# Fuel System

**Service Manual - JCB Dieselmax Tier 3 SE Engine**



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# Fuel Filter

## Removal and Replacement

The procedure for removing and replacing the fuel filter is described as part of the routine maintenance procedures, see ***Section 3 Routine Maintenance***.

# Fuel Lines

## Identification

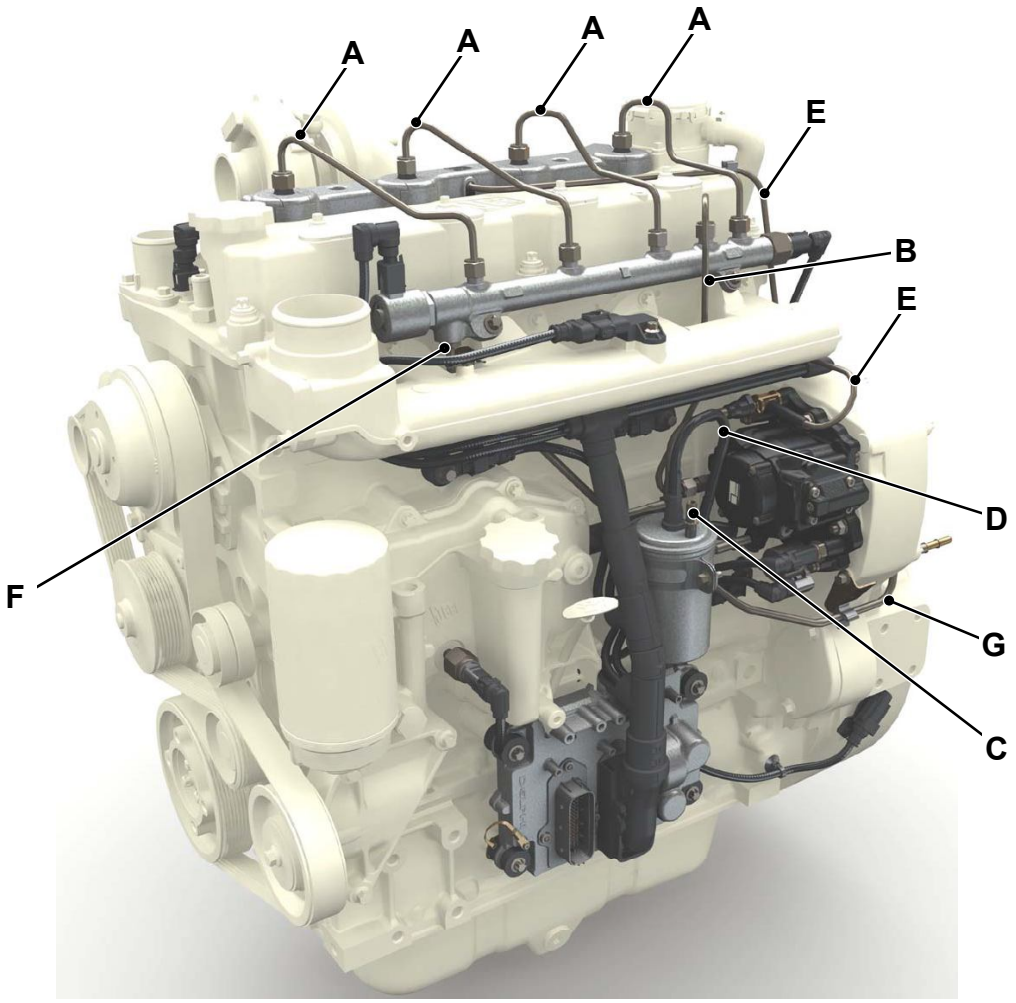


**Fig 1.**

**Table 1. High Pressure Fuel Lines**

| | |
|---|---|
| **A** | Pipe assembly - rail to injector (4) |
| **B** | Pipe assembly - high pressure pump to rail |

**Table 2. Low Pressure Fuel Lines**

| | |
|---|---|
| **C** | Fuel supply - from lift pump and pre-filter/water separator |
| **D** | Fuel supply - from filter to high pressure pump |

**Table 3. Bleed-off Fuel Lines (Low Pressure)**

| | |
|---|---|
| **E** | Pipe assembly - fuel injectors to tank |
| **F** | Pipe assembly - rail to tank |
| **G** | Return to tank |

# Removal and Replacement

## High Pressure Fuel Lines

### ⚠ WARNING

**Do not open the high pressure fuel system with the engine running. Engine operation causes high fuel pressure. High pressure fuel spray can cause serious injury or death.**

13-3-2-16

**Table 4. Service Tools**

| Item | Part Number | Description |
|---|---|---|
| T1 | General | Flare Nut Socket |

### Before Disconnecting or Removing Fuel Lines

### ⚠ WARNING

**Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.**

ENG-8-5_2

***Important:*** *Before you start work make sure that you have the correct new parts. The high pressure fuel lines MUST BE REPLACED with new ones. The new fuel lines must remain sealed inside their bags before use. If a bag is open DO NOT USE the fuel line, get a new one.*

**1** Make sure that the engine is safe to work on. The engine must cool and pressure in the fuel system must decay before you start work. If the engine has been running wait at least one hour before you start work.

**2** Clean the engine. Obey the correct procedures. Refer to ***Section 1, Cleaning the Engine***.

**3** Remove the protective cover **2A**. Push out the four plastic segments **2B**. Remove the screws **2C** and lift off the cover.

**4** Remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.

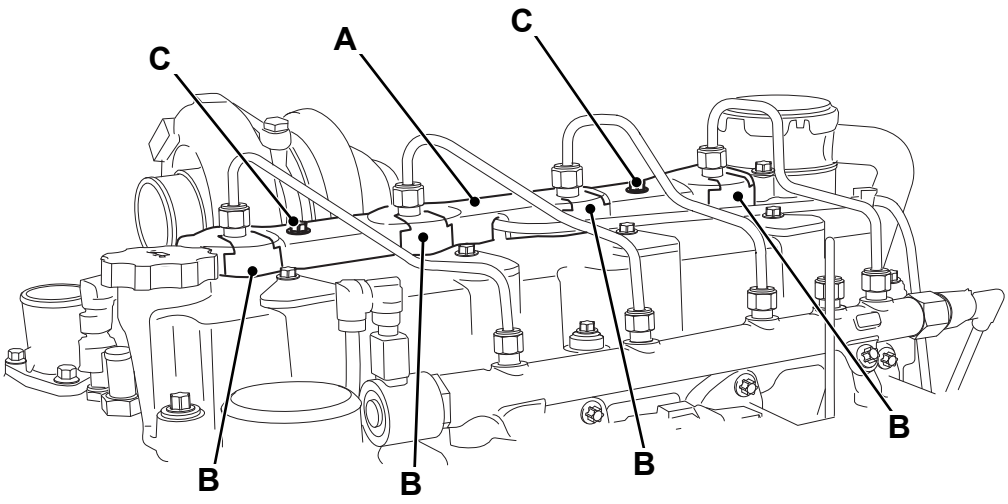


**Fig 2.**

## Injector Fuel Lines

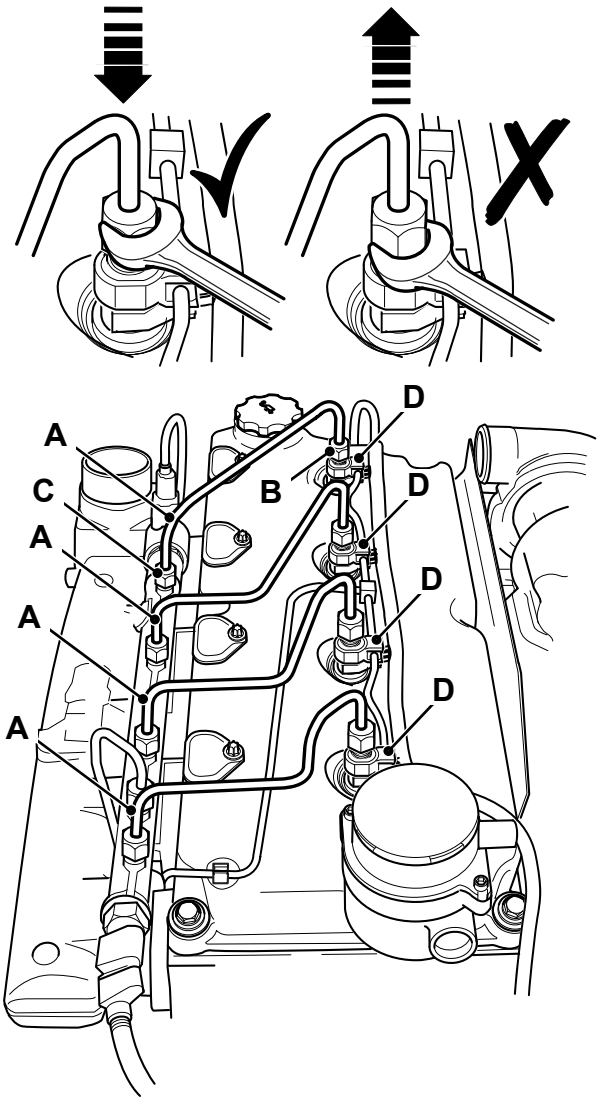


Fig 3.

### Removal

**⚠ WARNING**

**Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.**

ENG-8-5_2

**1** Remove the fuel lines **3-A** one at a time. The procedure describes how to remove one fuel line.

- **a** Put open ended spanner **3-T1** at the top of nut **3-B**. This will prevent damage to the nut.
- **b** Loosen nut **3-B**. Do not remove the nut at this step.
- **c** Put open ended spanner **3-T1** at the top of nut **3-C**. This will prevent damage to the nut.
- **d** Loosen the nut **3-C**. Do not remove the nut at this step.
- **e** Push the fuel line against the injector cone and at the same time remove the nut **3-B**.
- **f** Keep the fuel line against the injector cone and remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.
- **g** Push the fuel line against the rail cone and at the same time remove the nut **3-C**.
- **h** Keep the fuel line against the rail cone and remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.
- **i** Make sure that there is no dirt or debris on the fuel line or its connectors.
- **j** Remove the fuel line.
- **k** Seal all open ports using the correct parts from service kit.

**2** Repeat step **1** to remove the other fuel lines.

**3** Discard the old fuel lines.

**Replacement**

***Important:*** *The high pressure fuel lines MUST BE REPLACED with new ones. The new fuel lines must remain sealed inside their bags before use. If a bag is open DO NOT USE the fuel line, get a new one. DO NOT open the bag until you are ready to assemble the fuel line.*

**1** Make sure that the bleed-off adapters **3-D** are assembled on the injectors BEFORE fitting the high pressure lines.

**2** Assemble the fuel lines one at a time. The procedure describes how to assemble one fuel line.

**a** Put the correct end of the fuel line against the correct injector cone.

**b** Tighten the nut **3-B** with your hand.

**c** Put the other end of the fuel line against the correct rail cone.

**d** Tighten the nut **3-C** with your hand.

***Note:*** *Nuts must be tightened in the correct sequence. Tighten nut **3-B** and then nut **3-C**.*

**e** Put the spanner at the top of nut **3-B** and tighten it to the correct torque. ⇨ ***Table 5. Torque Settings (7-5)***.

**f** Put the spanner at the top of nut **3-C** and tighten it to the correct torque. ⇨ ***Table 5. Torque Settings (7-5)***.

**Table 5. Torque Settings**

| Item | Nm | lbf ft |
|---|---|---|
| **2-C** | 10 | 7.4 |
| **3-B** | 27 | 19.9 |
| **3-C** | 27 | 19.9 |

### High Pressure Pump Fuel Line

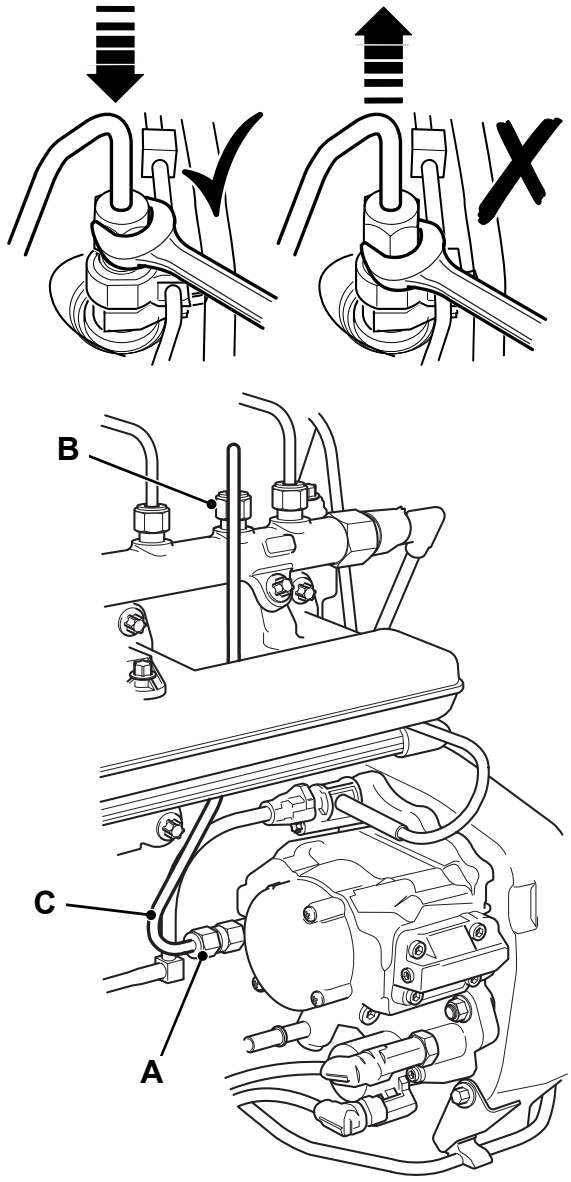


Fig 4.

**Removal**

**1** To remove the fuel line:

**a** Put open ended spanner at the top of nut **4-A**. This will prevent damage to the nut.

**b** Loosen nut **4-A**. Do not remove the nut at this step.

**c** Put open ended spanner at the top of nut **4-B**. This will prevent damage to the nut.

**d** Loosen the nut **4-B**. Do not remove the nut at this step.

**e** Push the fuel line **4-C** against the pump cone and at the same time remove the nut **4-A**.

**f** Keep the fuel line **4-C** against the pump cone and remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.

**g** Push the fuel line **4-C** against the rail cone and at the same time remove the nut **4-B**.

**h** Keep the fuel line **4-C** against the rail cone and remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.

**i** Make sure that there is no dirt or debris on the fuel line or its connectors.

**j** Remove the fuel line **4-C**.

**k** Seal all open ports using the correct parts from service kit.

**2** Discard the old fuel line.

### Replacement

***Important:*** *The high pressure fuel lines MUST BE REPLACED with new ones. The new fuel lines must remain sealed inside their bags before use. If a bag is open DO NOT USE the fuel line, get a new one. DO NOT open the bag until you are ready to assemble the fuel line.*

**1** To assemble the fuel line.

**a** Put the correct end of the fuel line **4-C** against the pump cone.

**b** Tighten the nut **4-A** with your hand.

**c** Put the other end of the fuel line against the correct rail cone.

**d** Tighten the nut **4-B** with your hand.

***Note:*** *Nuts must be tightened in the correct sequence. Tighten nut **4-A** and then nut **4-B**.*

**e** Put the spanner at the top of nut **4-A** and tighten it to the correct torque.

**f** Put the spanner at the top of nut **4-B** and tighten it to the correct torque. ⇨ *Table 6. Torque Settings (7-7)*

**Table 6. Torque Settings**

| Item | Nm | lbf ft |
|---|---|---|
| **4-B** | 27 | 19.9 |
| **4-C** | 27 | 19.9 |

### After Replacing the Fuel Lines:

**1** Ensure that all lines are correctly fitted and located in retaining clips as applicable. If retaining clips are missing or damaged they must be replaced or renewed.

**⚠ WARNING**

**Fluid Under Pressure**

**Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of fluid under pressure and wear protective glasses. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.**

INT-3-1-10_2

**⚠ WARNING**

**Fuel oil is highly inflammable. Stop the engine immediately if a fuel leak is suspected. Completely wipe off any spilt fuel which could cause a fire.**

8-3-4-3_1

**2** Start the engine and check for fuel leaks.

## Low Pressure Fuel Lines

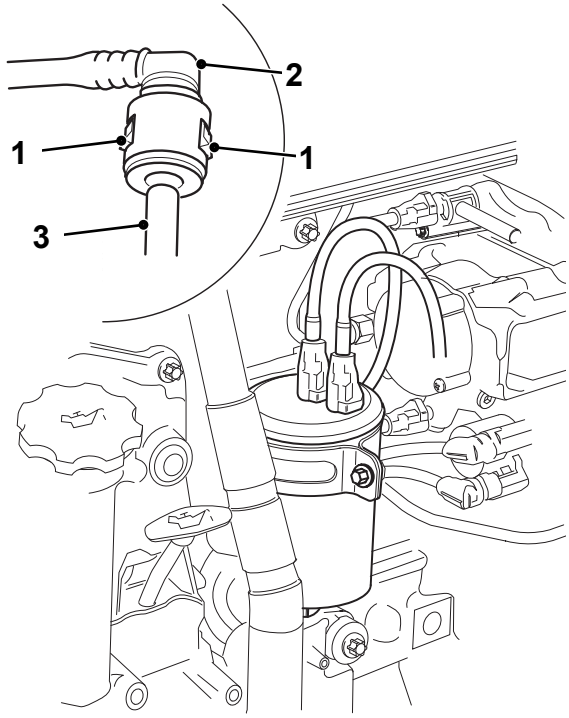


**Fig 5.**

### Before Disconnecting or Removing Fuel Lines:

**⚠ WARNING**

**Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.**

ENG-8-5_2

**1** Make sure that the engine is safe to work on.

**2** Clean the engine. Obey the correct procedures. Refer to ***Section 1, Cleaning the Engine***.

***Important:*** *DO NOT try to repair fuel lines or connectors. Defective fuel line assemblies must be replaced.*

### Removal

The low pressure fuel lines have a nylon fitting attached to the pipe that replaces the nut and olive. The fittings are part of the pipe and not a separate item. Defective fuel line assemblies must be replaced.

**1** To release the fuel line, first press and hold buttons **1** (1 each side of the coupler). Push the coupler **2** towards the connector spigot **3** then withdraw.

**2** Cap all open ports to prevent ingress of dirt and debris.

### Replacement

**1** To refit the fuel line, press and hold buttons **1**. Push the coupler **2** over the connector spigot **3** and release the button **1**. The connector will be heard to click when it is fully home and locked in place.

**2** To check that the connection has been fully remade, attempt to pull the connector from the connector spigot without releasing the lock mechanism. (A gentle pull is all that is required, if the connection is not good the connector will release very easily.)

### After Replacing the Fuel Lines:

**1** Ensure that all lines are correctly fitted and located in retaining clips as applicable. If retaining clips are missing or damaged they must be replaced or renewed.

**⚠ WARNING**

**Fluid Under Pressure**

**Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of fluid under pressure and wear protective glasses. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.**

INT-3-1-10_2

**⚠ WARNING**

**Fuel oil is highly inflammable. Stop the engine immediately if a fuel leak is suspected. Completely wipe off any spilt fuel which could cause a fire.**

8-3-4-3_1

**2** Start the engine and check for fuel leaks.

## Injector Bleed-off Lines (Low Pressure)

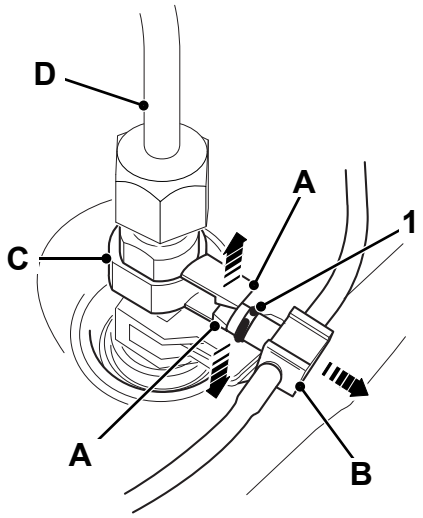


Fig 6.

**Table 7. Component Identification**

| | |
|---|---|
| **A** | Location tabs - bleed line clip |
| **B** | Connector - bleed line |
| **C** | Bleed line clip |
| **D** | High pressure fuel line |

**Table 8. Service Parts**

| | |
|---|---|
| **1** | `O' ring - bleed line connector (4) |

### Before Disconnecting or Removing Fuel Lines:

**⚠ WARNING**

**Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.**

ENG-8-5_2

1 Make sure that the engine is safe to work on.

2 Clean the engine. Obey the correct procedures. Refer to ***Section 1, Cleaning the Engine***.

3 Remove the protective cover. Push out the four plastic segments **5**. Remove the screws **4** and lift off the cover.

4 Remove any dirt or debris that is exposed. Refer to ***Section 1, Cleaning the Engine***.

5 To remove the bleed line clips **6-C** remove the high pressure fuel lines **6-D** first. ⇨ ***High Pressure Fuel Lines (7-3)***.

***Important:*** *DO NOT try to repair fuel lines or connectors. Defective fuel line assemblies must be replaced.*

### Removal

***Note:*** *The following details the removal and replacement of 1 bleed-off connector. The procedure for the remaining 3 connectors is identical.*

1 Gently spring the location tabs **6-A** apart and pull out the bleed line connector **6-B**. DO NOT use excessive force on the tabs .

2 Remove and discard `O' ring **6-1**.

3 Pull off discard the bleed line clip **6-C**.

4 If it is necessary to remove the bleed off line assembly, remove the nylon fitting at the high pressure pump. ⇨ ***Low Pressure Fuel Lines (7-8)***.

5 Cap all open ports to prevent ingress of dirt and debris.

### Replacement

1 Push a new bleed line clip over the injector the correct way round, aligned with the bleed port in the injector.

2 Fit new a `O' ring **6-1**.

3 Push in the bleed line connector **6-B** until the tabs **6 - A** snap over the connector.

4 If applicable, replace the high pressure fuel lines with new ones. DO NOT use a high pressure fuel line that was removed. ⇨ ***High Pressure Fuel Lines (7-3)***.

### After Replacing the Fuel Lines:

1 Ensure that all lines are correctly fitted and located in retaining clips as applicable. If retaining clips are missing or damaged they must be replaced or renewed.

**⚠ WARNING**

**Fluid Under Pressure**

**Fine jets of fluid at high pressure can penetrate the skin. Keep face and hands well clear of fluid under pressure and wear protective glasses. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of fluid. If fluid penetrates your skin, get medical help immediately.**

INT-3-1-10_2

**⚠ WARNING**

**Fuel oil is highly inflammable. Stop the engine immediately if a fuel leak is suspected. Completely wipe off any spilt fuel which could cause a fire.**

8-3-4-3_1

**2** Start the engine and check for fuel leaks.

## Rail Bleed-off Line (Low Pressure)

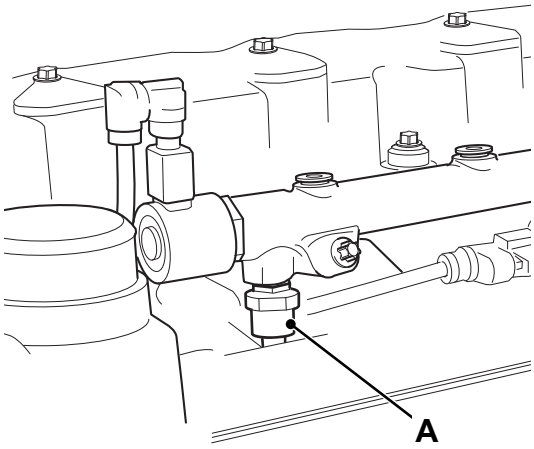


**Fig 7.**

The rail bleed off fuel line **7A** is a low pressure type. For the correct removal and replacement procedures ⇨ *Low Pressure Fuel Lines (🗋 7-8)*.

# Common Rail Assembly

## Removal and Replacement

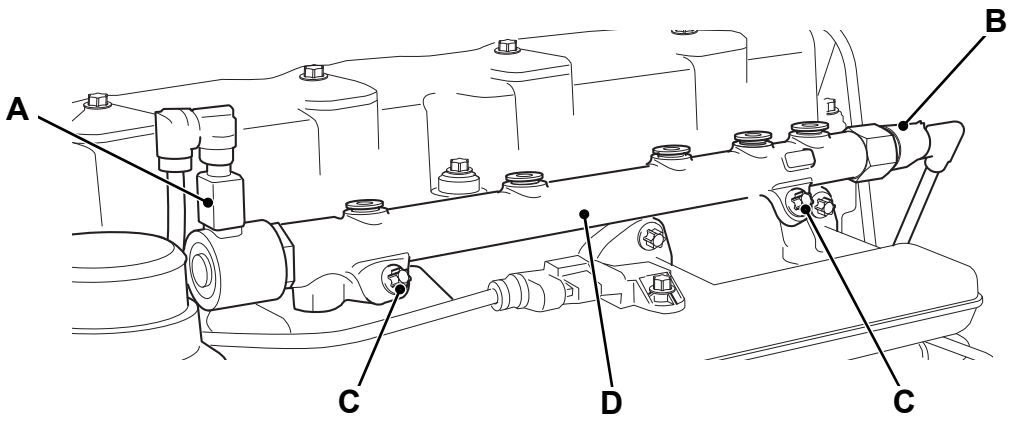


**Fig 8.**

***Important:*** *DO NOT remove the high pressure fuel valve **8A** or the fuel pressure sensor **8B** from the rail. If these components are defective replace the complete common rail assembly with a new one.*

**Table 9. Component Identification**

| | |
|---|---|
| **A** | High pressure fuel valve |
| **B** | Fuel pressure sensor |
| C | Bolts (2) |
| **D** | Rail assembly |

**Table 10. Torque Settings**

| Item | Nm | lbf ft |
|---|---|---|
| **C** | TBA | TBA |

### Before Removal

**⚠ WARNING**

**Clean the engine before you start engine maintenance. Obey the correct procedures. Contamination of the fuel system will cause damage and possible failure of the engine.**

ENG-8-5_2

**1** Make sure that the engine cannot be started.

**2** Clean the engine. Refer to ***Section 1, Cleaning the Engine***.

**3** Remove the high pressure fuel lines. Refer to ***Fuel Lines***.

**4** Remove the fuel bleed off line at the rail. Refer to ***Fuel Lines***.

### Removal

**1** Disconnect the electrical connector at the high pressure fuel valve **8A**.

**2** Disconnect the electrical connector at the fuel pressure sensor **8B**.

**3** Remove the bolts **8C** and lift off the common rail assembly **8D**.

***Important:*** *Seal the common rail assembly inside a clean plastic bag until it is ready for use. If the assembly is defective discard it and get a new one.*

### Replacement

Replacement is the opposite of the removal procedure. During the replacement procedure do this work also:

1 Torque tighten bolts **8C**, see ⇒ *Table 10. Torque Settings (7-12)*.

# Fuel Lift Pump

## Removal and Replacement

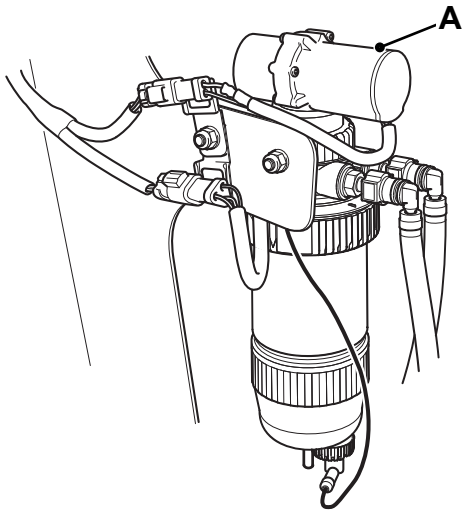


**Fig 9.**

The fuel lift pump **9A** is an integral part of the water separator and fuel pre-filter. The pump is a non serviceable part. If the pump is damage or faulty the complete assembly must be replaced.

The fuel lift pump and filter is part of the machine assembly. For the correct removal and replacement procedure see the relevant machine documentation.

# High Pressure Fuel Pump

## Removal and Replacement

### Component Identification

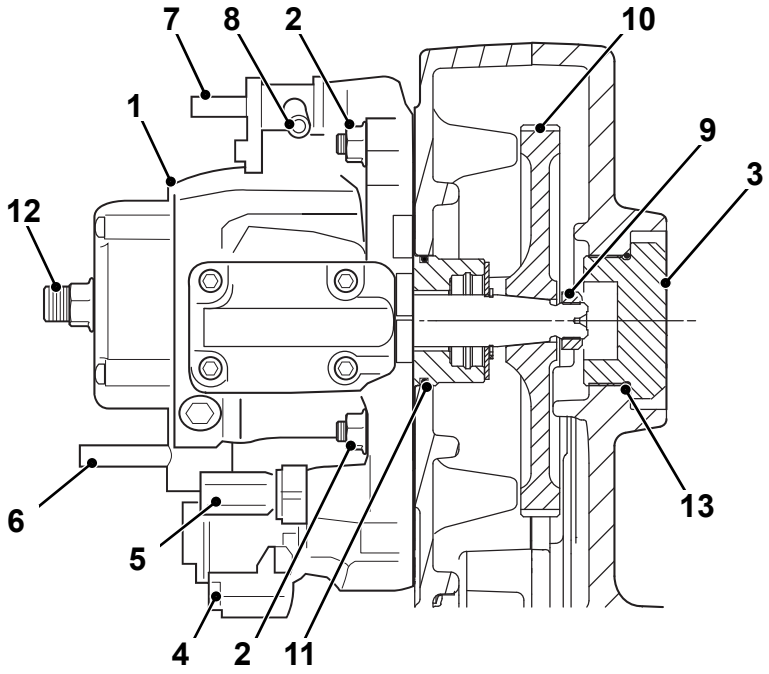


**Fig 10.**

**Table 11. Component Identification**

| | |
|---|---|
| **1** | Fuel injection pump |
| **2** | Pump fixing nuts (3 off) |
| **3** | Injection pump gear cover |
| **4** | Inlet metering valve electrical connector |
| **5** | Fuel temperature sensor electrical connector |
| **6** | Fuel line connector (inlet) |
| **7** | Fuel bleed-off connector |
| **8** | Fuel bleed-off connector, injector bleed off |
| **9** | Drive shaft nut |
| **10** | Drive gear |
| **11** | Injection pump `O' ring oil seal |
| **12** | High pressure fuel outlet |
| **13** | Gear cover `O' ring oil seal |

**Table 12. Service Tools**

| Item | Part Number | Description |
|---|---|---|
| **A** | 892/01148 | Crankshaft timing pin |
| **B** | 892/01154 | Socket - Injection pump gear cover |
| **C** | 892/01147 | Crankshaft turning tool |
| **E** | 892/01155 | Gear removal tool comprises: |
| **F** | | Reaction cap |
| **G** | | Tool body |
| **H** | | Special bolt |
| **J** | General | `C' shaped ring spanner - Injection pump inner nut |

## Before Removing:

***Important:*** *The following procedures include removal and replacement of fuel system components. Before starting the procedures the engine assembly MUST BE CLEANED. See* ***Section 1, Cleanliness Requirements, Cleaning the Engine .***

**1** Ensure that the engine cannot be started.

**2** Remove the high pressure fuel line at port **10-12**, see ***Fuel Lines - Removal and Replacement***. Cap all open ports and pipes.

**3** To improve access to the pump remove the fuel filter. See ***Section 3, Routine Maintenance***.

## Removal

***Important:*** *When removing components dirt and debris may become exposed or dislodged. Stop the removal procedures and clean away the exposed deposits. See* ***Section 1, Cleanliness Requirements, Cleaning the Engine .***

**1** Release the fuel line couplings at the inlet connection **10-6** and bleed-off connections **10-7** and **10-8** on the pump. Cap all open ports and pipes.

**2** Uncouple the electrical connectors at the inlet metering valve solenoid **10-4** and fuel temperature sensor **10-5**.

**3** Remove plug **11-1**.

**4** Using the crankshaft turning tool **11-C** turn the crankshaft until timing pin **11-A** engages in the crankshaft timing hole.

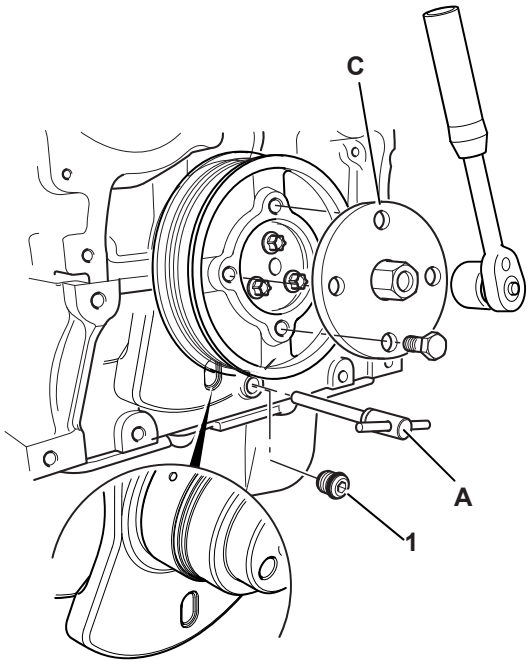


**Fig 11.**

### Fit the Gear Removal Tool

**5** Remove fuel injection pump gear cover **12-3** using service tool **12-B** and a suitable ratchet drive.

**6** Undo and remove the drive shaft nut **12-11**.

**7** Undo and remove the nuts **13-2**. Use special spanner **J** to undo the nut close to the cylinder block. Be sure to remove all 3 nuts.

**8** Fit reaction cap **12-F** (service tool) over the pump shaft. Screw service tool **12-G** to the housing. Using a suitable ratchet drive and socket screw in bolt **12-H** (service tool) until resistance is felt.

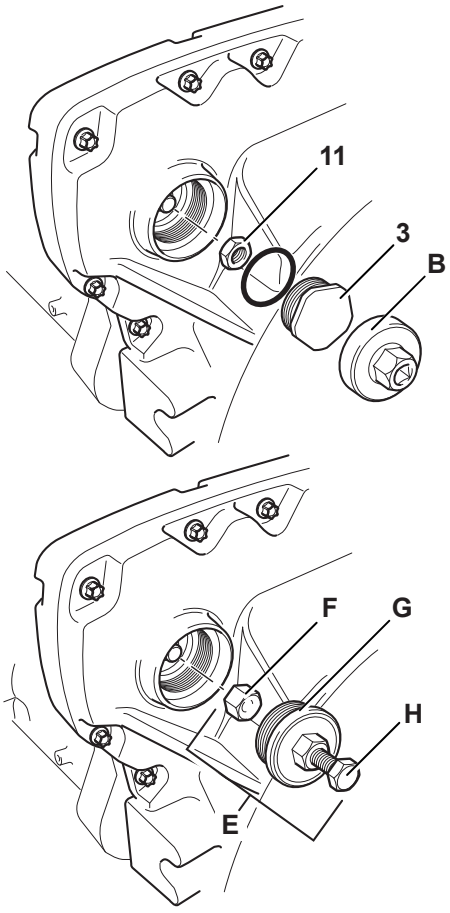


**Fig 12.**

### Remove the Pump

**9** The injection pump drive gear **13-10** is located on a taper on the pump drive shaft. To remove the pump the taper lock must be `broken'. Support the fuel pump. Tap the end of bolt **13-H** with a soft faced hammer. When the taper `breaks' there will be an audible sound.

***Note:*** *The pump drive gear connects to the injection pump drive shaft by means of taper lock alone. There is no mechanical locking key.*

**10** Remove service tools **13-H**, **13-G** and **13-F**. Withdraw the pump from the flywheel housing.

***Important:*** *Service procedures on the high pressure fuel pump can only be carried out by specialist personnel with the relevant training and equipment.*

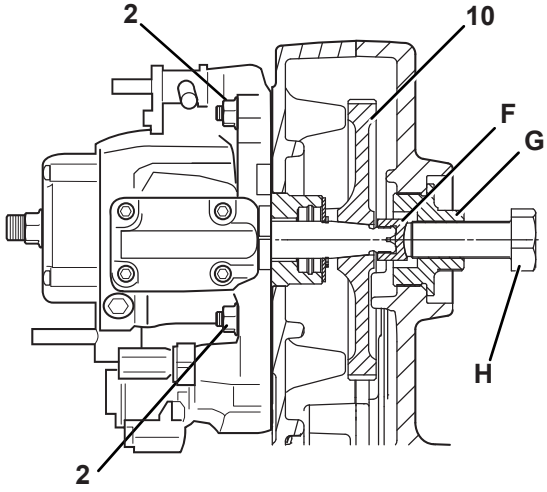


**Fig 13.**

## Replacement

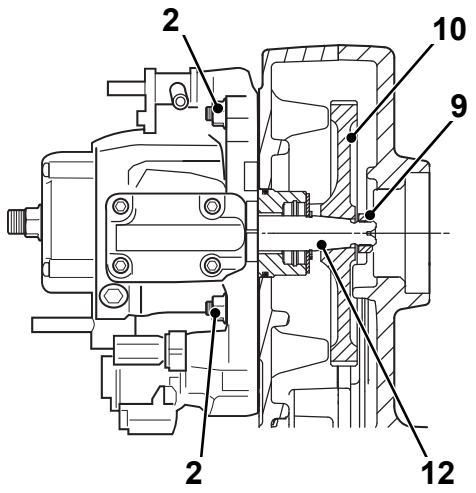


Fig 14.

1 Make sure that taper surfaces on the injection pump drive shaft and gear **14-12** are clean and free from oil.

2 Make sure that the oil seal **15-16** is correctly located on the pump mounting face.

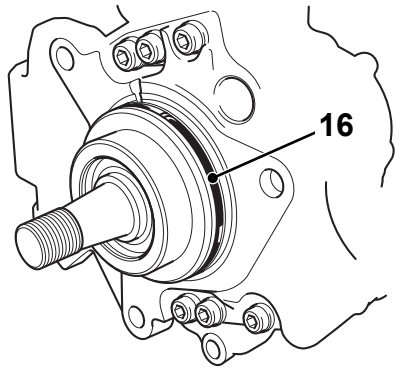


Fig 15.

3 Locate the pump onto the mounting studs. Locate the drive gear **14-10** over the pump drive shaft.

4 Fit and torque tighten the nuts **14-2**. ⇨ ***Table 13. Torque Settings (7-18)***.

5 Fit and torque tighten the pump gear nut **14-9**. ⇨ ***Table 13. Torque Settings (7-18)***.

***Note:*** *If a washer is supplied with a replacement pump, DO NOT FIT THE WASHER. Secure the gear with the nut* ***9*** *only.*

6 Fit the gear cover **16-3** using service tool **16-B**. Make sure its sealing `O' ring is correctly fitted. Torque tighten the gear cover. ⇨ ***Table 13. Torque Settings (7-18)***.

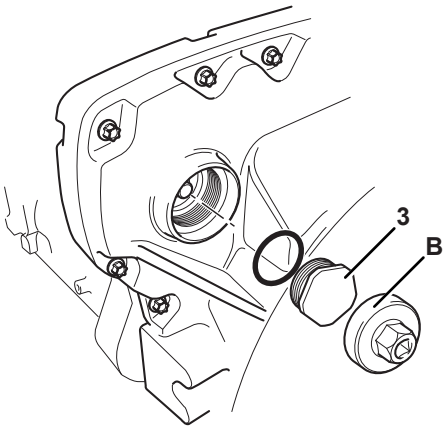


Fig 16.

**Table 13. Torque Settings**

| Item | Nm | lbf ft |
|---|---|---|
| **2** | 24 | 18 |
| **3** | 70 | 51.6 |
| **9** | 65 | 48 |

## After Replacing

**1** Remove the crankshaft turning tool.

**2** Remove the crankshaft timing pin and re-fit the bedplate plug.

**3** Reconnect the fuel line couplings at the inlet connection **17-6**, bleed-off connections **17-7** and **17-8** on the pump.

**4** Fit a new high pressure fuel line at port **17-12**, see ***Fuel Lines - Removal and Replacement***.

**5** Couple the electrical connectors at the inlet metering valve **17-4** and fuel temperature sensor **17-5**.

**6** Replace the fuel filter. See ***Section 3, Routine Maintenance.***

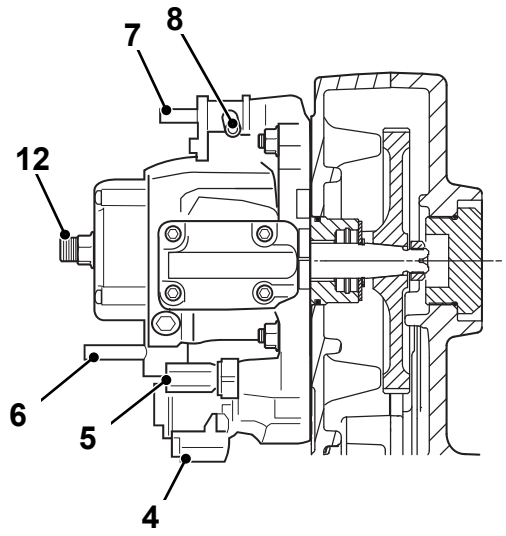


**Fig 17.**

**7** Start the engine and check for fuel leaks.

# Fuel Injectors (Atomisers)

## Removal and Replacement

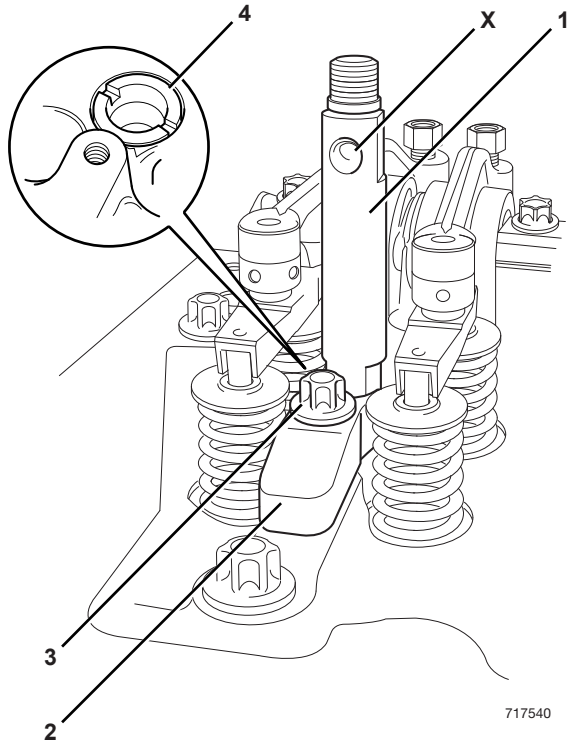


Fig 18.

**Table 14. Component Identification**

| | |
|---|---|
| 1 | Injector |
| 2 | Injector clamp |
| 3 | Injector clamp bolt |
| 4 | Injector sleeve |
| X | Injector bleed-off port |

**Table 15. Service Parts**

| | |
|---|---|
| 1.3 | Fuel Injector Caps |
| 6.9 | Sealing Washer |
| 6.10 | Injector Sealing `O' Ring |

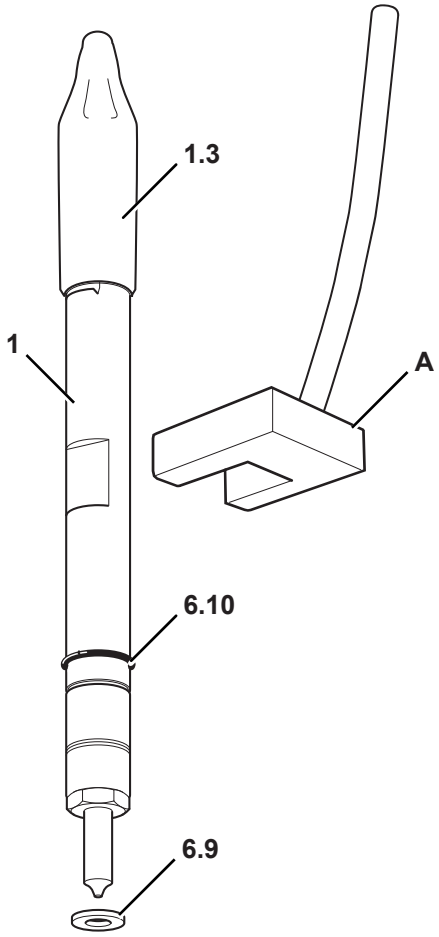


Fig 19.

**Table 16. Service Tools**

| Item | Part Number | Description |
|---|---|---|
| T1 | General | Star Drive Socket |
| A | | Injector removal tool |

## Removal

### Before removing

1 Remove the high pressure and fuel bleed-off lines, see ***Fuel Lines - Removal and Replacement***. Be sure to cap all open ports.

2 Remove the rocker cover, see ***Section 12 Base Engine - Cylinder Head.***

3 Record which injector is for which cylinder. The injectors must be installed in the same positions.

***Note:*** *If a fuel injector is defective it must be replaced.*

### Removal

The following procedure is for **18-1** injector, the procedures are identical for all injectors.

1 Undo the injector clamp retaining bolt **18-3** and lift away the clamp **18-2**.

2 Use service tool **19-A** to lever the injector **18-1** from its sleeve **18-4**. DO NOT remove the caps from the injector ports.

3 Remove and discard the sealing washer **19-6.9**. Label the injector to ensure its replacement in its original cylinder. Place a clean protective cap over the nozzle of the injector.

4 Remove and discard the `O' ring **19-6.10**.

## Replacement

***Important:*** *The fuel injectors are not interchangeable between cylinders or other engines. Be sure to install injectors in same positions. If a new or different injector is installed the engine electronic control unit (ECU) must be re-programmed. Refer to* ***Section 10, Engine Electronic Control Unit, Vehicle Set Up Data****.*

When new or different injectors are fitted, record the calibration code ⇨ *Fig 20. (7-21)*. Record which cylinder the injector is fitted. Refer to ***Section 10, Engine Electronic Control Unit, Vehicle Set Up Data***.


**Fig 20.**

Replacement is the reverse of removal but note the following:

1 Clean off any sludge or oil from the inner bore of the injector sleeve **18-4**. Be sure not to damage the surface of the bore. Any damage or surface contamination will cause the injector sealing `O' ring **19-6.10** to fail.

2 Fit a new `O' ring **19-6.10**.

3 Fit a new sealing washer **19-6.9**.

4 Be sure to orientate the injector correctly, with the bleed-off port **18-X** facing the right hand side (exhaust manifold) of the engine. Make sure the injector is pushed fully into the cylinder head.

**5** Torque tighten the injector clamp bolt **18-3**, see ⇒ *Table 17. Torque Settings (7-22)*

**Table 17. Torque Settings**

| Item | Nm | lbf ft |
|---|---|---|
| 3 | 24 | 17.7 |

### After Replacing

**1** Replace the rocker cover, see ***Section 12 Base Engine, Cylinder Head.***

**2** Renew the high pressure fuel lines, see ***Fuel Lines - Removal and Replacement.***

**3** Replace the low pressure fuel lines, see ***Fuel Lines - Removal and Replacement.***

**4** Start the engine and check for fuel leaks.

# Bleeding Air From The System

## Bleeding Air From The System

The procedure for bleeding air from the fuel system is described as part of the routine maintenance procedures, see ***Section 3 Routine Maintenance***.

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