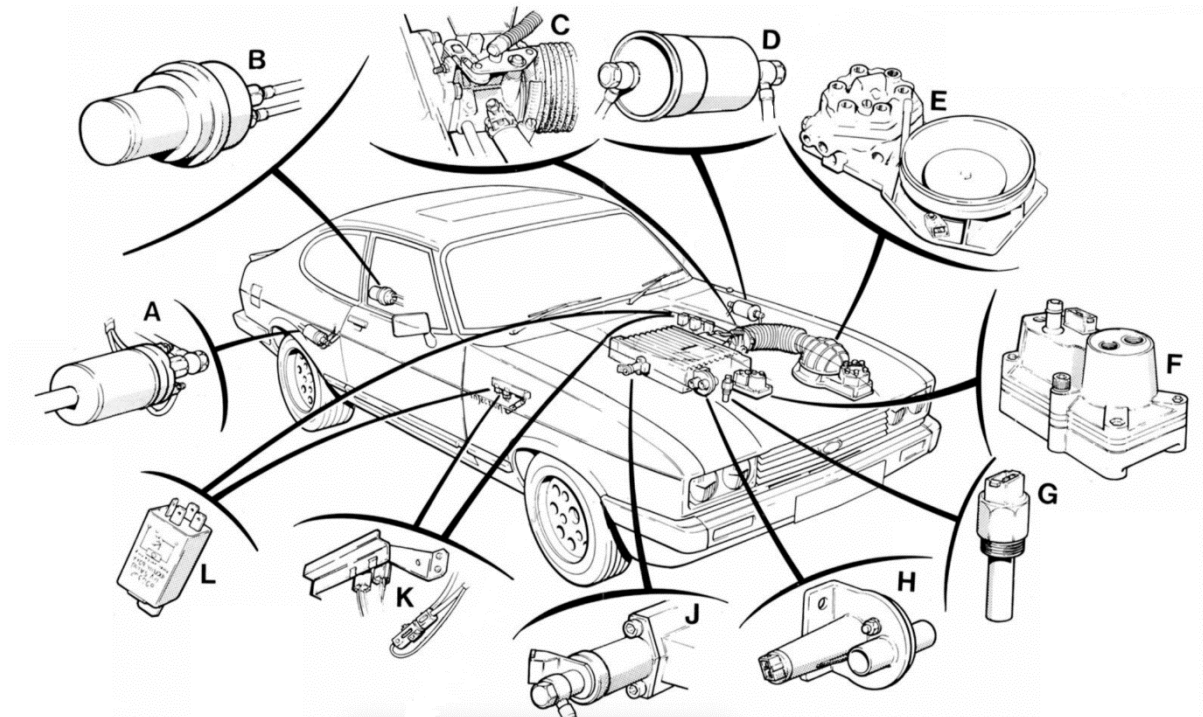


# Bosch K Jetronic- Mechanical Fuel Injection

## Trouble-shooter



**NOTE:-** whilst working on any fuel system, care and attention should be taken to avoid the petrol coming in contact with any source of ignition, this can include: hot engine components, High Tension (HT) sparks and smoking.

## Introduction

This article is taken from a Capri Club International Magazine (May 1999) and was written by: Ian Coulson *Aff. IMI. Technical Advisor*

## "We Unravel The Mystery"

I have been working in the motor trade for almost 10 years now, and have been working with K-Jetronic for 8 of them. Most of the information I will use comes from course notes I have from attending the Ford Service Training College at Daventry on the Bosch K-Jetronic fuel injection system training course.

I have since moved on from working at a Ford main dealer to a Volkswagen Audi dealer in York, and attending the K-Jetronic training course at the V.A.G training centre at Milton Keynes, as the same system was fitted across the VW Audi range. It is probably the first fuel injection system that was used by a number of motor manufacturers and on the whole, is pretty reliable. it is quite a basic, mechanical system, as opposed to the more technical

electronic engine management systems available now, and as such, is open to wear, corrosion and sticking of components and requires a certain amount of adjusting and cleaning to keep it working in the way Mr. Bosch intended.

## General Description

Fuel is supplied from the tank by an electric fuel pump. It passes through to the fuel accumulator, up to the fuel filter, where it then passes to the metering head. Air drawn in by the engine lifts the sensor plate, which in turn is connected to the control plunger inside the metering head.

As this lifts inside it's chamber, pressurised fuel is passed to the injectors, the amount being governed by the amount of air lifting the sensor plate, which sprays continuously on the back of the inlet valves inside the engine. As the valve opens, the air and the sprayed fuel pass into the combustion chamber and ignition takes place.

Firstly, the fuel system.

## Fuel Pump

The fuel pump is located at the rear of the car on the drivers side. It is fastened on the side of the tank in a rubber housing to cut down on noise. It is fed by a rubber pipe which is connected to the fuel tank directly.

It must receive 12 volts to make it work, so it has 2 electrical terminals on it's forward facing end. It is fitted with 2 valves inside, one is the safety valve which, in the event of a blockage in the system, will release fuel back to the inlet side, and a non-return valve. This keeps fuel in the system ahead of the pump after the engine has been switched off.

Fuel passes through the body of the pump and out through the central union on it's forward facing end and up to the fuel accumulator.

## Testing

The fuel pump is a sealed unit and cannot be repaired. If it fails, it can give a few symptoms, the most obvious being that the car will not start at all. If it becomes noisy, this is an indication that all is not well. It can cause jerky running when under heavy load when accelerating and even misfiring when revving up when stationary. If it shorts out inside, it will blow the fuse. This is mounted under the dash on the driver's side, but I will cover this more in the electrical system section.

Only basic tools are required to change the pump, being a 19mm spanner for the fuel pipe union, a screwdriver for the fuel pipe clip and an 8mm spanner or socket to remove the bracket from the fuel tank. You will also need something to plug the supply pipe from the tank otherwise you will get a petrol bath! Not recommended.

## Fuel Accumulator

This is also located at the rear of the car, just above the fuel tank. It is a metal housing with 2 fuel pipes bolted into one end and a small breather hole at the other. Inside is a large spring, a diaphragm and a steel plate with a fuel feed hole through it.

Fuel, pressurised by the fuel pump, enters the fuel accumulator and forces the diaphragm against its spring to its stop. It remains in this position all the time the engine is running. When the engine and consequently the fuel pump is switched off, the diaphragm is allowed to return under spring pressure, trapping the residual pressure in the system rather like a tyre valve. It will retain this pressure for about 20 minutes. It is fitted to keep pressure in the system so the fuel, when switching off a hot engine, does not vaporise causing hot starting difficulties.

## Testing

The fuel accumulator is a sealed unit and is not repairable. The spring inside is very strong, so the unit should not be cut open as injury could result.

The 'holding pressure' which this unit provides is difficult to check without the specialist gauges, but no doubt a garage would undertake this for you. The only thing you can really do is to check that the breather hole has not become blocked. Fuel then passes up the engine bay to the fuel filter which is a silver cylindrical object bolted to the passenger side inner wing. If it gets blocked, it can cause the same symptoms as a faulty fuel pump and can be checked by doing a fuel pump delivery rate check which I will describe later.

## Metering Head / Fuel Distributor

So the heart of the system - the metering head or fuel distributor as it is sometimes known. This is mounted right at the front of the engine bay on the passenger side and has a host of black pipes leading to and from it. Fuel enters the metering head from the fuel filter, via the union on the passenger side nearest the large black air ducting. Inside it passes into a central chamber. As the plunger travels up the chamber, it uncovers a series of slots which are connected to the unions on its top, which are connect to the fuel injectors in the engine.

The more of these slots it uncovers, the more fuel passes to the injectors. The plunger is connected to an arm which has a large disk on it. If you remove the large black air duct, this disk can be visible. It is bolted to the arm sensor plate and housing. The air drawn in by the engine lifts this sensor plate and, as it is connected to the plunger, also allows more fuel to the injectors. The more air is drawn in, the higher the plate moves so the higher the plunger moves - uncovers more slots and allows more fuel to the injectors.

## Testing

The fuel metering head should not be stripped down as it is a very finely machined unit and can be damaged easily. The only real problem that I have encountered with it is of it sticking

due to corrosion on it caused by water in the fuel. A good fuel system cleaner added to a tank of fuel will usually cure most problems with it.

The air sensor plate on the other hand can be adjusted. First, it should be clean. it should be central in its housing and it should be set at the correct height. The edge of the sensor plate should be level with the start of the cone shaped section of the housing.

If this is incorrectly set, not central and catching on the side of the housing or dirty, it will cause the fuel/air ratio to be wrong for the whole engine rev range leading to poor starting, lack of power, flat spots and high fuel consumption.

After cleaning, raise the sensor plate right up and underneath is a metal 'R' shaped spring. Bend this spring up or down to achieve the correct height. If it is not central, undo the 10mm bolt in the centre and pass a feeler blade around its edge until it centralises itself. After adjusting, it will be necessary to have idle speed and mixture reset using a CO meter. Again, most garages would carry this out for you.

## Injectors

These are mounted underneath the ribbed air chamber on top of the engine and are secured in the inlet manifold. They release a finely atomised spray in a cone shape, continuously - the amount depending on the position of the plunger in the metering head.

## Testing

Again, they are a sealed unit, but they can be cleaned by fuel system cleaner as described previously. If they get dirt in them or the spring goes weak, they can give an incorrect spray pattern causing a reduction of power in the associated cylinder. the main fault with injectors is 'dribbling'. When the engine is switched off, pressure is still in the system - thanks to the accumulator.

If the injector is not seating properly due to dirt or wear, it will allow fuel to dribble into the cylinder, wetting the lug and more importantly reducing the holding pressure. This can cause various hot starting problems, mainly starting on 4 or 5 cylinders, then clearing after a rev. This can be checked by running the engine and then removing the injectors with the pipes still attached and placing them on some tissue paper and watching to see if they are damp.

## The Warm-up-Regulator

This is mounted right at the front of the engine with 2 fuel pipes bolted to it, with different size unions and a grey electrical plug. Basically, it is the 'choke'. It provides a richer mixture for cold starting and during the warm up phase. Fuel passes to it from the central union on the metering head. When the engine is cold, the warm up regulator is open, allowing fuel to pass through it. This reduces the pressure acting downwards on the plunger in the metering head, allowing it to lift higher than normal so allowing more fuel to the injectors and giving a

richer mixture. As it heats up, by engine temperature and its heating element inside, it closes off slowly causing higher pressure to act on top of the plunger, forcing it down again, so weakening off the mixture. This pressure is called 'control pressure' and again needs the special gauges to check it.

## Testing

Behind the larger of the 2 unions is a metal gauze filter. If this gets blocked, it causes the warm up regulator to remain closed, causing very bad flat spots and poor acceleration during the warm up phase, just like trying to drive without using the choke. It can be cleaned out using clean petrol. It also has a vacuum connection to it. This is for full load enrichment. At full load, engine vacuum is low, which opens the valve slightly, reducing the pressure on the control plunger and giving a slightly richer mixture.

## The Electrical System

There are various switches, valves and relays in the K-Jetronic fuel injection system, so I will try and describe their function and how to test them.

### Fuel Pump Relay

This is to be found under the dash on the drivers side, above the bonnet release handle along with a few other relays. It is pink in colour and has 5 terminals. The brown wire is connected to earth, the red wire is connected to battery live via a 20 amp fuse which is mounted next to the relay, the black wire is fed with ignition live, the green wire is from the coil terminal 1 with a pulsed live to tell the relay the engine is running and the last terminal has 2 wires going to it. They are both black with a red tracer, the thickest of which goes to the fuel pump. The other wire goes to the heating element of the warm up regulator and the auxiliary air valve, whose operation I will cover shortly. Just switching on the ignition will not cause the fuel pump relay, and consequently the fuel pump to switch on. It must receive a pulse from the coil before it will work. This is a safety device so in the event of an accident when the engine is stalled but the ignition is left on, the fuel pump is automatically switched off to reduce the risk of fire.

for test purposes, the 4 pin heated rear window relay can be substituted for the fuel pump relay to make the pump run with just the ignition on. This relay is in the same place as the fuel pump relay and is black in colour and has a red 16 amp fuse on top of it, under the plastic cover. I must stress that this must ONLY be done when doing the fuel pump delivery test. This test is described later.

### Auxiliary Air Valve

This provides the fast idle during the warm up phase and is bolted to the front of the ribbed air chamber with 2 black pipes going to it, one from each side and a black electrical plug. When the engine is cold, the valve is open. You can check this by removing both pipes from it. You should be able to see through it. It allows air into the engine without it going through

the throttle valve almost like an air leak. This extra air, coupled with the extra fuel allowed in by the warm up regulator, gives increased idle and mixture to run the cold engine.

As it warms up, it slowly closes until when hot it is closed completely. This can be checked by squeezing one of the hoses. If the engine is cold, the revs must drop; if the engine is hot it should not affect the speed.

It is heated by the engine and also by a heating element - hence the electrical plug. It is a 2 pin plug, one connection being earth, the other being live via the fuel pump relay. This can be checked with a test light or meter. The resistance of the heating coil can be checked. This is done by unplugging the electrical plug and putting an ohmmeter across the 2 terminals of the valve. It should be approximately 40 ohms. The electrical plug to the warm up regulator can be checked for voltage and resistance in exactly the same way although the resistance of its heating element is only 25 ohms.

## Thermo-Time Switch & Cold Start Injector

I have linked these 2 items as they work hand in hand with each other. The thermo-time switch is a large brass switch screwed into the water jacket at the very front of the engine and has a brown electrical plug. It has 2 wires going to it, one from the starter motor i.e. only live when the starter is cranking and the other goes to the cold start injector.

The cold start injector is bolted onto the driver's side of the ribbed air chamber and has a fuel pipe and a blue electrical plug. This also gets a live from the starter motor and gets its earth via the contacts inside the thermo-time switch. this can be checked with a meter or test light as previously described.

To check the valve itself, it should be removed from the air chamber and placed in a measuring container. It should spray for between 1 and 8 seconds dependant on temperature (it will not spray at all over 40 degrees C) and should give a fine conical spray. It should not 'dribble' at all once the valve has shut down. this test should be carried out with the coil lead removed and the engine cranked on the starter.

There is an extra item fitted to the Capri injection, which you may have heard 'clicking' from time to time. this is the 'impulse module' and is a 4 pin relay mounted under the dash near the fuel pump relay.

When the engine is cranked when it is hot, if it does not start after 2 seconds, the impulse module provides an earth to the cold start valve in the form of a pulse, making it spray fuel to aid starting. It pulses for 1 second and then switches off and then pulses at 1 second intervals until starting takes place.

## Fuel Pump Delivery Rate

The fuel pump delivery rate is checked at the return line at the fuel metering head. It is checked here because it not only checks the pressure from the pump, bit it also checks to see if there are any blockages on the way. For example, the fuel filter maybe. The return line

union is on the passenger side of the metering head and is the larger of the 2 unions side by side and has an arrow on it pointing away from the metering head. Attach a pipe of approximately 2 feet long to the short rubber hose coming from the union and place it in a measuring container, then substitute the fuel pump relay with the heated rear window relay and switch on the ignition. The fuel pump should deliver a minimum of 750cc of fuel in 30 seconds. If this is not obtained, check the voltage of the fuel pump. A minimum of 11.5 volts is required and if this is OK, repeat the test at the fuel filter inlet pipe. If the required amount of fuel is obtained then the fuel filter must be partially blocked.

This is basically the K-Jetronic fuel injection system.

I hope I have covered all the problem areas and lifted some of the mist surrounding this system. It is quite straightforward in its operation, providing diagnosis and testing is carried out logically and one step at a time. here is a checklist to help you acheive this.

<b>CHECK LIST</b>		
<b>OPERATIONS</b>		<b>SPEC</b>
1. Battery voltage		12.5 - 13.0 v
2. Fuel, air electrical connections		Visual
3. Fuel pump voltage		Min. 11.5 v.
4. Air sensor plate		Free movement
5. Air sensor plate position		Flush fit
6. Auxiliary air valve	a) resistance	40 ohms
	b) voltage	Min 11.5 v.
7. Fuel pump delivery - cc. in 30 secs.		750cc.
8. Warm up regulator	a) resistance	25 ohms.
	b) voltage	Min. 11.5 v.
9. Cold start valve	a) spray pattern	Conical
	b) Leak Test	None

Just to close, this system is quite reliable and as such, you should not jump to the conclusion that there is something wrong with it when the car is difficult to start or is not running quite right. You must always check the basics first. Check the idle and mixture, spark plugs can cause all sorts of problems if they are worn or are cracked. Plug leads can also cause problems, especially in damp weather. if the engine earth strap is broken or the contacts dirty, then the starter can demand extra current so not leaving enough for the spark to be sufficient for cold starting. Basic items such as these should be checked prior to diving into the injection system.

Happy diagnosing and keep the legend alive. Ian Coulson *Aff.I.M.I. Technical Advisor.*



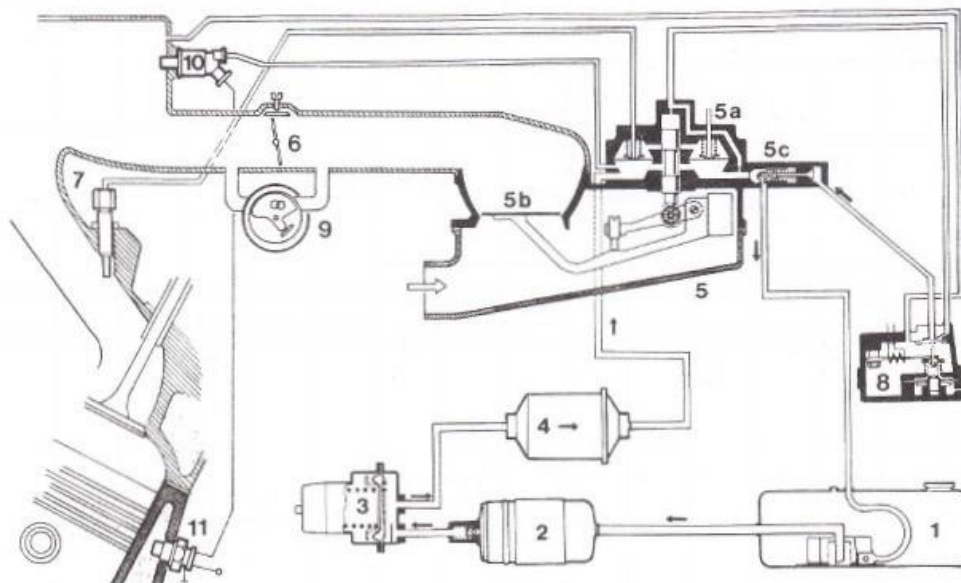


Fig. 3.32 Fuel injection system flow diagram (Sec 22)

- |                    |                        |                           |                      |
|--------------------|------------------------|---------------------------|----------------------|
| 1 Fuel tank        | 5 Mixture control unit | 6 Throttle plate assembly | 10 Start valve       |
| 2 Fuel pump        | 5a Fuel distributor    | 7 Injector valve          | 11 Thermotime switch |
| 3 Fuel accumulator | 5b Air sensor          | 8 Warm-up regulator       |                      |
| 4 Fuel filter      | 5c Pressure regulator  | 9 Auxiliary air device    |                      |

## TROUBLE SHOOTER

FAULT	CHECK POINT SEQUENCE
Engine fails to start or difficult to start when cold	1 2 3 4 5 9 10 8 7 12 16 17 18
Engine fails to start or difficult to start when warm	1 2 3 8 7 11 13 17 18 20 28
Erratic idling during warm up	10 3 11 12 17 18
Erratic idling engine warm	10 3 11 13 17 18 20
Backfire into inlet manifold	13 18
Poor response to throttle opening	6 7 13 16 10 19 20
Backfire into exhaust system	10 13 17 20
Misfire under load	17
Poor performance	2 10 7 13 16 18 20 19
Engine runs on	7 11
High fuel consumption	13 17 20
Flat spot during acceleration	6 7 8 12 13 16 4
Idle CO level too high	10 7 13 17 20
Idle CO level too low	10 13 18 20
High idle speed cannot be adjusted	3 6 5 18
Engine starts but stops immediately	2 1 4 12 13

## TECHNICAL DATA

<b>Idle Speed</b>	
Manual transmission models	900±25 rpm
Automatic transmission models	850±25 rpm
<b>CO Level</b>	
Pre '83	1.25±0.25%
'83 on	1.5±0.2%
<b>Delivery Rate - Minimum</b>	
Capri	930 cc (1.64 pints)/30 seconds
<b>Main System Pressure</b>	
Capri	5.55±0.25 bar (79.8±3.6 lb/in <sup>2</sup> )
<b>Control Pressure - engine cold</b>	
Temperature	Pressure
Capri: 15°C	0.6 bar (8.7 lb/in <sup>2</sup> )
20°C	0.8 bar (11.6 lb/in <sup>2</sup> )
30°C	1.2 bar (17.4 lb/in <sup>2</sup> )
40°C	1.6 bar (23.2 lb/in <sup>2</sup> )
<b>Control Pressure - engine cold</b>	
Vacuum connected	3.6±0.2 bar (52.2±2.9 lb/in <sup>2</sup> )
Vacuum disconnected	2.9±0.2 bar (42.0±2.9 lb/in <sup>2</sup> )
<b>Residual (Holding) Pressure</b>	
Capri: After 10 minutes	1.7 bar (24.7 lb/in <sup>2</sup> )
After 20 minutes	1.5 bar (21.8 lb/in <sup>2</sup> )
<b>Warm-up Regulator</b>	
Minimum voltage supply	11.5 volts
<b>Injector Valves</b>	
Opening pressure Capri	2.5-4.0 bar (36.5-51.5 lb/in <sup>2</sup> )



## Checkpoint ID

- 1 - Fuel Pump
- 2 - Fuel Pump connections and supply
- 3 - Auxiliary Air Valve
- 4 - Fuel Filter and supply pipes
- 5 - Cold Start Valve
- 6 - Air intake system for leaks
- 7 - Airflow Sensor Plate and / or Control Plunger
- 8 - Airflow Sensor Plate position
- 9 - Thermo-Time Switch
- 10 - Cold Start Valve for leaking
- 11 - Injector Valves
- 12 - Control Pressure - cold
- 13 - Control Pressure - warm
- 14 - Primary Pressure
- 15 - Differential Pressure
- 16 - System Pressure
- 17 - Fuel System for leaks
- 18 - Vacuum System for leaks
- 19 - Throttle Valve
- 20 - Idle Speed and CO content
- 21 - Starting Enrichment function
- 22 - Correction function (diagnostic test / Ford)
- 23 - Post Start Enrichment function
- 24 - Warm Up Enrichment function
- 25 - Acceleration Enrichment function
- 26 - Full Load Enrichment function
- 27 - Throttle Switch Adjustment Impulse Module (if fitted)