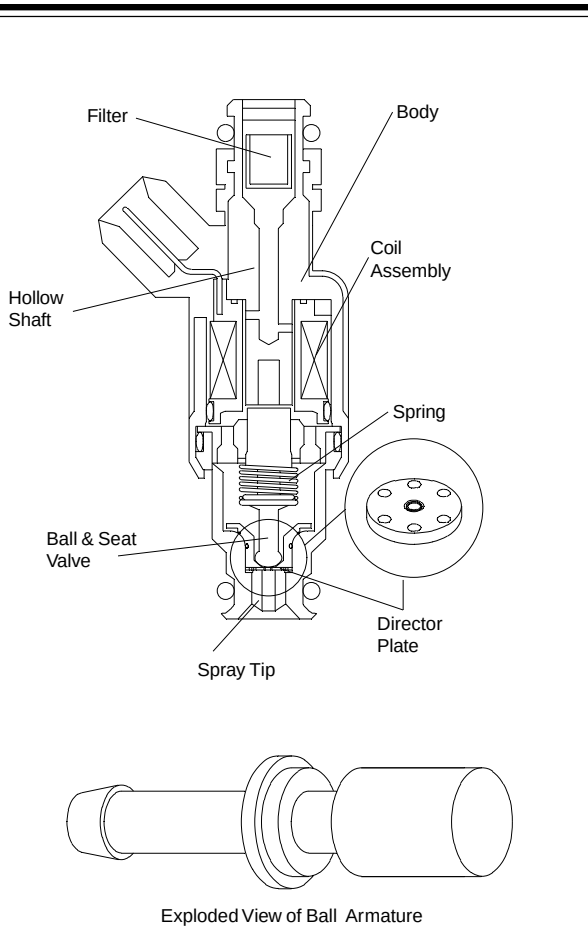
Figure 7

the injector, there are a number of different armature designs. Lets take a look at three main designs: the pintle style, the ball and seat style and the disc style. These pieces are made of highly finished metals which help provide a leak-tight seal for the life of the injector.

The pintle style is typically a long shaft, that flares out when it comes to the tip, kind of like the head of a pin (Fig. 5). This pintle shaft typically weighs about 4.0 grams. This pintle style typically extends past the bottom of the injector housing, making this style injector particularly susceptible to injector fouling. Lets examine why.

When the vehicle engine is shut down some of the intake valves will naturally be left open. This allows the heat inside the cylinder to rise past the intake valve to the injector area (Fig. 6). There may still be some residue of fuel on the pintle tip of the injector, which protrudes from the end of the injector. The heat begins to bake this residue of fuel onto the injector pintle. This leads to a buildup over time that causes poor fuel spray, lean mixtures, poor driveability and high emissions.

A pintle cap has been used by some manufacturers to try to reduce the deposits on these style injectors. These pintle caps have many different designs. Some of these are shown in Figure 7.



Ball & Seat Style Injector

Figure 8

The ball and seat style is shown in Figure 8. The ball and seat are made of stainless steel and the ball typically weighs about 1.8 grams. As you can see their seating area is raised from the bottom of the injector. Located under the ball and seat is a director plate. This

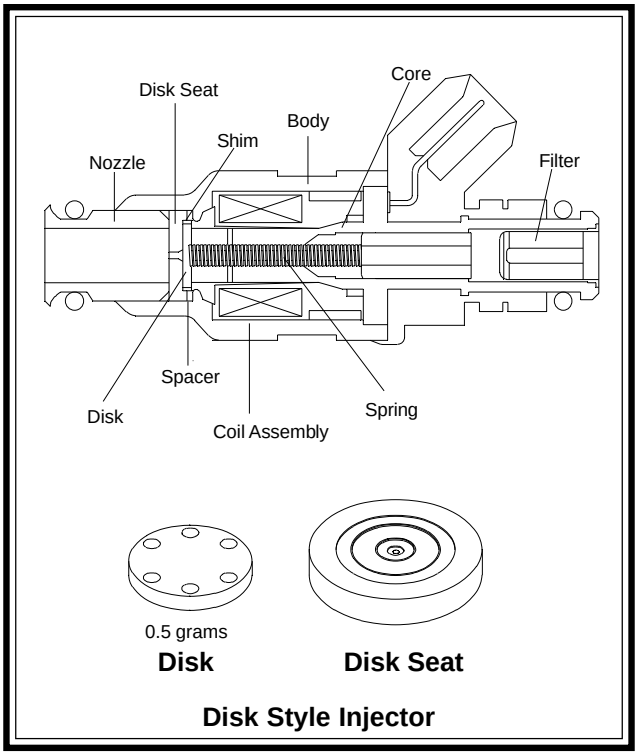


Figure 9

typically contains six holes, which gives this injector a 25° conical spray pattern. This director plate is insensitive to fuel deposits. These designs make this style injector less susceptible to fouling.

The disk style injector uses a disk and seating surface for fuel delivery (Fig. 9). The disk weighs only 0.5 grams. The disk and seating surface are recessed up into the body of the injector, which makes this design much less prone to carbon and varnish deposits.

Whichever of these style armatures is used, the injectors function the same. Lets see how this works using the disk style injector (Refer to Figure 10). A spring and the hydraulic force from the fuel holds the disk closed. So when the solenoid is not energized, the force of the fuel pressure and the spring will prevent fuel flow.

When the PCM energizes the injector a magnetic field is created. The disk will remain against the seat, until the strength of the magnetic field pulling the armature up overcomes the hydraulic force plus the force of the spring trying to hold the armature down. When this occurs then pressurized fuel will flow through the metering orifice.

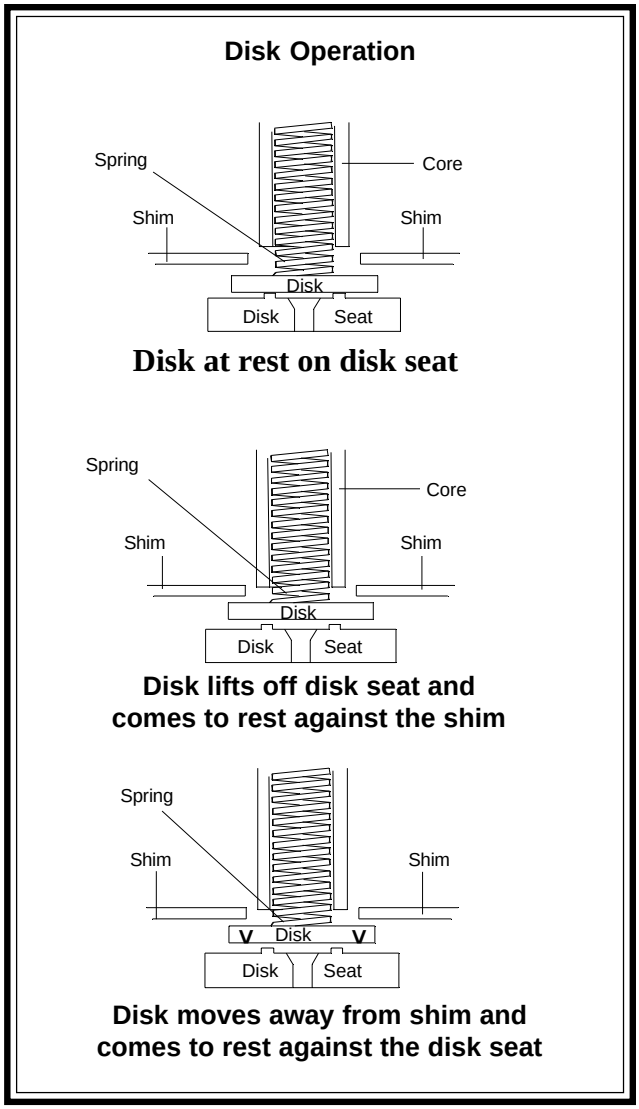


Figure 10

When the PCM de-energizes the injector the magnetic field begins to decay. The armature will remain in the open position until the spring force becomes greater than the decaying magnetic force. At this time the armature will close stopping fuel flow.

It is important to note that there is a lag time, no matter how small, between the time the PCM energizes or de-energizes the injector and the injector opens or closes. This plays into how linear the fuel delivery is in an injector.

We will continue our study of injectors next issue.

TOMCO INC.

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