

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: PDC

MAINTAIN CYLINDER

HEADS

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MODULE OBJECTIVE

- To enable the learner to maintain the cylinder head of a diesel engine.

LEARNING OBJECTIVES

On completion of this module, the learner must be able to:

- Conduct a compression test on all the cylinders.
- Remove and replace the cylinder head gasket.
- Remove, clean and replace the air filter.
- State the possible causes for poor compression and the function of the air filter.

ASSESSMENT AND EVALUATION CRITERIA

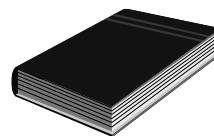
- A theory and practical test will be set at the end of the module and must be completed without using references.
- In the theory test, the learner must correctly state the function of the air filter and all the possible causes for poor compression.

In the practical test the learner will be required to –

- Do a full compression test on a diesel engine,
- Remove and replace the cylinder head gasket, and
- Remove, clean and replace the air filter.

The following standards must be achieved:

- The rocker assembly nuts must be loosened and tightened in the correct sequence, i.e. as described in the resources of this module, and tightened to the specified torque.
- Precautions must be taken to prevent dirt from entering the fuel system.
- There must not be any fuel leaks at the injectors and the injector pump.
- Precautions must be taken to prevent damage to the injector tips.
- The cylinder head nuts must be unscrewed and tightened in the correct sequence, i.e. as described in the resources of this module.
- The cylinder head gasket must be fitted as described in the workshop manual.
- The cylinder head bolts must be torqued as specified in the workshop manual.
- There must not be any damage to the fasteners.
- All the fasteners must be replaced and tightened to the correct specifications.
- There must not be any fuel leaks.
- There must not be any water leaks.
- There must not be any oil leaks.
- The tappets must be set in the correct sequence, i.e. as described in the resources.
- The valve clearance must be as specified in the workshop manual.
- Air inlet hood, the dust bowl and air cleaner body must be properly cleaned.
- Air filter must be blown clean in the correct manner and without damage to the filter.
- Air filter assembly must be assembled and mounted correctly (as described in these notes)
- All safety procedures must be adhered to.



ADDITIONAL RESOURCES

- A demonstration by a competent person e.g. a Training Officer.
- Workshop manual.
- Audio-visual aids if available.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM



PDC

MAINTAIN CYLINDER HEADS

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
<ul style="list-style-type: none"> • Use hand tools • Use compressed air to blow out an air filter 	<ul style="list-style-type: none"> • Using damaged tools or wrong tools for the job can cause injury and damage to equipment. • Filter may be ruptured if air is directed at one point. • Harm can be caused if compressed air is directed at co-workers. 	<ul style="list-style-type: none"> • Always use the correct tool for the job. • Ensure tools are in good condition. • Use tools correctly. • Wear appropriate PPE where necessary. • Always take good care of tools. Maintain, clean and store it properly. • Take care to blow out the filter evenly by moving the air stream around and by blowing in the opposite direction of the normal air intake. • Take care when using compressed air. Do not direct compressed air at other persons.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of Learner: _____

Signature of Training Officer: _____

Date: _____

1. MAINTAIN A CYLINDER HEAD OF A DIESEL ENGINE.

TASK/ITEM: Introduction

DESCRIPTION:

- Module PDS explained that the ignition or combustion takes place as a result of the compression of air, which causes the temperature to rise.
- If any leakage of air occurs while it is being compressed it will lead to a loss in power.

Causes of air leakage in a diesel engine

- Worn pistons or piston rings.
- This is indicated by a blue/white exhaust smoke.
- A faulty cylinder head gasket.

The cylinder head gasket forms a seal between the combustion chambers, water jackets and the oil ports and between the cylinder head and the engine block (Fig. 1).

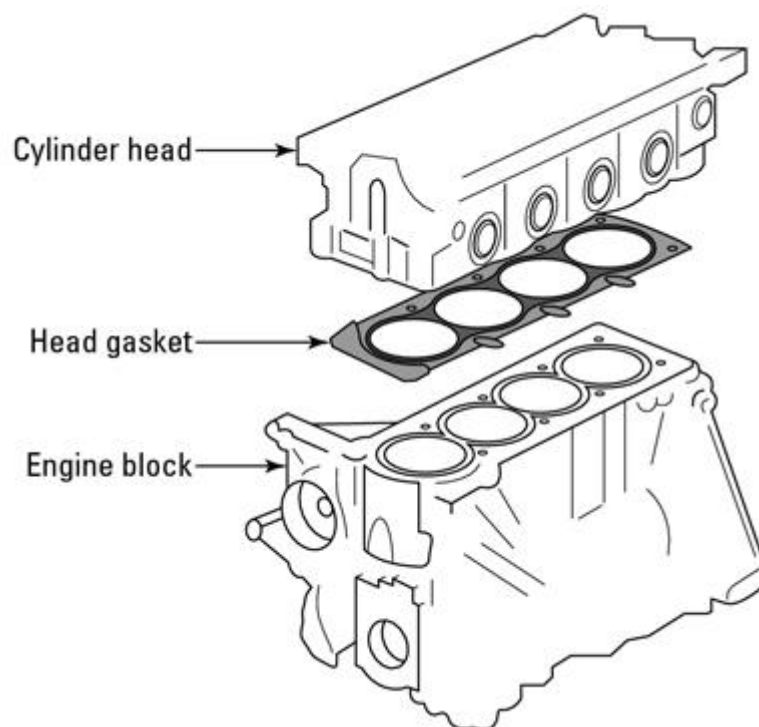


Fig1

The symptoms of a faulty cylinder head gasket are -

- Overheating of the engine,
- Water in the sump indicated by an increase in the oil level.

Sticky or pitted valves will cause the air to leak past the valve and valve seat.
Tappet clearance is too small.

See Fig. 2 for explanation of the tappet clearance.

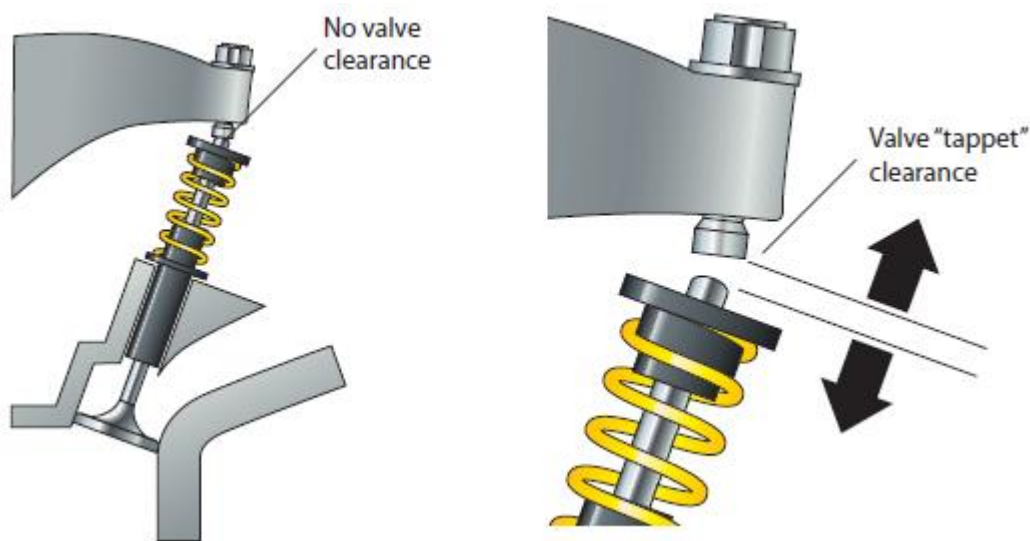


Fig 2

NB: The tappet clearance is the clearance between the top of the valve stem and the rocker

If this clearance is too small, it will cause the valve not to seat properly.

Injectors, which are not securely fastened, can also cause air leakage in a diesel engine.

2. THE COMPRESSION TESTER

ITEM / TASK: The compression tester

DESCRIPTION:

- Even compression on all the cylinders is essential to provide even power strokes and thus even operation of the engine.
- The compression of an engine can be tested with a compression tester (Fig.3)

NB: make sure the correct compression tester is selected for the type of engine being tested (Diesel / Petrol Engine)



Fig 3

Note: The method for using the compression tester is explained later in this module.

3. SETTING TAPPET CLEARANCE

ITEM / TASK: Setting tappet clearance

DESCRIPTION:

Before a compression test is done on an engine, the tappet clearance must be checked and set in the following manner:

- Clean and remove the tappet cover.
- Move the "stop" control lever to the "off" position.
- Turn the engine until both tappets of one cylinder are in the "rocking" position and the piston at top dead centre (TDC). (See Fig. 4).

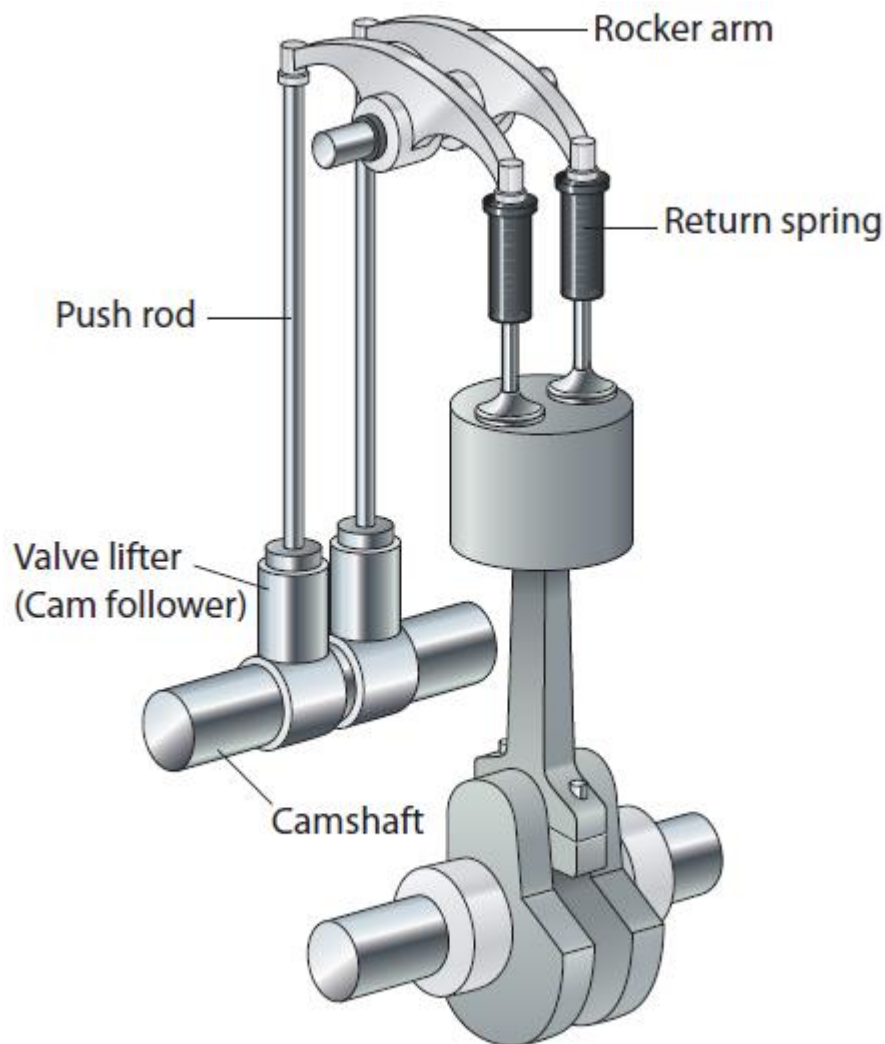


Fig 4

- Make a mark opposite the marker on the flywheel with a piece of chalk.
- Turn the engine another full turn (360°) until your chalk mark lines up with the marker again.

NB: The piston will again be at TDC but both valves will be closed. This signifies the end of the compression stroke and is the position to set the tappet clearance (Fig. 5)

- Figures 4 show the stroke relationship to the tappet and valve positions.
- Establish the correct tappet clearances from the workshop manual for the particular engine.
- Unscrew the locknut on the clearance adjuster.

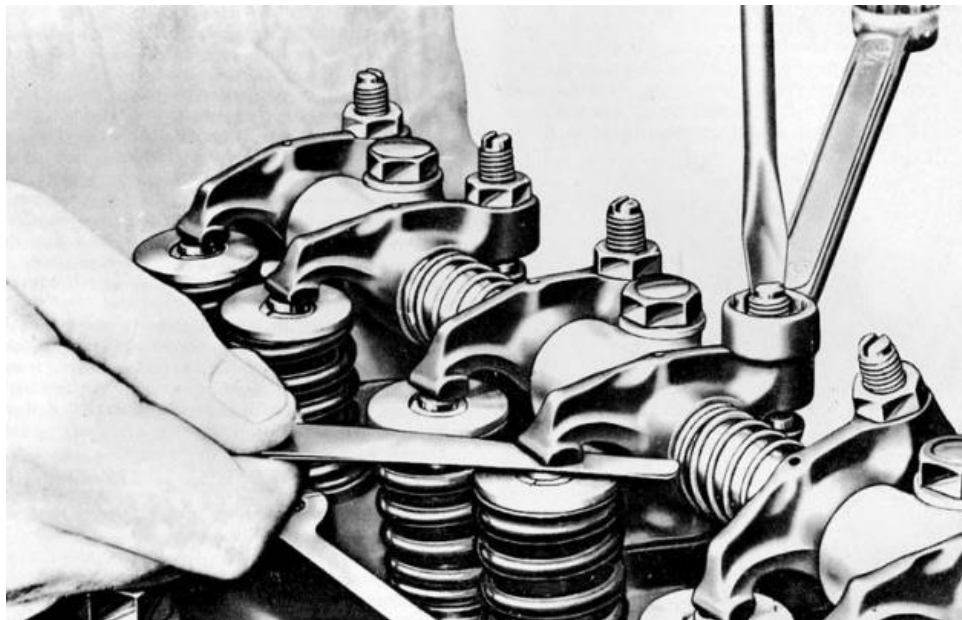
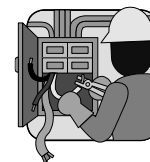


Fig 5

- Place a feeler gauge of the correct dimension (tappet clearance) between the top of the valve stem and the rocker.
- Screw in the clearance adjuster until a slight drag is felt on the feeler gauge.
- Tighten the locknut.
- Check the clearance again.
- Follow the same procedure to adjust the tappets on the remaining cylinders.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

PRACTICE



Adjust the tappets on the diesel engine.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

4. TEST THE COMPRESSION OF A DIESEL ENGINE

ITEM / TASK: Test the compression of a diesel engine.

DESCRIPTION:

The following procedure may be used.

- Start the engine and let it run until it attains its normal working temperature, then switch it off.
- Remove all the injectors (Fig. 6).

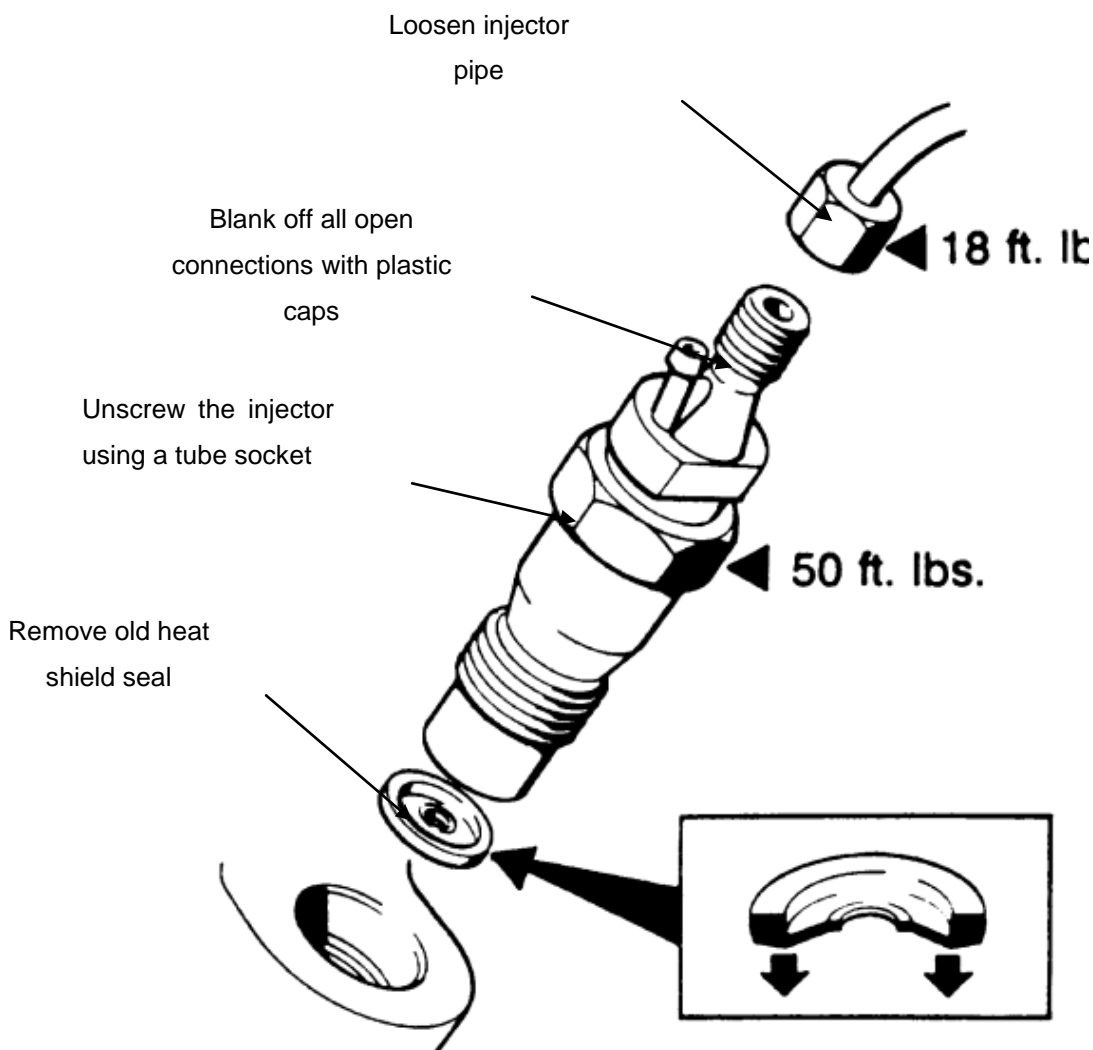


Fig. 6

- Turn the engine a few turns by hand or with the self-starter motor to remove the combustion deposits.

- Select and fit an adaptor to one of the injector holes. (Fig. 7)



Fig. 7

- Connect the high pressure flexible tube of the tester to the adaptor (Fig. 8).

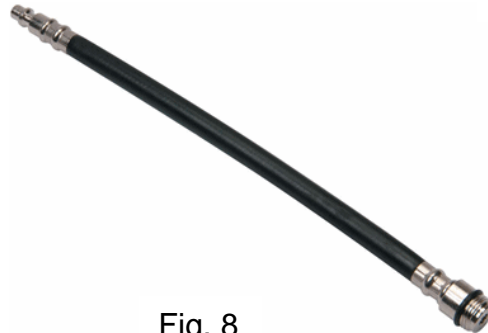


Fig. 8

- Turn the engine by hand or with the self-starter motor until the instrument pointer comes to a standstill.

NB: If the intake manifold is fitted with a butterfly, make sure that it is in the fully open position (see Fig. 9)

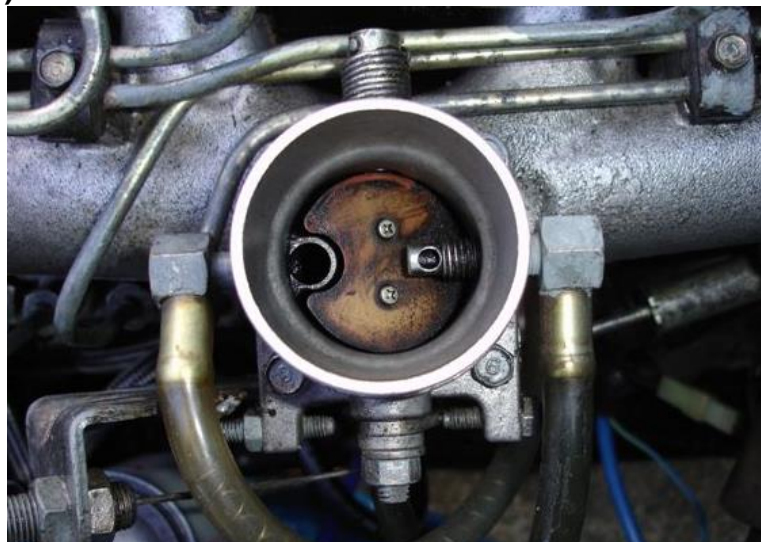


Fig. 9

- Take the reading and record it on a piece of paper if the tester is not fitted with a recording chart.
- Release the pressure in the tester. A non-return valve in the compression tester retains the pressure in the gauge, thus making an accurate reading possible.
- Remove the tester.
- Test all the remaining cylinders and record their pressures.
- Compare the pressure readings with the specified pressure in your workshop manual.

NB: If a difference of more than 100 kpa is measured, you should trace and rectify the fault. (The above test is referred to as a dry test).

- Squirt approximately a teaspoon full of engine oil into the No.1 cylinder. (This is referred to as a "wet test") (Fig. 10).

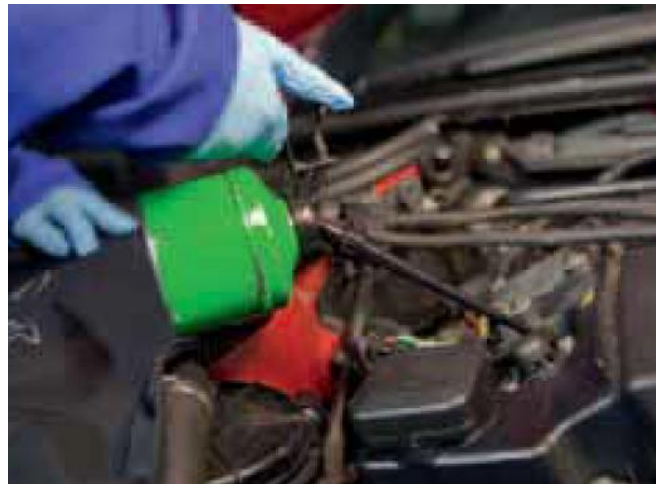


Fig 10

- Do another wet compression test on the No. 1 cylinder.
- Record the pressure.
- Do the same test on the remaining cylinders.

NB:(a) If any one or all of the cylinders show a notable increase in compression with the wet test, it can be accepted that the loss of compression is due to worn pistons and piston rings.

(b) If a cylinder with a low reading from the dry test does not show any notable increase in pressure in the wet test, the most likely fault is a burnt or sticky valve.

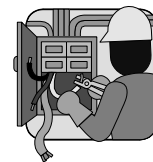
DO THE SELF-TEST AND PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

SELF TEST 1



What are the possible causes for poor compression on a diesel engine?

PRACTICE



Conduct a compression test on a diesel engine and record the pressures of each cylinder.

Diagnose the condition of the valves, pistons and rings and record the likely causes of any faults that may exist.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

5. TESTING FOR EXHAUST GAS IN THE RADIATOR

ITEM / TASK: CO2 Checking in Radiator (with CO2 test liquid)

DESCRIPTION:



WARNING

- **DO NOT** open the radiator cap before ensuring it is cool.
- Heatproof gloves and eye protection should be worn when operating.
- **DO NOT** disconnect the test tool from radiator opening before releasing the pressure from the radiator (it is normal that the coolant is partially released and lost) or ensuring the radiator is cool.
- Please avoid the circulated coolant up to the lower chamber or even exceed to the red level line, when this situation occurs:
 - Turn the brass adaptor clockwise in order to release the fluid, and then turn the brass adaptor anticlockwise to lock it.
 - If the fluid keeps in high volume, please turn off the engine and release the fluid.

6. OPERATING INSTRUCTIONS

ITEM / TASK: Operating instructions

DESCRIPTION:

Step 1

- Prepare a container and remove the approximately 1/10 of the volume of the coolant.(Fig.11 next page)

Step 2

- Disassemble the rubber cone from the detector.

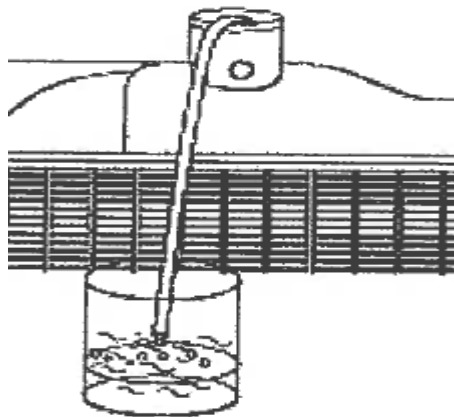


Fig.11

Step 3.1

- Install the rubber bulb, cap, upper chamber, lower chamber, brass adaptor and the available radiator cap one after another(This way could provide a safer and more accurate test) and then , fill the upper chamber with the blue detector liquid till the black line.(Fig. 12)



Fig.12

Step 3.2

- Alternative instalment for the situation where there is no available radiator cap.
- Install the rubber bulb, cap, upper chamber, lower chamber and rubber cone one after another.
- Please hold the detector body as operating.

Step 4

- Pump the rubber bulb continually to draw steam from radiator.

7. TEST ANALYSIS

ITEM / TASK: Test Analysis

DESCRIPTION:

- If exhaust gas is present in the cooling system, the colour of the test liquid turns from blue to green or yellow when the steam mixes with the CO₂ detector liquid in the detector.(Fig.13)
- If the detector liquid still in blue during the test operation, it means the gasket is still in good condition.



Fig.13

8. REMOVE A CYLINDER HEAD GASKET

ITEM / TASK: Remove a cylinder head gasket

DESCRIPTION:

The major steps in removing a cylinder head gasket are as follows:

- Clean the outside of the engine properly. This is a precaution, which must be taken to prevent any dirt from entering the engine.
- Remove the battery terminals.
- Remove the air cleaner assembly and related components.
- Disconnect the exhaust pipe from the exhaust manifold.
- Remove the injector pipes from the injectors and injection pump.

NB: Cap all the exposed openings in the pump and the injectors to prevent dirt from entering.

- Disconnect the cold start equipment, if fitted.
- Shut off the fuel at the tank and remove the fuel filters and fuel lines.
- Remove the injector leak-off pipes and injectors.
- Remove the tappet cover.
- Visually check the push rods for straightness before they are removed. This is done by rotating them with the valve closed (Fig. 14). If the push rods are not straight, do not attempt to straighten them replace them.

NB: The stripping sequence described above may differ for different engines.

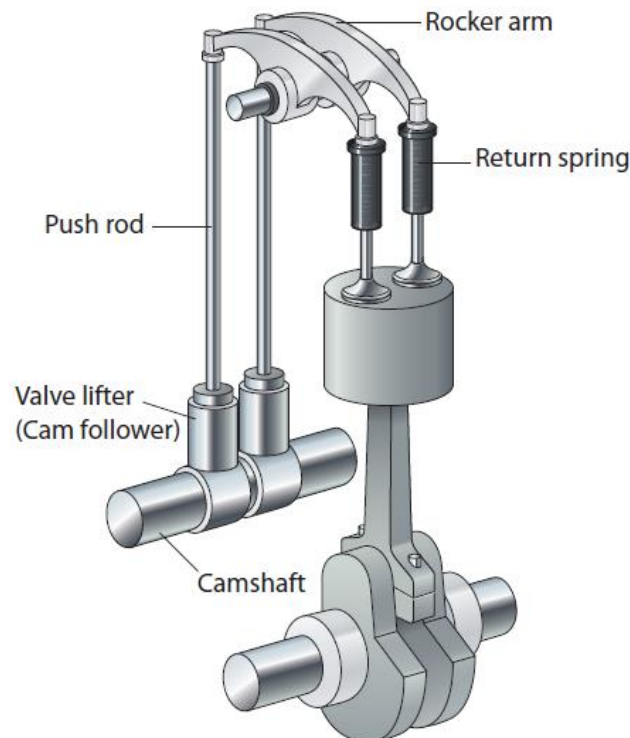


Fig 14

- Loosen and remove the bolts that hold the rocker shaft onto the cylinder head

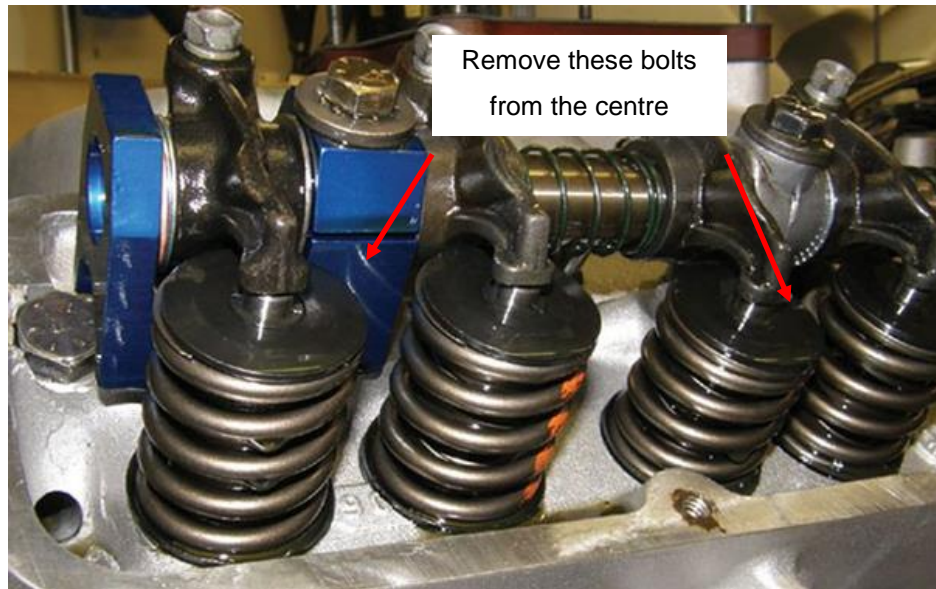


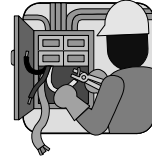
Fig15

NB: Do not remove these bolts separately. Loosen them evenly and alternately, working outwards from the centre, until all the tension has been relieved.

- Remove the rocker shaft assembly.
- Remove the valve push rods from their holes in the cylinder head and arrange them in a rack in the same order in which they were removed.
- Unscrew the cylinder head bolts in the reverse order of the tightening sequence. Refer to the workshop manual for the tightening sequence.
- Carefully lift the cylinder head from the block. A sharp object should not be used to separate the cylinder head from the block. It will damage the faces of the cylinder head.
- Remove the gasket carefully from the cylinder head.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

PRACTICE



Remove the cylinder head and gasket from the engine.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

9. INSPECT AND REPAIR THE CYLINDER HEAD

ITEM / TASK: Inspect and repair the cylinder head

DESCRIPTION:

- Inspect the cylinder head for cracks, nicks or burrs.
- Remove all the burrs or nicks from the cylinder head face with an oilstone. Replace the cylinder head if it is cracked.
- Check the flatness of the cylinder head lengthwise, diagonally and cross wise with a straight edge and feeler gauge as shown in Fig. 16.

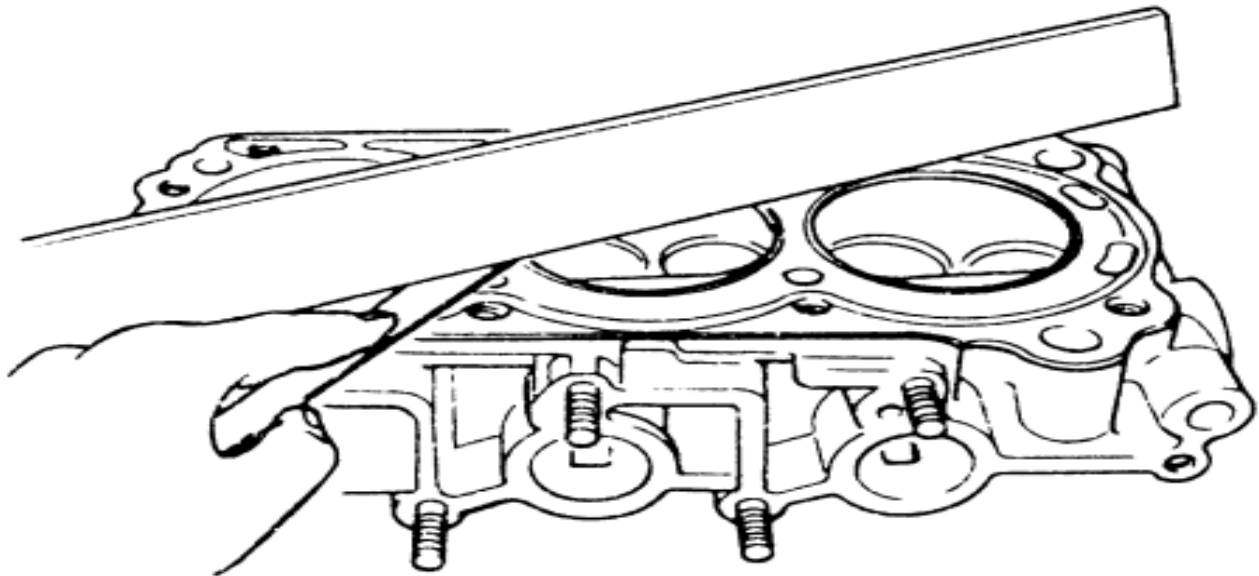
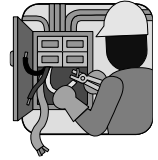


Fig 16

NB: The specification for flatness is 0,067mm in any 150mm. If the cylinder head falls outside this specification, arrange for it to be skimmed or replace it. Specifications may differ from engine to engine and manufacturer to manufacturer. The manual for the specific engine should be consulted.

DO THE PRACTICE BELOW BEFORE CONTINUING WITH THE REST OF THE MODULE



PRACTICE

Clean, inspect and repair the cylinder head that you have removed from the diesel engine.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

10. REPLACE THE CYLINDER HEAD

ITEM / TASK: Replace the cylinder head

DESCRIPTION:

- Ensure the faces of the cylinder head and cylinder block are perfectly clean.
- Place a new gasket on the cylinder block. Do not smear any grease or sealing compound on the faces of the gasket. On some gaskets "Front" and "Top" is stamped on one of the faces of the gasket. It should be fitted accordingly. You must also see that the holes in the gasket correspond with the holes in the block.
- Carefully position the cylinder head on the gasket.
- Lubricate the cylinder head bolts with engine oil and screw them on "finger" tight.

Install the valve push rods with the cupped ends up, in the holes in the cylinder head from which they were removed. Be sure that the ball ends of the push rods are seated in the tappet sockets (Fig. 17).

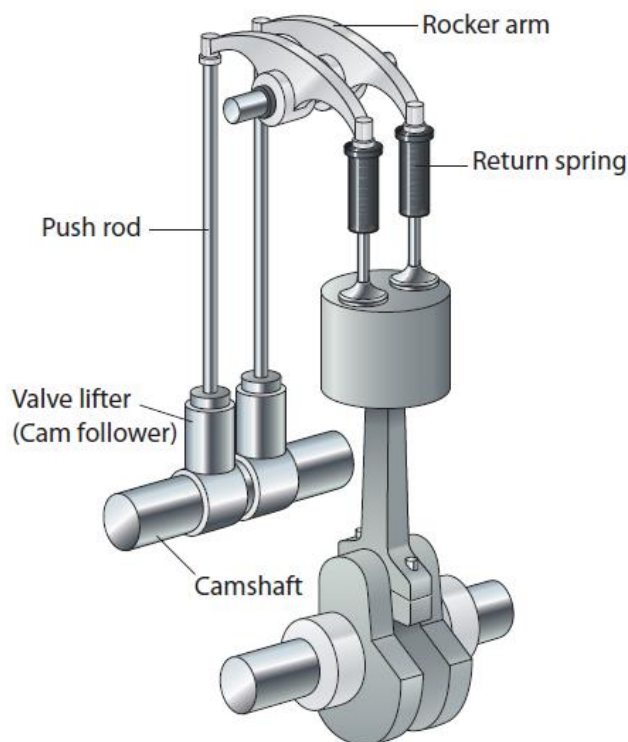


Fig. 17

- Position the rocker shaft assembly on the cylinder head. Make sure that the ball ends of the rocker arm adjusting screws are seated in the cupped end of the push rod (Fig. 17 above).
- Replace the rocker shaft retaining bolts and draw them up evenly and alternately, working outwards from the centre.

- Tighten the cylinder head bolts in the proper sequence as shown in the workshop manual. Tighten the bolts progressively in three steps with a torque wrench. For example, if the final torque of the bolts is 136Nm, first tighten them to 110Nm, then to 120Nm and finally to the specified torque of 136Nm.

NB: On some engines the rocker shaft is fitted after the cylinder head bolts have been tightened. This depends on whether the rocker shaft assembly is secured by the cylinder head bolts or by separate bolts.

- Set the valve clearance as learnt previously (Fig. 18).

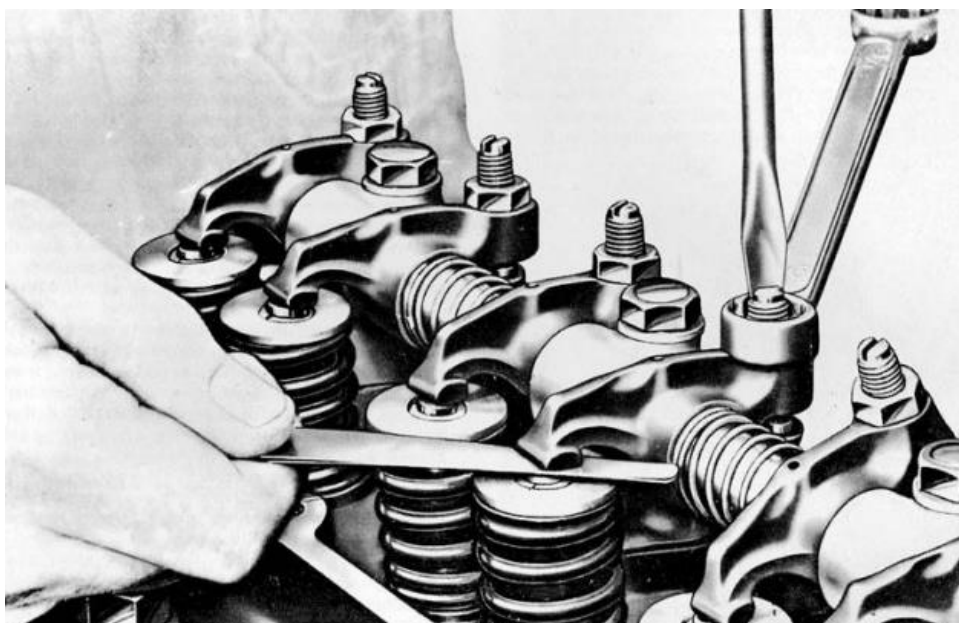
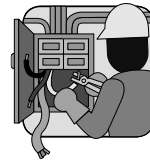


Fig. 18

- Replace the tappet cover using a new gasket and tighten the bolts to the specified torque.
- Replace the injectors and leak-off pipes.
- Replace the fuel filters and fuel lines.
- Connect the cold start equipment.
- Replace the injectors and injector pipes.
- Replace the radiator hoses and fill the radiator with coolant.
- Replace the exhaust pipe.
- Replace the air cleaner and the related components.
- Replace the battery terminals.
- Bleed the fuel system.
- Start the engine.

DO THE PRACTICE ON THE NEXT PAGE BEFORE CONTINUING WITH THE REST OF THE MODULE.

PRACTICE



Replace the cylinder head, set the tappet clearances and start the engine.

Ask your Training Officer to check your work and if it is correct, to sign below and then go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

11. MAINTAIN AIR FILTERS

ITEM / TASK: Introduction

DESCRIPTION:

Air filters prevent dust, dirt and other abrasive particles present in the air from being drawn into an engine or compressor. These contaminants cause friction, wear and overheating. Air filters can be classified as either **light/medium duty filters**, or **heavy duty filters**. The following three types of air cleaners that might be encountered are described below:

- oil wetted mesh filter
- oil bath air filter
- dry type air filter.

12. TYPES OF AIR FILTERS

ITEM / TASK: Oil wetted mesh air filter.

DESCRIPTION:

- This filter consists of a copper wire or crinkled aluminium mesh held in place with cylindrical screens.
- The element is dipped in oil and the excess oil drained off before installing it.
- The oil coating, which remains on the surface of the mesh, filters the air and prevents dirt entering the engine.

Disadvantages of this filter are that the element has to be washed and re-oiled frequently and that its efficiency is reduced with use. Fig. 19 shows this type of air filter

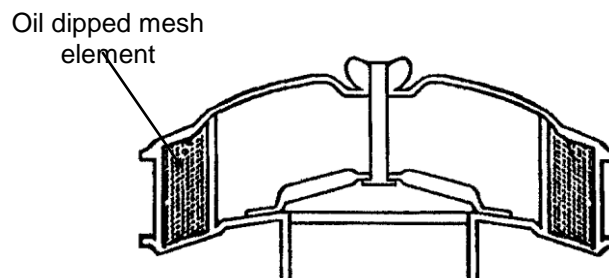


Fig. 19

13. OIL BATH AIR FILTER

ITEM / TASK: Oil bath air filter

DESCRIPTION:

- With the oil bath air filter, air enters the system and flows towards an oil bath in the base of the filter.
- The baffle deflects the air as it reaches the oil bath and when this happens the large particles of dust fall down and are trapped by the oil.
- The moistened air flows upwards through the mesh element, which removes the oil moisture and the remaining dust from the air (Fig. 20).

The white arrows represent the filtered air.

The black arrows represent the unfiltered air.

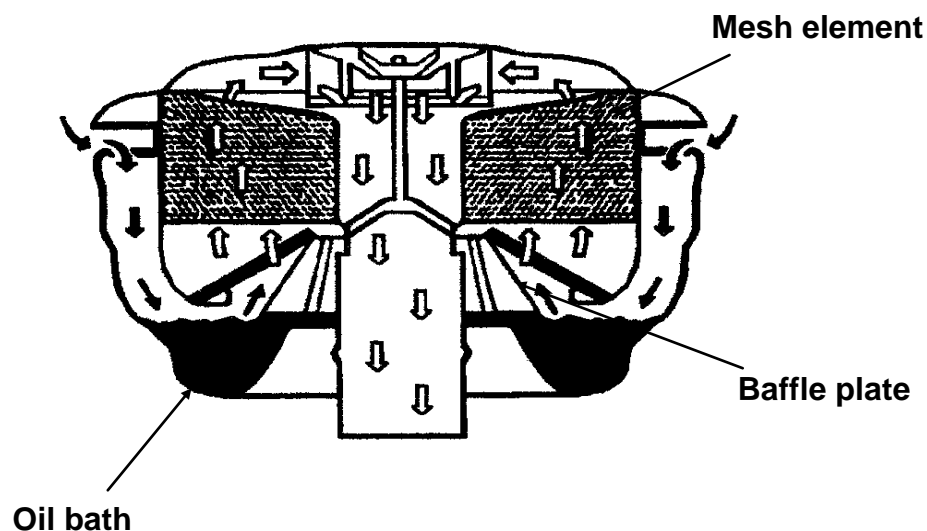


Fig. 20

Note: The two oil type of air filters described above are rarely encountered these days because they have been replaced by dry type air filters, which are commonly used in the mining industry.

14. DRY TYPE AIR FILTERS

ITEM / TASK: Dry type air filters

DESCRIPTION:

In both the light/medium and heavy duty types, the air cleaners consist of a permanent housing with a replaceable filter cartridge

Fig. 21 shows the cartridge for a light/medium duty air cleaner.

Light/medium dry element

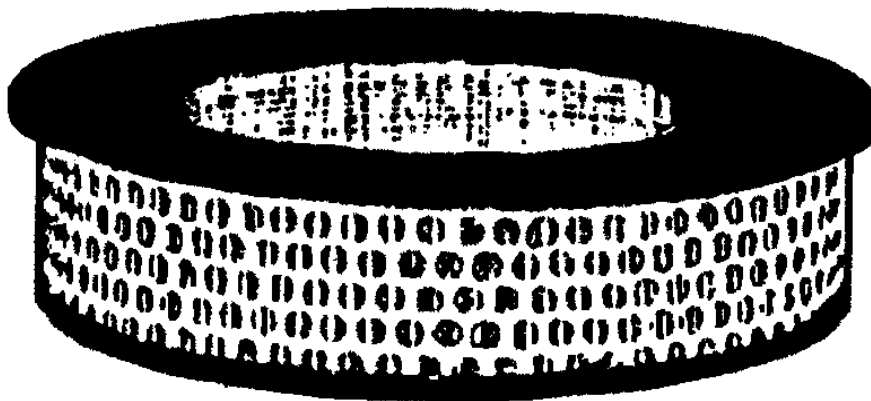


Fig. 21

- The outer and inner shells of the filter cartridges are made of thin perforated metal or mesh.
- The filtering media is made of thick, heavy paper, which is very much like blotting paper.
- It is pleated to give an increased filtering surface area as shown in Fig.22 on the next page

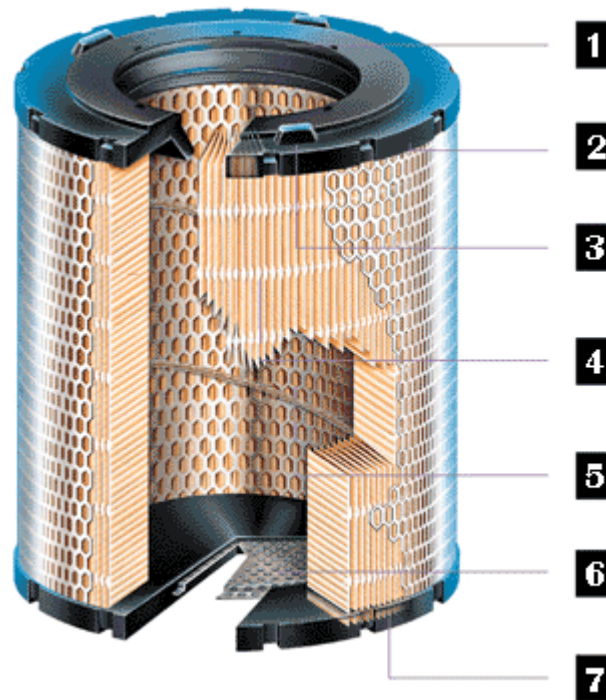


Fig.22

1. Heavy-Duty Radial Seal Gasket formed from special nitrile rubber compound. Will not degrade under temperature extremes, changes in restriction or vibration.
2. Flexible outer edges allow deflection for easy insertion and removal in housings which have minimum clearance.
3. Special Lugs hold filter securely in place to prevent vibration.
4. PermaPleat® Construction provides even pleat spacing to prevent bunching and ensure maximum element life.
5. Spiral Glue Binding provides added pleat stability to optimize media effectiveness.
6. Heavy-Duty End Cap Construction. Center portion specially reinforced to prevent constant flexing and potential failure during changes in intake pressure.
7. More Filtration Surface is provided by using a special plastisol binder which does not extend into the path of air flow.

- Fig. 23 shows a fully assembled heavy duty air cleaner.

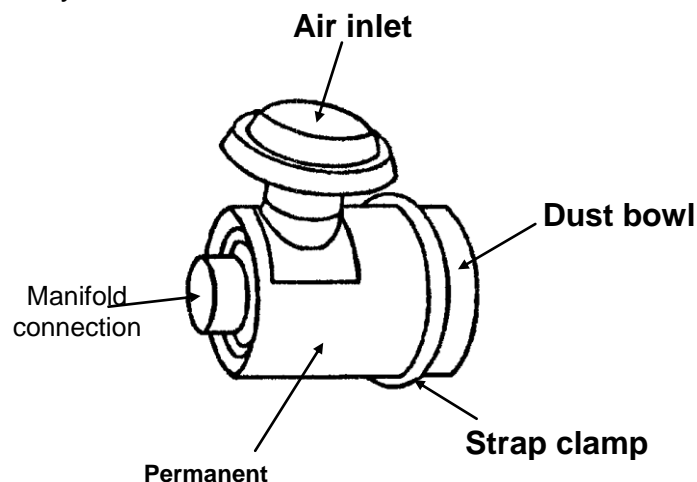


Fig. 23

15. STRIPPING AND CLEANING DRY TYPE AIR FILTERS

ITEM / TASK: Stripping and cleaning dry type air filters

DESCRIPTION:

- Stop and isolate the engine.
- Loosen the strap clamp.
- Remove the dust bowl and empty it of the dust.
- Loosen the wing nut (if one is fitted) and remove the cartridge.
- Remove the air inlet hood and wipe it with a clean linen cloth (never use waste).
- Wipe the inside of the air cleaner body.
- Replace the air inlet hood.
- Hold the cartridge away from the engine and blow it out with compressed air (Fig. 24).

NB: The air must be directed at the clean side of the cartridge, i.e. in the opposite direction of the normal intake flow of the air.

- The air pressure must not exceed 700 kpa.
- The air must not be directed in one position only because this may rupture the cartridge. (Refer to Item 2 on the HIAC Form)

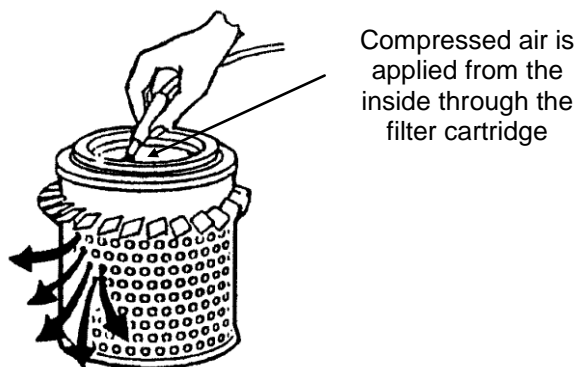


Fig 24

Note: A low suds detergent may also be use to wash the cartridge instead of blowing it out. Flammable materials should never be used.

- Inspect the cartridge for damage and, if it is all right, replace it in the air cleaner body.
- Wipe the dust bowl and replace it, making sure that the cartridge is sealed off completely at both ends.
- Check that all the securing bolts and clamps are tight.
- Check the air ducting for cracks or leaks and replace it if necessary

NB: Air filter service must be carried out as often as recommended by the manufacturer.

DO THE SELF-TEST AND THE PRACTICE BELOW BEFORE ATTEMPTING THE ASSESSMENT FOR THE MODULE.

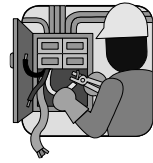
SELF TEST 2



State the purpose of an air filter.

Check your answer against the notes.

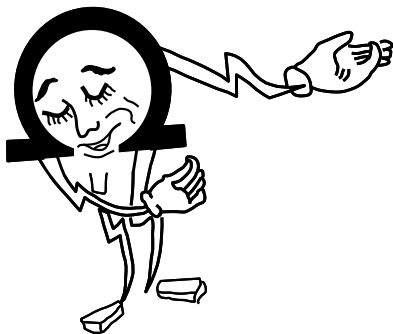
PRACTICE



Remove, clean and replace the air filter of a diesel engine.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

Once you have passed the entire practices, you are now at liberty to request a Formative Assessment from your Assessor.