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KUGELISCHER FUEL INJECTION SYSTEM

As fitted to BMW 2002 tii models.

BASIC SYSTEM DESCRIPTION.

With this system fuel is drawn from the fuel tank by an electrically operated roller cell fuel pump into an expansion chamber (to dampen noise from the fuel pump), both mounted below the fuel tank and mounted on the body on the off side rear. The fuel is then pumped through a steel pipe on the underside of the body (well worth replacing with copper or Kunifer) to the fuel filter mounted on the near side of the radiator. This removes any small particles that may damage the fuel injector pump. From the filter it supplies fuel to the injector pump at a constant pressure and flow rate. Excess fuel is returned from the damping valve at the back of the injector pump through the plastic return pipe which runs from the bulkhead behind the engine through the car along the off side inner sill and back to the fuel tank.

The injector pump is belt driven from the crankshaft and meters the fuel into the inlet manifold via the injectors in the correct proportions according to the engine load and speed requirements and at the correct time on to the backs of the inlet valves. The injections follow the firing order of the engine.

Air for mixing with the fuel (to make a combustible mixture) is supplied via the air filter to the throttle body which by means of the butterfly inside (linked to the injector pump and the throttle pedal)supplies the right amount of air to the manifold to mix with the fuel from the injector pump.

WARM UP PERIOD OF INJECTION.

On the rear of the injector pump is what could be called an AUTOMATIC CHOKE. It works in the following way. Control of the additional fuel and air quantity during warming up of the engine is via a heat-sensitive expanding element that is dependant on the cooling water temperature front the engine. This pushes out a rod which in turn decreases the injected fuel quantity as the cooling water temperature increases by changing the position of the eccentric shaft and thereby that of the control cam actuated rocker in the injector pump (if you don't understand that bit don't worry) read on. The air supply which feeds extra air to the manifold by means of a rubber pipe from the warm up unit is reduced accordingly as the rod moves out, by means of an air regulating cone also in the warm up unit.

COLD STARTING.

A solenoid injector valve is used to inject the additional amount of fuel, which is required for cold starting into the intake system. The valve is connected to the fuel supply system after the fuel filter and opens for a short time when the starter motor is operated. It is controlled time wise by both the thermotime switch and the Bosch Electronic Timer on the left hand side of the bulkhead.

TESTING THE FUEL PUMP.

1. Listen for the noise of the pump working when the ignition is switch on - switch off ignition.
2. Disconnect fuel return line from the petrol tank
3. With a measuring jug (minimum capacity 1 litre) check that 850 cc's minimum of petrol is delivered in 30 secs., when the ignition is switched on.

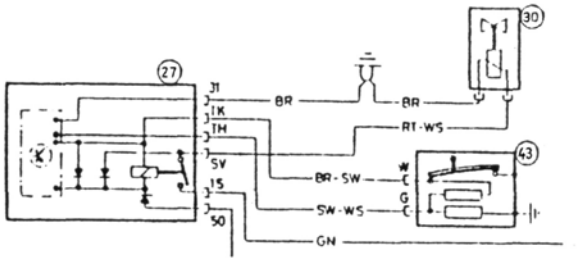
FUEL SYSTEM PROBLEMS

1. Non-running and no noise from fuel pump - could be fuse blown, wiring fault, dirty terminals, and duff pump.
2. Not enough fuel could be blocked fuel filter or fuel lines dirty connections to pump, air leaks on joints or pick up pipe or pump worn out.
3. Blocked or damaged damping valve on the rear of the injector pump.

TESTING - ELECTRICAL SYSTEM OF FUEL INJECTION SYSTEM

c) Checking time switch

27 time switch
30 start valve
43 thermo-time switch



BEFORE TESTING?

Check Red & White lead and Brown lead go to the start valve and not the Thermotime switch.

TO TEST START VALVE.

1. Remove air filter
2. Disconnect plug from Bosch Timer Box.
3. Turn on ignition.
4. Connect a test lead from battery POSITIVE to SV terminals of Timer Box. If fuel is ejected immediately the valve is in good order.

5. Leave ignition on for a minute and check for drips from the start valve, a leaky valve could cause rich mixture and bad hot starting.

TO TEST THERMO-TIME SWITCH

1. Disconnect plug from thermo time switch.
2. Connect test lamp between battery positive and terminal W on the thermo time switch (W is the terminal that the Brown & Black lead goes to).
3. If the coolant is below 31^0C the test lamp should light.
4. If in doubt of the engine temperature take the thermo time switch out and cool it down in cold water and carry out the above test with the thermo time switch out of the engine but remember to earth the thermo time switch casing.
5. With the test lamp still connected, connect a test lead from battery POSITIVE to terminal G on the thermo time switch (G is the terminal that the Black and White lead goes to). After a short interval the Bi-metallic strip inside will open and the test light should go out.

TO CHECK THE TIMER BOX.

1. Unscrew timer box from the left hand side of the engine bulkhead.
2. Connect test lamp between SV terminal and earth.
3. Disconnect low-tension lead from the coil.
4. Actuate starter motor with the ignition key.
5. After a short interval the test lamp should go out. This interval is dependent on the coolant temperature in the engine -

   20^0C = 9 to 15 seconds
   0^0C = 4 to 10 seconds
   35^0C+ = 1 second

6. Disconnect the plug from the thermo time switch.
7. Actuate starter motor again.
8. Test lamp should light for 1 second and then go out.
9. Connect the test lamp between terminal TH and earth.
10. Actuate starter and test lamp should remain illuminated as long as the starter motor is actuated.

Problem with this timer can cause both cold and hot starting problems.

SYNCHRONISATION OF FUEL INJECTOR PUMP AND OPENING OF THE THROTTLE BUTTERFLY.

The opening of the throttle butterfly (which lets more or less air into the engine) must be synchronised with the lever on the right hand side of the injector pump i.e. when the accelerator pedal is fully depressed the injector pump arm should be fully open and also the throttle butterfly fully opened. When the accelerator pedal is released the pump should be closed and the throttle butterfly be closed. In an ideal world and with new pivot bushes and linkages the length of the connecting rod from the injector pump should be 85mm long but this may have to be altered to get full throttle if the linkages are worn. Also check that the injector arm is not coming against the adjustable stop too soon.

1. Check that ignition timing valve clearances are O.K.
2. Check linkage length, bushes and rod ends also freedom of movement of all moving parts.
3. Take cover from the throttle valve.
4. Release lock nut from idle speed adjustment screw on the side of the throttle valve body.
5. Release the vertical rod linkage clamp screws.
6. Insert rod or drill into hole in throttle housing and push cam against it 4mm dia.
7. Fit rod through injection pump lever into hole behind it to hold injection pump lever in idle position.
8. Tighten the vertical rod clamp screws.
9. Remove the 2 rods from the throttle body and the injector pump and start the ending. Screw in idle speed adjustment if needed to keep engine running.

IDLE SPEED ADJUSTMENT

Carry this out with the engine hot. This is a juggling act between the injector pump opening including the throttle butterfly opening by means of the adjusting screw on the outside of the throttle body and the throttle butterfly adjusting screw (small one) which opens the butterfly independently of the injector pump to let more air into the engine and so weaken the fuel air mixture or closes the butterfly more to give a richer mixture. This really needs to be set using a CO Gas Analyser setting at about 2% CO at 850 to 950 rpm or set by ear to give a nice smooth idle speed at 850 to 950 rpm. If you have it a bit rich don’t worry it will only use a little more fuel on tick-over.

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SETTING THE MIXTURE

From tick-over to full power. This must also be carried out hot. The only really successful and easy way of setting the mixture is with a CO meter, but it can be carried out by running the car cutting the engine and checking the colour of the spark plugs when removed. If your Tii is only returning 20-25mpg and the exhaust pipe is black and sooty your car is running too rich, i.e. too much fuel for the air getting to the engine. To adjust the mixture over the complete speed range, adjust the screw (Allen screw 3mm with plastic cover) between the warm up unit and the eccentric shaft on the back of the injector pump.

Screwing in (clockwise richens)
Screwing out (anticlockwise weakens)

DO NOT WEAKEN TOO MUCH as this causes OVERHEATING - Holes in pistons, burnt valves as well as empty wallets. If you hear popping and banging in the exhaust when it was running O.K. before, you have gone too weak.

Final checks can be made by running the engine on the road and cutting the ignition taking a plug out and if white it is too weak.

Light chocolate brown - just right.

Black and sooty - too rich.

It you get the mixture just right you should get about 35mpg on a run which is better than an ordinary 2002 which it should be because its a more efficient engine and fuel system.

If you have a CO% meter set the mixture to 4 to 5% CO at 3,000 to 4,000 rpm.

TO SET WARM UP UNIT

1. Do this after setting the mixture as above but don't carry it out until the engine is completely cold.

2. Using a screwdriver press out the air-regulating cone from the warm up unit you can hold it out with a thin strip of metal in the groove.

3. Adjust the large washer plate until you have a gap of 2 to 3 mm's between the mixture screw and the stop.

4. Start the engine and watch the air regulating cone rise and when hot it should rise above the eccentric arm (when the mixture screw is on the stop) by about 4mm's and the cone project out of its casing by l0mm's.

5. If this gives you bad running during the warm up period try and decide if it is running too rich (lumpy running) or too weak (engine stalls) and adjust the large washer plate accordingly.

6. Screw down for richening and screw up for weakening.

POINTS TO NOTE: -

Remember your car and its injection unit may have been through many owners and garages who did not understand the system and didn't know what they were fiddling with and adjusting so if overhauling or setting up check back on everything and start from the beginning.

SAFETY: -

Always have a fire blanket and fire extinguisher available. Do not let petrol drip down under the car or into the engine bay etc. If possible work outside so that fumes cannot accumulate. Don't take the injectors out and run them as the atomised fuel is very explosive and a spark from the distributor or bad HT lead could cause a fire.

GOOD LUCK AND MAY YOU HAVE MANY INJECTIONS.
MIKE.