Fuel System (Diesel Injection) 23C

Index

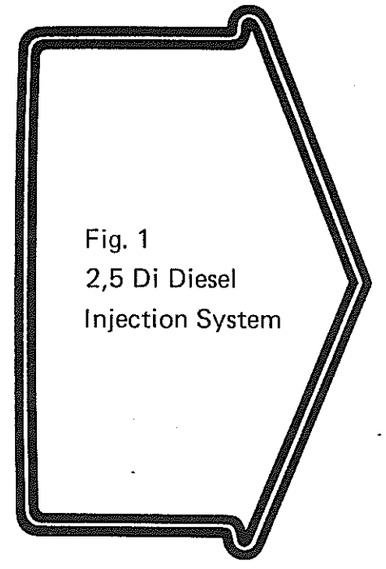

Fig. 1
2,5 Di Diesel
Injection System

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

The fuel injection system fitted to the Transit 2,5 litre Direct Injection diesel engine may be of the CAV or Bosch design.

The fuel system consists of a fuel injection pump (CAV or Bosch), injectors, fuel filter/hand primer, air cleaner (thermostatically controlled air cleaner Bosch only), and an inlet manifold cold start device (- 20°C engines).

The only adjustments which may be made without the use of special pump room facilities are to the idle speed and injection pump timing. These adjustments are described in the Service and Repair Operations Section.

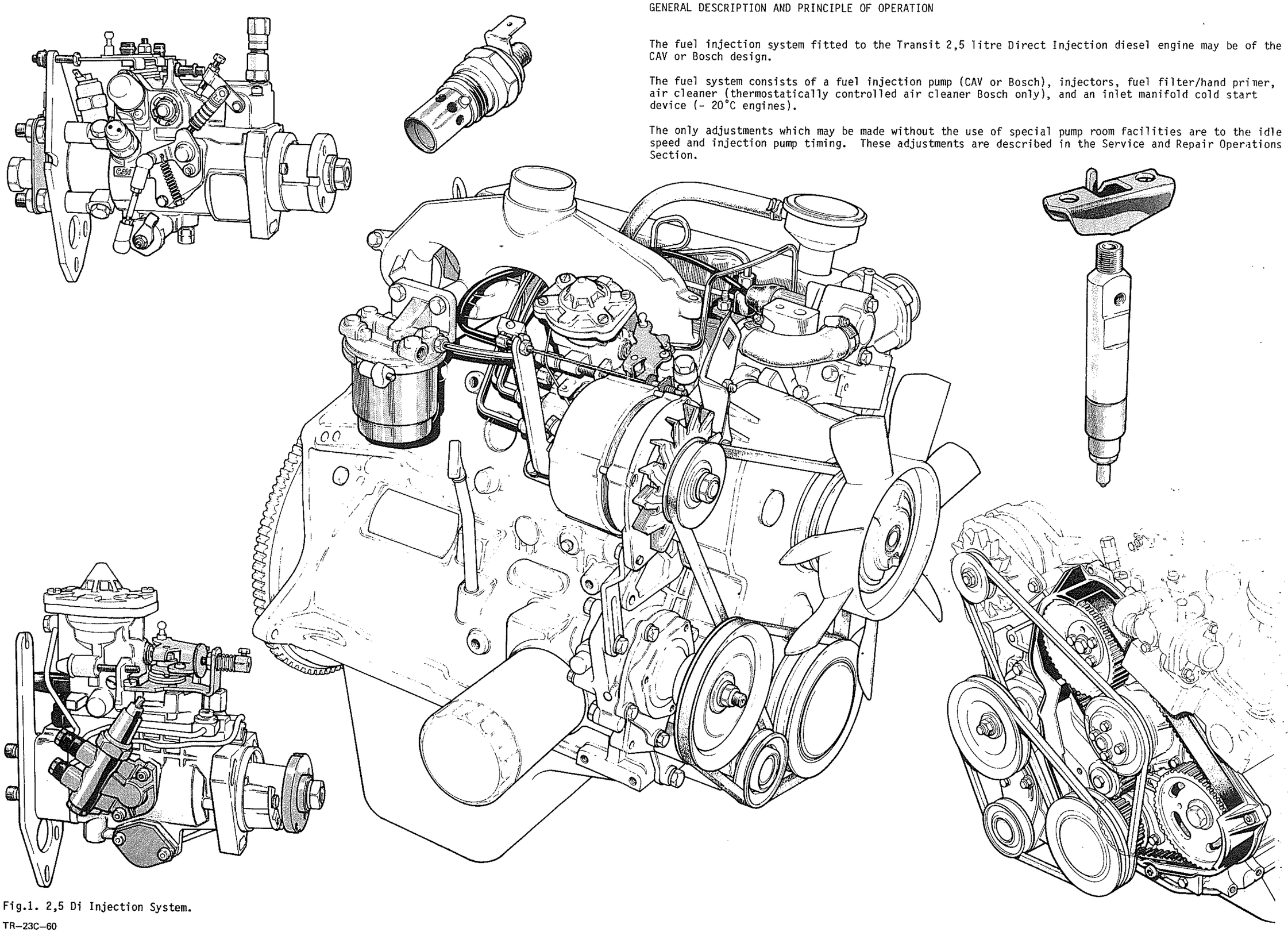

Fig.1. 2,5 Di Injection System.

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GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

FUEL INJECTION PUMP (CAV)

The CAV fuel injection pump is of the rotary type and is mounted on the right hand rear face of the cast aluminium front housing.

The fuel injection pump pulley is bolted to the drive flange and driven at half engine speed by a toothed belt.

The pump consists of a solid, one piece driveshaft supported on bearings housed in a machined aluminium casing. Four centrifugal governor weights are retained in a carrier fitted to the driveshaft and the mechanical governor linkage is located in a housing mounted above the four high pressure pumping elements and cam ring.

During operation the injection pump is completely filled with diesel fuel under pressure. Diesel fuel is constantly drawn into the injection pump via the fuel filter providing lubrication for the injection pump internal components. Excess fuel is returned to the fuel tank by a separate fuel line. This eliminates the necessity to bleed the fuel system.

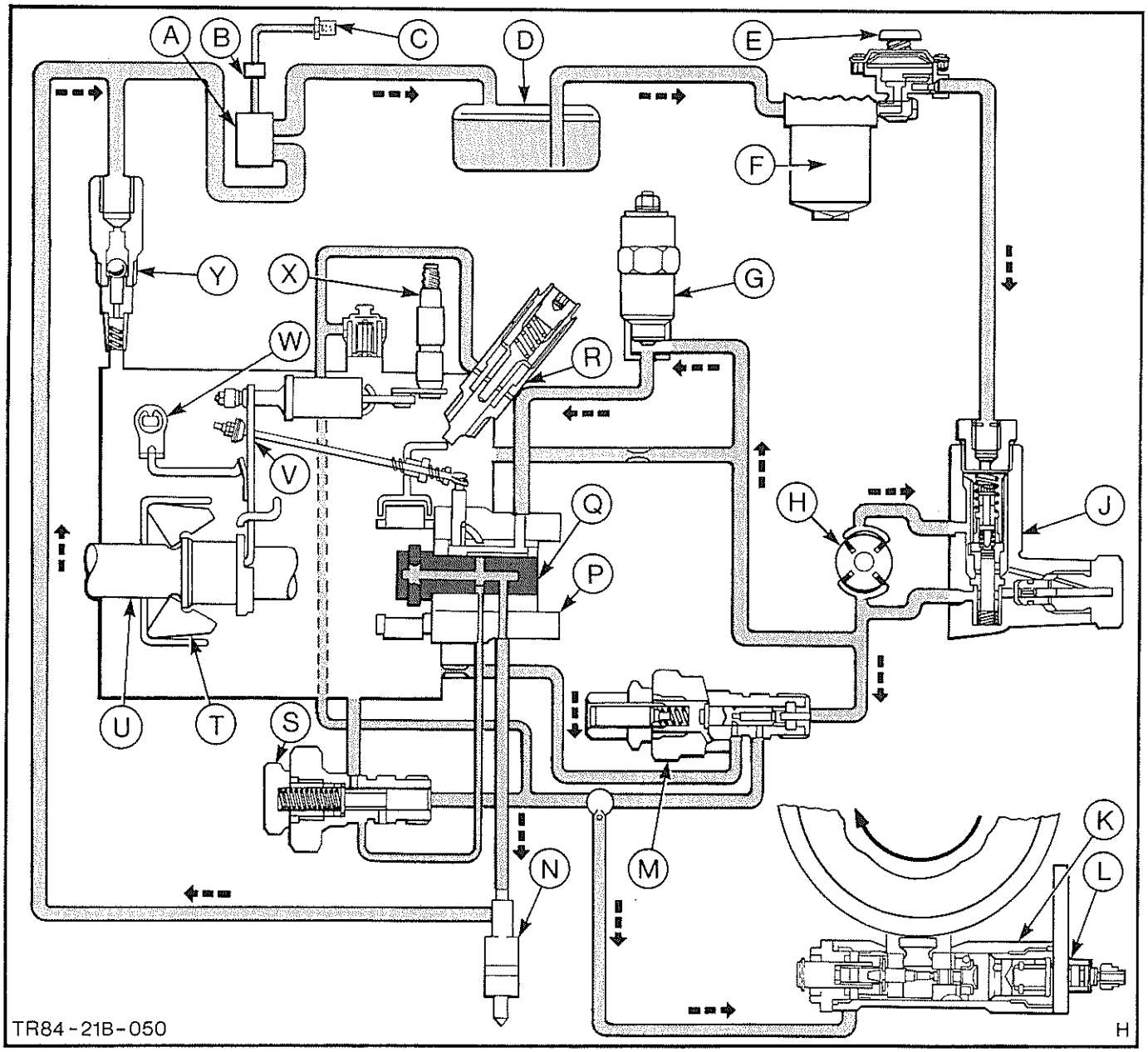


Fig.2. CAV fuel injection system.

A - Fast flame start reservoir (-20°C option)
B - Solenoid valve (-20°C option)
C - Element (-20°C option)
D - Fuel tank
E - Hand primer
F - Fuel filter
G - Shut-off solenoid
H - Transfer pump
J - Regulating valve
K - Advance unit
L - Cold advance lever
M - Latch valve
N - Fuel injector
P - Hydraulic head
Q - Rotor
R - Governor valve
S - Vent valve
T - Governor weights
U - Driveshaft
V - Governor lever
W - Idle shaft assembly
X - Throttle shaft
Y - Pressure valve

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

Hydraulic Head

Bolted to the rear of the casing is the 'hydraulic head' which houses a vane type pump, pressure regulating valve and stop control solenoid.

When the ignition is switched on and the engine is running, fuel will be drawn into the vane type pump where its pressure will be raised and controlled by a regulating valve. The regulating valve controls the fuel pressure (known as 'transfer pressure') to the metering valve which is operated by the throttle lever, and regulates the flow of fuel to the filling ports of the distribution rotor.

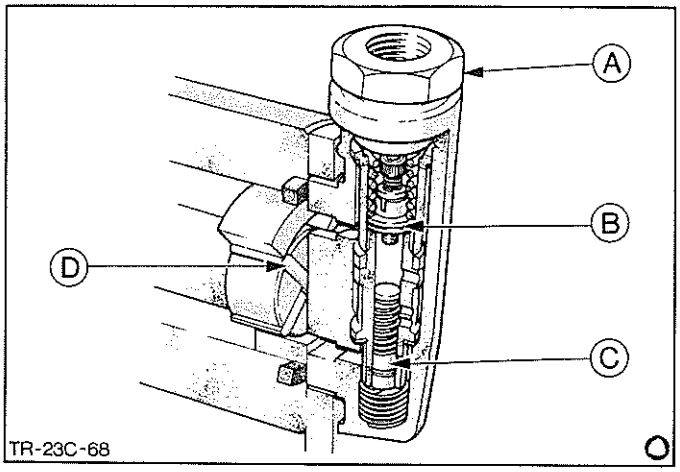


Fig.3. The transfer pump.
A - Fuel inlet
B - Transfer pressure
C - Regulating piston
D - Transfer pump adjuster

Distribution Rotor

The rotor carries four opposed high pressure pumping plungers which, under the action of fuel at filling pressure, push the rollers into contact with the internal lobes of the cam ring.

Torque Control Device

Maximum fuelling is preset by a sealed torque control device which controls two scroll plates located concentrically with, and either side of, the cam ring. The plates limit the outward movement of the rollers in contact with the pumping plungers thus adjusting maximum fuelling.

The scroll plate mechanism also gives automatic excess fuel for easier starting. At cranking speed, the scroll plates are rotated to a point which allows the pumping elements to move further apart, admitting fuel in excess of the normal maximum.

As soon as the engine runs, excess fuel is terminated by the action of the excess fuel piston, acting on the scroll plates, reducing fuel delivery.

Automatic Advance/Retard

The advance/retard unit automatically adjusts the cam ring to control the injection timing. As engine speed increases, fuel pressure rises and acts upon the hydraulic piston within the unit and opposes spring pressure. This pressure moves the piston and cam ring against the direction of rotation thus advancing the timing as pump speed increases.

For part throttle advance and retard an external lever adjusts the amount of pre-tension on the advance servo-piston. The position of this lever is controlled by a cam on the throttle lever.

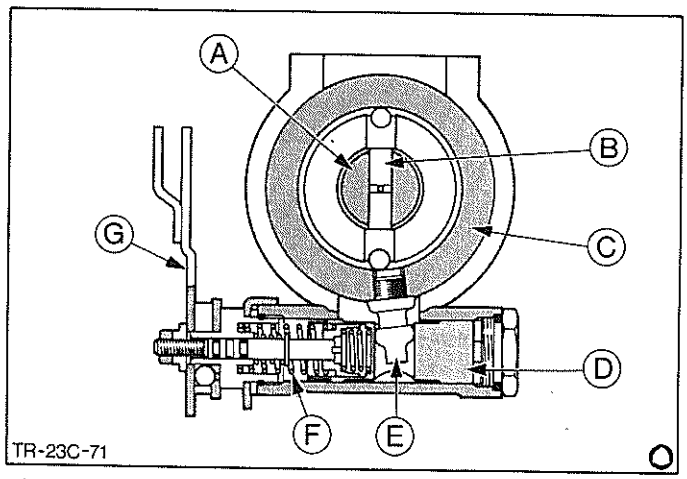


Fig.4. Auto advance and start retard unit.
A - Drive shaft
B - Roller and plunger
C - Cam ring
D - Transfer pressure chamber
E - Advance screw
F - Advance spring
G - Manual advance lever

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

The unit also incorporates a cold idle advance lever which is operated by a temperature sensitive 'waxstat' element via a control cable. During cold starting the control cable moves the idle lever to the fast idle position and simultaneously advances the timing by switching hydraulic pressure to the auxiliary advance piston thereby improving engine combustion and eliminating light load misfire until waxstat operating temperature has been reached.

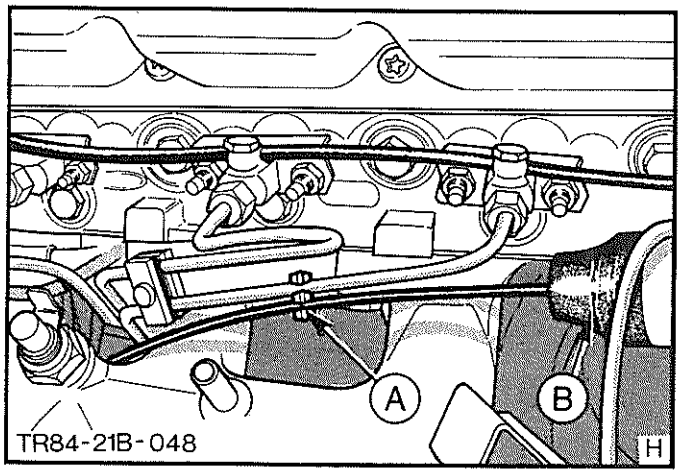


Fig.5. 'Waxstat' element and control cable.
A - Cable securing clip
B - Waxstat

Mechanical Governor

The two speed governor is of the mechanical flyweight type giving accurate control of the engine at idling and maximum speeds. The governor flyweight assembly is mounted on the driveshaft and is entirely contained within the pump body.

Movement of the governor flyweights, which pivot outwards from centrifugal force set up by driveshaft rotation, actuates a thrust sleeve. The sleeve, sliding along the driveshaft causes the governor arm to pivot about a fulcrum on the control bracket. This movement is transmitted by the governor link to the metering valve which rotates to change the quantity of fuel entering the filling ports. Rotating the metering valve changes the flow area between the groove in the valve and the metering port. The amount of fuel that enters the filling ports is therefore changed by varying the effective area of the metering orifice.

The governor link arm and spring is located in the upper part of the pump enclosed by the control cover which houses the throttle shaft and idling shaft.

At idling speeds, the position of the metering valve is controlled by the centrifugal force of the governor weights which compress the idling leaf spring against the idle actuator until a state of equilibrium is achieved.

At intermediate speeds, a preloaded main governor spring provides a direct link between the vehicle throttle pedal and the metering valve so that the amount by which the metering valve rotates is entirely a function of the throttle lever position.

At a predetermined speed approaching the maximum speed of the engine, the resulting centrifugal force of the governor flyweights exceeds the preload of the main governor spring and the metering valve is rotated to reduce the amount of fuel delivered.

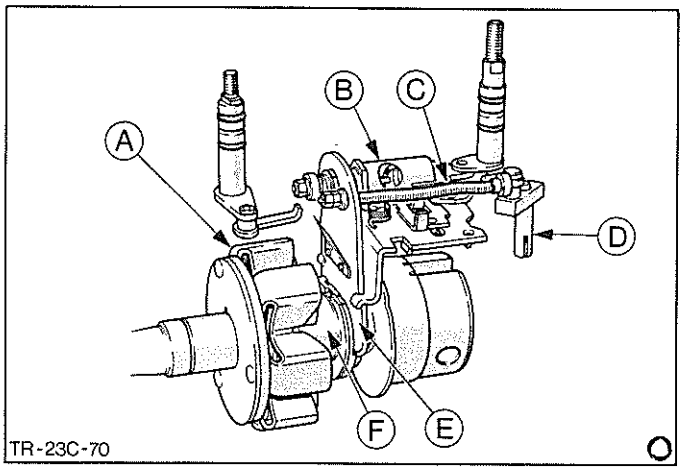


Fig.6. Two speed mechanical governor.
A - Centrifugal weght assembly
B - Main governor spring
C - Governor linkage
D - Metering valve
E - Governor arm
F - Thrust sleeve

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

FUEL INJECTION PUMP (BOSCH)

The Bosch fuel injection pump is of the rotary type and is mounted to the engine in a similar fashion to the CAV type injection pump.

A centrally mounted injection plunger operates in a bore supported in a cast iron body. The cast iron body is bolted to the main housing of the pump which contains the driveshaft, transfer pump, advance device, cam plate and rollers and the gear driven governor assembly.

As the driveshaft rotates, fuel is drawn into the injection pump by a transfer pump located in the front section of the injection pump body. The transfer pump supplies a constant quantity of fuel per revolution, and produces an injection pump body pressure via a regulating valve. The majority of fuel conveyed flows through the pressure regulating valve back again to the transfer pump supply in a closed loop. The remainder of the fuel flows through the pump interior into the high pressure chamber of the hydraulic head. A small quantity of excess fuel flows through the fuel outlet restrictor back to the fuel tank for cooling and acting as a constant air bleed.

The fuel return outlet adaptor fitted to the fuel injection pump is of a unique design providing a fuel restriction to ensure injection pump transfer pressure is constantly maintained. The banjo bolt unlike previous designs is the same as the inlet banjo bolt and does not incorporate a fuel restrictor.

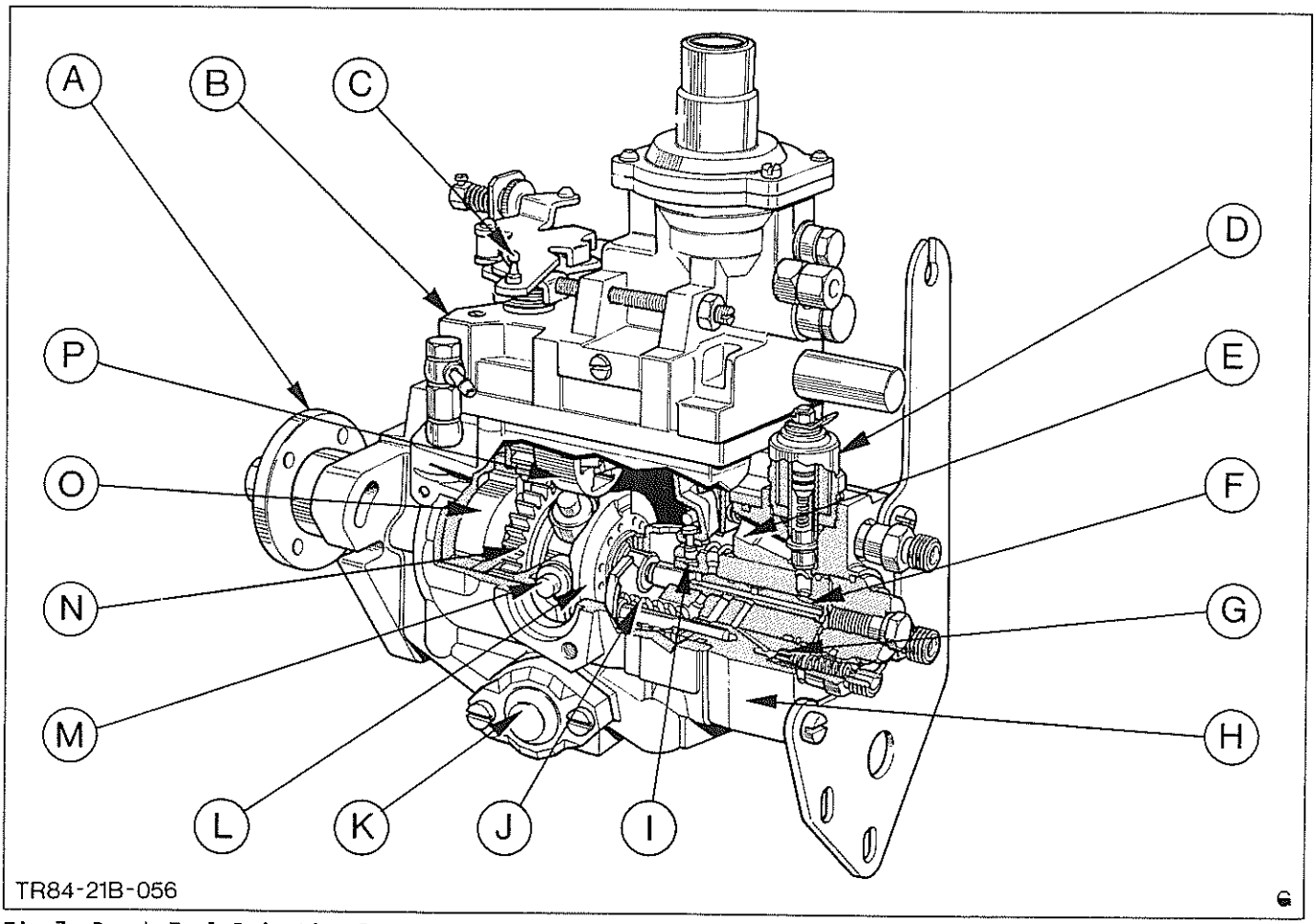


Fig.7. Bosch Fuel Injection Pump.

A - Drive flange
B - Governor cover
C - Throttle lever
D - Shut off solenoid
E - Inlet port
F - Plunger
G - Delivery valve
H - Hydraulic head
I - Governor collar
J - Plunger return spring
K - Advance unit
L - Cam plate
M - Roller
N - Governor drive gear
O - Transfer pump
P - Governor weight assembly

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

Transfer Pump

The transfer pump is of the displacement type and consists of a rotor, eccentric ring and has four free floating vanes. As the injection pump shaft rotates fuel enters the lower section of the transfer pump and is trapped between the free floating vanes and rotor. Further rotation of the injection pump shaft causes fuel to be trapped between vanes and rotor and moved to the upper section of the transfer pump, where it is compressed and supplied at pressure into the injection pump body (filling the pumping element). Pressurised fuel is also transferred via an external pipe to the advance unit located at the base of the injection pump. This pressure is controlled by means of a pressure regulating valve.

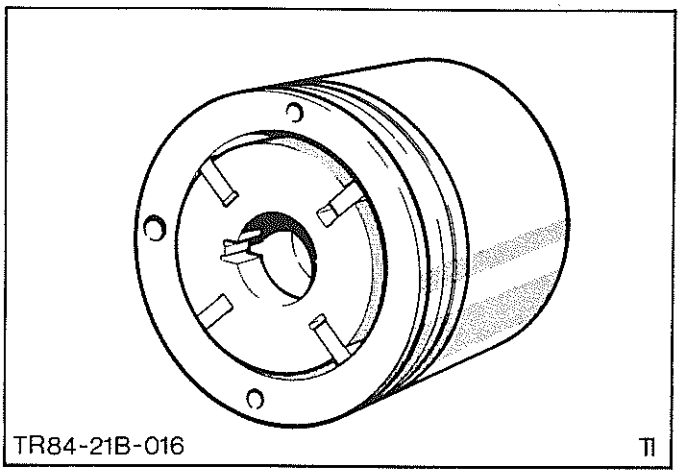


Fig.8. Transfer pump.

Pressure Regulating Valve

The pressure regulating valve controls the fuel pressure to the distribution rotor from the transfer pump according to engine speed.

During normal operation the valve piston will be held up against spring pressure controlling the amount of fuel being returned to the supply pump. As output pressure increases with engine/pump speed, the piston will be forced further up allowing more fuel to return to the inlet side of the vaned transfer pump.

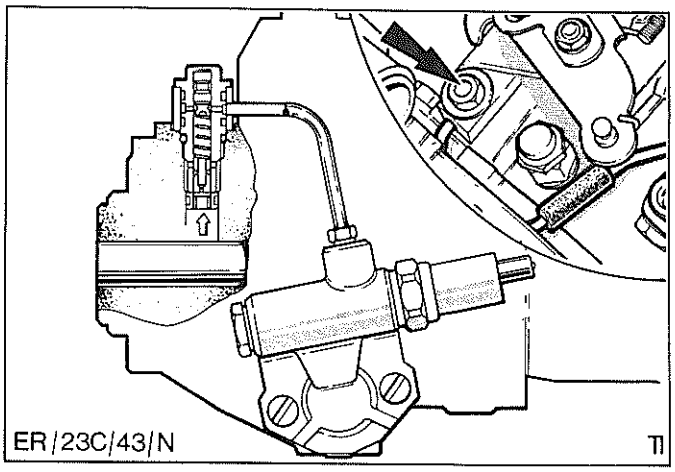


Fig.9. Pressure regulating valve.

Automatic/Cold Start Advance Unit

The automatic advance device ensures that the fuel delivered is synchronised with engine speed and load to give the best possible conditions for starting and performance. It is located below the distribution rotor and consists of a hydraulic piston, cam ring and peg. The unit is operated by fuel pressure from the transfer pump. As engine speed increases, a pressure increase will occur at the transfer pump. This rise in fuel pressure will act upon the piston face and force the cam ring to rotate against the direction of rotation of the rotor, thus advancing the injection timing. As the engine speed decreases pressure in the transfer pump will fall allowing the cam ring to return to its normal position.

The advance and retard mechanism is fitted with a temperature sensitive starting aid. During starting with a cylinder block temperature below 50°C (and thus an injection pump temperature of less than 50°C), and subsequent engine warm-up, the injection timing is automatically hydraulically advanced.

The valve controlling the cold start timing advance is bolted to the right hand side of the injection pump housing. The valve assembly consists of a temperature sensitive expansion element, pin and spring loaded ball valve, housed in an aluminium case.

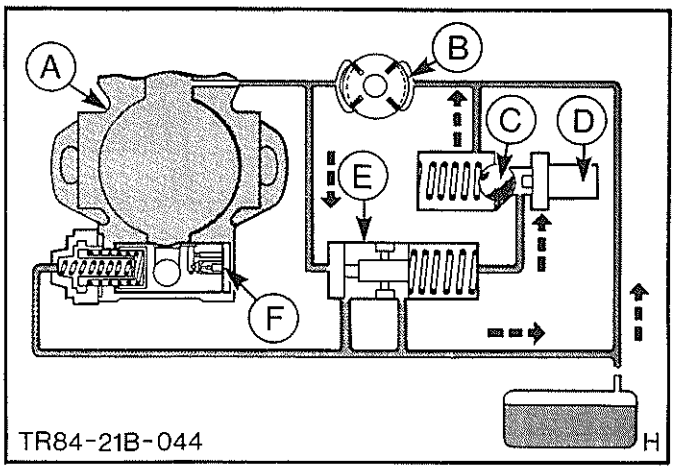


Fig.10. Cold start advance system (schematic).
A - Pump body
B - Vane pump
C - Ball valve
D - Thermal valve
E - Pressure regulating valve
F - Advance piston

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

During cold starting, fuel flows through a restricted bore in the pressure regulating valve to the inlet port of the cold start advancement valve. At cylinder block temperatures below 50°C, the expansion element pin lifts away from the ball valve allowing the ball to close and fuel pressure alone must overcome the force of the spring. This causes a slight rise in pressure in the fuel on the spring side of the pressure regulating valve piston, which results in a correspondingly higher pressure on the advance and retard piston giving increased movement in the advance direction.

When the engine block temperature rises above 50°C, an electrical feed will be directed to the expansion element, via a thermo-switch, which forces the pin to open the ball valve causing the fuel pressure on the spring side of the pressure regulating valve to drop. Therefore, allowing the advance and retard to operate normally.

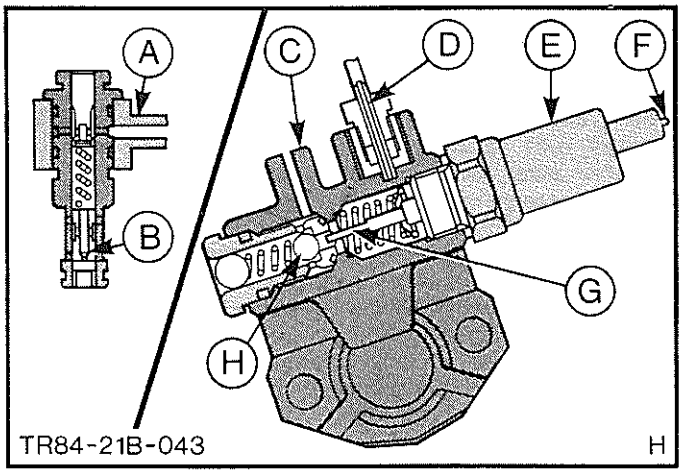


Fig.11. Cold start timing control valve.
A - Fuel supply
B - Regulating valve
C - Fuel return
D - Restricted bore
E - Expansion element
F - Electrical connection
G - Pin
H - Ball

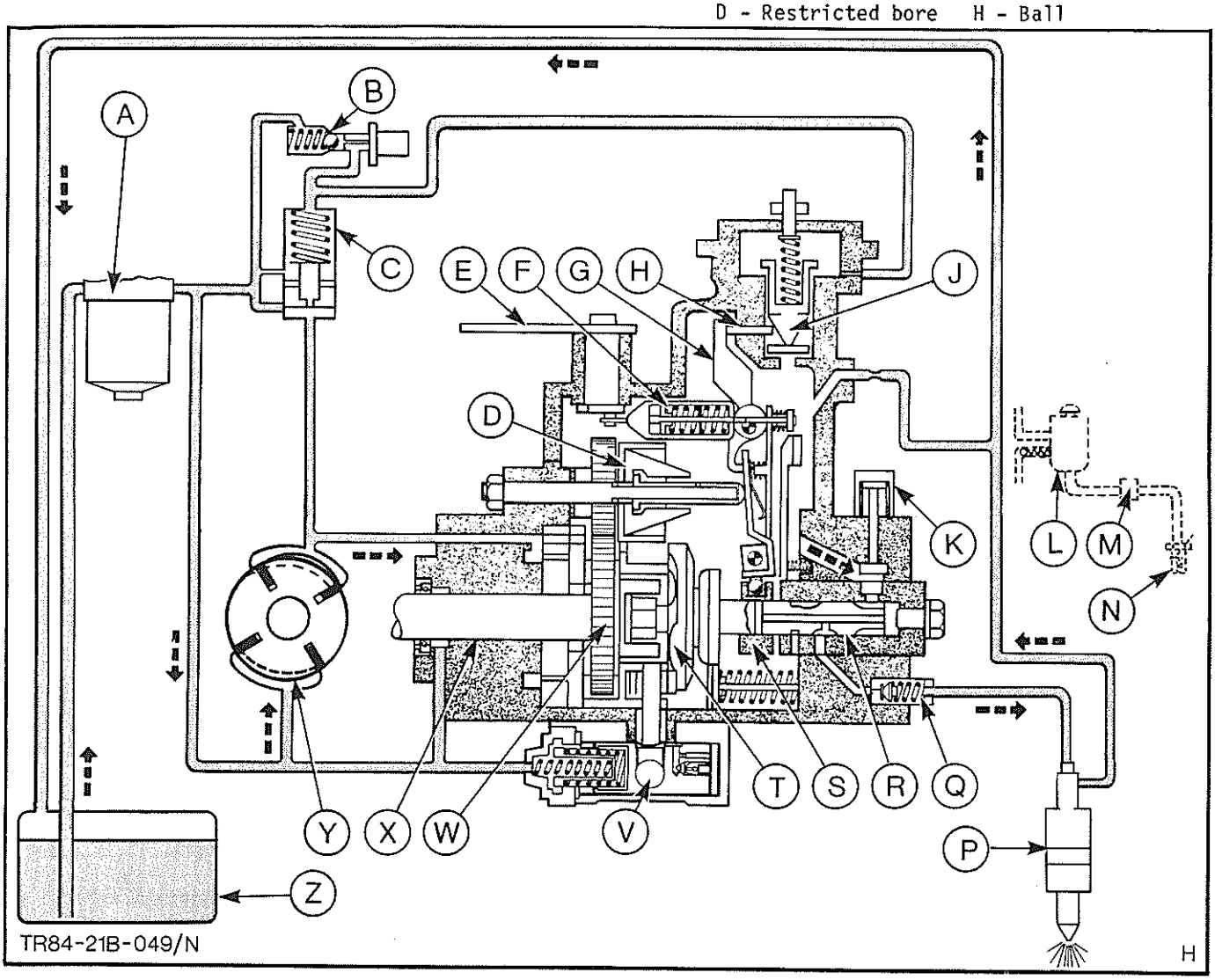


Fig.12. Bosch Fuel System Schematic.
A - Fuel filter
B - Thermal valve
C - Pressure regulating valve
D - Governor weight assembly
E - Throttle lever
F - Governor spring assembly
G - Pivoting lever
H - Guide pin
J - Control cone
K - Shut-off solenoid
L - Fast flame start aid reservoir (-20°C option)
M - Solenoid(-20°C option)
N - Element (-20°C option)
P - Injector
Q - Delivery valve assembly
R - Injector plunger
S - Governor collar
T - Camplate
V - Advance piston
W - Governor drive gear
X - Drive shaft
Y - Vane pump
Z - Fuel tank

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

Mechanical Governor

The mechanical governor is driven by a toothed gear arrangement within the main injection pump body. The gear assembly drives a centrifugal flyweight assembly. As the governor rotates, centrifugal force causes the flyweights to move outward and press on a sliding sleeve against the governor spring pressure via a fulcrum lever. The preload force of the governor springs is adjusted by the position of the throttle lever.

With increasing speed the centrifugal force overcomes the governor springs and, via the fulcrum lever, alters the position of the control collar. The control edge of the collar uncovers the spill port allowing fuel to escape from the delivery plunger. This effectively controls the quantity of fuel delivered thus limiting the speed of the engine under given load conditions.

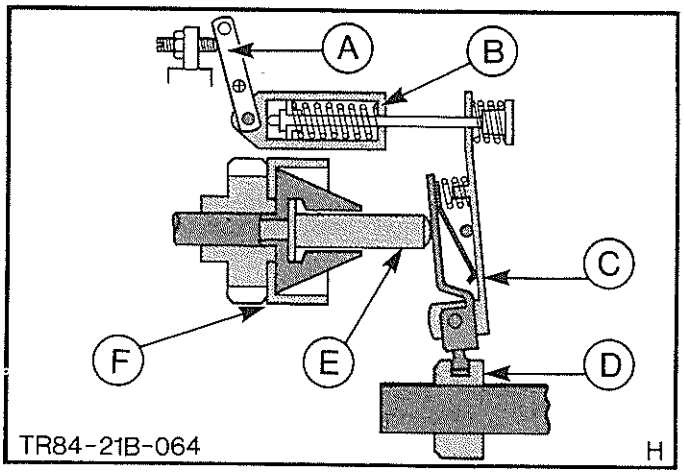


Fig.13. Two speed mechanical governor.
A - Throttle lever
B - Governor spring assembly
C - Fulcrum lever
D - Collar
E - Plunger
F - Weight assembly

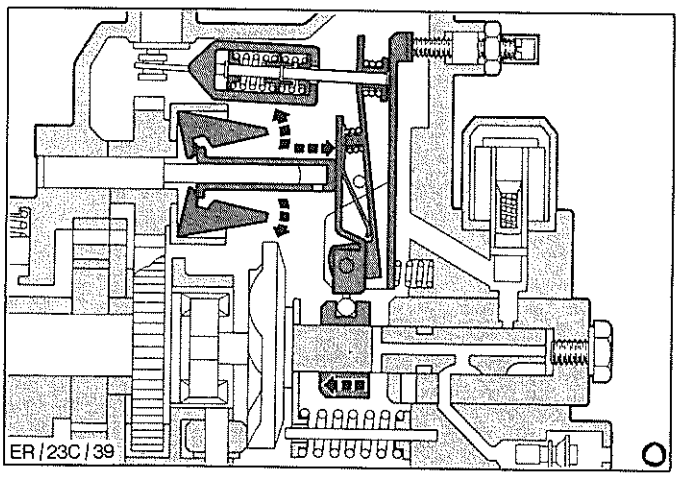


Fig.14. Maximum governor setting.

Torque Control Device

The torque control device is contained in an aluminium housing which forms the governor top cover.

The unit consists of a spring loaded piston, pin and lever and its function is to control fuel delivery to produce the optimum torque characteristics over the engine speed range.

Fuel pressure within the pump body acts upon the bottom of the spring loaded piston forcing it to rise. As the piston rises, a pin follows the contour of a taper machined on the side of the piston. The movement of the pin is transmitted to the governor and sleeve assembly via the pivoting lever mounted on a spindle in the housing.

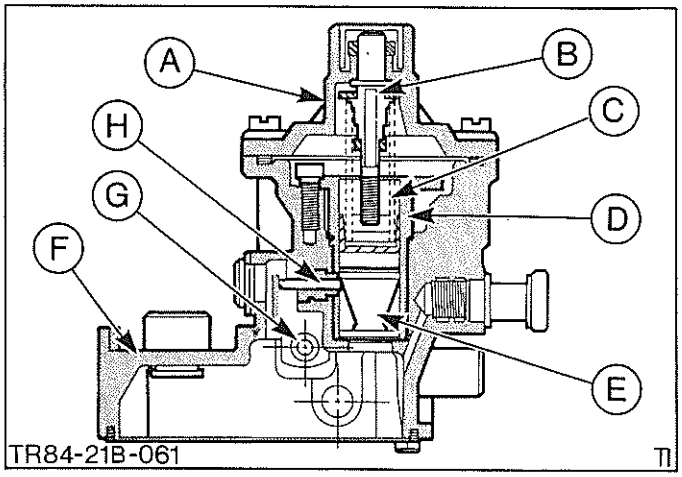


Fig.15. Torque control device.
A - Top cover
B - Adjuting screw
C - Spring
D - Piston
E - Control cone
F - Governor cover
G - Stop lever
H - Guide pin

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

STOP CONTROL SOLENOID

The stop control solenoid is located at the rear on both CAV and Bosch injection pumps. The design and operation of both types are similar. The valve consists of an electrically operated solenoid, plunger and return spring. The plunger locates into the main fuel gallery and when the ignition is switched off the plunger will block the fuel supply.

When the ignition is switched on the solenoid becomes energised and pulls the plunger back, against spring pressure, to clear the fuel gallery.

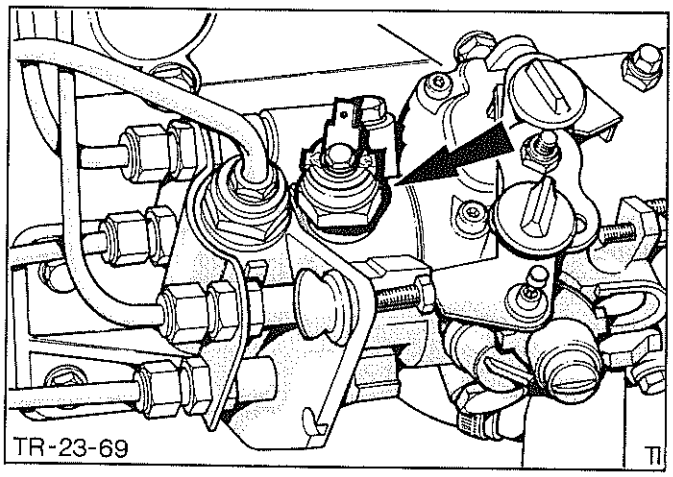


Fig.16. Stop control solenoid.

INJECTORS

The CAV and Bosch injectors are very similar in design and the following description applies to both.

Each of the four fuel injectors is retained in the cylinder head by a pressed steel plate secured by two diametrically opposed studs and nuts. A steel body houses a spring loaded needle valve and filter. The bottom part of the body is externally threaded and the jointing face between the nozzle and body is accurately machined and lapped square to the centre line of the body. Two small dowels protrude from this face to locate the injector nozzle which is retained by the nozzle cap nut.

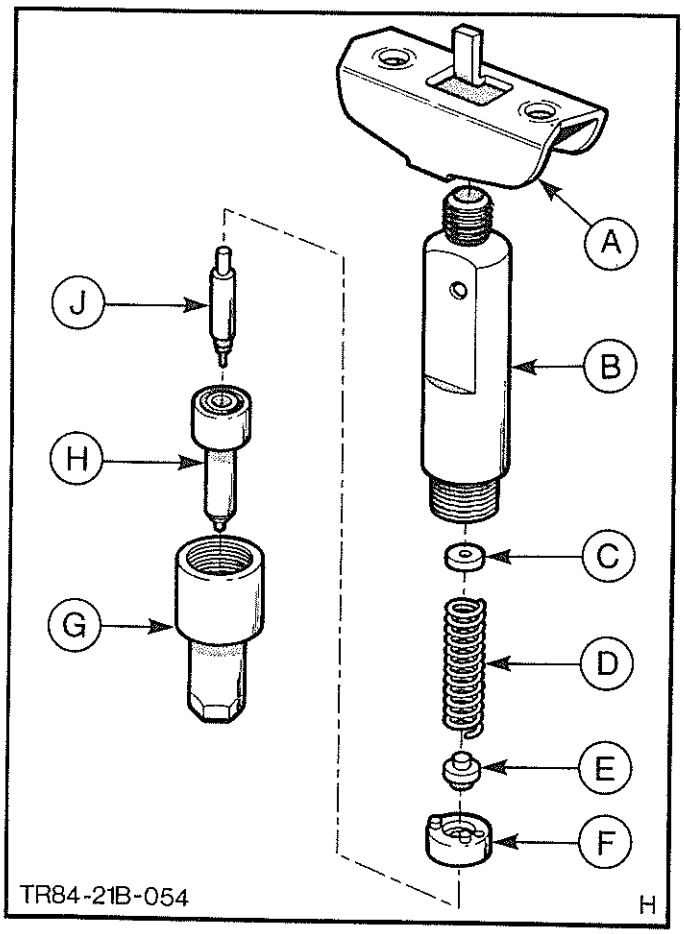


Fig.17. Injector assembly.

A - Retainer plate	D - Spring	H - Nozzle
B - Body	E - Spring seat	J - Needle
C - Shim	F - Adaptor	
	G - Retainer	

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

The nozzle is circular with a shoulder machined on the outside and a central drilling (into which fits the injector needle) down from the top which stops just short of the nozzle end. An angled drilling which carries fuel enters the central drilling on the lower half of the nozzle. The bottom end of the nozzle is machined to form a shallow cone with a 'pip' in the centre. Four very small diameter spray holes are drilled in the side of the 'pip' and break through into a small internal drilling below the conical seat. The top half of the drilling is slightly larger than the bottom half and is very accurately machined to accept the needle.

The top half of the injector needle is slightly larger in diameter than the bottom half to allow fuel to flow freely to the needle seat and spray holes. The needle is hardened and ground to a very accurate finish. The bottom end of the needle has a conical seat which matches the seat in the nozzle. The needle and nozzle are matched and the conical seat is ground and lapped to give a very close and accurate fuel tight fit.

Spring pressure is transmitted to the needle via a spring seat which locates on a spigot machined on the top of the needle. Spring and, consequently, injector burst pressure are adjusted by the fitment of different thickness shims between the top of the spring and the top of the central bore in the body.

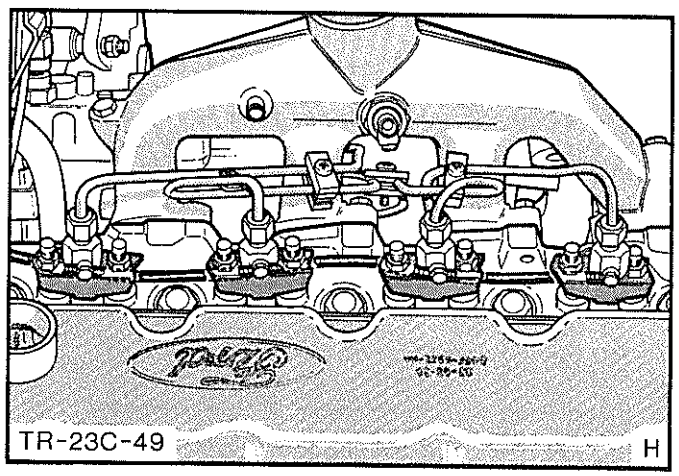


Fig.18. Injector location.

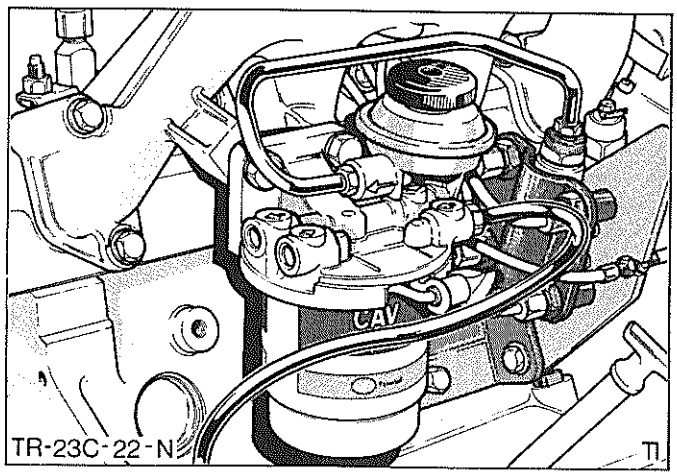


Fig.19. Fuel filter assembly.

FUEL FILTER

The fuel filter assembly is bolted to the inlet manifold on the right hand side of the engine just behind the fuel injection pump. A thermoplastic pipe connects the inlet port (identified by an arrow on the cast aluminium filter head) to the fuel tank. Fuel drawn from the tank, passes through the filter (where any contaminating particles are trapped) and out through the hand primer (where fitted) to the fuel injection pump.

HAND PRIMER

On engines equipped with CAV fuel injection systems, a hand primer will be fitted to the outlet port of the fuel filter to assist in priming the fuel system.

To prime the fuel system (after changing a fuel filter or running out of fuel) pump the plunger slowly for approximately 35 strokes. Start the engine and run engine at fast idle to ensure all air is purged from the system.

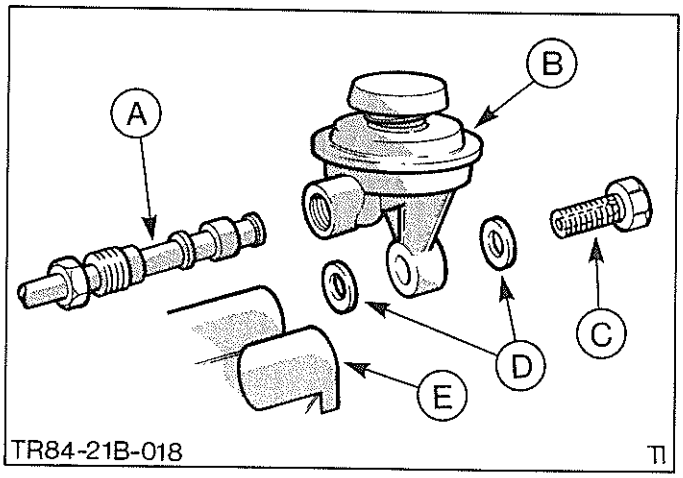


Fig.20. Hand primer assembly.
A - Fuel inlet pipe
B - Hand primer
C - Banjo bolt
D - Sealing washers
E - Fuel filter

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

COLD START AID (where fitted)

When specified a -20°C option is fitted to the fuel system. This assists engine starting in low ambient temperatures by preheating the air in the inlet manifold. The system consists of a remote reservoir and solenoid valve fitted to the engine compartment bulkhead. This supplies fuel to a 'fast flame start' heating element fitted in the inlet manifold below the air cleaner assembly.

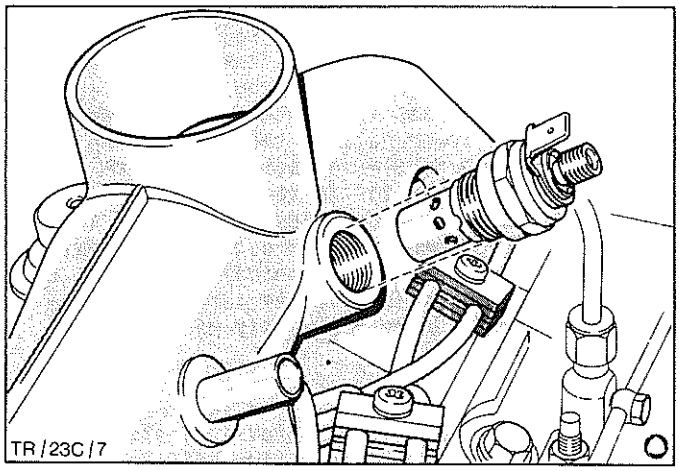


Fig.21. Heater/igniter assembly.

The reservoir is connected by thermoplastic tubing into the leak off return fuel line so that it is constantly supplied with fuel when the engine is running. The top of the reservoir incorporates an atmospheric vent valve which is protected by a gauze and breather tube. The valve closes when the reservoir is full so that surplus fuel flows back to the tank via an over-flow pipe. At the bottom of the reservoir an outlet pipe connects to the solenoid valve. The solenoid valve remains closed and the reservoir full during normal engine running and shut down.

Both solenoid valve and heating element are operated via a control box assembly which in turn is actuated by the ignition switch. The control box is designed to sense ambient temperatures within the engine compartment and at temperatures below -10°C it supplies current to the heater element and solenoid valve as well as activating a 'pre heat' warning light on the vehicle instrument panel. Fuel then flows under the action of gravity from the reservoir to the heater where it is ignited. After 5 seconds the warning light is extinguished. The system continues to operate for approximately 8 seconds after cessation of cranking.

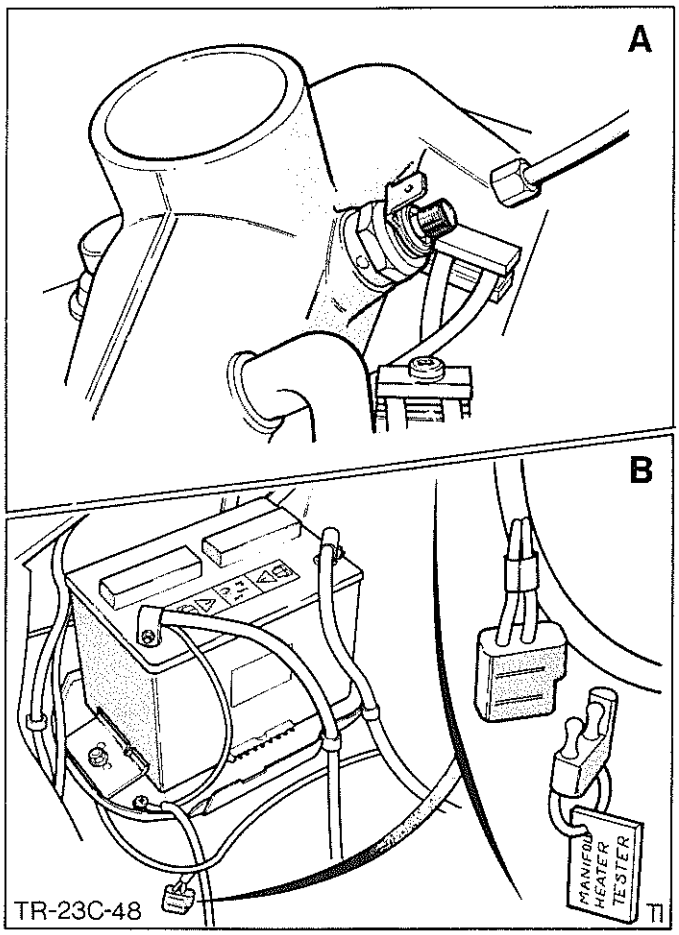


Fig.22. Fast flame reservoir purge.
A - Disconnect fuel feed
B - Bridge solenoid connection

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

AIR CLEANERS

Two types of air cleaner are currently used on the 2,5 Di engined variants.

Vehicles fitted with the CAV type fuel injection system use a fixed spout, replaceable paper element type air cleaner. On engines fitted with this type of air cleaner there is no service requirement to adjust th air cleaner spout for summer or winter use.

Bosch fuel injection system utilise a thermostatically controlled air cleaner. This type of air cleaner has the ability to automatically control air intake temperature at a constant pre-determined figure during normal driving conditions. The purpose of this type of air cleaner is to assist in meeting emmision regulations by providing air at the correct temperature for optimum fuel combustion.

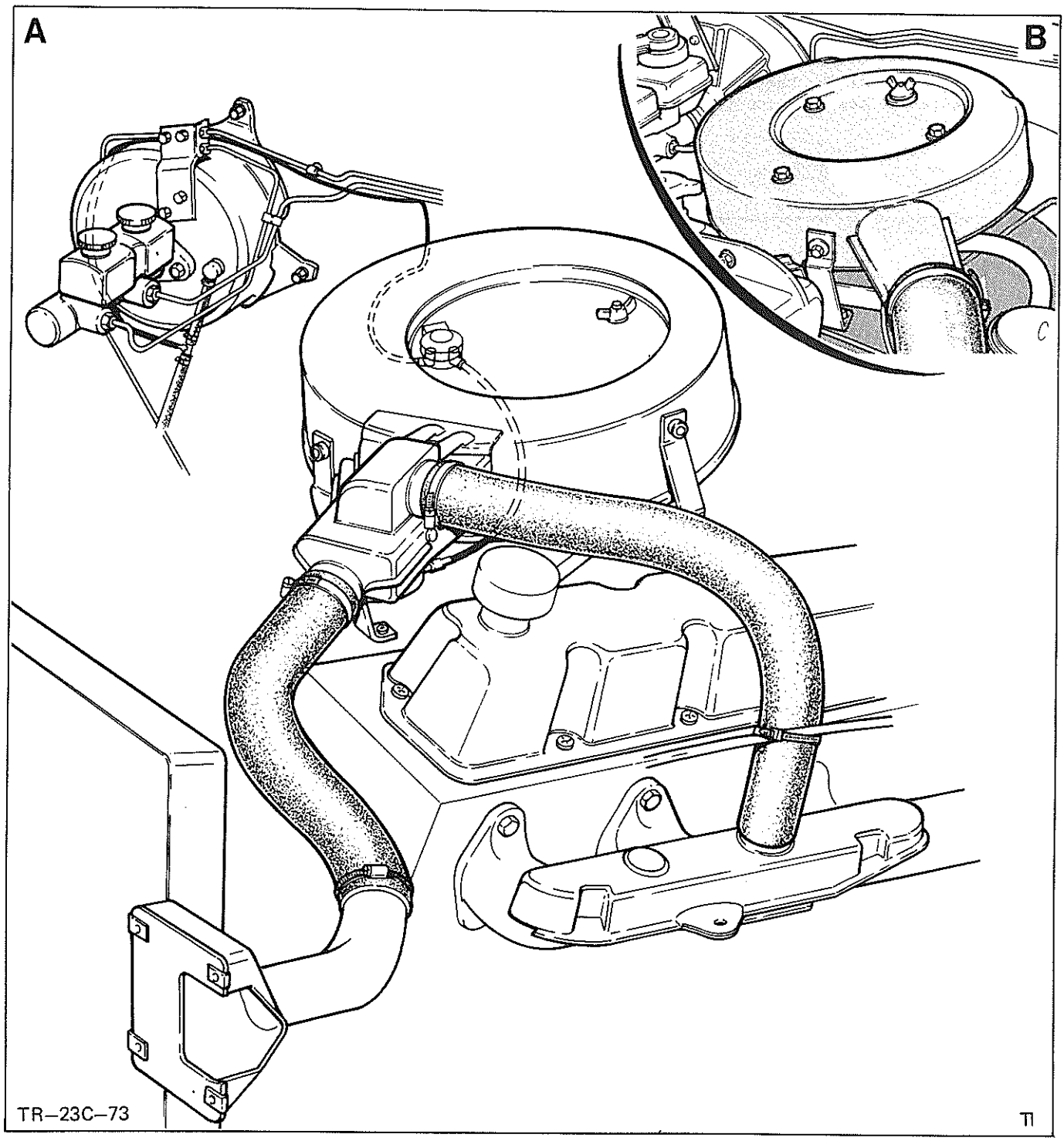


Fig.23. A - Thermostatically controled air cleaner (Bosch injection system)
B - Standard air cleaner (CAV injection system)

GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

AIR CLEANERS (cont'd)

The thermostatically controlled air cleaner has two sources of air supply, one from a cool air intake (ducted from the front grille panel) and a second source from a heat box mounted around the exhaust manifold. Air supply through the air cleaner is controlled by a flap valve mounted on the air spout. The flap valve blends cool air and hot air to achieve the required air intake temperature.

The flap valve is operated by a vacuum diaphragm which holds it fully open as long as vacuum is maintained above 65 mm of mercury. Under these conditions only hot air from the exhaust manifold is allowed to enter the air cleaner. Vacuum feed for the diaphragm unit is supplied from an unique 'T' piece located in the brake/servo vacuum hose.

The heat sensor unit is located inside the air cleaner and senses the temperature of the air actually entering the air cleaner. The unit consists of a vacuum take off point, a bi-metal strip and a valve. When the air flow past the sensor is cold the valve in the sensor unit will be closed allowing full vacuum to be available at the diaphragm unit.

The combined effect of the heat sensor, vacuum diaphragm unit, and flap valve, is to control the blend of hot and cold air under engine load, thereby maintaining a constant air intake temperature.

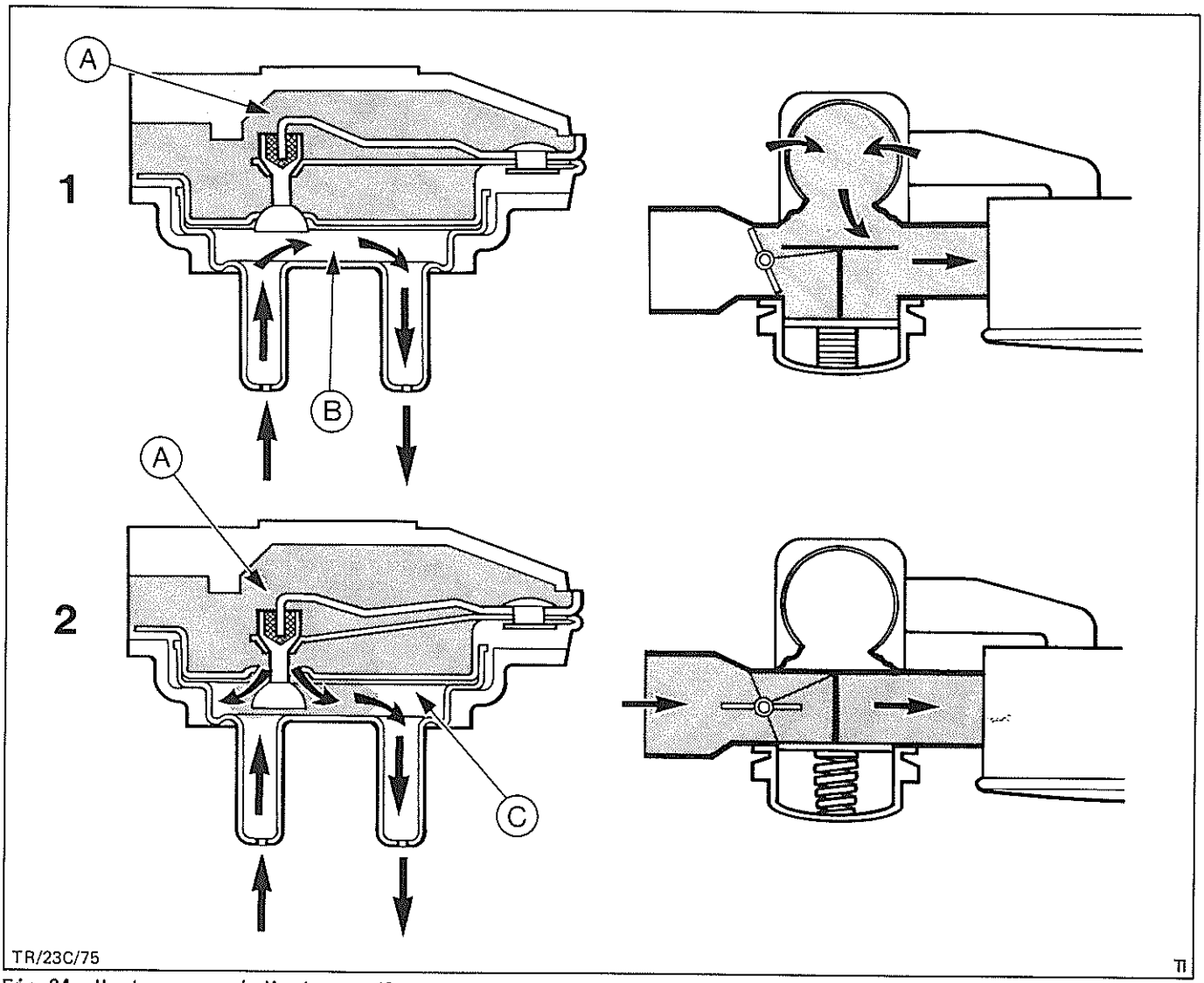


Fig.24. Heat sensor / diaphragm flap operation.

1 - Sensor COLD
A - Open to atmosphere
B - Servo vacuum

2 - Sensor HOT
A - Open to atmosphere
C - Vacuum reduced by air bled through valve

SERVICE ADJUSTMENTS AND CHECKS

GENERAL PRECAUTIONS AND OBSERVATIONS

- Fuel injection equipment is manufactured to extremely fine tolerances. It is therefore essential to ensure that the utmost care is taken when servicing/repairing fuel injection components. Damage, however slight, will have an adverse effect on vehicle performance.
- Whenever any fuel system component is removed, all open fuel connections, including injector delivery pipes, should be protected against dirt ingress by fitting dust caps or plugs.
- When cleaning and testing fuel system components, an odourless kerosene or a special substitute test fuel oil should be used.
- Always use a good quality barrier cream when handling fuel system components, as a certain amount of fuel oil is likely to be present in components which have been in use.
- Never allow spray from injectors under test to come into contact with the skin, since the working pressure can be sufficient to penetrate the skin.

WARNING: OBSERVE STRICT HEALTH, SAFETY AND FIRE PRECAUTIONS. DO NOT SMOKE OR USE NAKED LIGHTS. AVOID INHALING FUMES FROM CLEANING AGENTS OR FUEL OIL.

SERVICE ADJUSTMENTS AND CHECKS

At the specified service intervals the following operations should be checked:

- Check/Adjust slow idle speed
- Check/Adjust for diesel fuel leaks
- Renew fuel filter
- Check diesel exhaust smoke

For further details refer to Section 54 of this Manuual (P.D.I. and maintenance procedures)

During vehicle operation it may become necessary to purge the thermostart cold start system to prevent waxing during the change period from summer to winter grade fuels. Should this become necessary the following procedure must be carried out: (refer to Section 54 of this Workshop Manual Operation 54 738 4).

1. Remove supplypipe from solenoid valve to fast flame heater element at element connection.
2. Place end of pipe in a suitable container.
3. Bridge test circuit connection using suitable two 'bullet' connectors with wire link connection, Fig.24.
4. Turn the ignition on for 25 seconds then turn off ignition. Then repeat to ensure system is free from any summer grade fuels during winter sub-zero conditions.

NOTE: The dash board warning light will operate for the first 5 seconds. THIS SHOULD BE IGNORED.

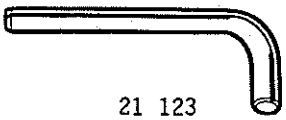
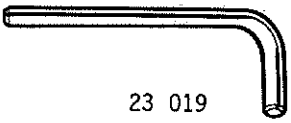
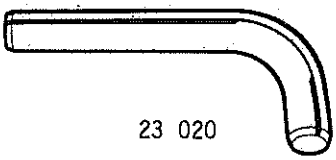
5. Remove bridge connection.

NOTE: DO NOT leave bridge connector connected to the circuit. Failure to remove will result in the cold start circuit operating every time ignition is switched on.

- Refer to Section 54 (P.D.I. and maintenance procedures) for further details of this operation.

6. Reconnect fuel supply pipe to the heater element.

SPECIAL SERVICE TOOL RECOGNITION

Tool	Tool Name
 21 123	Engine Timing Peg (Camshaft)
 23 019	Engine Timing Peg (Fuel Pump)
 23 020	Engine Timing Peg (Flywheel)

NOTE: When carrying out some repair operations it will be necessary to use specialist equipment these suggested equipments are detailed below:

- Injector dismantling jig.
- Nozzle nut socket.
- Nozzle cleaning kit.
- Hartridge multiclean.
- Hartridge light probe.
- Hartridge nozzle viewer.

DIESEL FUEL SYSTEM DIAGNOSIS

The following procedures have been devised to assist in making the most accurate diagnosis of any fuel system condition. The diagnosis procedures detail the sequence of items to be checked and where necessary, the appropriate corrective action when investigating complaint conditions which may be encountered in service.

It is not intended to incorporate all repair methods within the text. Whenever necessary, reference should be made to the appropriate Workshop Manual section to establish the method of carrying out each repair and the correct technical data.

The condition diagnosis procedures are divided into ten categories which represent the most common categories of concern, these are:

Condition 1 Engine will not start or is difficult to start (HOT or COLD)

2 Erratic idling when engine is warm

3 Engine hunts when idling

4 Engine misfire during vehicle operation

5 Unsatisfactory performance

6 Excessive fuel consumption

7 Lack of power

8 Engine cannot be switched off

9 Incorrect engine speeds

10 Engine will not rev up when cold

11 Bosch injection system

To make the most effective use of these condition diagnosis procedures, first test the vehicle to establish which category or categories the symptoms fall in.

Having established which of the conditions listed above is most appropriate, refer to the relevant condition diagnosis chart or charts.

Before carrying out any test procedure the following preliminary checks should be carried out as they may identify the need for remedial action before carrying out more time consuming diagnosis.

- Ensure that the correct starting procedure has been carried out. (see Page 17 for full details of starting procedure)
- Ensure vehicle has adequate fuel in the tank, of correct type: DIESEL FUEL - NOT PETROL

  If petrol has been added to the tank, it will float on the top of the diesel and can be smelt.

  If petrol has been added to the diesel, the system must be drained and flushed out using CLEAN diesel fuel. The fuel filter must also be changed and the vehicle refilled with new DIESEL fuel.
- Check that the fuel system does not contain water.
- In sub-zero temperatures it is possible for wax crystals to separate out from the fuel and cause a blockage in the fuel system.
- Check battery/starter condition.
- Ensure there is no obvious signs of fuel leaks from fuel system. Joints which leak can draw air into the fuel system causing poor engine performance.

NOTE: Do not overtighten rubber olive low pressure connections.

- Remove degas coolant filler tank cap and check for any oil/coolant contamination.

DIESEL FUEL SYSTEM DIAGNOSIS

- Remove oil level dipstick and check for any diesel or coolant contamination.
- Check vehicle history of service intervals. Failure to comply with correct service intervals may have an added effect on vehicle performance.

NOTE: The fuel injection pump is preset during manufacture. The maximum 'No load' speed, maximum fuel screw and pressure regulating valve are sealed and must not be tampered with. A visual check should be made of these before any complaint condition is investigated.

When investigating any complaint condition the exhaust gases should be observed for colour and density. Smoke emitted from the exhaust may assist in investigation and identification of possible corrective actions required.

The correct exhaust emission (if the vehicle is correctly maintained and is at its normal operating temperature) should emit no more than a faint haze from the exhaust pipe.

Smoke is generated when combustion is unsatisfactory and therefore a proportion of the fuel is not doing useful work.

In the following notes it is assumed that the engine is in good condition and is therefore not burning excessive amounts of lubricating oil.

Black Smoke:

This consists of a large number of carbon particles which are produced when fuel is heated in 'oxygen lean regions' of the combustion chamber.

Blue Smoke:

This consists of large numbers of fuel oil particles of about 0,5 microns diameter or less.

These particles are condensed droplets of partially burnt or unburnt fuel which have passed through 'low temperature regions' of the combustion chamber, and may also be caused by burning lubricating oil caused by some mechanical defects.

White Smoke:

This consists of a large number of condensed droplets of partially burnt or unburnt fuel larger than about 1,0 micron diameter. To produce white smoke the fuel will have had more time to condense than for blue smoke, e.g. a cold engine running at light load and low speed could produce white smoke. Retarded injection timing would not give the fuel suitable conditions to burn correctly, and this can also produce white smoke.

It is important to realise that the majority of the items listed would not arise if the correct maintenance operations were carried out at the specified intervals.

Before any part of the fuel supply system is dismantled the surrounding area must be thoroughly cleaned. When the fuel system has been reassembled and all nuts tightened to the specified torque, it will be advisable to bleed the system to assist the self purge system.

COLD STARTING:

Vehicles fitted with a cold starting aid or those fitted with standard equipment (cold climate territories where the temperatures may fall below -10°C), engine noise may be more noticeable during engine warm up. This is due to the injection pump timing being automatically advanced to ensure smooth engine/vehicle performance. When the engine is sufficiently warm, the automatic advance will return to its normal operating position.

Starting Procedure

1. Turn ignition switch to position II.

2. If the cold start aid warning light is illuminated on instrument panel, wait until the light goes out and then proceed to sub-operation 4.

3. If cold start aid warning light is NOT illuminated proceed to sub-operation 4.

4. Fully depress clutch and accelerator pedals, crank engine by turning ignition key to position III.

NOTE: DO NOT crank engine continuously for more than 20 seconds. If engine fails to start repeat above procedures.

5. Immediately the engine starts release the accelerator pedal and allow the ignition switch to return to position II.

NOTE: Should the engine still fail to start refer to the Fuel System Diagnosis Procedures.

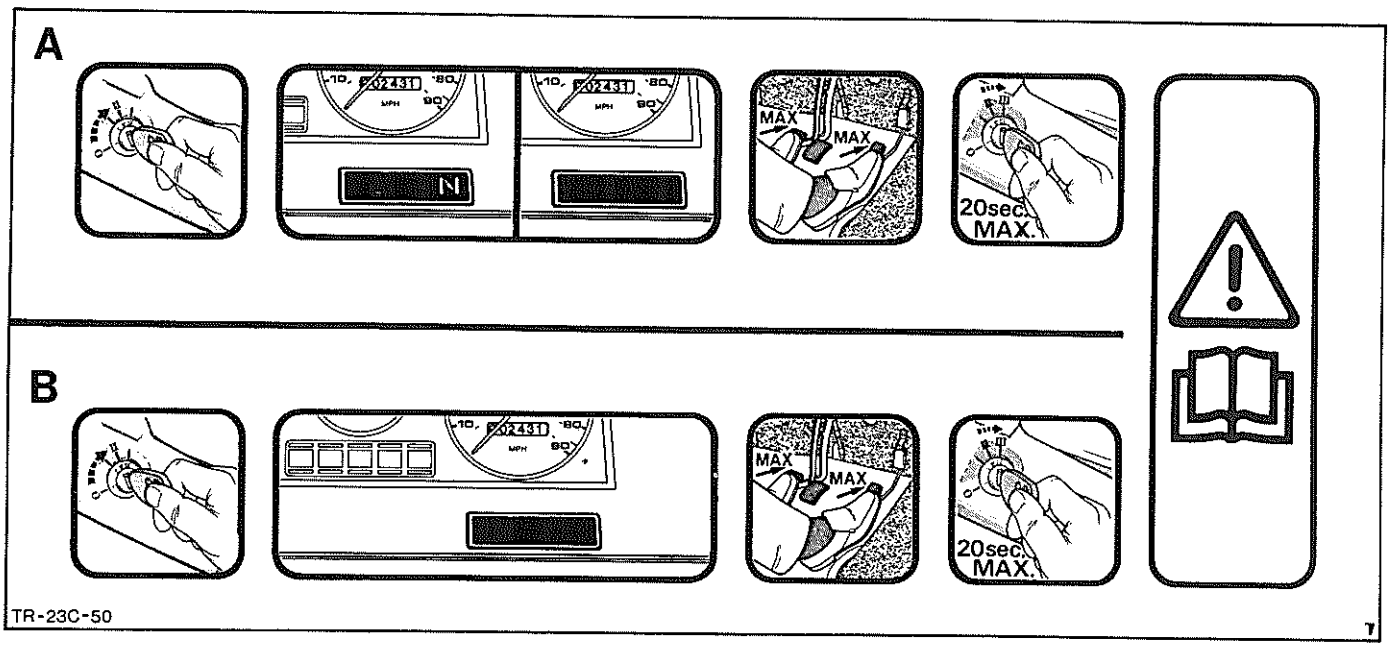


Fig.25. Starting decal: A - Starting procedure when cold
B - Starting procedure when hot

DIESEL FUEL SYSTEM DIAGNOSIS CHARTS

Condition	Possible Causes	Remedy
Condition 1		
Engine will not start or is difficult to start HOT or COLD	Fuel tank vent blocked	Remove filler cap slowly and listen for 'Hiss'. • Clean fuel tank filler cap.
	Fuel shut off (stop) solenoid not operating	Remove stop solenoid wire connection and check solenoid operation: • Turn ignition on and touch wire onto solenoid connection. A click sound should be heard. • If no click check voltage supply to solenoid with (12 volts/battery voltage) ignition on.
	Faulty cold start device	Check fast flame system: • Disconnect fuel supply pipe from fast flame heater, activate system and check fuel flow to the heater. • Check voltage supply to fast flame heater.
	Injection timing incorrect	Remove timing belt cover, check and adjust injection pump timing. (see Operation No. 23 414)
	Fuel starvation	Check fuel system for unrestricted fuel flow: • Slacken injector pipe at injectors, crank engine and observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. NOTE: If engine starts investigate restriction in fuel return. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect an auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking (air in). Rectify as necessary.

DIESEL FUEL SYSTEM DIAGNOSIS CHARTS

Condition	Possible Causes	Remedy
Condition 2		
Erratic idling when engine is warm	Air in fuel system	Check all pipe unions and joints in fuel system for tightness and effective sealing. Do not overtighten.
	Idle speed incorrect	Using a tachometer, check and adjust idle speed (see specification).
	Faulty Injector(s)	Remove injectors and test (see specification).
	Injection timing incorrect	Remove timing belt cover, check and adjust injection pump timing. (see Operation No. 23 414).
Condition 3		
Engine hunts when idling	Fuel tank vent blocked	Remove filler cap slowly and listen for 'Hiss'. • Clean fuel tank filler cap.
	Severely choked fuel filter	• Fit new filter element
	Fuel starvation	Check fuel system for unrestricted fuel flow. • Slacken injector pipe at injector and injection pump, observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect an auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking(air in). Rectify as necessary.
Condition 4		
Engine misfires during vehicle operation	Faulty injector(s)	Remove injector(s), test and rectify as necessary. Check injector seatings in cylinder head are gas-tight. Do not bend high pressure pipes.
	Severely choked fuel filter	• Fit new filter element.
	Check engine condition	Remove degas tank cap, check for gas leaks through coolant. Remove high pressure pipes and injectors. Check compressions. Check valve clearances are adjusted correctly. Ensure engine valve gear is operating correctly. Check for damaged cylinder head gasket. Check for valve seat damage, worn piston/bore, sticking rings etc.

Condition	Possible Causes	Remedy
Condition 5		
Unsatisfactory performance	Fuel tank vent blocked	Remove fuel filler cap slowly and listen for 'Hiss'. • Clean fuel filler cap
	Severely choked fuel filter	• Fit new fuel filter element
	Fuel starvation	Check fuel system for unrestricted fuel flow. • Slacken injector pipe at injector and injection pump, observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect a auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet.
	Fuel return blocked	• Eliminate cause of blockage. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking (air in). Rectify as necessary.
	Air in fuel system	Check all pipe unions and joints in the fuel system for tightness and effective sealing. Do not overtighten.
	Injection timing incorrect	Remove timing belt cover, check and adjust injection pump timing. (see Operation No. 23 414)
	Fuel injector(s) malfunctioning	Remove injector(s) and test (see specification). Do not bend high pressure pipes.
Condition No.6		
Excessive fuel consumption	Faulty fuel connections	Check all pipe unions and joints in the fuel system for tightness and effective sealing. Do not overtighten.
	Air starvation	Check and, if necessary, replace air cleaner element, check air supply hose for deterioration, kinks and splits.
	Fuel injector(s) malfunctioning	Remove injector(s) and test (see specification). Do not bend high pressure pipes.
	Injection timing incorrect	Remove timing belt cover check and adjust injection pump timing. (see Operation No. 23 414)

Condition	Possible Causes	Remedy
Condition No.7		
Lack of power	Before checking the following possible causes ensure that: Vehicle is not overloaded Tyre pressures are correct for load carried Clutch is not slipping Brakes are not binding Engine reaches maximum No-Load speed The fuel injection pump has not been tampered with and seals are unbroken Check that maximum/full throttle can be obtained The density of exhaust smoke is checked with engine warm and under load	

Possible Causes	Remedy
Air starvation	Check and, if necessary, replace air cleaner element. Check air supply hose for deterioration, kinks or splits.
Severely choked fuel filter	• Fit new fuel filter element
Fuel starvation	Check fuel system for unrestricted fuel flow: • Slacken injector pipe at injector and injection pump, observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect an auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking (air in). Rectify as necessary.
Fuel injector(s) malfunctioning	Remove and test injector(s) (see specification. Do not bend high pressure pipes.
Injection timing incorrect	Remove timing belt cover, and crankshaft sealing plugs and check injection pump timing.
Low engine compressions	Remove injectors and check compressions of each cylinder. Rectify as necessary. Do not bend high pressure pipes.

Condition	Possible Causes	Remedy
Condition No.8		
Engine cannot be switched off	Fuel shut off (stop) solenoid not operating	Remove stop solenoid wire connection and check solenoid operation: • Turn ignition on and touch wire onto solenoid connection, a click sound should be heard. • If no click check voltage supply to solenoid (12 volts/battery voltage) ignition on.
Condition No.9		
Incorrect engine speeds	Severely choked fuel filter	• Fit new fuel filter element.
	Fuel starvation	Check fuel system for unrestricted fuel flow: • Slacken injector pipe at injector and injection pump, observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect an auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking (air in). Rectify as necessary.
	Idle speed incorrect	Using tachometer, check and adjust idle speed (see specification).
	Maximum no load speed incorrect	Do not adjust, consult Bosch or CAV agents.

Condition	Possible Cause	Remedy
Condition No.10		
Engine will not rev up when cold	Insufficient fuel in tank	Fill tank with adequate fuel.
	Fuel tank vent blocked	Clean fuel tank filler cap.
	Fuel shut off solenoid defective	Check solenoid operation.
	Fuel waxing	Check fuel filter and fuel lines (see Page 15)
	Severely choked fuel filter	• Fit new fuel filter element
	Fuel starvation	Check fuel system for unrestricted fuel flow: • Slacken injector pipe at injector and injection pump, observe fuel discharge whilst cranking engine. • Remove fuel return connection from injection pump crank engine and observe fuel being returned to the fuel tank. • If no fuel is being returned to the fuel tank remove fuel supply pipe to injection pump and connect an auxiliary fuel supply. Repeat above test. NOTE: Auxiliary tank must be below the line of the injection pump inlet. • If fuel flow is evident this indicates that the fuel supply pipe, fuel filter or fuel tank is restricted or leaking (air in). Rectify as necessary
	Waxstat failure (CAV)	• Check position of pump levers (cold position) Replace waxstat.
	Injection timing incorrect	Remove timing belt cover, check and adjust injection pump timing.
	Poor engine performance	Remove injectors and check cylinder compressions. Do not bend high pressure pipes.

23 174 AIR CLEANER - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers and disconnect battery.
2. Disconnect air cleaner intake hose from air cleaner spout.

Thermostatically controlled air cleaner

Disconnect air cleaner diaphragm vacuum pipe from brake servo supply pipe 'T' piece connector.

Disconnect hose from exhaust manifold heater box.

3. Remove mounting stay bolt/s and centre wing bolt. Lift off air cleaner assembly.

To Install

4. Position air cleaner onto inlet manifold and secure with wing bolt and mounting stay bolts.
5. Reconnect air cleaner intake hose to air cleaner spout.

- Reconnect air cleaner vacuum pipe to brake servo supply pipe 'T' piece connection and clip pipe into position.
- Reconnect hose to exhaust manifold heater box.
- Reconnect battery, remove fender covers and close hood.

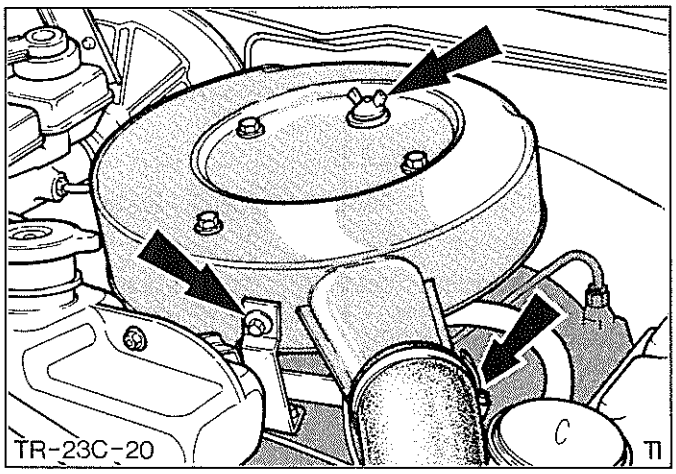


Fig.28. Air cleaner assembly (CAV).

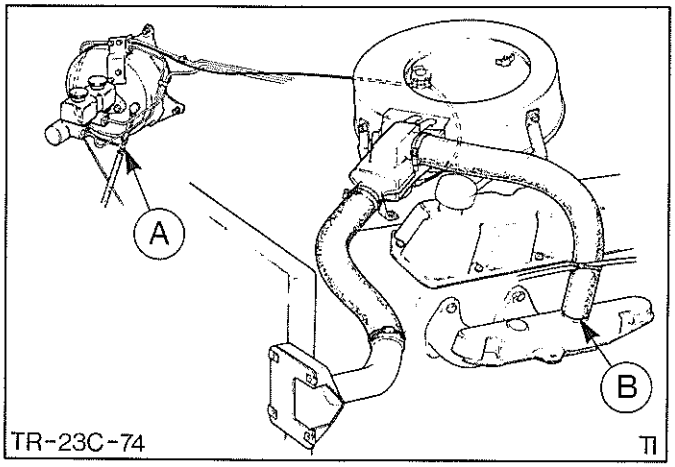


Fig.29. Thermostatically controled air cleaner assembly mountings (Bosch).
A - Vacuum connection
B - Warm air heat box connection

23 184 ELEMENT - AIR CLEANER - REPLACE

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers and disconnect battery.
2. Remove air cleaner assembly as detailed in Operation No. 23 174 of this section.
3. Remove three bolts from upper section of air cleaner and split air cleaner in two sections.
4. Remove element.

To Install

5. Using new element, reassemble air cleaner and secure the two sections with the three bolts.
6. Refit air cleaner assembly as described in Operation No. 23 174 of this section.
7. Reconnect battery.
8. Remove fender covers and close hood.

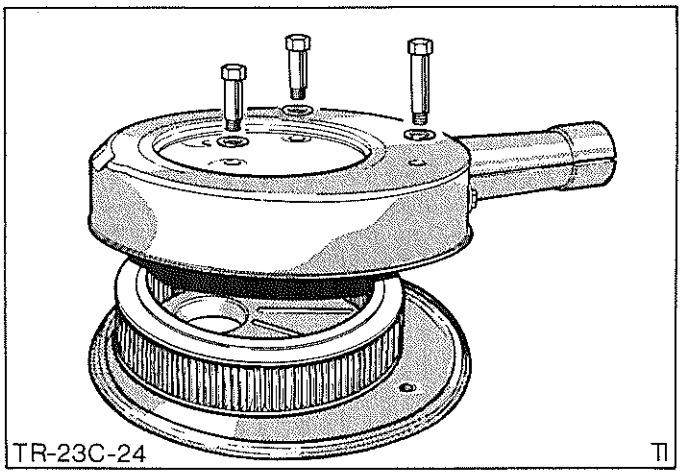


Fig.30. Separate the two sections and remove the air cleaner element.

23 410 INJECTION PUMP - CHECK TIMING

SPECIAL SERVICE TOOLS REQUIRED:

Injection pump timing peg	.. ..	23-019
Crankshaft timing peg	.. .. ..	23-021

To Check

1. Open the hood, fit fender covers, disconnect the battery and the wire fitted to the stop control solenoid on the fuel injection pump.
2. Remove the bolts and detach the air cleaner assembly from the inlet manifold as described in Operation 23 174.
3. Remove rocker cover. Remove and discard the old rocker cover gasket.
4. Remove the plastic plug from the timing peg hole in the rear of the cylinder block adjacent to the engine identification plate.
5. Remove the rubber plug from the front of the engine timing belt cover and crankshaft pulley assembly.
6. Rotate engine using socket and ratchet on front crankshaft pulley centre nut.
7. Continue to turn engine so that No.1 piston begins to rise onto compression stroke, number 7 valve starts to rise (valves 7 and 8 rocking).
8. Insert the engine timing peg (Special Tool 23-020) into the hole in the rear of the cylinder block and apply light pressure so that as the flywheel is turned, the peg will drop fully into the hole in the flywheel as the crankshaft reaches 11° BTDC.
9. With the crankshaft now set to 11° BTDC, check the injection pump timing by inserting the pump timing peg (Special Tool No. 23-019) through the access hole in the timing belt cover and into position in the fuel injection pump and pulley flange timing holes.

NOTE: The timing peg should slide easily through the hole in the fuel injection pump pulley flange and locate fully and squarely into the hole in the injection pump body.

If the peg will not locate due to the holes being out of alignment. Refer to Operation No. 23 411 Injection Pump - Adjust Timing.

10. Remove the timing pegs from the engine and refit rubber and plastic plugs to timing belt, crankshaft and flywheel holes.
11. Refit rocker cover and new gasket and tighten the retaining screws to specified torque in correct sequence (see Fig.29). Immediately retorque screws in same sequence.
12. Refit air cleaner as described in Opp.23 174
13. Reconnect stop control solenoid and battery. Remove fender covers and close hood.

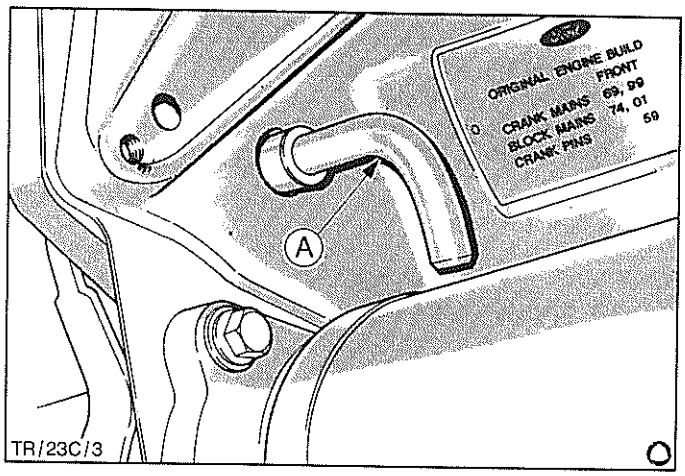


Fig.31. Crankshaft timing peg location.

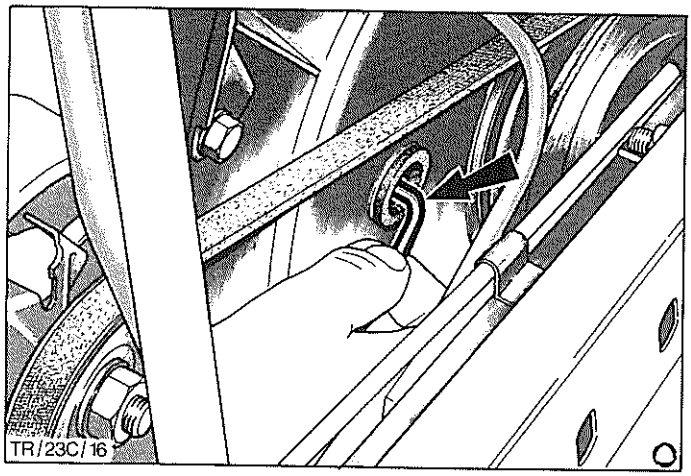


Fig.32. Insert pump timing peg through access hole in timing cover.

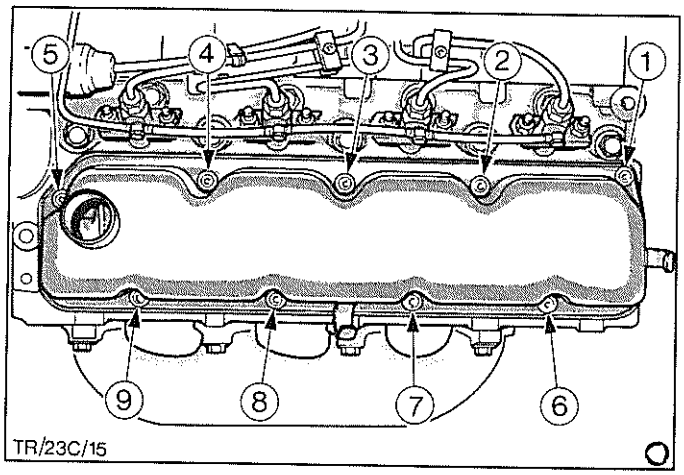


Fig.33. Rocker cover screw tightening sequence.

23 411 INJECTION PUMP - ADJUST TIMING

SPECIAL SERVICE TOOLS REQUIRED:

Camshaft timing peg	21-123
Injection pump timing peg	23-019
Crankshaft timing peg	23 020

To Adjust

IMPORTANT: BEFORE TURNING THE ENGINE, ENSURE THAT ALL THE TIMING PEGS HAVE BEEN REMOVED FROM THE ENGINE.

1. Remove the grille as detailed in Operation 43 232.
2. Remove the radiator as detailed in Operation 24 254.
3. Slacken the nut and remove the viscous fan assembly from the threaded water pump shaft.
4. Remove the four bolts and detach the water pump drive pulley from the water pump flange.
5. Loosen the vacuum pump drive belt tensioner and remove the belt.
6. Loosen the alternator adjuster/mounting bolts and remove the fan/alternator drive belt.
7. Remove the six screws and detach the timing belt cover assembly.
8. Ensure that the crankshaft is still set at 11° BTDC by inserting the timing peg (23-020) into the flywheel. If the flywheel has moved, refer to Operation No.23 410 sub-operations 6 to 8 for alignment procedure.
9. Using the 8,0 mm timing peg (Special Tool No. 21-123) lock the camshaft pulley in position.
10. Slacken the three bolts securing the drive belt pulley to the fuel injection pump flange.
11. Align the hole in the fuel injection pump pulley with the hole in the pump body by rotating the drive hub relative to the pulley.

NOTE: To rotate the injection pump drive shaft carefully tap the side of the pulley bolts clockwise or anti-clockwise as required until timing peg can be fitted, see Fig.31.

12. Insert timing peg Special Tool 23-019 through injection pump pulley.

NOTE: If the adjustment cannot be obtained by rotating the pulley, remove timing belt and adjust injection pump so that bolts are central to the slots in the pulley. Refit timing belt, refer to Operation No.23 414 for correct timing belt replacement.

13. Tighten the three pump driveshaft pulley bolts.

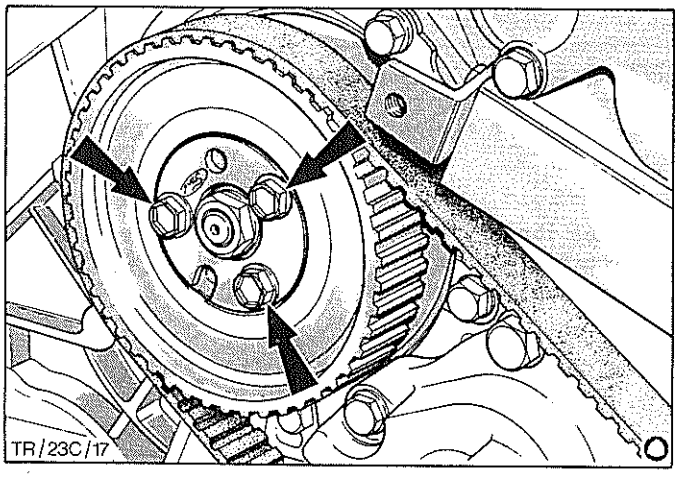


Fig.34. Slacken driveshaft pulley to fuel injection pump flange bolts.

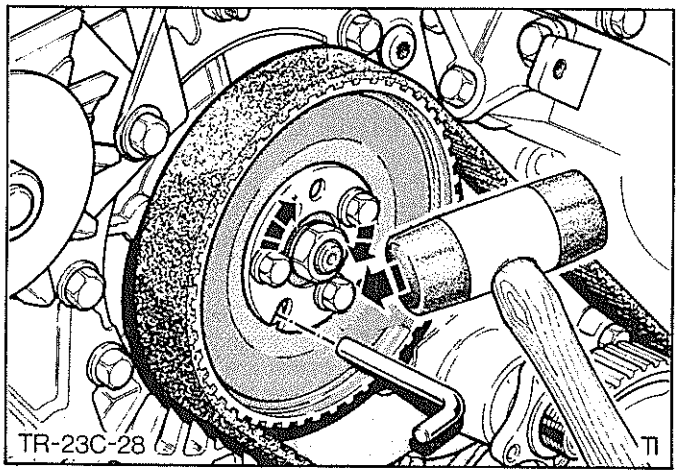


Fig.35. Rotate injection pump driveshaft until timing peg can be fitted.

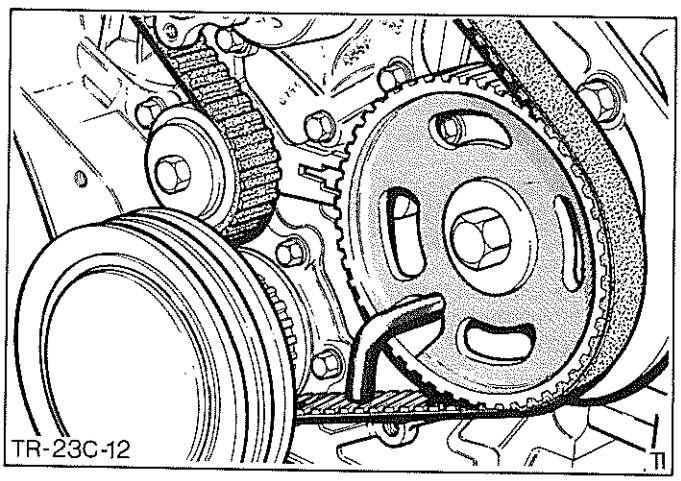


Fig.36. Insert timing peg through camshaft pulley.

14. Remove all three timing pegs and rotate the engine clockwise through two revolutions and align timing peg holes as detailed in Operation 23 410, sub-operations 6 to 8. Re-insert the three timing pegs to check that the injection pump timing is still correct.

NOTE: If the holes of the fuel injection pump pulley and body do not align, repeat sub-operations 9 to 14.

To Reassemble

15. Remove the flywheel timing peg and refit the plastic blanking plug.

16. Remove both the camshaft and fuel injection pump timing pegs from the pulleys.

17. Fit the rocker cover and a new gasket and tighten the retaining screws to the specified torque in the correct sequence, Fig.29.

18. Position the timing cover assembly on the engine front housing and secure with the six screws. Tighten the screws to the specified torque. Refit the rubber plug into the timing peg hole.

19. Refit the water pump pulley assembly onto the water pump drive flange and secure. Tighten the bolts to the specified torque.

20. Refit the viscous fan to the threaded water pump shaft.

21. Fit the fan/alternator drive belt over the pulleys, tension the belt and tighten the alternator adjusting/mounting bolts to the correct specification.

22. Fit the vacuum pump drive belt over the pulleys, tension the belt and tighten the tensioner bolts to the specified torque.

23. Refit the radiator as detailed in Operation 24 254.

24. Refit the grille as detailed in Operation 43 232.

25. Position the air cleaner assembly onto the inlet manifold, tighten mounting bolts and refit air intake hose.

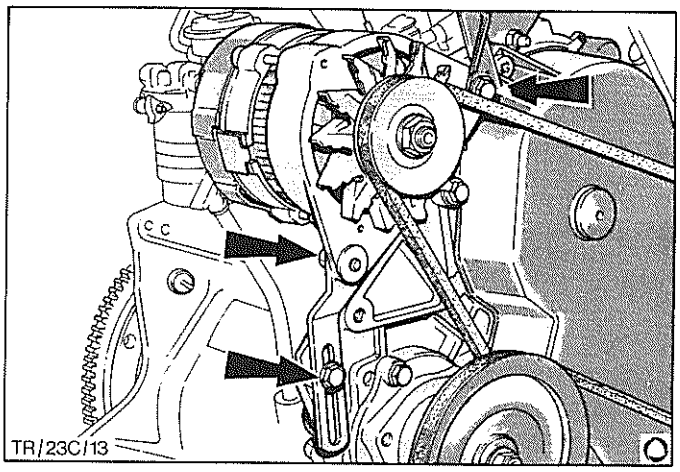


Fig.37. Refit and adjust alternator belt.

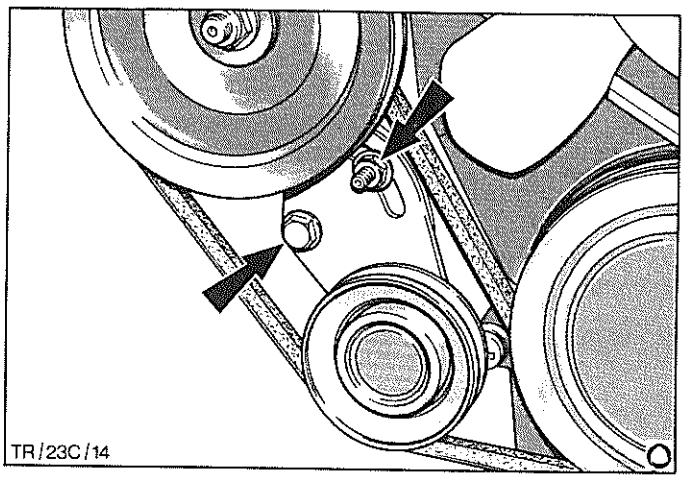


Fig.38. Refit vacuum pump drive belt and adjust to correct tension.

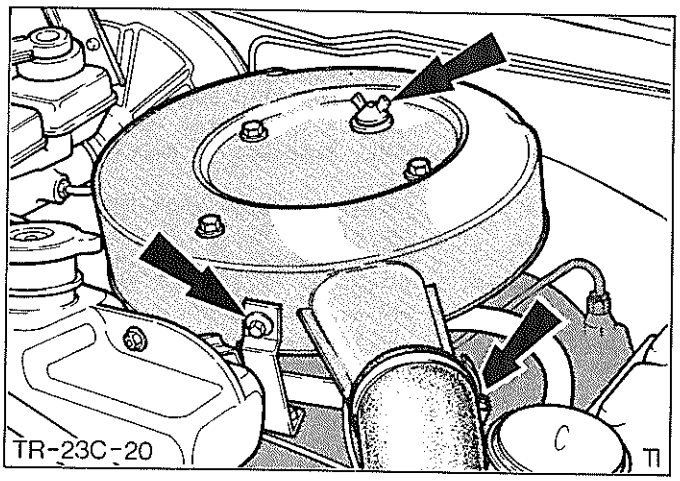


Fig.39. Refit air cleaner assembly.

26. Reconnect the battery and the stop control solenoid wire.

27. Replace crankshaft damper pulley rubber plug.

28. Start the engine and check for fuel, oil and water leaks.

29. Remove the fender covers and close the hood.

23 413 4 ENGINE IDLE SPEED - ADJUST

NOTE: All the following adjustments must be made with the engine at normal operating temperature.

Do not adjust speed settings unless the tachometer is known to be accurate.

Where an optical or pulse type of tachometer is to be used, apply reflective tape or connect as directed by the manufacturer's instructions.

Check that the throttle lever on the injection pump has full and free movement and that the lever is 'solid' on the idle stop before adjusting the idle speed.

Rectify any loose, excessively worn or maladjusted throttle linkage before proceeding further.

1. Open hood and fit fender covers.

To Adjust Idle Speed

2. Start the engine. Using a suitable portable tachometer, measure and record the engine idle speed (rev/min).

3. If necessary, slacken the locknut and adjust the idle speed stop screw until a smooth idle within the specified range is obtained. Tighten the locknut to the specified torque.

4. Check the setting by lightly depressing and quickly releasing the throttle pedal two or three times to ensure a consistent return to the specified speed. Readjust if necessary.

NOTE: On Bosch fuel injection pumps when the engine is hot a gap of 2,5 to 3,5 mm (0,10 to 0,14 in) should exist between the throttle lever and the knurled end fitting on the waxstat control cable. If the gap is not to specification, slacken the locknut and rotate the knurled fitting as required. When the gap has been reset, tighten the locknut.

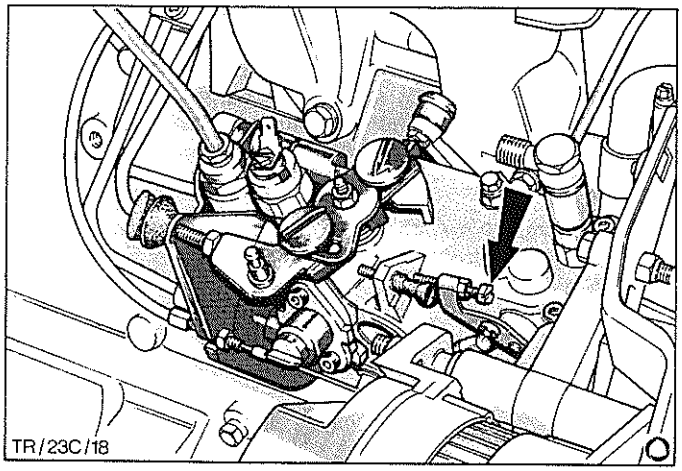


Fig.40. Idle speed adjustment screw (CAV).

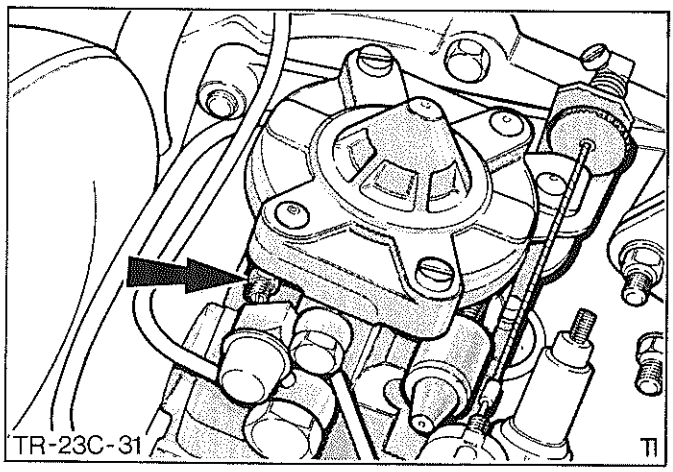


Fig.41. Idle speed adjustment screw (Bosch).

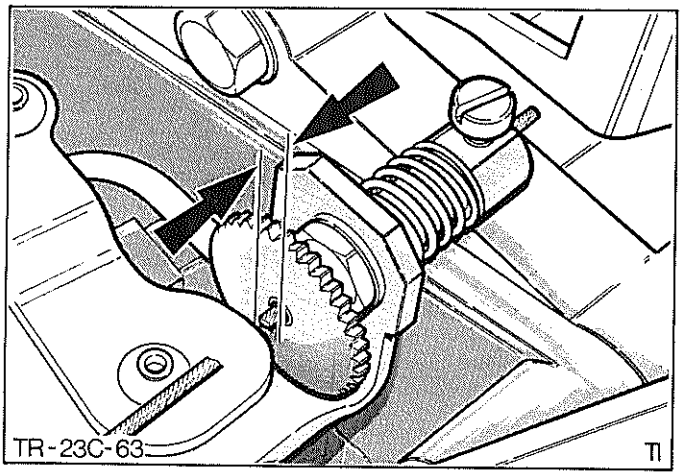


Fig.42. Adjust knurled screw on 'waxstat' control cable to obtain 2,5 to 3,5 mm clearance.

23 413 4

NOTE: Vehicles fitted with CAV type injection pump:

If, after carrying out idle speed check or adjustment, the engine continues to stall/cut out, the following action must be carried out:

- Ensure engine is at operating temperature.
- Remove tamper proofing by cutting off with knife. (B in Fig.43.)
- Hold screw and undo locknut.
- Screw in anti-stall screw quarter turn. Repeat test and adjust until stall condition is overcome.
- Tighten locknut and reseal screw with lead seal and wire.

5. Remove the fender covers and close hood. Road test the vehicle and check for satisfactory performance.

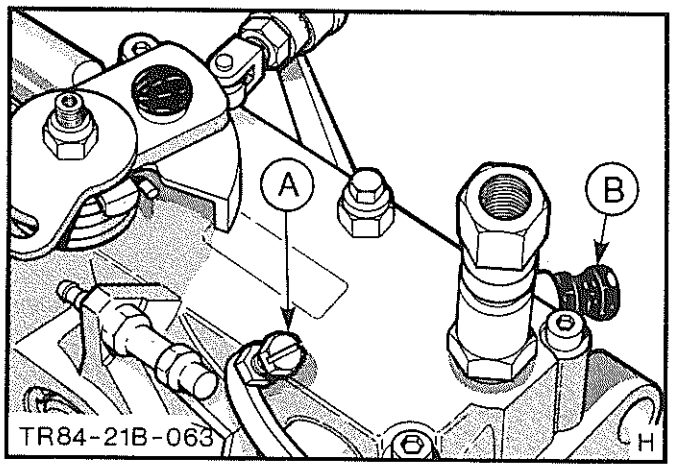


Fig.43. Anti-stall screw (CAV).
A - Idle speed screw
B - Anti-stall screw

23 414 INJECTION PUMP - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED:

Camshaft timing peg	21-123
Injection pump timing peg	23-019
Crankshaft timing peg	23-020

CAUTION: DO NOT ALLOW DIESEL FUEL TO SPILL ONTO THE STARTER MOTOR.

To Remove

1. Open hood, fit fender covers and disconnect battery.
2. Remove the bolts and detach the air cleaner assembly from the inlet manifold.
3. Remove the grille as detailed in Operation 43 232.
4. Remove the radiator as detailed in Operation 24 254.
5. Loosen the vacuum pump drive belt tensioner pulley and remove the belt.
6. Loosen the alternator adjusting/mounting bolts and remove the fan/alternator drive belt.
7. Slacken the nut and remove the viscous fan assembly from the threaded water pump shaft.
8. Remove the four bolts and detach the fan and water pump pulley assembly.
9. Remove the six screws and detach the timing belt covers assembly.
10. Slacken the fuel pump pulley bolts.

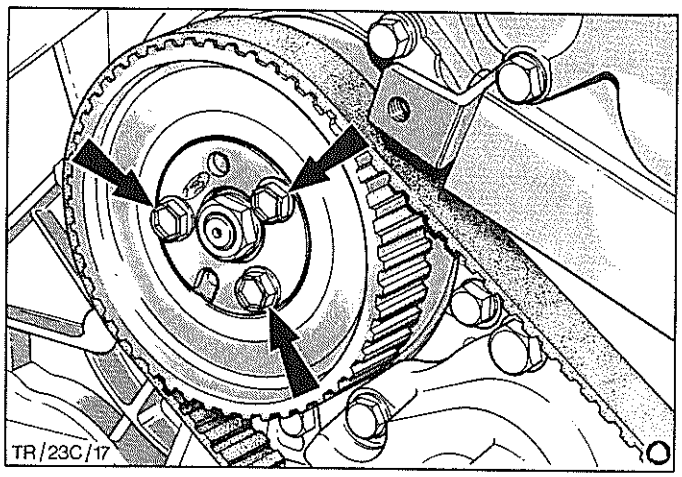


Fig.44. Slacken fuel pump pulley bolts.

11. Remove the screws and detach the rocker cover.

12. Continue to turn engine so that No.1 piston begins to rise onto compression stroke, number 7 valve starting to rise.

13. Remove the plug from the timing peg hole in the rear of the cylinder block adjacent to the engine identification plate.

14. Insert the engine timing peg (Special Tool 23-020) into the hole in the rear of the cylinder block and apply light pressure so that as the flywheel is turned clockwise approximately 45° the peg will drop fully into the hole in the flywheel as the crankshaft reaches 11° BTDC.

NOTE: To allow the camshaft pulley to move freely, the rocker shaft must be removed in order to relieve the spring tension through the pushrods and cam followers on the camshaft.

15. Remove the bolts and detach the rocker shaft assembly from the cylinder head.

16. Slacken the timing belt tensioner adjusting pulley bolts, push the tensioner back against spring pressure (away from the camshaft pulley) and temporarily tighten the pulley bolts to retain the tensioner in this position.

17. Slide the toothed timing belt off the fuel injection pump drive pulley. Remove injection pump pulley.

18. Remove the three bolts securing the fuel injection pump pulley to the drive flange and detach the pulley.

19. Disconnect and remove the four injection high pressure fuel feed pipes and leak off pipe. Fit dust caps to the injectors, fuel injection pump, and pipe connection points immediately.

20. Disconnect the throttle and 'Waxstat' fuel control cables from the fuel injection pump.

21. Disconnect the fuel shut off solenoid wire, and Bosch start advance wire from the fuel injection pump.

22. Disconnect the low pressure fuel feed pipe from the filter to the fuel injection pump. Seal the connection points with suitable dust caps.

23. Remove the four retaining bolts and detach the fuel injection pump rear support bracket from the engine.

24. Remove the three nuts and bolts securing the fuel injection pump to the adaptor plate and carefully lift out the fuel injection pump assembly.

NOTE: Support the fuel injection pump during this operation to prevent damage.

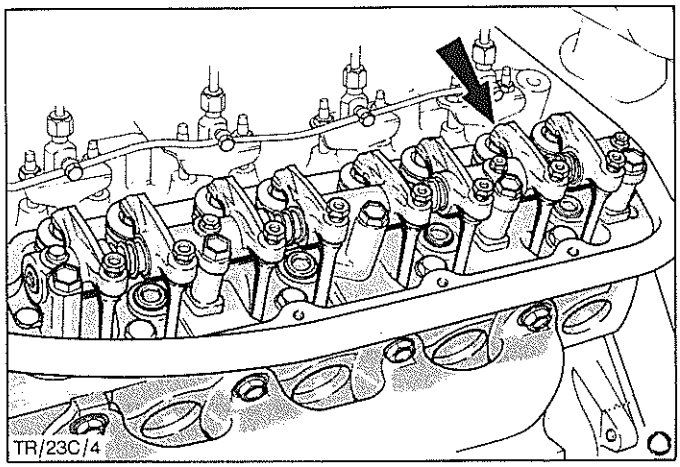


Fig.45. Set engine to No.1 piston on TDC. No.7 valve rising.

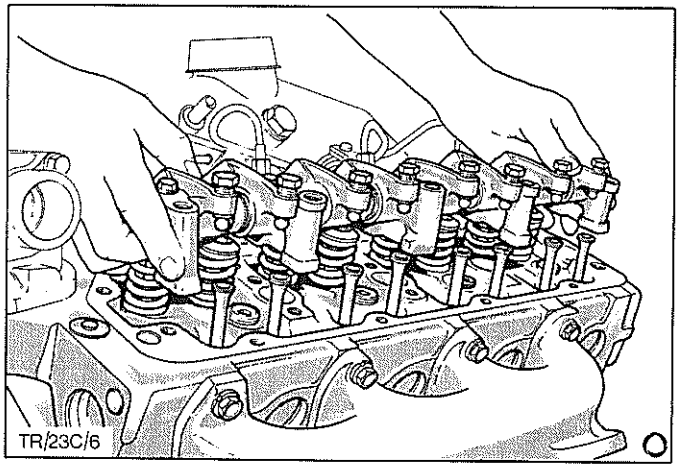


Fig.46. Remove rocker shaft assembly from the cylinder head.

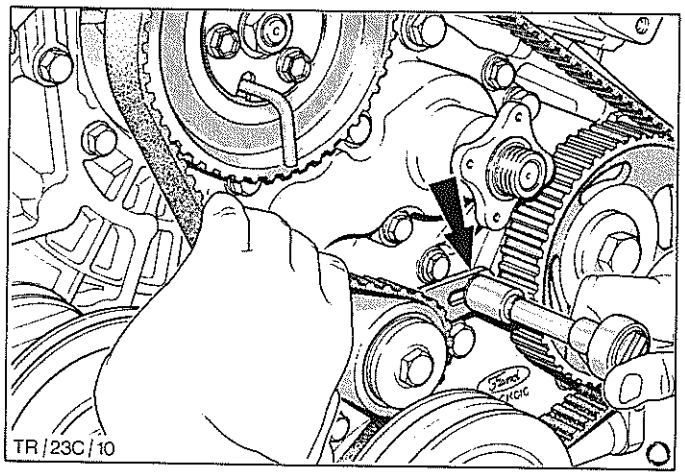


Fig.47. Slacken timing belt tensioner adjuster.

To Install

25. Carefully lift the fuel injection pump into position on the rear face of the adaptor plate. Locate the three mounting nuts and bolts and tighten evenly to the specified torque.

26. Fit the rear support bracket to the fuel injection pump and cylinder block.

CAUTION: TIGHTEN THE BOLTS EVENLY AND ENSURE THAT THE BRACKET DOES NOT FORCE THE PUMP AWAY FROM ITS NATURAL ALIGNMENT WITH THE FRONT ADAPTOR PLATE HOUSING.

27. Tighten the rear support bracket bolts to the specified torque.

28. Fit the fuel injection pump pulley to the flange and loosely fit the retaining plate and bolts. Ensure that the pulley bolts are in the centre of the elongated slots.

To Set the Fuel Injection Pump Timing

29. Fit the three timing pegs, Special Tool Numbers 21-123, 23-019 and 23-020, to the flywheel, camshaft pulley and fuel injection pump pulley.

30. Fit the toothed timing belt over the crankshaft, camshaft and finally the fuel injection pump pulley.

NOTE: It may be necessary to slightly rotate the fuel injection pump pulley to correctly align the teeth of the belt and the pulley.

31. Slacken the timing belt tensioner bolts, depress and release the timing belt on its longest span to activate the tensioner. Tighten tensioner securing bolts.

32. Remove the three timing pegs and tighten the three fuel injection pump pulley bolts to the specified torque.

33. Rotate the engine clockwise through two revolutions. Re-insert the Special Tool 23-020 and peg the flywheel as it approaches 11° BTDC.

34. Check the timing by inserting the timing pegs into the camshaft and injection pump pulleys.

NOTE: If the holes of the fuel injection pump pulley and body do not align, refer to Operation No.23 411, sub-operations 9 to 14.

35. Remove the three timing pegs and rotate the engine a further 130°. Slacken the tensioner bolts, depress and release the belt on the longest span to activate the tensioner. Tighten the tensioner bolts to the specified torque.

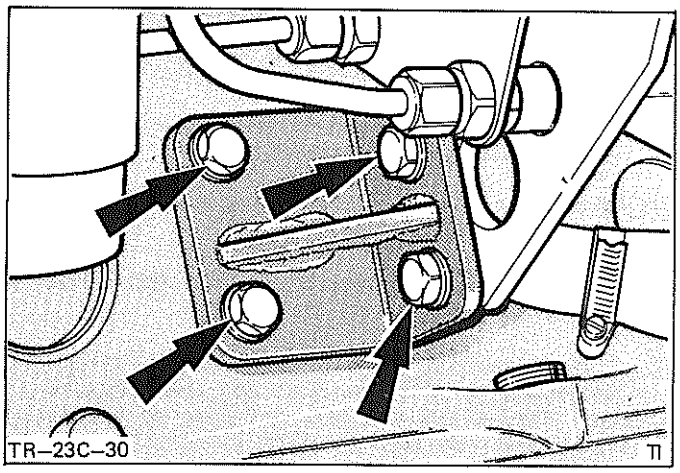


Fig.48. Fit rear support bracket to fuel injection pump and cylinder block.

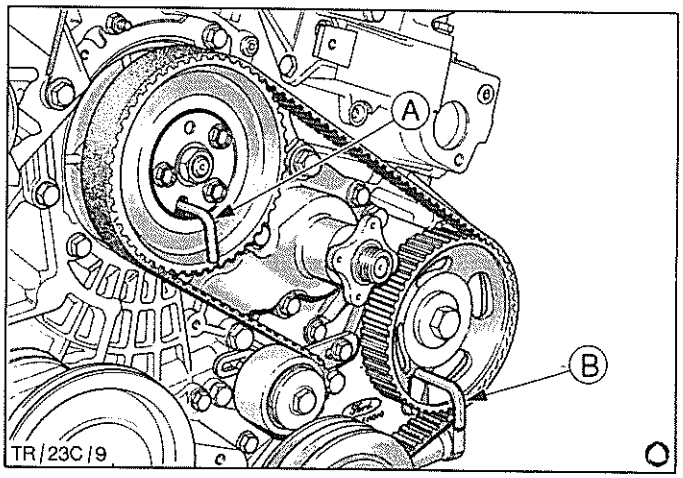


Fig.49. Fit timing peg to camshaft and injection pump.
A - Injection pump pulley timing peg
B - Camshaft pulley timing peg

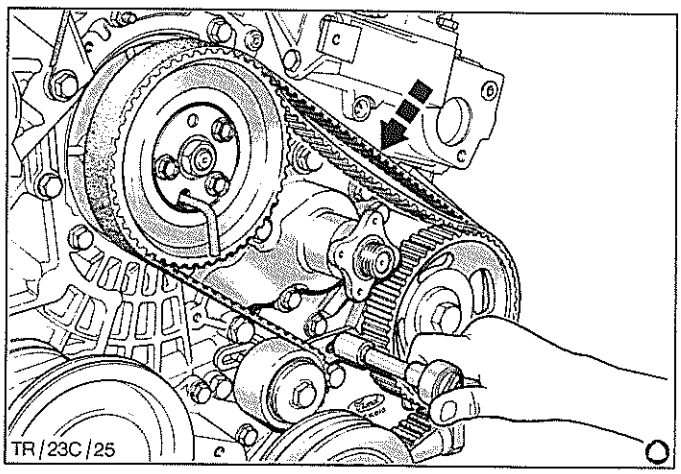


Fig.50. Depress and release the timing belt on the belt's longest span.

36. Turn the engine clockwise to 11° BTDC and make a final check on the timing by inserting the three timing pegs in the respective holes.

NOTE: The engine will need to be rotated through approximately 1.1/2 revolutions.

37. Remove the flywheel timing peg and refit the plastic blanking plug.

38. Remove both the camshaft and fuel injection pump timing pegs from the pulleys.

39. Inspect sealing washers and olives, replace as necessary. Refit the high and low pressure fuel feed pipes and leak off pipe to the fuel injection pump and the fuel filter.

40. Refit the rocker shaft assembly and tighten the retaining bolts to the specified torque.

41. Adjust the valve clearances as detailed in Section 21 of this Workshop Manual.

42. Fit the rocker cover and a new gasket. Tighten the retaining screws to the specified torque in the correct sequence.

43. Position the timing cover assembly on the engine front housing and secure with the six screws. Tighten the screws to the specified torque.

44. Place the pulley assembly onto the water pump drive flange and secure with the four bolts. Tighten the bolts to the specified torque.

45. Fit the viscous fan to the threaded water pump shaft.

46. Fit the fan/alternator drive belt over the pulleys, tension the belt and tighten the alternator adjusting/mounting bolts to the specified torque.

47. Fit the vacuum pump drive belt over the pulleys, tension the belt and tighten the tensioner bolts to the specified torque.

48. Refit the radiator as detailed in Operation No. 23 254.

49. Refit the grille as detailed in Operation No. 43 232.

50. Prime the fuel system (CAV only).

51. Fit the throttle cable to the fuel pump throttle lever as described in Operation 23-826.

52. Reconnect waxstat fast idle control cable as described below:

CAV Injection Pump (engine temp. below 36°C 97°F)

Fit the waxstat fast idle control cable nipple to the cold idle/advance lever. Fit the end adjuster to the bracket with the M6 locknuts either side.

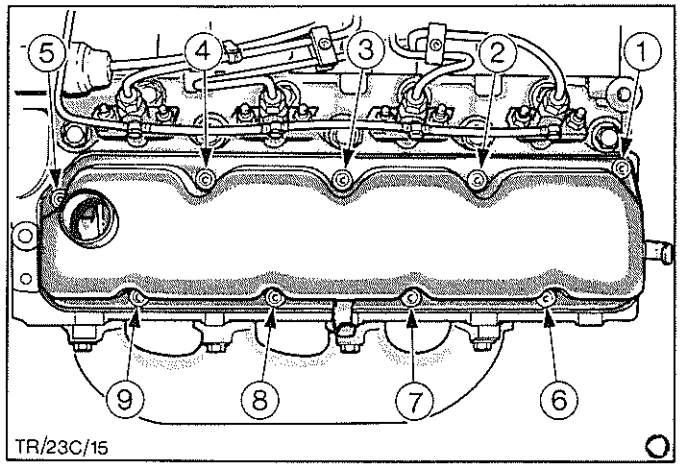


Fig.51. Tighten rocker cover bolts in correct sequence, then retorque immediately.

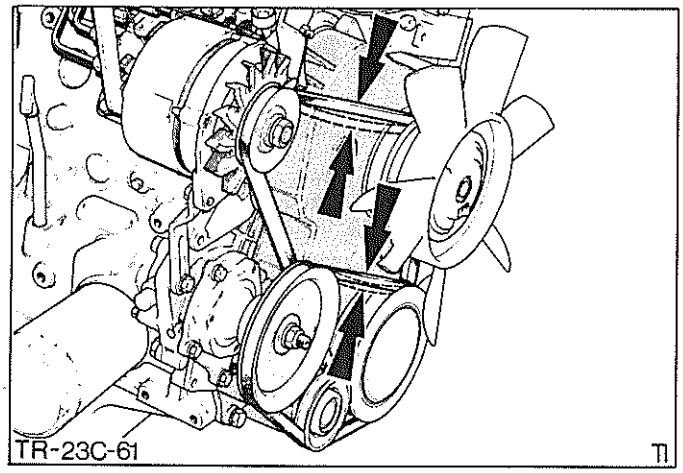


Fig.52. Refit alternator/vacuum drive belts and adjust belt tension.

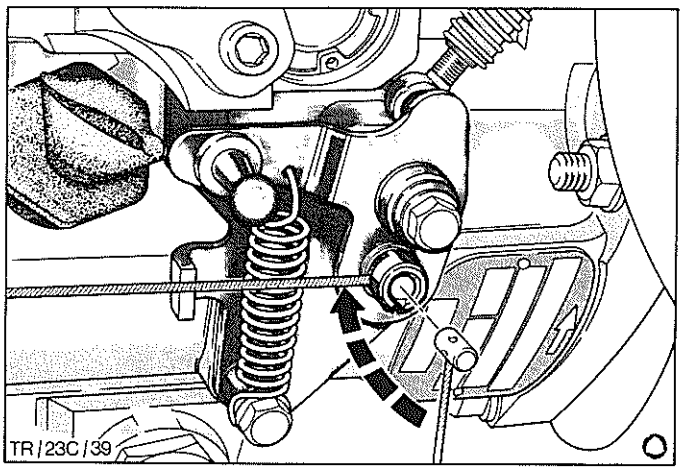


Fig.53. Reconnect waxstat cable to injection pump. (C.A.V. Pump illustrated)

To Adjust the Cable

NOTE: Vehicles built before June 1984 may be fitted with a -20°C waxstat and can be identified by the lettering C1C stamped on the outer body of the waxstat. Vehicles with this type of waxstat the outer cable will need to be pulled towards the rear of the engine (to fully tension the inner cable) when adjusting.

- Unscrew the outer cable and tighten other locknut against the fuel injection pump adjustment bracket to give a 2 to 3 mm gap between the inner cable ferrule and adjuster end. Tighten locknut.

  Check that a gap of 2 to 3 mm exists between the inner cable ferrule and adjuster, and that the cold idle lever is hard against the cold stop.

NOTE: At engine temperatures ABOVE 36°C with the inner cable pulled hard towards the adjuster the cold idle/advance lever should be hard against the cold operation stop, with a gap of 2 to 3 mm between inner cable ferrule and adjuster end.

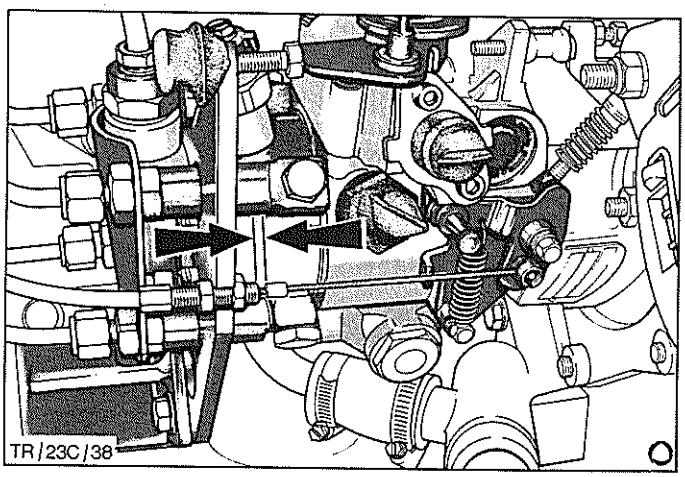


Fig.54. Adjust cable until a 2 to 3 mm gap between the ferrule and end of adjuster (CAV).

Bosch Injection Pump (engine temp. below 36°C 97°F)

- Fit the waxstat fast idle cable adjuster into pump bracket, the inner nut having been screwed onto the adjuster as far as possible, and the outer nut finger tight against the bracket.

- Feed inner cable through the fuel injection pump spring loaded fast idle sleeve to adjust the cable.

- Rotate the fuel injection pump throttle lever forward into the open position and temporarily retain in this position.

- Push the spring loaded fast idle sleeve fully home against the fast idle stop, and tighten the cable clamping screw (exposed inner cable should be kept as straight as possible during this operation).

- Unscrew outer adjusting nut and tighten inner locknut against the bracket until a 2 to 3 mm gap exists between inner cable ferrule and adjuster end is obtained. Tighten locknuts against bracket. Release throttle lever.

- Check that a 2 to 3 mm gap exists between the inner cable ferrule and adjuster end when the fast idle sleeve is hard against the fast idle stop.

53. Position the air cleaner assembly onto the inlet manifold, fit the bolts and securely tighten.

54. Reconnect the battery and refit the stop control solenoid and cold start advance wires.

55. Refit the crankshaft pulley rubber plug.

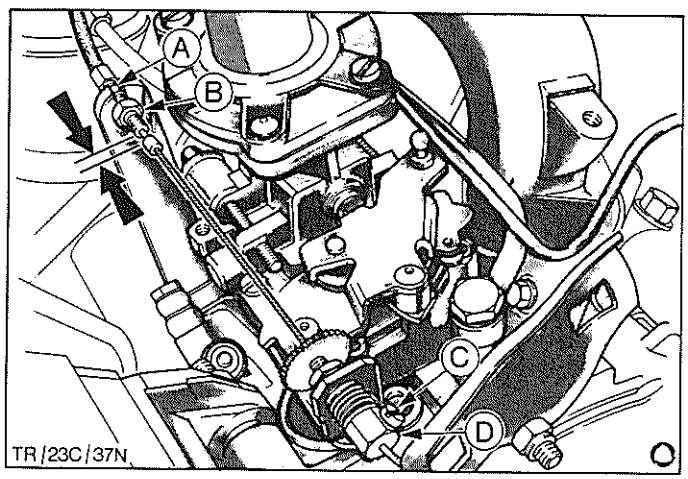


Fig.55 Adjust cable until a gap of 2 to 3 mm between ferrule and cable end adjuster is maintained (Bosch).
A - Inner locknut C - Cable clamp screw
B - Outer locknut D - Fast idle sleeve

55. Start the engine and check for fuel, oil and water leaks.

NOTE: If the engine fails to start, slacken No.1 and 2 injector high pressure fuel feed pipes and crank the engine until fuel is pumped out of the pipes. Tighten the connections once engine starts.

56. Remove fender covers and close hood.

23 455 INJECTORS - REMOVE AND INSTALL

To Remove

1. Open the bonnet, fit fender covers and disconnect battery.
2. Remove the bolts and detach the air cleaner assembly from the inlet manifold.
3. Remove the banjo bolts and washers, detach the leak off pipe from the injectors. Fit dust caps.
4. Remove the four high pressure fuel feed pipes at the injectors. Fit dust caps.
5. Remove the eight retaining nuts, lift off the retaining plates and remove the four injectors from the cylinder head.
6. Remove and discard the old injector sealing washers from either the injector nozzle or the injector bore in the cylinder head. Fit protective caps to the injector nozzles.

NOTE: Ensure all FOUR injector sealing washers are removed from either injector bore or injector nozzle.

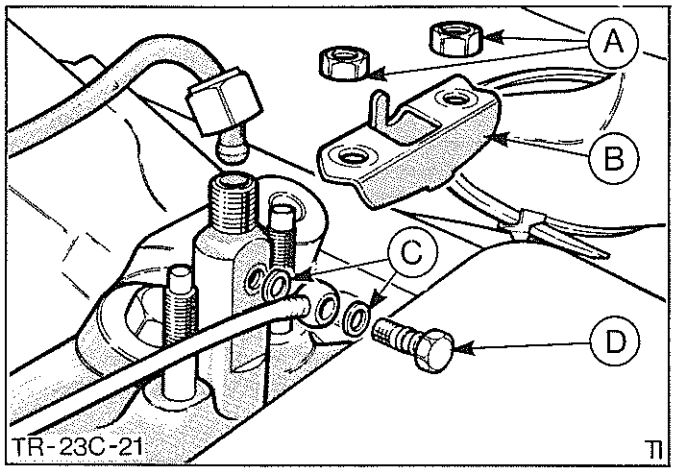


Fig.56. Disconnect banjo bolts and remove leak off pipe.
A - Securing nuts C - Sealing washers
B - Injector clamp D - Banjo bolt

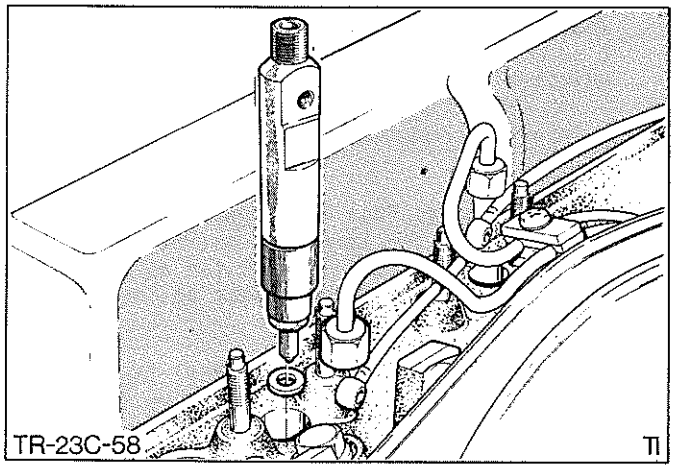


Fig.57. Lift out injectors and sealing washers.

To Install

7. Remove the protective caps from the injectors and fit new sealing washers to injector nozzles.
8. Locate the injectors into the bores in the cylinder head ensuring that the leak off connection faces the rocker cover.
9. Fit the four injector retaining clamps ensuring that the tab faces the inlet manifold and that the arrow shape formed by the retaining plate points towards the front of the engine.
10. Fit the eight injector clamp nuts to the studs and tighten evenly to the specified torque.
11. Remove the dust caps and fit the injector leak off pipe. Using new sealing washers, tighten the banjo bolts to the specified torque.

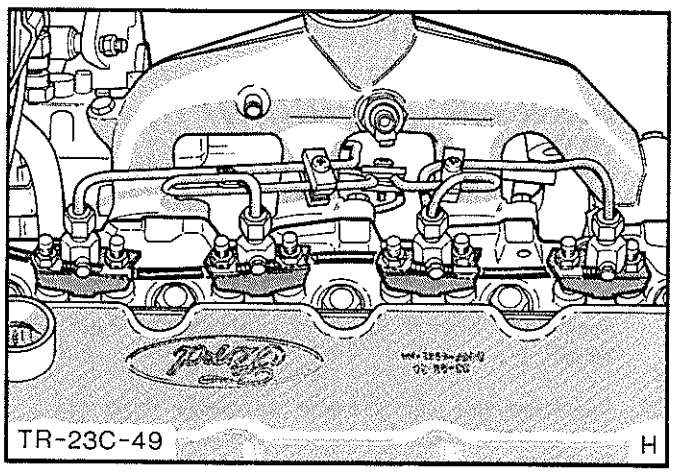


Fig.58. Refit injector retaining clamps ensure that the arrow shape points towards the front of the engine.

12. Remove the dust caps and fit the high pressure fuel pipes to the injectors and injection pump. Tighten to correct specification.

13. Fit the air cleaner assembly to the inlet manifold and tighten the retaining bolts.

14. Reconnect the battery, start engine and check for fuel and compression leaks.

15. Remove the fender covers and close hood.

23 454 8 INJECTOR - OVERHAUL

SPECIAL SERVICE TOOLS REQUIRED:

Dismantling Jig	HH-112
Nozzle Nut Socket	CT-9009
Nozzle Cleaning Kit	CT-9014
Nozzle Multiclean Machine ..	HH-013
Probe Light Kit	ANR-6
Nozzle Viewer	HH-103

To Dismantle

CAUTION: THE NOZZLE AND THE NEEDLE FROM ANY ONE INJECTOR ARE A MATCHED PAIR AND MUST BE KEPT TOGETHER.

1. Place the injector on the dismantling jig (Special Tool No. HH-112) and remove the nozzle nut using the special socket (Special Tool No. CT-9009). Remove the nozzle and needle valve, the spacer, the spring seat and the spring. Remove the pressure adjustment shim from the top of the spring recess, this may be held in by suction.

Cleaning and Inspection

2. The cleaning of injectors is best achieved by the use of special tools (Special Tool No. CT-9014). All the injector components must have all the carbon completely removed, injector spray holes should be cleaned using wire probes. Hold the probes in the hand chuck provided and to avoid bending or breaking the wire ensure that only 1,0 mm (0,04 in) protrudes from the chuck. The probe wire diameter must be 0,01 mm (0,004 in) less than the specified spray hole diameter.

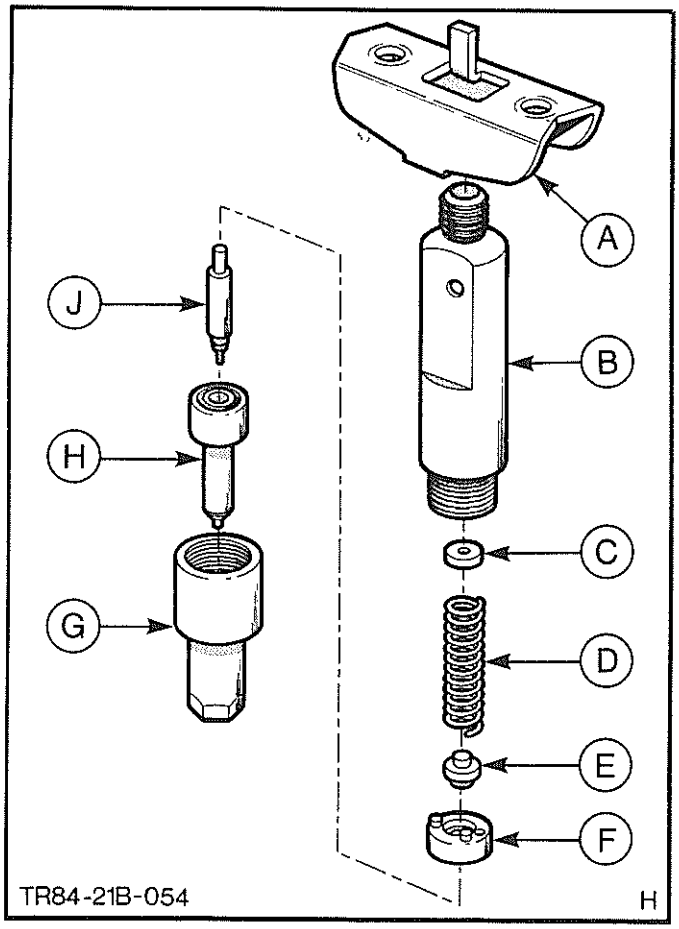


Fig.59. Injector assembly.
A - Retainer plate
B - Body
C - Shim
D - Spring
E - Spring seat
F - Adjuster
G - Retainer
H - Nozzle
J - Needle

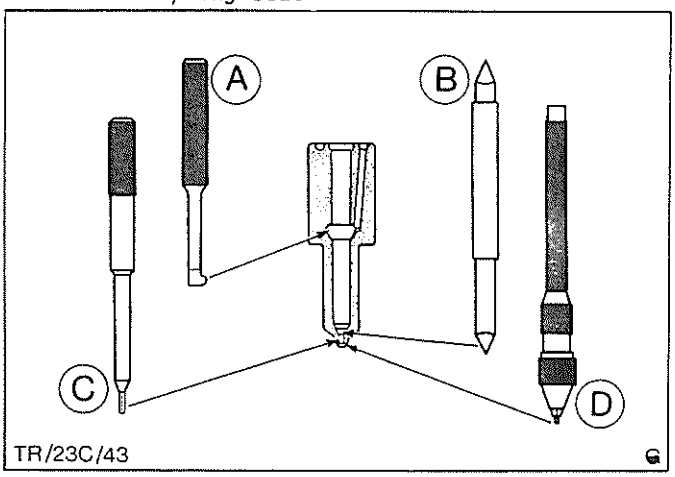


Fig.60. Injector cleaning tools.
A - Recess scraper
B - Seat scraper
C - Tip scraper
D - Nozzle hole probe and chuck

23 454 8

WARNING: ADEQUATE EYE PROTECTION AND PROTECTIVE CLOTHING MUST BE WORN WHEN HANDLING THE FOLLOWING SUBSTANCES:

- Liquid ACETONE and its accompanying vapour are HIGHLY FLAMMABLE. It should not be used near a naked flame or near electrical equipment. The working area must be well ventilated. No smoking. No static discharges. Avoid prolonged skin contact.

  If splashed in the eye, open eyelids fully, wash eye continuously with water for 10 minutes. Obtain medical advice without delay.

- CAUSTIC SODA is CORROSIVE and will cause skin burns. Skin contact must be avoided at all times.

  If skin contact occurs rinse thoroughly with water immediately and continue for a few minutes. Then wash with soap and water and pat dry. Contaminated clothing must be quickly removed.

  If swallowed, take immediately to hospital. A cupful of water or milk may be given slowly if able to swallow.

  If splashed in the eye, open eyelids fully, wash eye continuously with water for 10 minutes.

  Obtain medical advice without delay.

NOTE: When there is a hard carbon deposit which cannot be readily removed by using the tools, one of the following two solvents may be used.

a) Acetone - Immerse the nozzle in acetone for up to half an hour which will normally be sufficient to soften the deposit. On removing the nozzle from the acetone it is important immediately to rinse it in clean test oil to prevent corrosion occurring on the highly finished surfaces.

b) Caustic Soda - Dissolve 55g (2 oz) of caustic soda in 0,5 litre (1 pint) of water (11% concentration by weight), and add 15g (0,5 oz) of non-foaming detergent. Place the nozzle in the solution and boil for at least one hour but not for more than one and a half hours.

CAUTION: A CONCENTRATION OF CAUSTIC SODA OF MORE THAN 15% MAY CAUSE ROUGHENING OF IMPORTANT SURFACES OF THE NOZZLE AND THUS MAKE THE INJECTOR UNSERVICEABLE. TO PREVENT THIS OCCURRING, AS A RESULT OF EVAPORATION, HOT WATER SHOULD BE ADDED PERIODICALLY TO THE BOILING SOLUTION TO MAINTAIN, OR SLIGHTLY EXCEED, ITS ORIGINAL LEVEL.

3. After treatment, remove the nozzle from the solution and wash it in running water to remove all traces of caustic soda. After washing, immerse the nozzle in a de-watering oil and remove the surplus by draining.

4. If it was necessary to use one of the solvents, it may still be necessary to remove particles of softened carbon lodging in recesses or corners with the appropriate tool.

5. An additional aid to cleaning the nozzle interior is the injector testing machine and the self-contained nozzle 'multiclean' machine (Special Tool No. HH-013).

6. Using the 'Probelight' kit (Special Tool No. ANR-6) and the Nozzle Viewer (Special Tool No. HH-103), carefully examine the nozzle and needle seat. If the seats are ridged, pitted or discoloured due to overheating, a new nozzle assembly must be fitted.

7. Check the spring for breakage or cracks in the wire. Inspect all the remaining parts for excessive wear and damage and replace with new parts as necessary.

8. With the nozzle held at 45° from the vertical, lift the needle valve 7 mm (0,28 in) from its seat. Check that it is free to fall back to its seat, under its own weight, when it is wet with test oil. After having been pressed home by hand in any position, the needle must also be free to fall from its seat when the nozzle is inverted and still inclined at the same angle from the vertical.

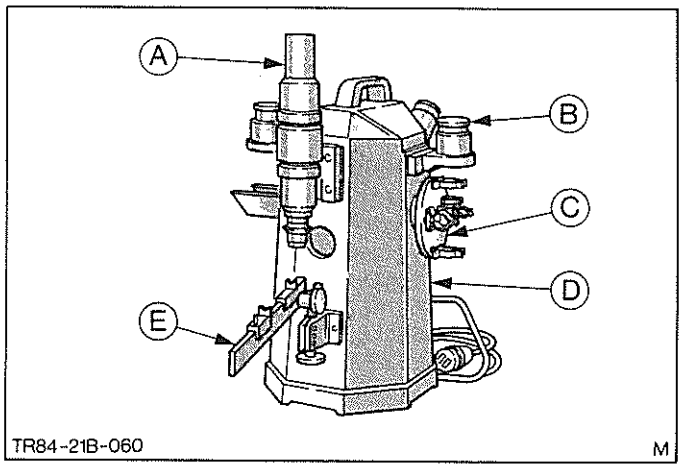


Fig.61. Nozzle viewer.
A - Needle microscope
B - Nozzle viewer
C - Nozzle holder
D - Light projector
E - Needle holder

To Reassemble

NOTE: Rinse all the injector parts in clean test oil before reassembly. Do not dry the parts, all the parts must remain wet during reassembly. On no account must rag or absorbent paper be allowed to come into contact with the internal injector parts.

9. Place the injector holder on the dismantling jig and place a pressure adjusting shim (see note below) in the spring recess in the holder followed by the spring. Place the spring seat, the spacer and the nozzle assembly in position (ensuring that the dowels engage correctly), screw on the retaining nut and tighten to the specified torque using the special socket (Special Tool No. CT-9009).

NOTE: If injector pressure shim is replaced, the new shim must be of the original shim thickness.

10. After assembly, if the injector is not to be tested and adjusted immediately, the union connectors and the nozzle must have dust caps fitted.

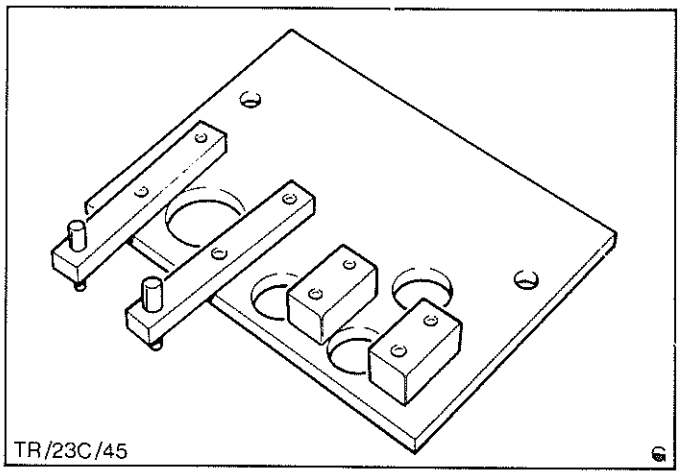


Fig.62. Dismantling jig.

23 454 8

Testing and Adjustment

SPECIAL TOOLS REQUIRED:

Testing Machine Bosch 240A or Hartridge HH 601

WARNING: GREAT CARE SHOULD BE TAKEN WHEN TESTING INJECTORS TO ENSURE THAT THE ATOMISED SPRAY FROM THE NOZZLE DOES NOT COME IN CONTACT WITH HANDS OR ANY OTHER PARTS OF THE BODY. THE HIGH PRESSURES INVOLVED WITH THE ATOMISATION OF THE TEST OIL MAY CAUSE IT TO PENETRATE THE SKIN CAUSING POSSIBLE BLOOD POISONING. GOGGLES, GLOVES AND SUITABLE PROTECTIVE CLOTHING SHOULD BE WORN DURING TESTING.

NOTE:

a) New or reconditioned injectors that have previously been tested and adjusted and have subsequently been stored, must always be tested for opening pressure and spray condition, irrespective of their shelf life, before fitting to an engine.

b) The test machine must be maintained in line with the manufacturer's operating manual.

c) Before testing injectors for opening pressure or back leak, close the pressure gauge isolating valve and then open it one quarter of a turn (90°). This will act as a damper and prevent the gauge needle from oscillating too violently thus obtaining a more accurate pressure reading. However, even with this dampening effect, it is still difficult to make an accurate reading as to when the nozzle actually bursts. The best method is to depress the machine handle to build up pressure slowly, watch the gauge carefully and note the highest pressure on the gauge just before the injector bursts.

d) When flushing and settling the injector needle and spring or when testing the injector spray condition and pattern, always close the pressure gauge isolating valve to:

i) Protect and prolong the life of the gauge.

ii) Prevent the oscillating gauge affecting the spray pattern.

e) If the injector does not pass one or more of the following tests, it must be dismantled, checked, reassembled and retested. If the injector fails one or more of the tests for a second time, it must be scrapped.

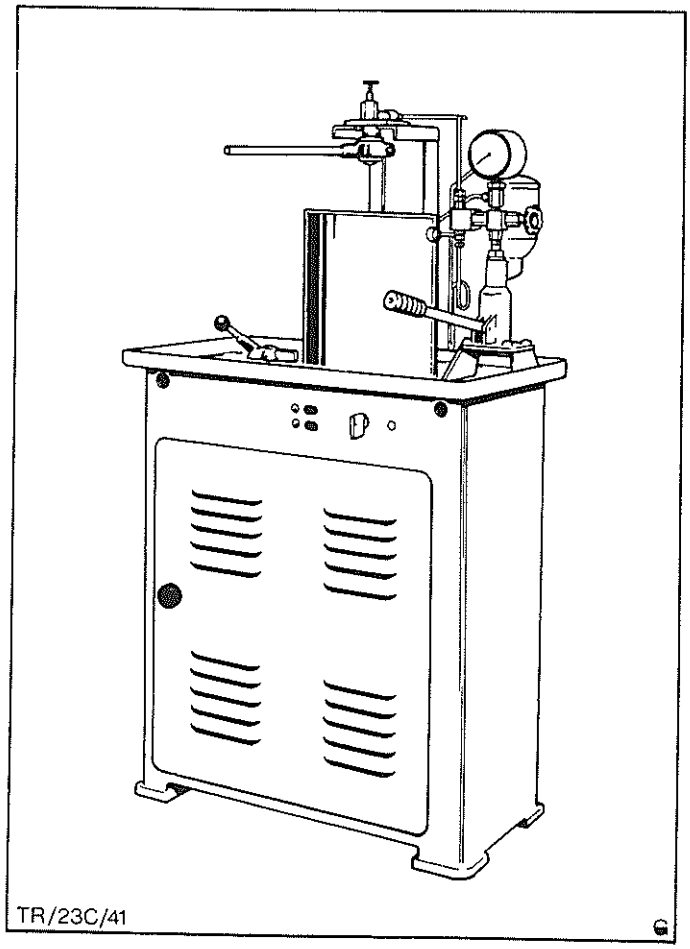


Fig.63. Bosch 240A nozzle tester.

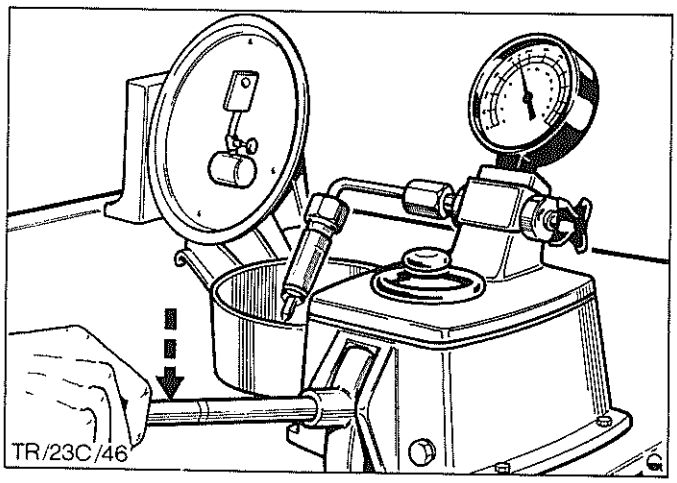


Fig.64. Testing back leakage time.

Pressure Setting

11. Remove the blanking cap, if fitted, from the injector high pressure union and the nozzle and place the injector on the test machine mounting bracket. Connect the high pressure pipe and tighten the union nut securely. Open the test oil flow control valve on the machine one full turn. Switch on the spray chamber light and extractor fan.

12. Quickly operate the pump handle several times to flush the injector and to settle the spring and needle.

13. Pump the machine handle and slowly turn the test oil flow control valve on the machine towards the closed position until the flow is just sufficient to produce a well atomised spray.

14. Pump the machine handle and note the opening pressure registered on the gauge. If the injector is not opening at the specified pressure, remove the injector from the test machine.

15. Dismantle the injector and change the pressure adjusting shim. A thicker shim will increase the opening pressure, a thinner shim will reduce the pressure. Reassemble the injector and retest. Repeat this procedure on a 'trial and error' basis until the nozzle opening pressure is within the specified tolerance.

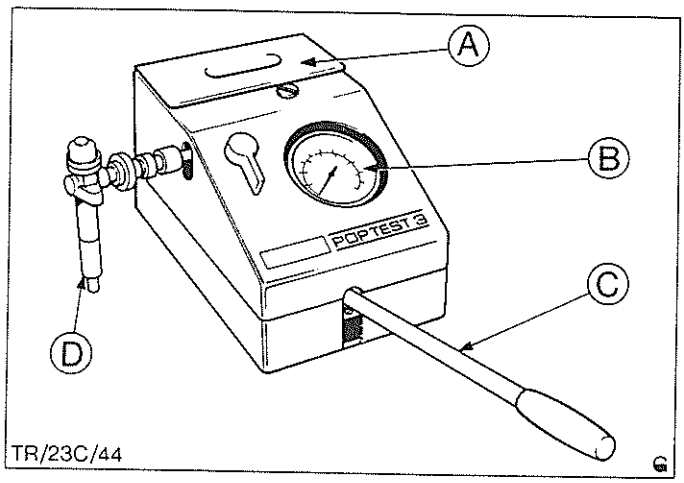


Fig.65. Nozzle pop test.
A - Oil supply
B - Pressure gauge
C - Pump handle
D - Injector

Spray Pattern

NOTE: The pumping rate on the test machine handle is very important when testing spray pattern. The handle should be pumped at a rate of 1 to 2 down strokes per second.

16. Pump the machine handle and observe the spray from the injector. For correct functioning it is essential that the injector 'chatters' throughout the entire period of spraying.

17. The spray from the holes in the nozzle must be equal in shape, size and intensity. The spray must be free from 'hosing', streaks and 'softness'.

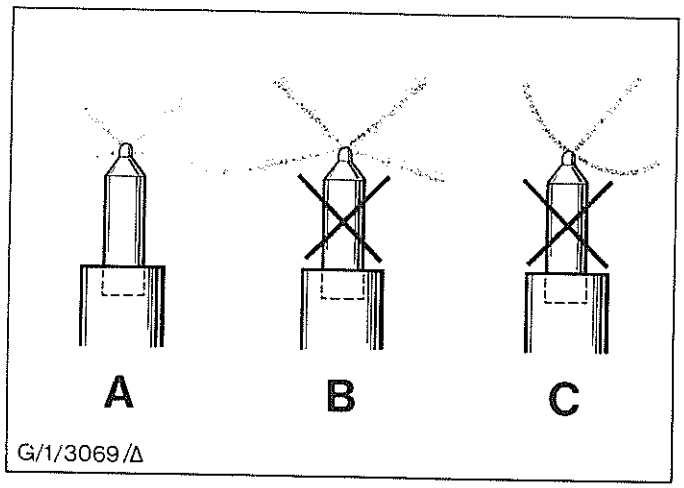


Fig.66. Spray pattern.
A - Correct - hard spray no tracking
B - Incorrect - soft spray
C - Incorrect - tracking

Back Leak Test

18. Press down on the pumping handle slowly until the specified back leak test upper pressure is obtained. Take the hand off the pumping handle and start the timer while the gauge is still registering the upper pressure. Measure the time taken for the pressure to fall to the specified lower pressure. The time taken for this fall in pressure should be within the specified tolerance.

NOTE: If the back leak time is greater than the specified value, this could indicate that the needle to nozzle clearance is too tight and the needle may seize if this nozzle assembly is used in an engine, change for another nozzle assembly and retest.

19. If the back leak is less than the specified value, first check for external leaks, such as at the pipe union connection and the nozzle to holder sealing face, also check the nozzle retaining nut torque. Next carry out the nozzle seat leakage test. If this test proves negative, then the cause is probably too much clearance between the needle and nozzle, change for another nozzle assembly and retest.

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Nozzle Seat Leakage Test

20. Ensure that the spray chamber extractor is switched off.

21. Wipe the nozzle tip with absorbent paper or non-fluffy cloth to ensure that the nozzle is completely dry. Push down on the pump handle slowly to raise the pressure to 10 bar (10,2 kg/cm^2, 145 lb/in^2) below the specified nozzle opening pressure and continue to push down on the handle sufficient to maintain the pressure steady at this value for 6 seconds. After this time, nozzle dampness is permissible but if any droplet falls the injector has failed this particular test.

NOTE: Failure in the test indicates poor sealing between the needle and nozzle seat. This could be caused by, foreign matter trapped on the seat, incorrect seat angles, non-concentric seats or damaged seat faces.

22. Remove the injector from the test machine. If the injector has passed all the tests satisfactorily and is not to be fitted to an engine immediately, replace the dust caps on the high pressure union connection and on the nozzle.

23 483 PIPES - INJECTOR DELIVERY - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers and disconnect battery.

2. Remove air cleaner assembly as described in Operation No. 23 174.

3. Remove anti-vibration clamps from injector pipes.

4. Remove injector pipes from injectors and injection pump, fit blanking plugs to both injectors and injection pump to prevent dirty entry.

5. Fit blanking plugs to injector pipes and remove pipes from engine, carefully feeding through inlet manifold.

NOTE: DO NOT bend or reshape injector pipes otherwise damage will result.

To Install

6. Guide injector pipes between inlet manifold and cylinder head. Remove blanking plugs from injectors, injection pump and injection high pressure pipes.

7. Refit injector pipes to injectors and injection pump. Care must be taken not to apply any strain on pipes when securing.

NOTE: Hand tighten both ends before fully tightening to correct torque.

8. Refit anti-vibration clamps to injector pipes.

NOTE: Failure to fit anti-vibration clamps will result in injector pipe fatigue.

9. Refit air cleaner assembly as described in Operation No. 23 174.

10. Reconnect battery, remove fender covers and close hood.

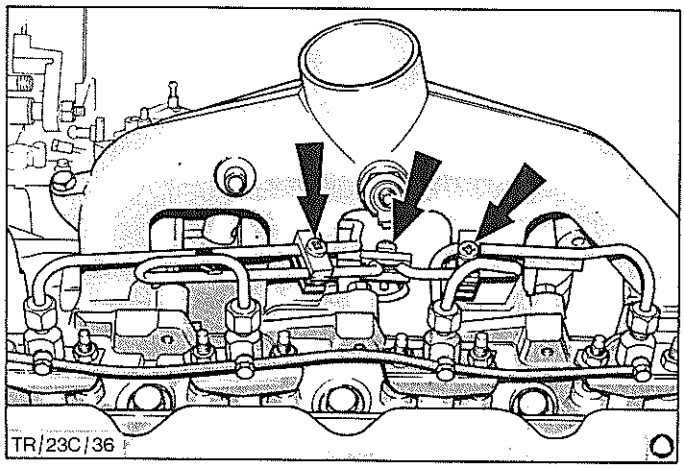

Fig.67. Remove injector pipe anti-vibration clamps.

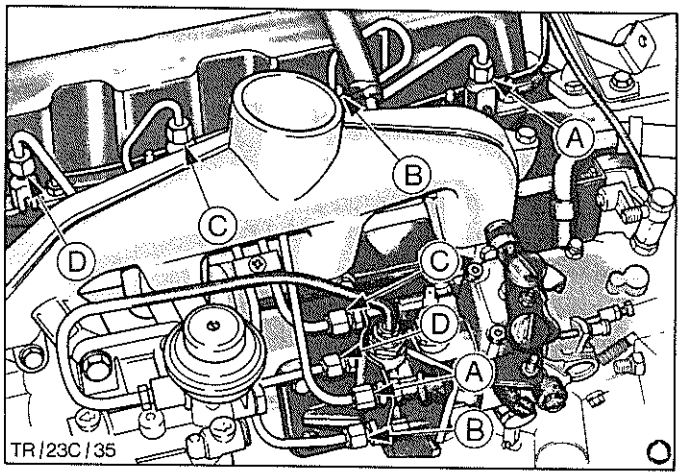

Fig.68. Refit injector pipes to injection pump.
A - No.1 cylinder injector pipe
B - No.2 cylinder injector pipe
C - No.3 cylinder injector pipe
D - No.4 cylinder injector pipe

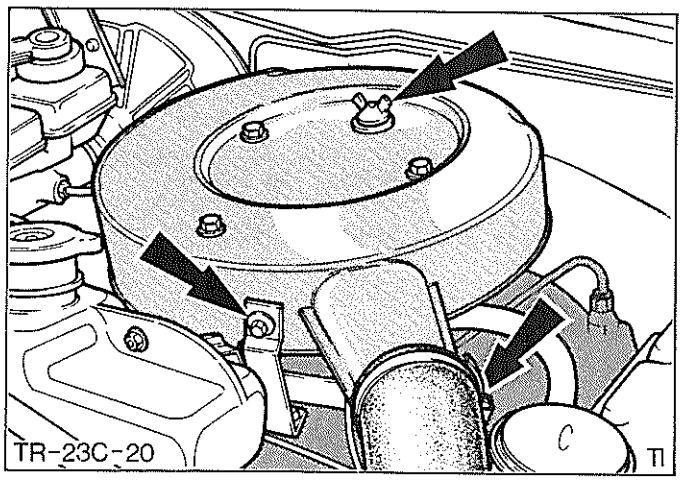

Fig.69. Reconnect air cleaner assembly.

23 534 FUEL PUMP - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

NOTE: Fuel pump (hand primer) is only fitted to vehicles equipped with a CAV fuel system.

To Remove

1. Open hood, fit fender covers and disconnect battery.
2. Place a protective cover over starter motor assembly. Disconnect injection pump supply pipe from fuel pump.
3. Remove banjo bolt and two sealing washers from fuel filter/fuel pump housing.
4. Lift out fuel pump assembly.

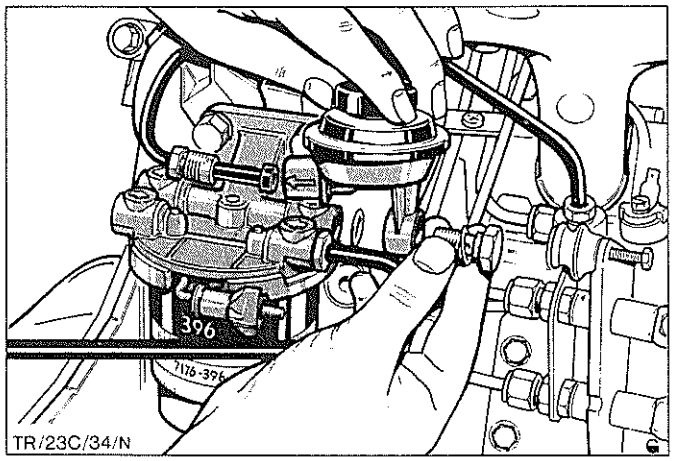

Fig.70. Remove banjo bolt and sealing washers.

To Install

NOTE: Inspect all rubber sealing ferrule on high and low pressure pipes and replace as necessary.

5. Locate fuel pump assembly to fuel filter, set vertical and secure with banjo bolt and new sealing washers.
6. Reconnect injection pump supply pipe to fuel pump.
7. Remove protective cover from starter motor.
8. Reconnect battery, remove fender covers and close hood.

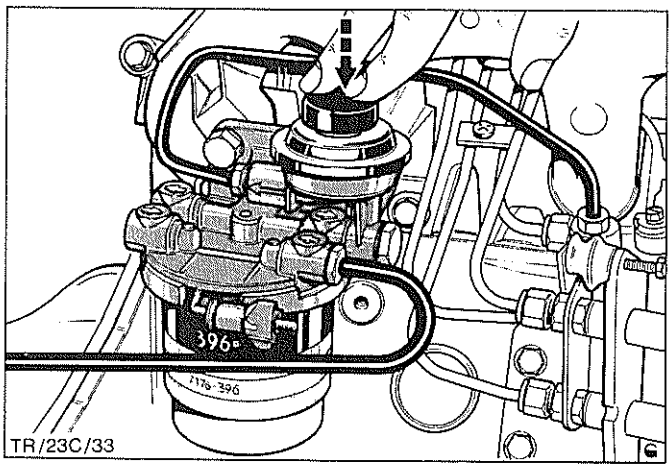

Fig.71. Locate fuel pump assembly to fuel filter and prime pump by depressing plunger.

23 545 FUEL FILTER - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers and disconnect battery.
2. Place a protective tray over starter motor assembly.

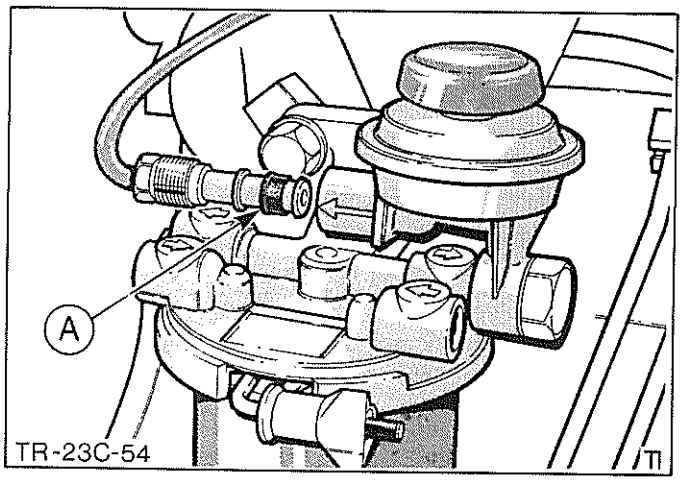

Fig.72. Disconnect fuel supply pipes from fuel filter and lift pump.
A - Sealing rubber ferrule

3. Disconnect fuel supply and outlet pipes from fuel filter (fuel pump) assembly.

4. Remove fuel pump if fitted.

5. Remove filter assembly mounting bolts, lift out fuel filter assembly.

6. Drain unit. Refer to Section 05 - Health and Safety Precautions of this Manual for fuel safety.

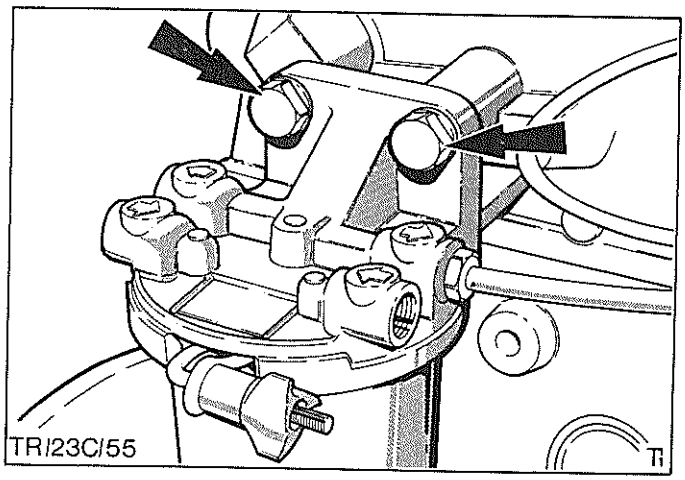

Fig.73. Fuel filter to manifold securing bolts.

To Install

NOTE: Inspect all rubber sealing olives on low pressure pipes, replace as necessary.

7. Refit fuel filter assembly and secure to inlet manifold.

8. Refit fuel pump to filter (if fitted).

9. Reconnect fuel filter inlet pipe and injection pump supply pipe.

10. Remove protective cover from starter motor assembly.

11. Reconnect battery and start engine. Run engine until fuel system purges itself of air.

NOTE: On engines fitted with a CAV fuel system, the fuel system should be primed using the fuel hand primer pump before attempting to start the engine.

Remove fender covers and close hood.

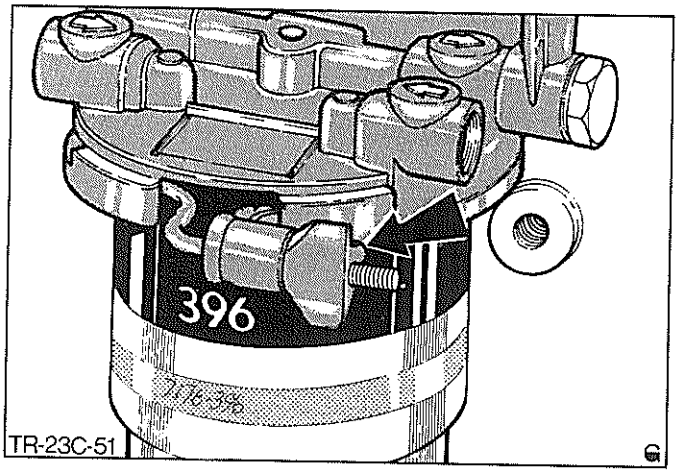

Fig.74. Slacken fuel filter band clamp securing wing nut fully before removing filter element.

23 546 ELEMENT - FUEL FILTER - REPLACE

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers and disconnect battery.

2. Place a protective cover over starter motor.

3. Slacken off fully fuel filter element retaining clamp wing nut.

4. Carefully pull fuel filter element sideways and down towards starter motor in order to remove from filter body.

5. Drain fuel from filter into suitable container. Refer to Section 05 - Health and Safety Precautions of this Manual for the disposal of the waste fuel.

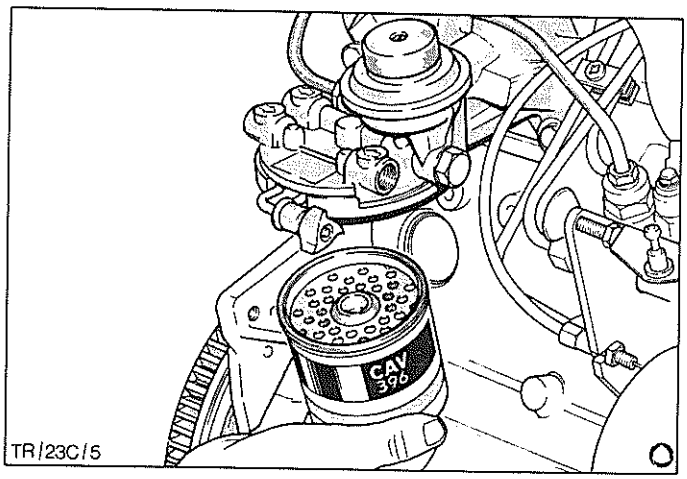

Fig.75. Carefully pull down fuel filter. Care must be taken not to spill fuel over starter motor.

23 546

To Install

6. Insert new fuel filter element into filter body, push element up until it dips into position.

7. Tighten filter element retaining clamp wing nut fully (by hand).

8. Pull down on element to ensure it is correctly locked in position.

9. Remove protective cover from starter motor assembly.

10. Reconnect battery and start engine. Run engine until fuel system purges itself of air.

NOTE: For engines equipped with a CAV fuel system the fuel filter system should be primed using the fuel hand primer pump before attemtping to start the engine.

11. Remove fender covers and close hood.

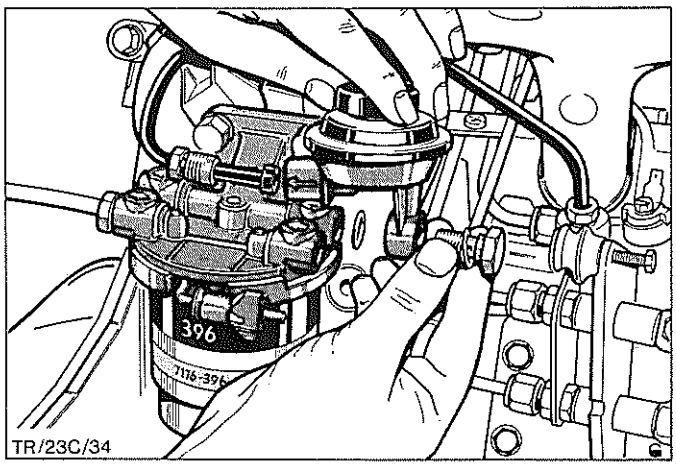

Fig.76. Priming fuel filter using primer pump assembly (CAV fuel system only).

23 548 FUEL RESERVOIR - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers, disconnect battery.

2. Place suitable drain tray below reservoir.

3. Disconnect breather pipe.

4. Disconnect fuel supply and outlet pipes.

5. Remove two bolts and detach reservoir.

To Install

6. Locate reservoir in position and secure.

7. Reconnect fuel supply and outlet pipes to reservoir.

8. Reconnect breather pipe.

Reconnect battery, remove fender covers and close hood.

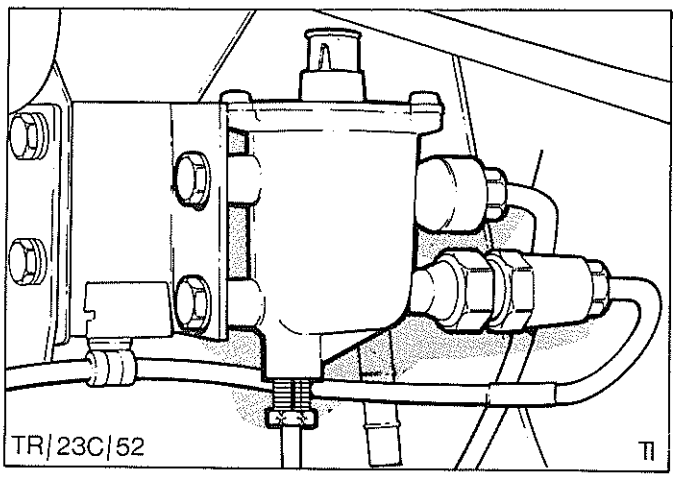

Fig.77. Cold start reservoir.

23 766 ELEMENT - FAST FLAME HEATER - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

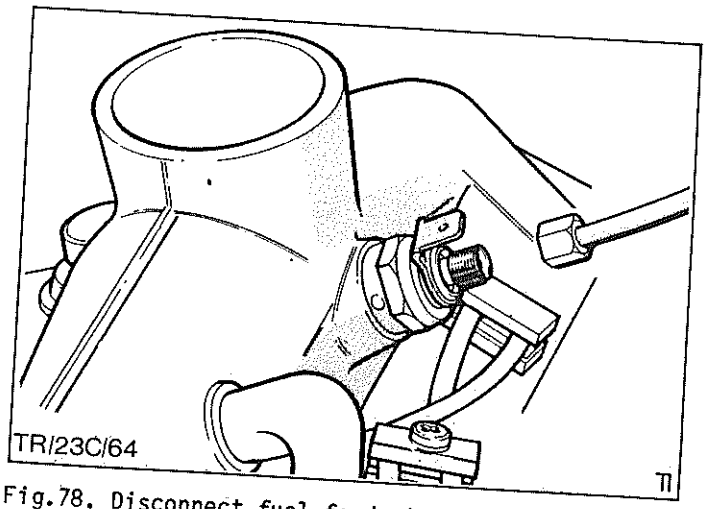

Fig.78. Disconnect fuel feed pipe from heater element.

To Remove

1. Open hood, fit fender covers, disconnect battery.

2. Using suitable container drain fast flame heater element fuel supply pipe by removing the fuel pipe from the heater connection.

3. Remove air cleaner assembly as detailed in Operation 23 174 of the section.

4. Disconnect the electrical connection from the inlet manifold fast flame heater element.

5. Unscrew fast flame heater element from inlet manifold.

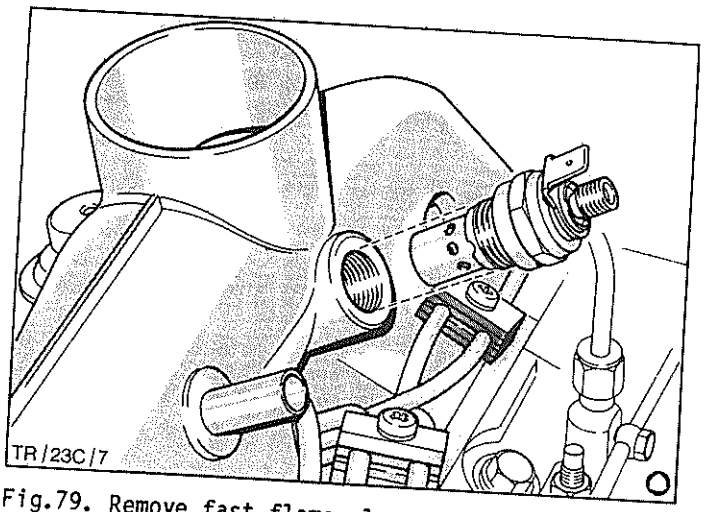

Fig.79. Remove fast flame element from inlet manifold.

To Install

6. Screw in heater element into inlet manifold and tighten to correct specification.

7. Reconnect fuel supply pipe to heater element.

8. Reconnect electrical connection to heater element.

9. Refit air cleaner assembly as described in Operation 23 174.

10. Reconnect battery, remove fender covers and close hood.

23 826 CABLE - ACCELERATOR - REMOVE AND INSTALL (includes: adjust)

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers, disconnect battery.
2. From inside vehicle, disconnect accelerator cable from pedal shaft.
3. From under hood disconnect outer cable complete with retaining grommet from bulkhead outer cable support bracket. Using screwdriver, prise grommet out of bulkhead bracket.
4. Remove outer cable grommet and discard the grommet (a new grommet must be used if cable is to be refitted). Unclip cable from top edge of radiator.
5. Using a spare cable bracket (Part Number 72GB9677UA) make up a special tool for disconnecting cable from engine bracket as described in Section 23A, Operation No.23 826.
6. Disconnect inner cable from injection pump throttle lever.
7. Pull out steel clip and use special tool to remove adjuster from engine bracket and detach cable assembly.

NOTE: On LHD vehicles it is necessary to remove plastic tie clip from radiator top hose.

To Install

8. Position cable through engine bracket and reconnect inner cable to injection pump throttle lever.
9. Push outer cable adjuster into engine bracket and ensure steel clip is pushed fully home.
10. Slide retaining grommet into bulkhead outer cable support bracket. Slide cable through grommet and bracket and push cable until it clicks into position.
11. From inside vehicle reconnect inner cable to throttle pedal.
12. Reclip throttle cable to top edge of radiator or secure to top hose (LHD).
13. With the assistance of a second technician, hold throttle pedal fully down until it stops on the support bracket, then adjust cable until full throttle is obtained on the injection pump lever.
14. Release throttle pedal and check that injection pump lever returns to its idle position.
15. Reconnect battery, remove fender covers and close hood.

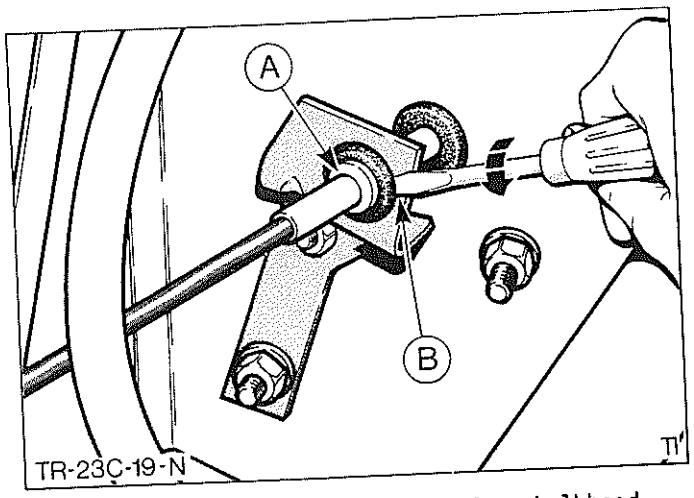

Fig.80. Disconnect throttle cable from bulkhead bracket.
A - Grommet
B - Insert screwdriver

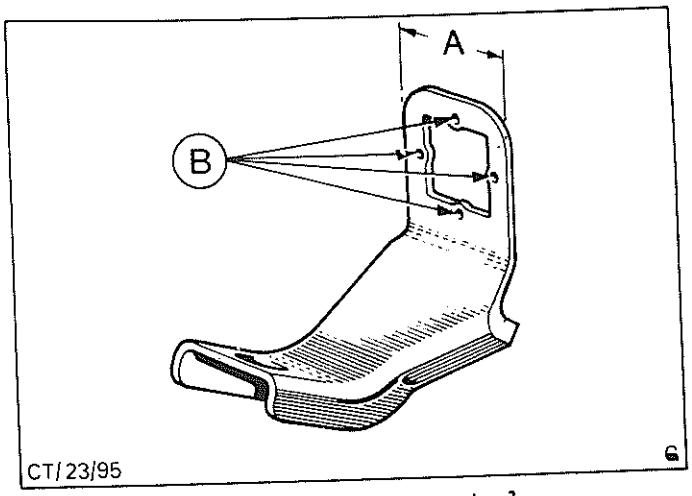

Fig.81. Accelerator cable remover tool.
A - 25 mm (1,0 in)
B - 4 dot holes

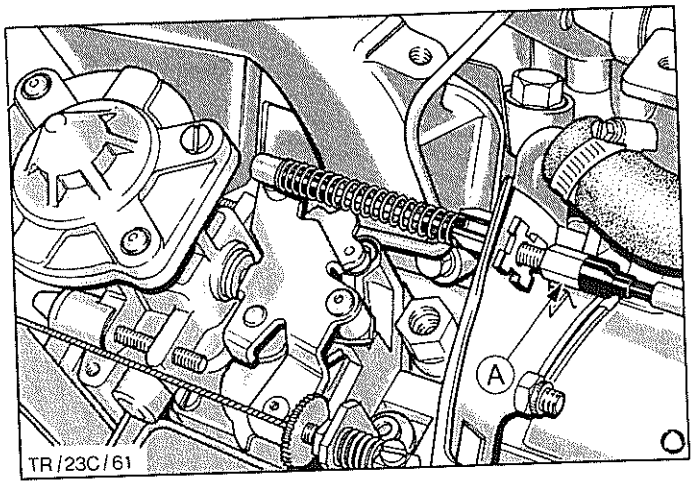

Fig.82. Adjust throttle cable tension.
A - Adjuster

23 828 CABLE - IDLE SPEED CONTROL - REMOVE AND INSTALL

SPECIAL SERVICE TOOLS REQUIRED: NONE

To Remove

1. Open hood, fit fender covers, disconnect battery.
2. Remove air cleaner assembly as detailed in Operation No. 23 174.
3. Drain coolant, refer to Section 24.
4. Remove the two waxstat securing bolts from thermostat housing.
5. Slacken outer cable adjusting nuts and remove cable from bracket. Lift out waxstat and cable assembly.
6. Disconnect idle speed control inner cable from cold start advance lever, lift out waxstat and cable assembly.

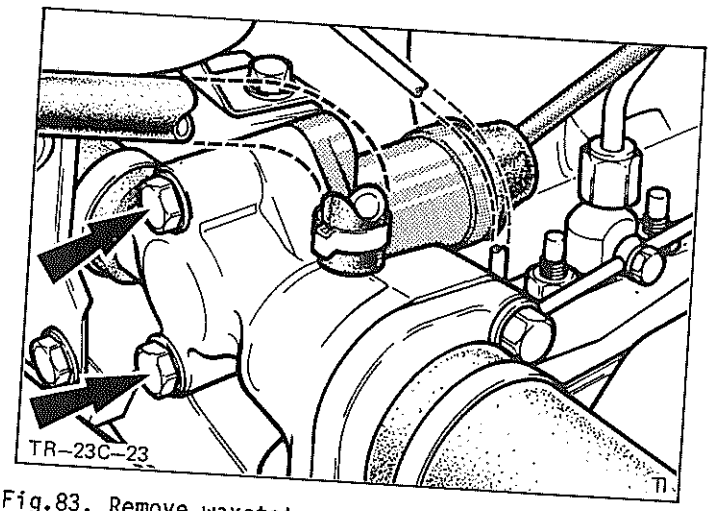

Fig.83. Remove waxstat securing bolts from thermostat housing.

To Install

7. Using new gasket refit waxstat to thermostat housing and secure.
8. Fit the idle speed control cable to the idle/advance lever.
9. Reconnect the outer cable to bracket with one nut either side.
10. Adjust cable as described below:

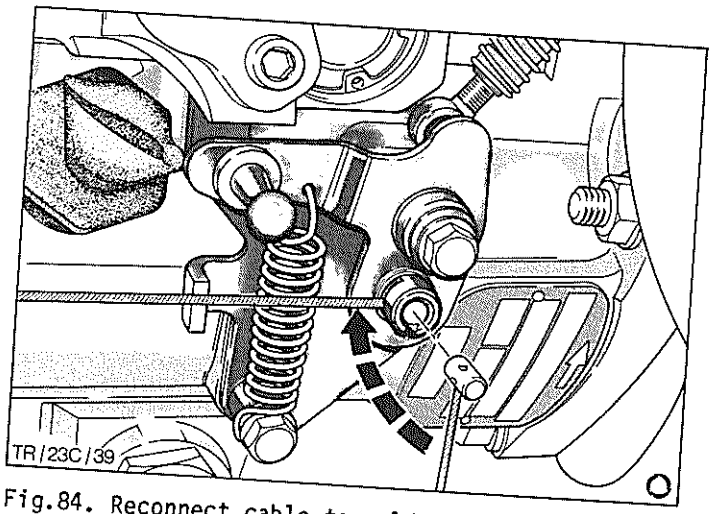

Fig.84. Reconnect cable to cold start advance lever.

CAV Injection Pump (engine temp. below 36°C 97°F)

- Fit the waxstat fast idle control cable nipple to the cold idle/advance lever. Fit the end adjuster to the bracket with the M6 locknuts either side.

NOTE: Vehicles built before June 1984 may be fitted with a -20°C waxstat and can be identified by the lettering C1C stamped on the outer body of the waxstat. Vehicles with this type of waxstat the outer cable will need to be pulled towards the rear of the engine (to fully tension the inner cable) when adjusting.

- Unscrew the outer cable and tighten other locknut against the fuel injection pump adjustment bracket to give 2 to 3 mm gap between the inner cable ferrule and adjuste end. Tighten locknut.
- Check that a gap of 2 to 3 mm exists between the inner cable ferrule and adjuster, and that the cold idle lever is hard against the cold stop.

NOTE: At engine temperatures ABOVE 36°C with the inner cable pulled hard towards the adjuster the cold idle/advance lever should be hard against the cold operation stop, with a gap of 2 to 3 mm between inner cable ferrule and adjuster end.

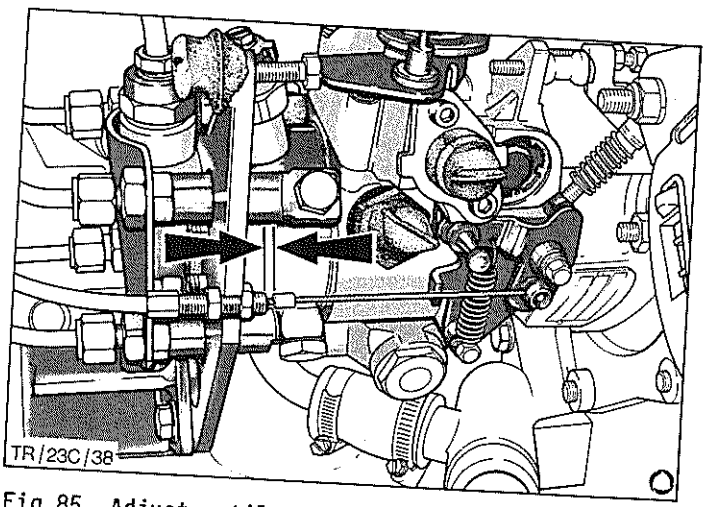

Fig.85. Adjust until a 2 to 3 mm gap between ferrule and end of cable adjuster.

23 828

Bosch Injection Pump (engine temp. below 36°C 97°F).

- Fit the waxstat fast idle cable adjuster into pump bracket, the inner nut having been screwed onto the adjuster as far as possible, and the outer nut finger tight against the bracket.
- Feed inner cable through the fuel injection pump spring loaded fast idle sleeve to adjust the cable.
- Rotate the fuel injection pump throttle lever forward into the open position and temporarily return in this position.
- Push the spring loaded fast idle sleeve fully home against the fast idle stop, and tighten the cable clamping screw (exposed inner cable should be kept as straight as possible during this operation).
- Unscrew outer adjusting nut and tighten inner locknut against the bracket until a 2 to 3 mm gap exists between inner cable ferrule and adjuster end is obtained. Tighten locknuts against bracket.
- Release throttle lever.
- Check that a 2 to 3 mm gap exists between the inner cable ferrule and adjuster end when the fast idle sleeve is hard against the fast idle stop.

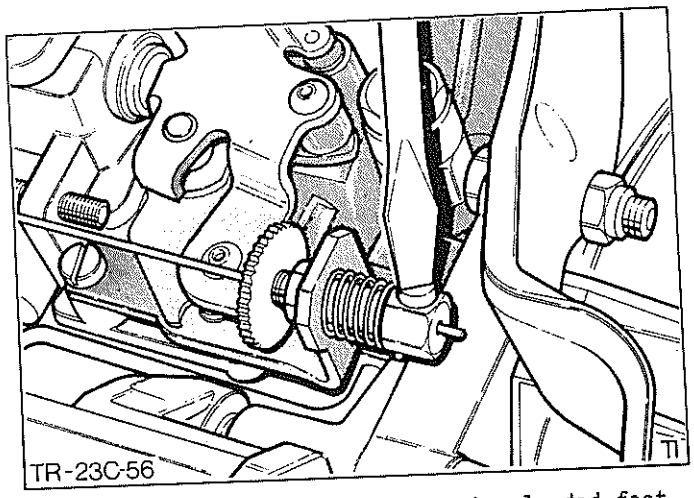

Fig.86. Reconnect cable to the spring loaded fast idle sleeve.

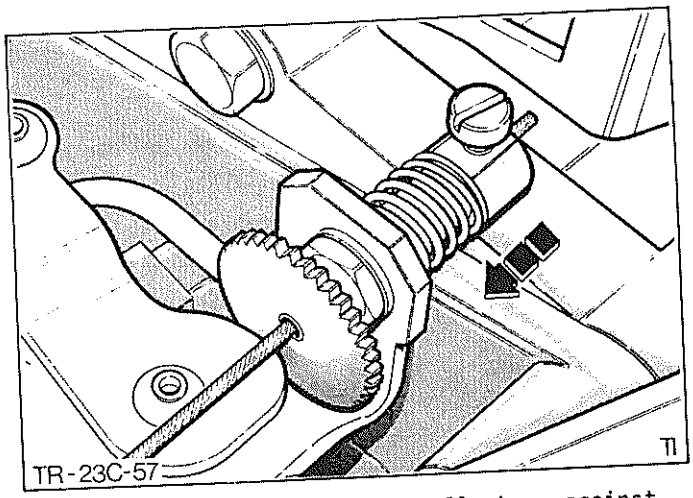

Fig.87. Push fast idle sleeve fully home against its stop in the fast idle position.

11. Refill coolant to correct level.
12. Refit air cleaner assembly as described in Operation 23 174.
13. Reconnect battery, remove fender covers and close hood.

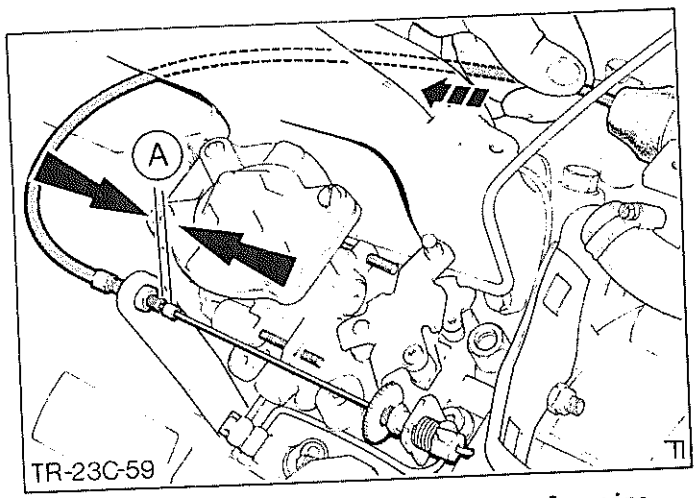

Fig.88. Pull outer cable towards rear of engine. A - 2 to 3 mm gap between the end of cable adjuster and ferrule must exist.

TECHNICAL DATA

GENERAL

Injection Pump Timing	11° before top dead centre
Timing Belt Tension	220 - 345 N (50 - 78 lbf)
Engine Idle Speed	800 - 850 RPM
Engine Maximum Full Load Speed	4000 RPM
Engine Maximum No Load Speed	4320 - 4480 RPM
Fuel Tank Capacity	68 litres (15 Imp. galls.)
Injector burst pressure settings	CAV 260 atmospheres Bosch 250 atmospheres

Back Leak Time:

Bosch - Pressure Fall 240 to 190 Bar	5 to 40 seconds
CAV - Pressure Fall 172 to 142 Bar	5 to 40 seconds

Ambient Temperature/Back Leak Time Correction chart

Ambient Temp. °C	Ambient Temp. °F	Corrected Time in Seconds	
10	50	7 to 34,5	
16	60	6 to 30	Nominal
21	70	5,5 to 27	
27	80	5 to 24	
32	90	4,5 to 21	

TECHNICAL DATA

Tightening Torques

(Clean threads slightly oiled)

	Nm	kgm	lbf.ft
Alternator:			
Adjusting strap M8	12 to 15	1,2 to 1,5	9 to 11
Support bracket M8	18 to 23	1,8 to 2,3	13 to 17
Crankshaft:			
Pulley centre bolt	312 to 345	31,8 to 35,3	230 to 256
Flywheel to crankshaft	59 to 67	6,0 to 6,8	44 to 49
Fuel filter to inlet manifold	15 to 21	1,5 to 2,1	11 to 15
Hand primer banjo bolt	26 to 34	2,6 to 3,4	19 to 25
Leak-off pipe connections			
Side fitting	6 to 8	0,6 to 0,8	4 to 6
Pump top fitting	15 to 21	1,5 to 2,1	11 to 15
Low pressure fuel pipe unions (rubber olive type)	9 to 11	0,9 to 1,1	7 to 8
Injection pump:			
Pump to mounting plate	21 to 26	2,1 to 2,6	15 to 19
Mounting plate to front housing	24 to 30	2,4 to 3,1	18 to 22
Rear support bracket bolts	21 to 26	2,1 to 2,6	15 to 19
Pulley bolts	22 to 27	2,2 to 2,7	16 to 20
C.A.V. stop solenoid	15 to 20	1,5 to 2,0	11 to 15
Bosch stop solenoid	20 to 25	2,0 to 2,5	15 to 18
Bosch advance expansion element	15 to 20	1,5 to 2,0	11 to 15
Bosch advance unit banjo bolts (M6)	8 to 12	0,8 to 1,2	4 to 9
Injectors			
Injector clamp nuts	12 to 15	1,2 to 1,5	9 to 11
Feed pipe nuts	18 to 20	1,8 to 2,0	13 to 15
Feed pipe clamps	7 to 9	0,7 to 0,9	5 to 7
Manifolds			
Exhaust to head	40 to 50	4,5 to 5,1	32 to 37
Inlet to head	20 to 25	2,0 to 2,5	15 to 18
Oil Pump:			
Pump to front housing	17 to 21	1,7 to 2,1	12 to 15
Cover to front housing	20 to 25	2,0 to 2,5	15 to 18
Rocker cover 1st stage			
Tighten screws in sequence	6 to 8	0,6 to 0,8	4 to 6
2nd stage	6 to 8	0,6 to 0,8	4 to 6
IMMEDIATELY retorque in same sequence			
Rocker shaft:			
Locating bolts - M6	8 to 11	0,8 to 1,1	6 to 8
Pedestal bolts - M8	26 to 32	2,6 to 3,3	19 to 24
- M10	63 to 70	6,4 to 7,0	46 to 51
Timing belt:			
Cover to front housing	5 to 9	0,5 to 0,9	4 to 7
Tensioner plate	20 to 25	2,0 to 2,5	15 to 18
Idler pulley centre bolt	51 to 64	5,2 to 6,5	38 to 47
Vacuum Pump:			
Pump to front housing	31 to 39	3,2 to 4,0	23 to 29
Pump pulley nut	70 to 90	7,1 to 9,2	52 to 66
Water Pump:			
Pump to front housing - M8	11 to 15	1,1 to 1,5	8 to 11
- M10	40 to 51	4,1 to 5,2	30 to 38
Pulley bolts	7 to 10	0,7 to 1,0	5 to 7