



## Section 6

# Test Procedures

Service Manual - JCB 444 Engine

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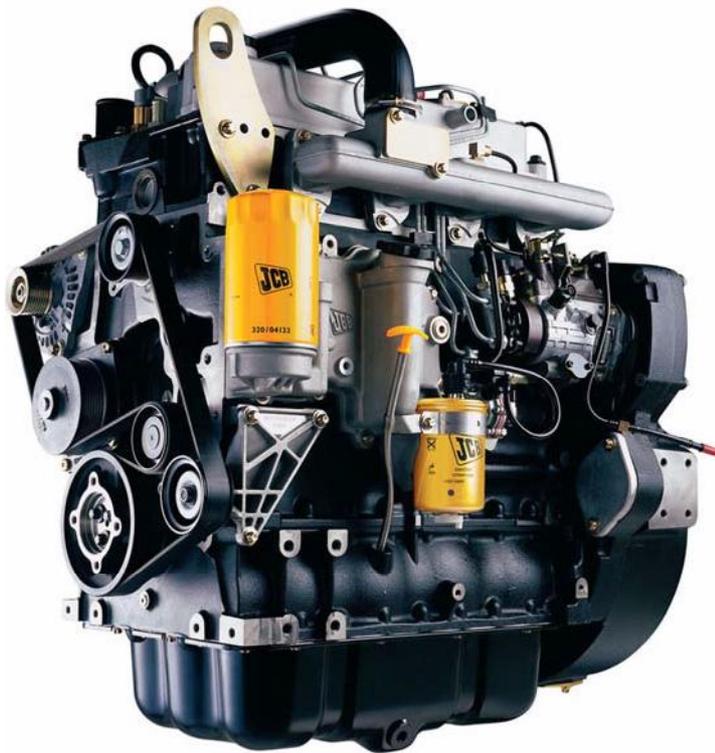
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# Introduction

## Test Procedures Introduction

When completing any tests on equipment, the appropriate safety precautions must be adhered to.

Refer to **Care & Safety, Section 2**, for a reminder of safe practices and potential hazards.

Use appropriate testing equipment. Always use genuine parts and equipment.

A list of the recommended service tools is given in Section 1, use the tools when specified. For instance, there is a crankshaft turning tool specifically designed to enable the engineer to turn the engine by hand (say to set top dead centre (TDC)).

Safety must always come first, if you are unsure about any of the procedures, ask someone who knows.

If the engine must be running during the test, make sure there is adequate ventilation. If the machine is inside, then exhaust extraction equipment should be used.

## Testing

### Lift Pump Operation

⇒ [Fig 1. \(Fig 6-3\)](#)

The lift pump is a diaphragm type driven from the engine camshaft. The pump draws fuel from the tank, through the water trap, pumping it through the filter and into the fuel injection pump.

The pump incorporates a manually operated priming lever to aid fuel priming after maintenance.

Refer to **Section 4, Fuel System Descriptions** for a more detailed description of operation.

#### Pressure Test Procedures

If the fuel lift pump is suspect, then measure the output pressure between the fuel filter and the injection pump inlet.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Fit a suitable pressure gauge in the low pressure fuel line **1-A** (the fuel filter to injection pump inlet).
- 3 Start the engine and increase the speed to the 2200rpm.
- 4 Note the gauge reading which should be as detailed in **Section 1, Technical Data**.
- 5 If the volume of fuel is not being delivered, measure the lift pump inlet restriction.

#### Measuring the Inlet Restriction

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Fit a suitable vacuum gauge in the low pressure fuel line **1-B** (from pre-filter to lift pump inlet).
- 3 Start the engine and increase the speed to the 2200rpm.

- 4 Note the gauge reading which should be as detailed in **Section 1, Technical Data**.

**Note:** As the fuel filter becomes more blocked, the pressure drop from inlet to outlet will increase. If changing the fuel filter improves engine power performance, check if the lift pump is worn (a worn lift pump will not be able to force fuel through a partially blocked filter as easily as a clean filter).

- 5 If the volume is low, repeat the same test but from a temporary clean fuel supply into the lift pump inlet.
- 6 If using the temporary clean fuel supply solves the problem, check for leaks, bad connection, kinks or severe bends etc between the tank and the lift pump inlet.

In cold weather check if waxing has occurred in the fuel lines. Clean the fuel lines as required.

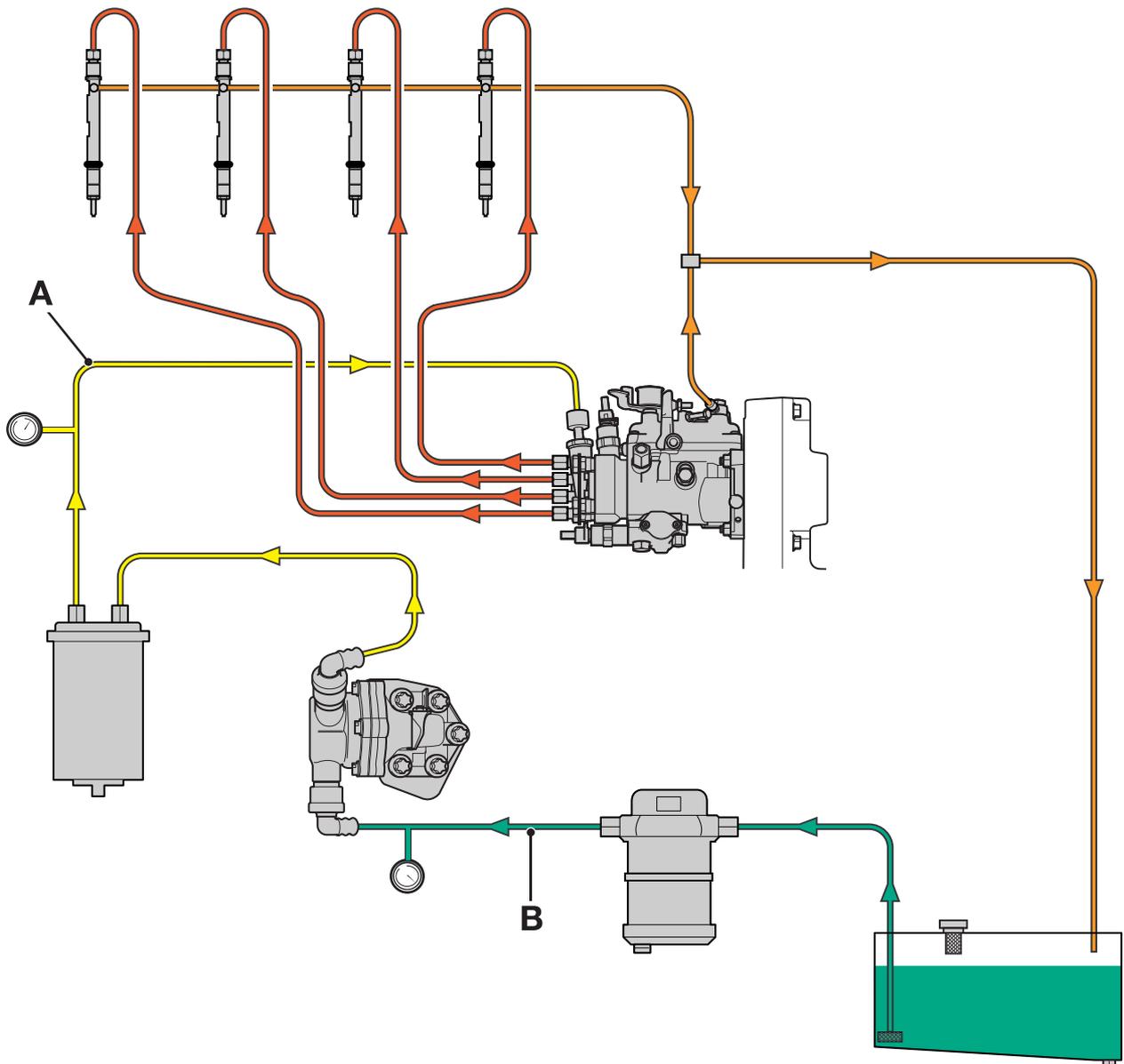


Fig 1.

## Fuel Injection Pump Delivery

Use the procedure described to check that high pressure fuel is being delivered to the fuel injectors.

Do not complete the procedure on a hot engine, fuel spilled onto a hot exhaust could create a risk of fire.

### WARNING

#### Diesel Fuel

Diesel fuel is flammable; keep naked flames away from the fuel system. Do not smoke while refuelling or working on the fuel system. Do not refuel with the engine running. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2\_1

### WARNING

Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of pressurised fluid and wear protective glasses. If fluid penetrates your skin, get medical help immediately.

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### WARNING

Hot oil and engine components can burn you. Make sure the engine is cool before doing this job. Bleeding a hot engine could cause fuel to spill on to a hot exhaust manifold creating a danger of fire.

13-3-1-16

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 With the engine switched off, loosen the 4 x injector union pipe fittings as shown at **2-A** (see Note).

**Note:** It is not necessary to completely remove the fitting, simply release the holding torque and leave the fitting loose but not completely removed.

- 3 Crank the engine and check for air free fuel from the loosened fittings.
- 4 Torque tighten the fittings to 25 - 26 Nm (16 - 19 lbf ft).

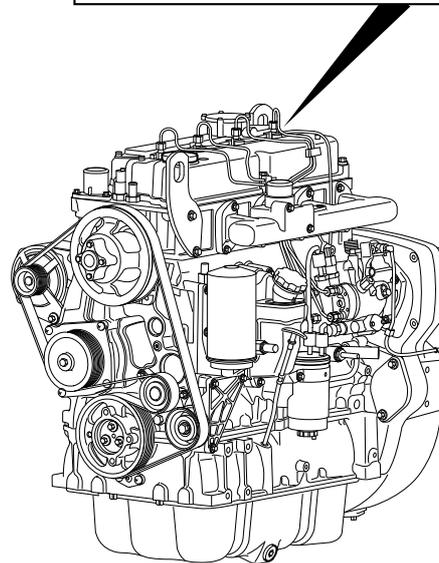
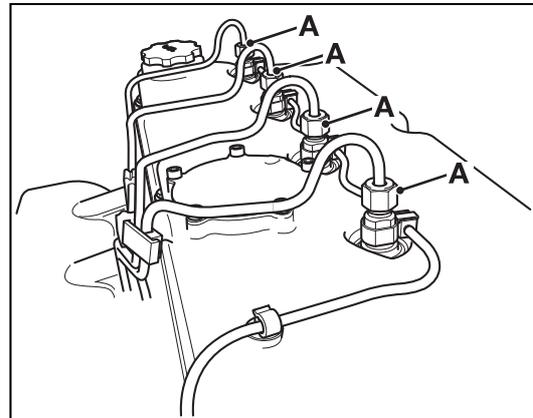


Fig 2.

## Engine Compression

⇒ [Fig 3.](#) ( [Fig 6-6](#) )

The following procedures describe how to check the engine compression using a 'dummy injector', refer to **Section 1, Special Tools** for the dummy injector part number.

Several factors can influence the compression pressure, the following conditions are assumed:

- The valve clearances have been set correctly, refer to **Section 12, Valve Clearances Adjustment** for the correct procedure.
- The correct engine oil lubrication oil has been used, refer to **Section 1, Lubricants and Capacities**.
- The engine oil level is correct, refer to **Section 3, Checking the Oil Level**.
- The correct type of diesel fuel has been used and the system correctly primed, refer to **Section 1, Fuel System Technical Data**.
- The battery and starting circuit is fully charged and in good condition, e.g. good earth paths, cable connections tight etc.

The compression tests should not be the only method used to check the condition of the engine, check other symptoms and complete additional tests were applicable.

When comparing the figures recorded in the following procedures, there should be a minimum variation of 3.5 bar (50 lb/in<sup>2</sup>) between each cylinder. If the variation is greater than this figure, then remove the cylinder head, refer to **Section 12** and closely inspect the cylinder bores, pistons and piston rings for signs of wear or damage. Repair as necessary.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Remove all four fuel injectors, refer to **Section 7, Fuel Injectors (Atomisers)**. Make sure the injectors are labelled for correct refitting at a later stage.
- 3 Install the 'dummy injector' item **3-A** in one of the vacant cylinder injector bores.
- 4 Fit a suitable pressure test gauge into the dummy injector fitting (see Note).

**Note:** The dummy injector is drilled and tapped 1/8-28 BSP x8.00mm deep to accept a standard pressure gauge fitting.

- 5 Ensure the engine will not start by removing the electric shut off solenoid (ESOS) fuse - refer to the machine handbook for fuse location and identification.

### WARNING

**When the engine is turning, there are parts rotating in the engine compartment.**

**Before starting this job make sure that you have no loose clothing (cuffs, ties etc) which could get caught in rotating parts.**

**When the engine is turning, keep clear of rotating parts**

2-3-3-10

- 6 Operate the starter motor to crank the engine, do not crank for longer than 20 seconds. Record the gauge reading.
- 7 Repeat steps 3 to 6 for the remaining three cylinders.

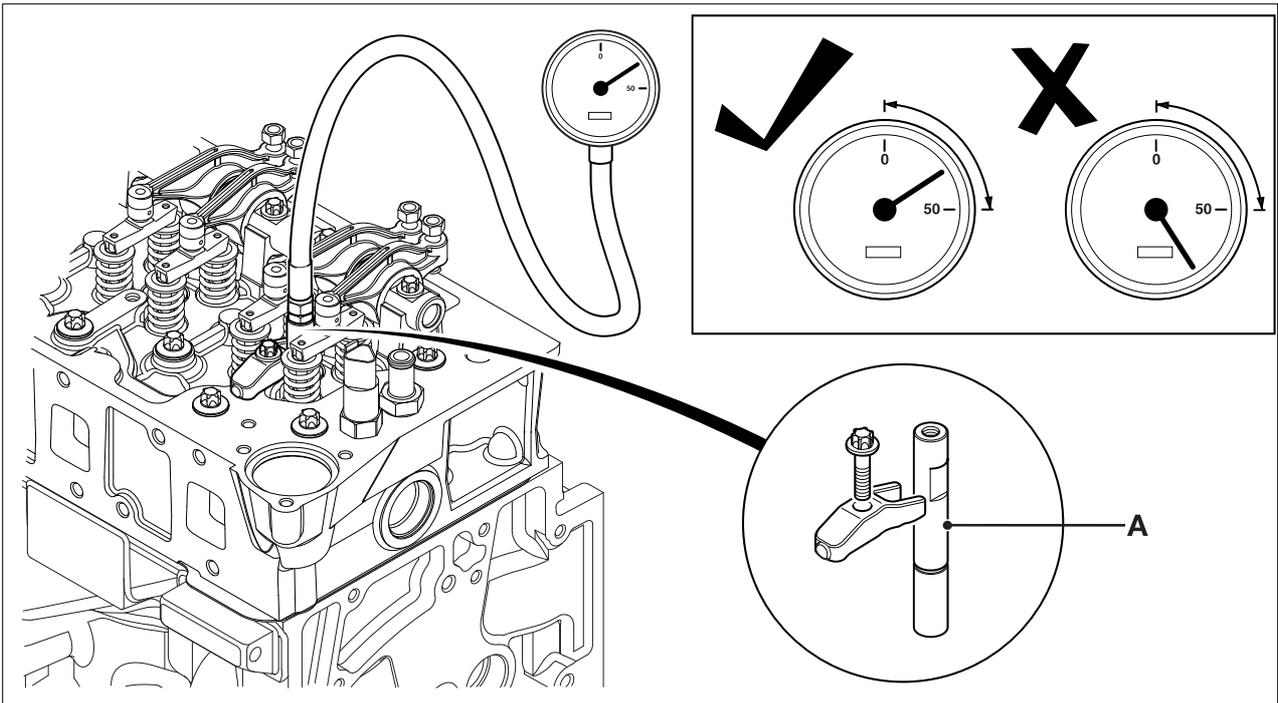


Fig 3.

## Engine Oil Pressure

Use the following procedures to measure the oil pressure. Refer to **Section 4, System Descriptions** for a full explanation of the lubricating oil circuit.

Several factors can influence the engine oil pressure, the following conditions are assumed:

- The correct engine oil has been used, refer to **Section 1, Lubricants and Capacities**.
- The engine oil level is correct, refer to **Section 3, Checking the Oil Level**.

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Disconnect the electrical connector to oil pressure switch **4-A**, and remove the switch from the cooler housing.
- 3 Fit a suitable test gauge into the vacant pressure switch port (M10x1.5 thread). Make sure the gauge has a sealing washer as shown at **4-B**.
- 4 Start the engine, increase the engine revs to the rated speed. Record the pressure gauge reading - refer to **Section 1, Technical Data**, for the recommended circuit pressure.
- 5 Remove the pressure gauge and refit the pressure switch.

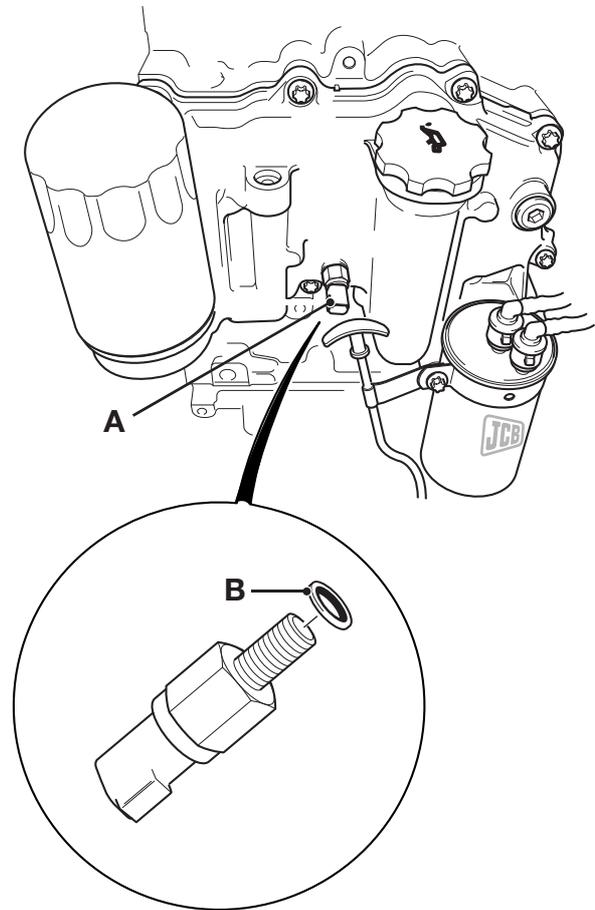


Fig 4.

### High Lubrication Oil Pressure

High oil pressure will be evident when starting in cold conditions. Typically the pressure will be 1 to 2bar (15 to 30lb/in<sup>2</sup>) higher in cold operation, the pressure should drop when the engine reaches normal operating temperature.

If the pressure remains high when operating temperature is achieved, check the oil level, if this is correct, suspect the oil pump relief valve is at fault.

### Low Lubrication Oil Pressure

Several factors can be the cause of low lubricating oil pressure:

- **low oil level** - typically evident as a loss of pressure when operating on uneven ground or on a gradient.
- **blocked oil filter** - a blocked filter will show as a gradual loss of pressure.
- **blocked suction strainer (pick-up pipe)** - typically evident as low pressure on start up, if the blockage frees itself in the sump, the pressure will pick up to normal.
- **coolant in the oil** - coolant in the lubricating oil will show as a 'milky' discolouration of the oil. and an increase in oil level. Check for damaged core plugs, lubricating oil cooler, cylinder head and/or gasket.
- **fuel in the oil** - fuel in the oil will result in 'thin' black lubricating oil, the oil will also have a diesel fuel smell. Check the FIP shaft seal, piston ring wear, lift pump diaphragm damage or injector leakage if fuel is evident in the oil.

## Thermostat

⇒ [Fig 5. \(□ 6-10\)](#)

A single thermostat **5-B** is used in the JCB 444 Engine. The thermostat is of the wax element type. Refer to **Section 4, Cooling System Description** for a detailed description of operation.

The thermostat is not repairable, if the unit is faulty, then a complete new item must be fitted.

### **WARNING**

**The cooling system is pressurised when the coolant is hot. When you remove the cap, hot coolant can spray out and burn you. Make sure that the engine is cool before you work on the cooling system.**

9-3-3-1\_2

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Remove the thermostat housing **5-A** and the thermostat **5-B** - refer to **Section 8, Cooling System** for the correct removal and replacement procedures.
- 3 Suspend the thermostat in a suitable container of coolant. Using an external heat source, gradually increase the temperature of the coolant.

**Note:** *When working with boiling water, all the necessary safety precautions must be taken.*

- 4 Using a thermometer, measure the temperature of the coolant.
- 5 When the coolant reaches the operating range of the thermostat the valve should start to open - movement of valve plate **5-C** should be evident.
- 6 Record the starts to open temperature, the fully open temperature and the amount of valve lift when fully open. Compare this with the data in **Section 1, Cooling System Technical Data**.

**Note:** *A period of 3 to 5 minutes before the thermostat valve starts to operate is normal because of the time required to 'heat soak' the thermostat.*

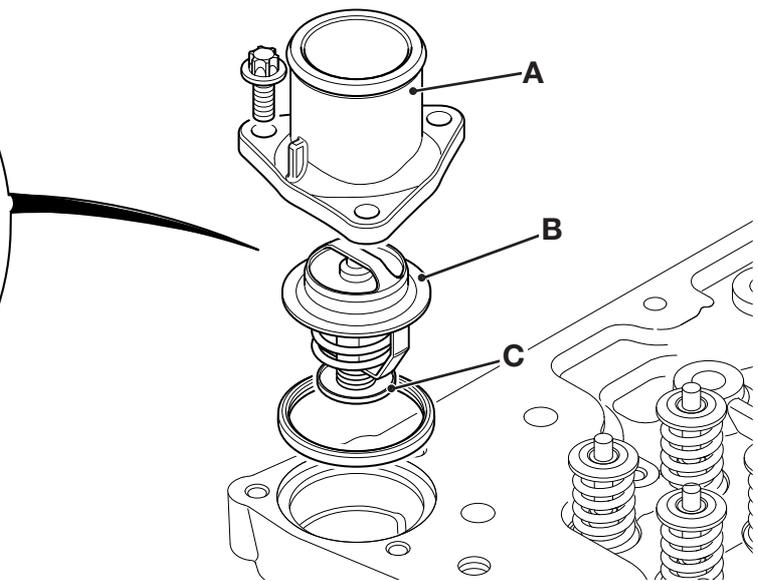
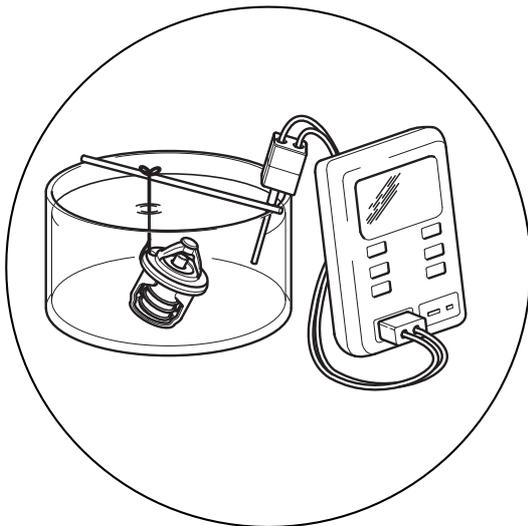
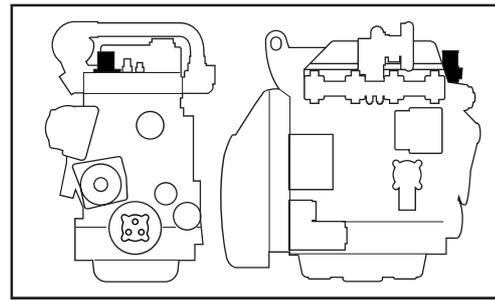


Fig 5.

## Air System and Turbocharger

⇒ [Fig 6. \(□ 6-12\)](#)

Excessive smoke from the exhaust stack combined with a complaint of low power could be as a result of:

- Dirt or dust (unfiltered air) ingested directly into the engine resulting in damage to the cylinder bores, there will also be a possible increase in oil consumption.
- Air leaks from the air hose connections.
- Exhaust manifold leaks (turbocharged engines).

### Air Filters

The air filter inner element **6-A** and outer element **6-B** should be changed at the recommended interval, refer to **Section 1, Service Schedules**.

In addition, most air filter housings will be fitted with a vacuum switch **6-C**. The switch will detect if there is a restriction on the air intake, and activate warning indicators such as an audible alarm and/or a visual indicator.

### Air Intake Connections

Check all hose connections for loose fitting and damaged hose clamps. Look specifically for splits or cracks in the hoses, as illustrated at **6-D**.

**Naturally Aspirated Engines:** Inspect the hoses regularly for tightness, splits and cracks. Pay particular attention to the hose **6-E** after the air filter into the intake manifold.

**Turbocharged Engines:** Inspect the hoses regularly for tightness, splits and cracks. Pay particular attention to the connections on the air intake to turbo compressor **6-F** and on the cross-over tube **6-G**.

### Exhaust Manifold Leaks (Turbocharged Engines)

Visually inspect for leaks at the exhaust manifold and turbocharger, shown at **6-H**. Make sure all gaskets are in good condition, replace as required.

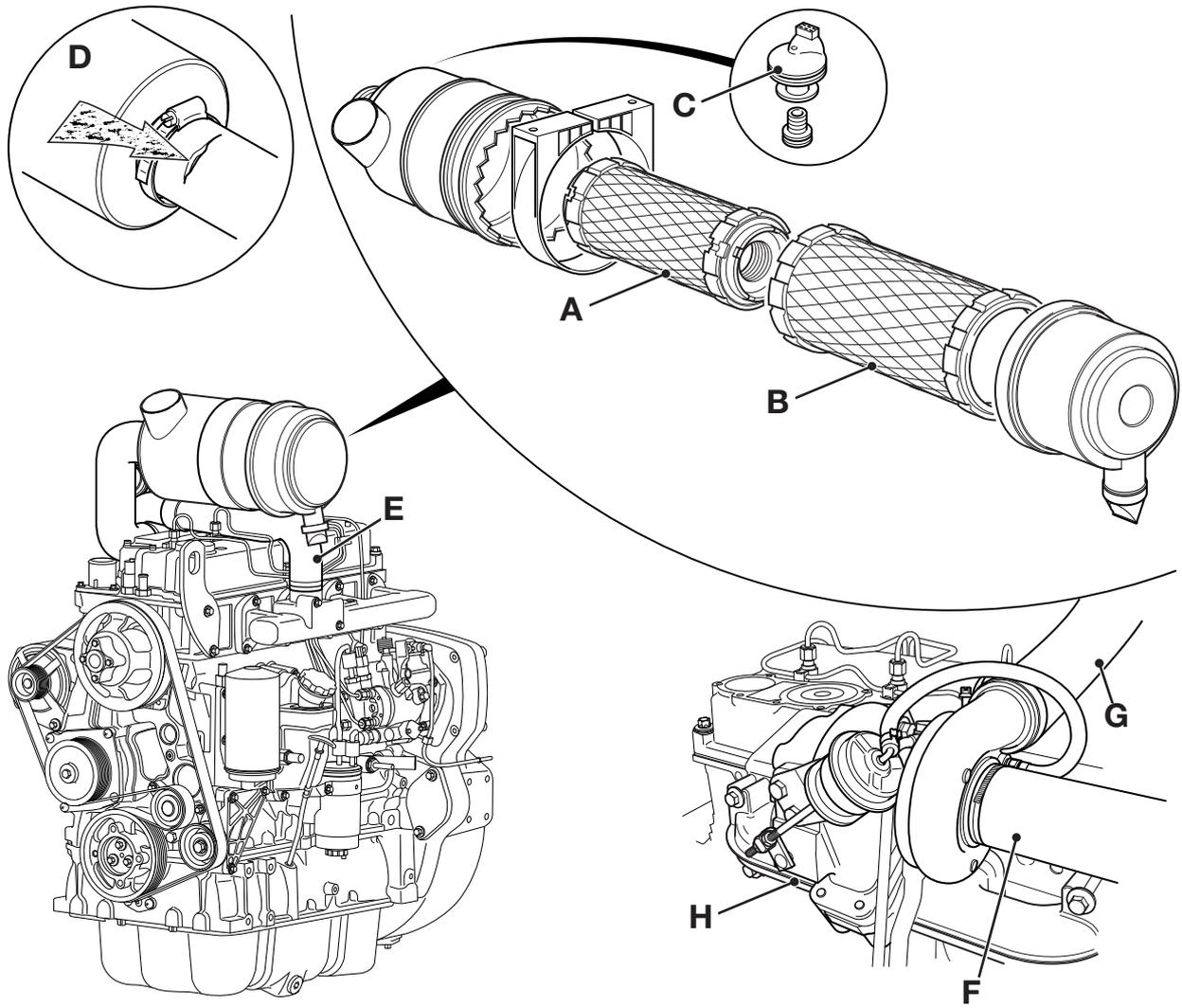


Fig 6.

## Turbocharger Checks

If unfiltered air has entered the turbocharger, then this could damage the compressor blades causing the unit to become imbalanced, eventually leading to bearing damage.

This type of failure would be particularly noticeable due to a drop in engine performance, possibly associated with excessive smoke.

Checking of the turbocharger is limited to visual and mechanical inspection of the blades and bearings. Measuring boost pressures (see **Section 4, Induction, Exhaust and Breather Systems**) is not an exact measurement of performance due to differing loads, engine ratings and application variants .

### **⚠ WARNING**

**Make sure the engine cannot be started. Disconnect the battery before doing this job.**

2-3-3-5

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Remove the compressor intake hose (shown at 7-A) and the exhaust pipe from the turbo unit (shown at 7-B).
- 3 Manually turn the turbine assembly. The blades should rotate freely with no interference. If the blades contact the housing face, or if there is a 'grating' feel as the unit is turned, then it is likely that the bearings have been damaged.

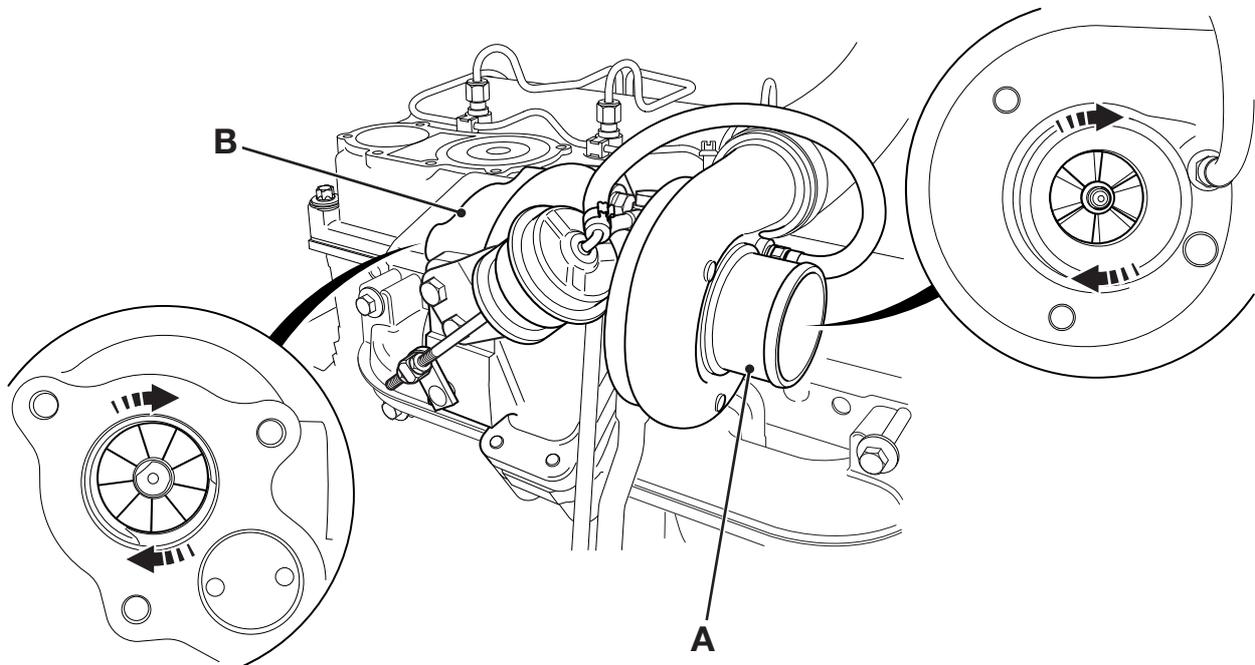


Fig 7.

### Wastegate Operational Check

⇒ [Fig 8. \(□ 6-15\)](#)

The pressure generated by the turbo compressor is known as 'boost pressure'. The boost pressure is controlled by the wastegate assembly. Refer to **Section 4, Induction, Exhaust and Breather Systems** for a full description of operation.

The procedure below describes how to check for wastegate movement and operation.

#### **WARNING**

**Make sure the engine cannot be started. Disconnect the battery before doing this job.**

2-3-3-5

- 1 Park and make the machine safe in accordance with the machine handbook instructions.
- 2 Set a dial test indicator (DTI) **8-A** onto the end face of the pushrod assembly **8-B**, as shown.
- 3 Attach a clean and regulated remote air supply to the wastegate capsule, as shown at **8-C**.
- 4 Apply a 1 bar (14.5 lb/in<sup>2</sup>) air supply, the actuating rod should move approximately 5 mm (0.25 inches).

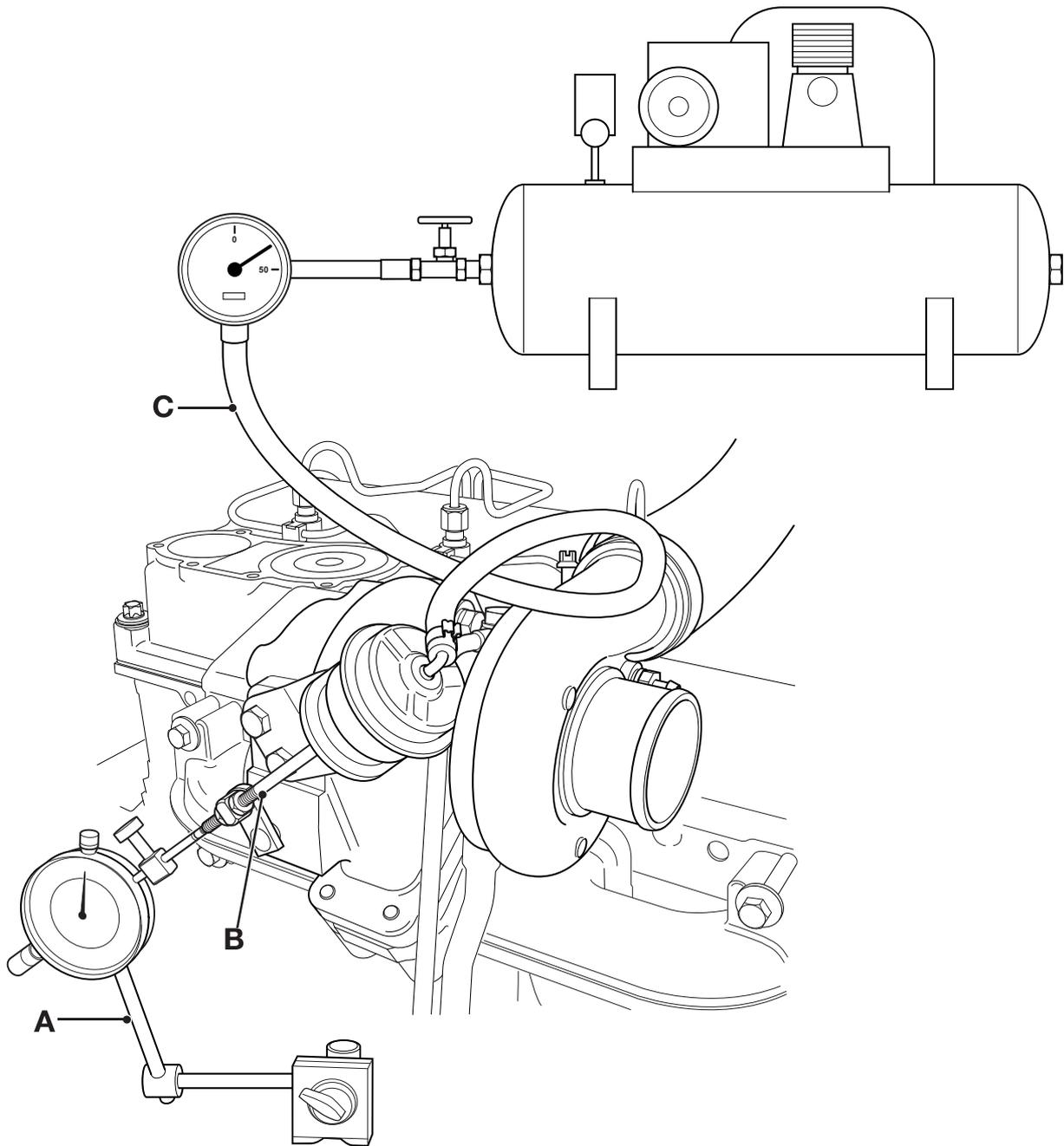


Fig 8.

## Using a Multimeter

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In order to obtain maximum benefit from the fault finding information contained in Section C it is important that the technician fully understands the approach to fault finding and the use of the recommended test equipment, in this case a FLUKE 85 or AVO 2003 digital multimeter, or a moving pointer (analogue) multimeter. The approach is based on a fault finding check list. In tracing the fault from the symptoms displayed you will be directed to make measurements using a multimeter.

These instructions are intended to cover the use of the recommended multimeters.

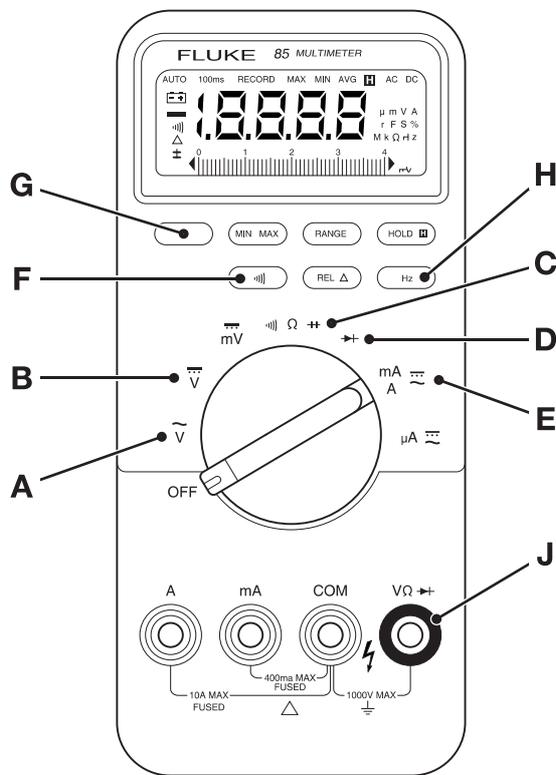


Fig 9. FLUKE 85

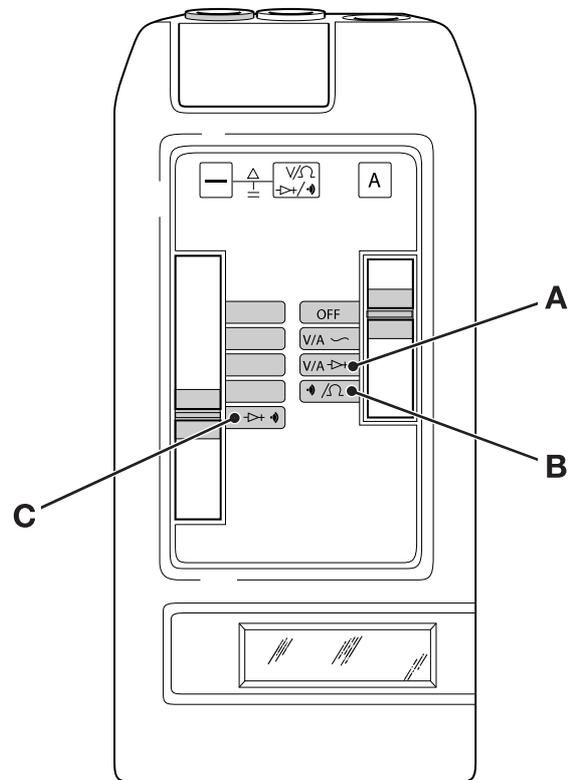


Fig 10. AVO 2003

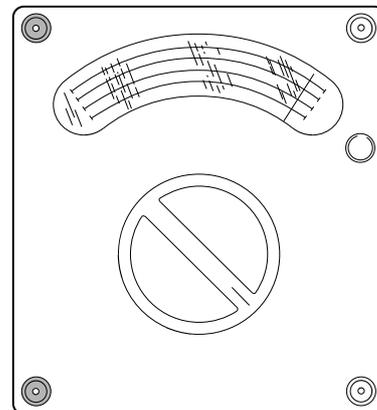


Fig 11. A Typical Analogue Meter

- 1 Make sure that the test leads are plugged into the correct sockets. The black test lead should be

plugged into the black socket (sometimes, this socket is also marked by a "-", or "E" or marked as "COMMON" or "COM"). The red test lead should be plugged into the red socket marked with "+", "V" or "Ω".

- 2 When making measurements ensure that the test probes have a good clean contact with bare metal, free from grease, dirt, and corrosion as these can cause a false reading.
- 3 When measuring voltage: Make sure that the correct range is selected, that is set the selector to a value equal to or greater than that you are about to measure. e.g. If asked to measure 12 Volts, set the selector to the 12V range. If there is no 12V range, set the selector to the next range higher, 20V for instance. If the meter is set to a range that is too low, it may be damaged. e.g. setting to the 2V range to measure 12V.

### Measuring DC Voltage

- 1 Select the correct range on the multimeter.
  - a On the FLUKE 85.  
Turn the switch to position **9-B**.
  - b On the AV0 2003.  
Move the right slider switch to position **10-A**, and the left hand slider switch to the appropriate range.
  - c On an analogue meter.  
Turn the dial to the appropriate DC Volts range.
- 2 Connect the black probe to the nearest available suitable earth point, usually this will be the starter motor earth, the battery negative, or the chassis. Connect the red probe to the wire or contact from which you are measuring the voltage.

### Measuring Resistance

- 1 Make sure there is no power to the part of the circuit you are about to measure.
- 2 Connect one probe at one end of the component or wire to be checked and the other probe at the other end. It does not matter which way round the two probes are placed.
- 3 Select the correct range on the multimeter.
  - a On the FLUKE 85.
    - i Turn the switch to position **9-C** and check that the W sign at the right hand side of the display window is on. If the F sign is on instead, press the blue button **9-G** to change the reading to Ω. Touch the meter lead probes together and press the **REL**<sup>3</sup> key on the meter to eliminate the lead resistance from the meter reading.
  - b On the AV0 2003.
    - i Move the right hand slider switch to position **10-B**, and the left hand slider switch to the appropriate Ohms (Ω) range.
  - c On an analogue meter.
    - i Move the dial to the appropriate Ohms (Ω) range.

### Measuring Continuity

- 1 Make sure there is no power to the part of the circuit you are checking for continuity.
- 2 Connect one probe to one end of the component or wire to be checked and the other probe to the other end. It does not matter which way round the two probes are placed.
- 3 Select the correct range on the multimeter.

**a** On the FLUKE 85.

Turn the switch to position **9-C** and check that the beeper symbol appears at the left hand side of the display window. If the F sign is on instead, press the button labelled **9-F** in the meter drawing.

If there is continuity in the circuit, the beeper will sound. If there is no continuity (open circuit), the beeper will not sound.

**b** On the AVO 2003.

Move the right hand slider switch to position **10-B**, and the left hand slider switch to position **10-C**.

If there is continuity (i.e. very low resistance) between two points the buzzer will sound.

**c** On an analogue meter.

Turn the dial to the lowest Ohms ( $\Omega$ ) range.

If there is continuity (i.e. very low resistance) between two points the needle will move across fully (or almost fully) to the right hand side of the scale.

### Measuring Frequency

The AVO 2003 and the analogue meter are not capable of measuring frequency, therefore a Fluke 85 digital multimeter must be used.

- 1 Insert the black plug into the COM socket on the meter and attach the probe to the nearest suitable earth point on the chassis, for example, the battery negative terminal.
- 2 Insert the red probe into socket **9-J**.
- 3 Turn the selector switch to position **9-A** and depress **9-G** repeatedly until **9-F** is highlighted on the top row of the display.
- 4 Press button **9-H** once.
- 5 Touch or connect the red probe to the frequency source to be measured. Press and hold button if an average reading is required.

### Testing a Diode or a Diode Wire

A diode wire is a diode with male connector fitted on one end and a female connector fitted on the other end. The diode is sealed in heatshrink sleeving.

#### 1 To test a Diode or a Diode Wire

##### a On the FLUKE 85.

- i Turn the switch to position **9-D**.
- ii Press the **HOLD** button and check that the **H** sign appears at the top right hand side of the display window.
- iii Connect the black probe to the end of the diode with a band or to the male connector of the diode wire. Connect the red probe to the other end of the diode or diode wire. If the beeper does not sound the diode or diode wire is faulty.
- iv Connect the red probe to the end of the diode marked with a band, or to the male connector of the diode wire, the black probe should be connected to the other end of the diode or diode wire. If the beeper sounds or the meter does not read **O.L.**, the diode or diode wire is faulty.
- v Press the **HOLD** button and check that the **H** sign disappears from the right hand side of the display window.

##### b On the AV0 2003.

- i Move the right hand slider to position **10-A**, and the left hand slider switch to position **10-C**.
- ii Connect the black probe to the end of the diode marked with a band, or to the male connector of the diode wire, the red probe should be connected to the other end of the diode or diode wire. If the Avometer does not buzz the diode is faulty.
- iii Connect the red probe to the end of the diode marked with a band, or to the male connector of the diode wire, the black probe should be connected to the other end of the diode or diode wire. If the Avometer does not read "1" the diode is faulty.

##### c On an analogue meter.

- i Select the Ohms 1000s (1k) range.

Connect the black probe to the end of the diode marked with a band, or to the male connector of the diode wire, the red probe should be connected to the other end of the diode or diode wire. The meter should read 20-400 k $\Omega$ , if it reads more than this the diode is faulty.

- ii Select the Ohms 100s range.

Connect the red probe to the end of the diode marked with a band, or to the male connector of the diode wire, the black probe should be connected to the other end of the diode or diode wire. The meter should read 300-400 $\Omega$ , if it reads less than this the diode is faulty.

## Battery

TC-001\_3

### Maintenance

To ensure that the battery provides optimum performance the following steps should be observed:

- 1 Make sure that the electrical connections are clean and tight. Smear petroleum jelly on connectors to prevent corrosion.
- 2 When applicable - never allow the electrolyte level to fall below the recommended level - 6 mm (1/4 in) above the plates. Use only distilled water for topping up.
- 3 Keep the battery at least three quarters charged, otherwise the plates may become sulphated (hardened) - this condition makes recharging the battery very difficult.

Extra precautions must be taken when bench charging maintenance free batteries, they are more prone to damage by overcharging than the standard type of battery:

- Never boost-charge a maintenance free battery.
- Never charge a maintenance free battery at a voltage in excess of 15.8 Volts.
- Never continue to charge a maintenance free battery after it begins to gas.

### WARNING

**Batteries give off an explosive gas. Do not smoke when handling or working on the battery. Keep the battery away from sparks and flames.**

**Battery electrolyte contains sulphuric acid. It can burn you if it touches your skin or eyes. Wear goggles. Handle the battery carefully to prevent spillage. Keep metallic items (watches, rings, zips etc) away from the battery terminals. Such items could short the terminals and burn you.**

**Set all switches in the cab to OFF before disconnecting and connecting the battery. When disconnecting the battery, take off the earth (-) lead first.**

**Re-charge the battery away from the machine, in a well ventilated area. Switch the charging circuit off before connecting or disconnecting the battery. When you have installed the battery in the machine, wait five minutes before connecting it up.**

**When reconnecting, fit the positive (+) lead first.**

### First Aid - Electrolyte

Do the following if electrolyte:

#### GETS INTO YOUR EYES

Immediately flush with water for 15 minutes, always get medical help.

#### IS SWALLOWED

Do not induce vomiting. Drink large quantities of water or milk. Then drink milk of magnesia, beaten egg or vegetable oil. Get medical help.

#### GETS ONTO YOUR SKIN

Flush with water, remove affected clothing. Cover burns with a sterile dressing then get medical help.

5-3-4-3\_1

### Testing

This test is to determine the electrical condition of the battery and to give an indication of the remaining useful 'life'.

Before testing ensure that the battery is at least 75% charged (SG of 1.23 to 1.25 for ambient temperature up to 27°C).

Ensure that the battery is completely disconnected from the vehicle.

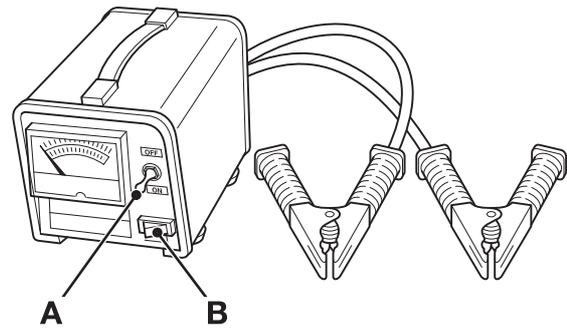
Connect up the battery tester as follows:

- 1 Set the CHECK/LOAD switch **12-A** to OFF.
- 2 Set rocker switch **12-B** to the battery voltage (12V).
- 3 Connect the red flying lead to the battery positive (+) terminal and the black flying lead to the battery negative (-) terminal.
- 4 Set the CHECK/LOAD switch **12-A** to CHECK to read the battery no-load voltage which should be at least 12.4 volts.

- 5 Set the CHECK/LOAD switch **12-A** to LOAD and hold down for 5-10 seconds until the meter reading stabilises. The reading should be at least 9 volts.

**Note:** Do not hold the switch in the LOAD position for more than 10 seconds.

- 6 → [Table 1. Fault Diagnosis \(6-21\)](#), if the foregoing tests are unsatisfactory.



**Fig 12. Battery Tester**

**Table 1. Fault Diagnosis**

| Battery Tester Readings  | Remedy   |
|--|--|
| <b>1</b> CHECK: 0 - 12.6 Volts<br>LOAD: less than 6 Volts  | Renew battery  |
| <b>2</b> CHECK: 6 - 12.4 Volts<br>LOAD: less than 9 Volts and falls steadily but remains in yellow zone. | Recharge and re-test. If tests still unsatisfactory renew battery.                 |
| <b>3</b> CHECK: less than 10 Volts<br>LOAD: less than 3 Volts  | Indicates battery has been over-discharged and unlikely to recover. Renew battery. |
| <b>4</b> CHECK: more than 11 Volts<br>LOAD: 6 - 10 Volts steady  | Charge battery which will probably recover.  |



### Specific Gravity Testing

The specific gravity of the electrolyte gives an idea of the state of charge of the battery. Readings should be taken using a hydrometer, when the electrolyte temperature is 15°C (60°F). If the battery has recently been on charge, wait approximately one hour (or slightly discharge the battery) to dissipate the surface charge before testing.

Readings should be as tabulated and should not vary between cells by more than 0.04. A greater variation indicates an internal fault on that particular cell.

If the electrolyte temperature is other than 15°C (60°F) a 'correction factor' must be applied to the reading obtained. Add 0.07 per 10°C (18°F) if the temperature is higher than 15°C (60°F) and subtract the same if the temperature is lower.

**Table 2. Specific Gravity at 15°C (60°F)**

|                                       | Fully Charged | Half Discharged | Fully Discharged |
|---------------------------------------|---------------|-----------------|------------------|
| Ambient temperature up to 27°C (80°F) | 1.270 - 1.290 | 1.190 - 1.210   | 1.110 - 1.130    |
| Ambient temperature above 27°C (80°F) | 1.240 - 1.260 | 1.170 - 1.190   | 1.090 - 1.110    |

## Alternator

TC-006

### General Description

The alternator is a three phase generator having a rotating field winding and static power windings.

When the start switch is turned on, current from the battery flows by way of the 'No Charge' warning light to the field winding. This creates a magnetic field which supplements the residual magnetism in the rotor poles. As the engine is started, the fan belt drives the rotor and alternating current is generated in the power windings as they are cut by the rotating magnetic field. Output is controlled by a solid state regulator which varies the field current in accordance with electrical demand.

Servicing is restricted to periodic inspection of slip ring brushes. Bearings are 'sealed for life'.

### Service Precautions

- 1 Ensure that the battery negative terminal is connected to the earthing cable.
- 2 Never make or break connections to the battery or alternator, or any part of the charging circuit whilst the engine is running. Disregarding this instruction will result in damage to the regulator or rectifying diodes.
- 3 Main output cables are 'live' even when the engine is not running. Take care not to earth connectors in the moulded plug if it is removed from the alternator.
- 4 During arc welding on the machine, protect the alternator by removing the moulded plug (or if separate output cables fitted, remove the cables).
- 5 If slave starting is necessary, connect the second battery in parallel without disconnecting the vehicle battery from the charging circuit. The slave battery may then be safely removed after a start has been obtained. Take care to connect batteries positive to positive, negative to negative.

### Charging Circuit Test

- 1 Ensure that all battery and alternator connections are in place, secure and making good metal - to - metal contact, especially the 'earth' connections to chassis and engine.
- 2 Adjust the alternator drive belt tension if necessary and make sure that the battery is well charged.
- 3 Turn the start switch to the ON position.  
  
'Oil pressure' and 'No charge' warning lights should glow. If any light fails, ⇒ [Check 1 \(□ 6-23\)](#).
- 4 Start the engine; all warning lights should extinguish rapidly.

If the 'No charge' warning light remains ON, ⇒ [Check 2 \(□ 6-24\)](#).

If the oil pressure warning remains on stop engine immediately and investigate the engine lubrication system.

#### Check 1

With start switch 'ON' try the heater motor and screen wiper.

If they operate normally, check the warning light bulb for blown filament.

Simultaneous failure of all items indicates a fault at the start switch. Check for cable disconnection before condemning the switch itself.

If the 'No charge' warning bulb is in good order, withdraw the triple plug from the back of the alternator. Make a temporary connection between the SMALL terminal in the plug and earth as shown below. If the 'No charge' warning bulb still fails to light, check the cable for continuity. If the bulb now lights, check the alternator for a defective regulator. ⇒ [Alternator Charging Test \(□ 6-24\)](#).

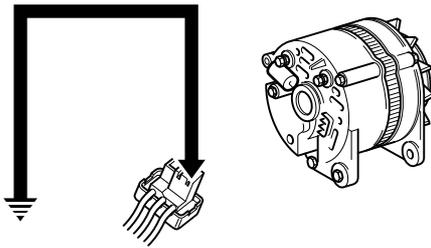


Fig 13.

#### Check 2

**Note:** The following checks should be made using an analogue (moving pointer) type meter.

- 1 Stop the engine and turn the starter switch to OFF.
- 2 Withdraw the alternator plug and connect the test meter between the large terminals and 'earth'. With the meter set to measure 12V DC, the meter should show battery voltage. If the reading is zero, check the cables for continuity, particularly at the starter terminals.

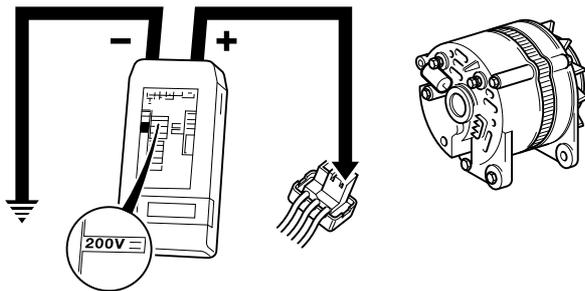


Fig 14.

If the voltage is correct, check the alternator.  
[⇒ Alternator Charging Test \( 6-24\).](#)

#### Alternator Charging Test

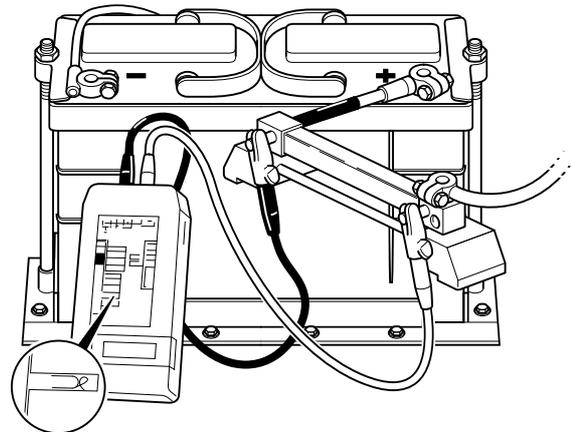


Fig 15.

- 1 Ensure that all battery and alternator connections are in place, secure and making good metal - to - metal contact, especially the 'earth' connections to chassis and engine.
- 2 Make sure that the alternator drive belt tension is correctly adjusted.
- 3 If the battery is in a fully charged condition, switch on the working lights for 3 minutes before commencing the test. Alternatively, operate the starter for a few moments with the engine shut off solenoid (ESOS) fuse removed (See **Fuse Identification**).
- 4 Install a 100 amp open - type shunt between the battery positive lead and the battery positive terminal.
- 5 Connect a multimeter positive lead to machine side of the shunt and negative lead to battery side of the shunt.
- 6 Connect the leads to the meter and set the meter to the relevant range as follows.

- AVO 2002**
- Red lead to volts (middle) socket on meter.
  - Black lead to negative on meter.
  - RH slider to DC voltage.
  - LH slider. ⇒ [Fig 15. \(□ 6-24\)](#).
- AVO 2003**
- Red lead to amps socket (marked A) on the meter.
  - Black lead to negative on meter.
  - RH slider to DC voltage
  - LH slider to 200 Shunt
- FLUKE 85**
- Red lead to volts socket (marked V ) on meter.
  - Black lead to COM socket on meter.
  - Set dial to mV.

- 11** Faults d, e, and f may be checked only by removing and dismantling the alternator for further testing.

- 7** Start the engine and run at maximum speed (see **Technical Data**). Meter should show maximum alternator output in Amps (see **Technical Data**).

**Note:** The meter reading should be taken as soon as possible after starting the engine, as the charging current will fall rapidly.

- 8** A zero reading indicates failure of the alternator and may be caused by one of the following conditions. These are listed in the order of probability.
- a** Defective suppression capacitor.
  - b** Dirty slip rings or worn brushes.
  - c** Defective regulator.
  - d** Defective rectifier.
  - e** Open or short - circuited field (rotor) windings.
  - f** Open or short - circuited power (stator) windings.
- 9** To check for fault a, disconnect the capacitor and repeat the charging test. Renew the capacitor if necessary.
- 10** To check for faults b and c, remove the regulator and brush box assembly. Check the condition of the brushes and, if necessary, clean the slip rings using extra-fine glass paper. The regulator may only be checked by substitution.

## Starter Motor

TC-005

### Starting Circuit Test

Before carrying out the voltmeter tests, check the battery condition and ensure that all connections are clean and tight.

To prevent the engine starting during the tests ensure that the engine stop fuse is removed, (refer to **Fuse Identification** page).

Check the readings in the following sequence using a voltmeter. Unless otherwise stated, the readings must be taken with the starter switch held in the 'start' position ('HS') and the transmission forward/reverse selector in neutral.

**Note:** Do not operate the starter motor for more than 20 seconds at one time. Let the starter motor cool for at least two minutes between starts.

- 1 Connect the voltmeter across the battery terminals. → [Fig 16.](#) ([□ 6-26](#)). Reading in 'start' position: 10.0V approximately. Minimum permissible reading in 'start' position 9.5V.

A low reading probably indicates a fault in the starter motor.

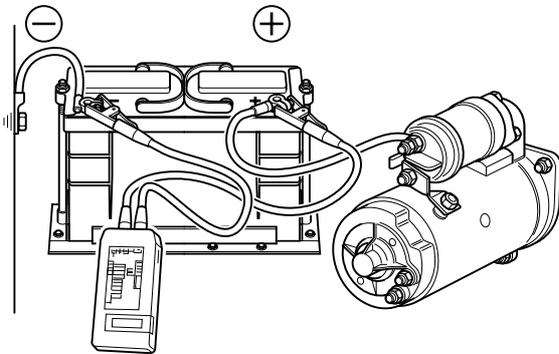


Fig 16.

- 2 Connect the voltmeter between the starter main terminal **17-A** and the commutator end bracket **17-B**. In the 'start' position, the reading should not be more

than 0.5V below the reading obtained in Step 1. Minimum permissible reading in 'start' position 9.0V.

If the reading is within this limit, continue to Step 3. If the reading is outside the limit, proceed to Step 4 and Step 5.

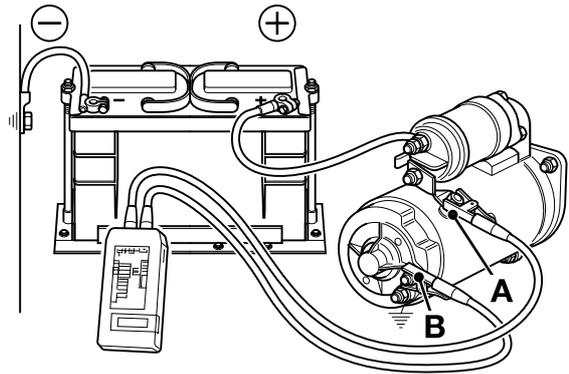


Fig 17.

- 3 Connect the voltmeter between the solenoid terminal **18-C** and a good earth. Minimum permissible reading in 'start' position: 8.0V.

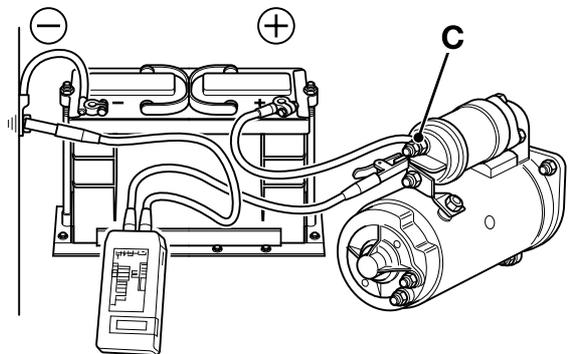


Fig 18.

- a If the reading is less than specified, connect the voltmeter between the neutral start relay terminal **19-D** and earth. An increase in reading to 8.0V indicates a fault in the wiring from the start relay to the solenoid.

- b If the reading between terminal **19-D** and earth is below 8.0V, connect the voltmeter between terminal **19-E** and earth. An increase in the reading to 8.0V indicates either a faulty start relay or a fault in the feed from the transmission selector switch to the relay solenoid. Check also the solenoid earth connection.

If the reading between **19-E** and earth is less than 8.0V, the fault must be in either the starter switch or in the wiring between the solenoid, starter switch, and the start relay.

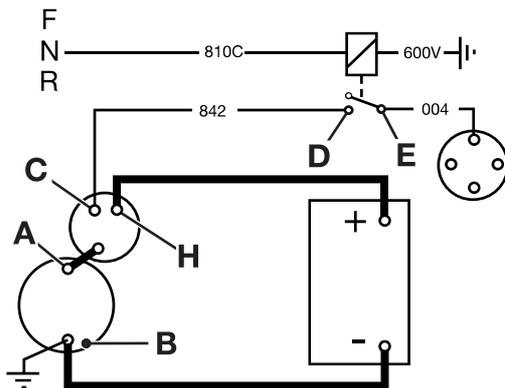


Fig 19.

- 4 Connect the voltmeter between battery negative and starter earth connection **20-B**. The reading in the 'start' position should be practically zero, maximum permissible reading 0.25V.

If the reading is above 0.25V, a high resistance in the earth lead or connections is indicated.

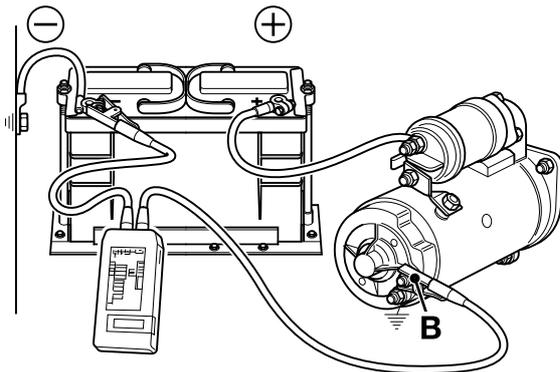


Fig 20.

- 5 Connect the voltmeter between battery positive and the starter main terminal **21-A**. With the starter switch 'off', the voltmeter should indicate battery voltage, but it should fall to practically zero when the switch is turned to the 'on' position, maximum permissible reading 0.25V.

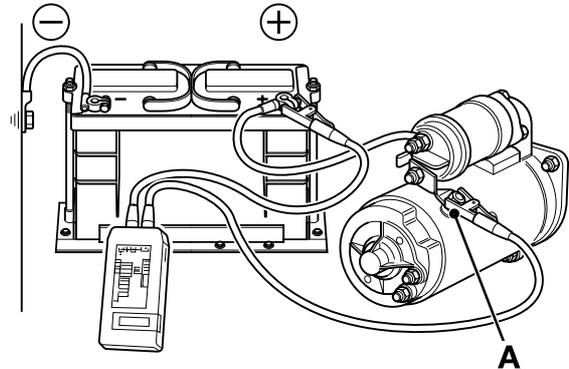


Fig 21.

If the reading is above 0.25V, a high resistance is present in the insulated lead or in the solenoid. Connect the voltmeter between the battery positive and solenoid connection **22-H**. If the voltmeter now reads zero with the switch closed, the fault is in the solenoid.

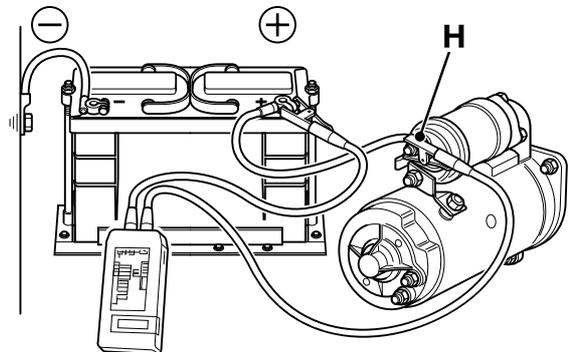


Fig 22.

- 6 Finally refit the engine stop fuse.



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