

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

CODE: PDS

START A FOUR-STROKE

DIESEL ENGINE

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MODULE OBJECTIVE

- To enable the learner to start and stop a four-stroke diesel engine, using the correct procedures.

LEARNING OBJECTIVES

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

- Explain the operating principles of a four-stroke diesel engine.
- Correctly start and stop a four stroke diesel engine.

ASSESSMENT AND EVALUATION CRITERIA

- A practical test will be set at the end of the module and must be completed without using references.
- The learner will be required to start and stop a four-stroke diesel engine in accordance with the following standards:

(A) Before starting the engine, the following must be checked:

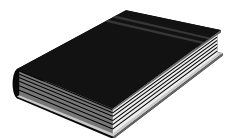
- That the radiator is filled with clean water.
- That the sump oil level is up to the "full" mark.
- That the battery is filled 6mm above the plates with battery water.
- That all the electrical connections are tight and free of sulphate.
- That no tools, materials or waste are lying on or around the engine.

(B) After the engine has started the following must be checked:

- That the oil pressure is according to specifications.
- That the generator is charging.
- When the engine has stopped, the stop control must be returned to the "run" position.
- All safety procedures must be adhered to.

ADDITIONAL RESOURCES

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



HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM**PDS****START A FOUR-STROKE DIESEL ENGINE**

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Start diesel engine	<ul style="list-style-type: none"> • Insufficient oil pressure can cause severe engine damage. • Tools left in engine bay can fall on to moving parts and cause injury or damage to the engine. • Running an engine in a poorly ventilated area can result in the accumulation of noxious exhaust fumes, which may pose a danger to health. 	<ul style="list-style-type: none"> • Check engine oil level before commencing starting procedures • Ensure all loose tools and equipment are removed before starting the engine. • Ensure proper ventilation if engine has to be started in a confined space. • Check water level in radiator before starting and running the engine.
2. Running the diesel engine	<ul style="list-style-type: none"> • Insufficient water in radiator can lead to engine damage from overheating. 	

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. OPERATING PRINCIPLES OF A DIESEL ENGINE

ITEM / TASK: Introduction

DESCRIPTION:

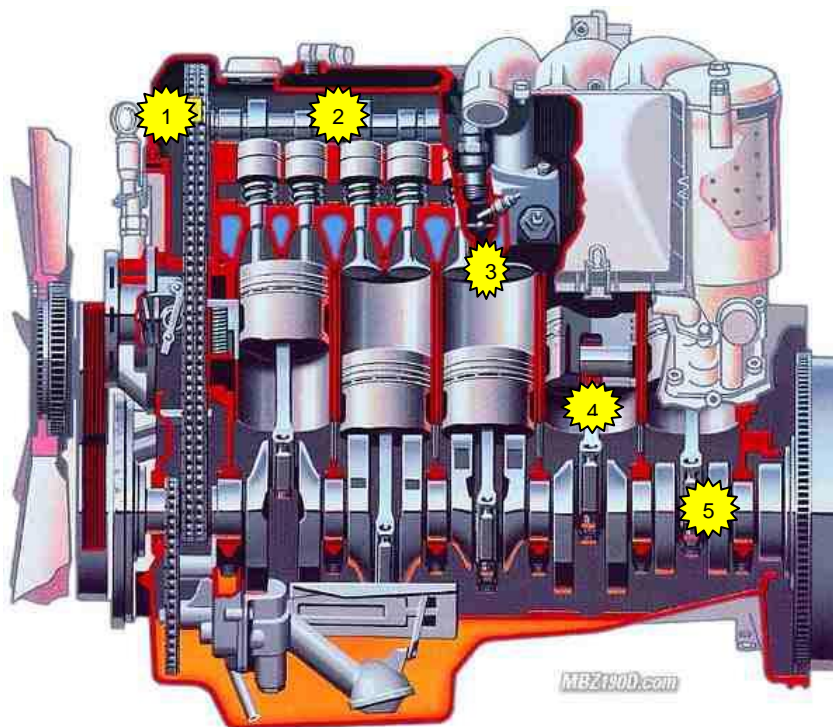
- Most of the vehicles used underground in the mining industry are driven by means of a diesel powered engine. As a maintenance man, you will be expected to maintain and to do running repairs on this type of engine.
- To enable you to do proper fault finding, you must know the working principles of a diesel engine.

2. MAIN PARTS OF A SIMPLE ENGINE

ITEM / TASK: Main parts of a simple engine

DESCRIPTION:

Fig. 1 shows the main parts of a simple engine.



1. Timing Chain
2. Camshaft
3. Valves
4. Connecting Rod
5. Crankshaft

Fig. 1

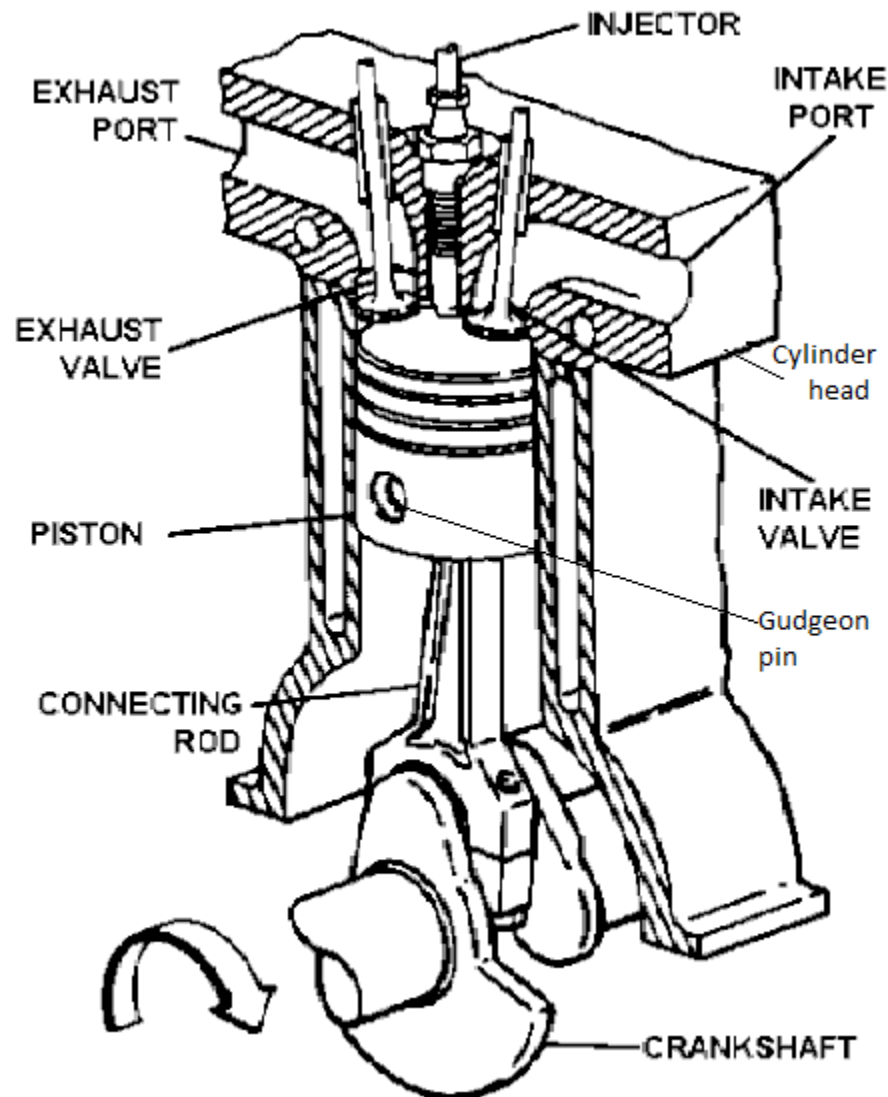


Fig. 2

The Cylinder

- In its simplest form is a tube of circular cross-section, closed at one end.

The Piston

- Fits closely inside the cylinder. Ideally it would be perfectly gas-tight yet perfectly free to move up and down inside the cylinder.

The Connecting Rod

- Connects the piston to the crankshaft. At the piston end is a pin called the gudgeon pin that is fitted into holes in the piston and the connecting rod to couple them together.

The Crankshaft

- Is the main shaft of the engine and is carried on bearings in the crankcase. The crank pin is offset from the main part of the shaft, and on it is fitted the connecting rod, which is free to turn.

3. WORKING PRINCIPLES

ITEM / TASK: Working Principles

DESCRIPTION:

- The rotation of the crankshaft causes the piston to move up and down inside the cylinder.
- The lines "A" and "B" in Fig. 3 indicate the limits of travel of the top of the piston

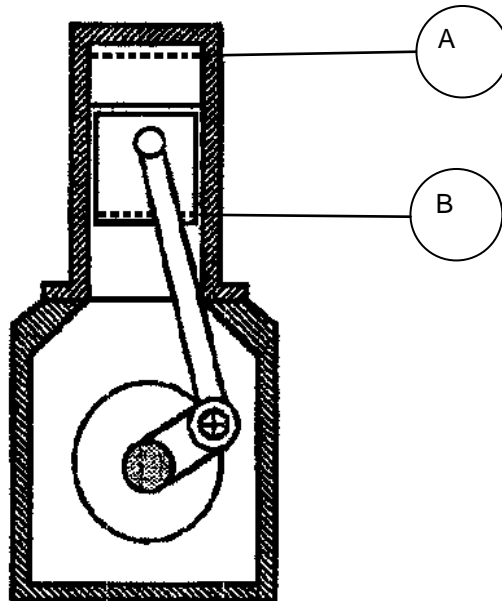


FIG. 3

- As the piston moves upwards, the space between its top surface and the closed end of the cylinder is reduced, i.e. the gas trapped in this space is compressed.
- As the piston moves downwards, the space above it is increased, i.e. the gas in this space expands.
- The crankshaft, which is connected to the piston is rotated by the piston moving up and down in the cylinder.
- Starting in the position shown in Fig. 2, the crankshaft rotates clockwise as the piston is pushed downwards until the piston reaches the lowest point of its travel. At this point the crank pin will be directly under the centre of the crankshaft, and the centres of the gudgeon pin, crank pin and crankshaft will all lie in a straight line. In this position pressure on the piston will have no turning effect on the crankshaft and this position is therefore called a dead centre.
- Another dead centre position occurs when the piston is at the top of its travel.
- These two dead centres, which are known as “bottom dead centre” (BDC) and “top dead centre” (TDC) respectively (Fig. 4), mark the limits of the piston’s travel.

- Movement of the piston from one dead centre to another is called a stroke and there are two strokes of the piston to every revolution of the crankshaft.

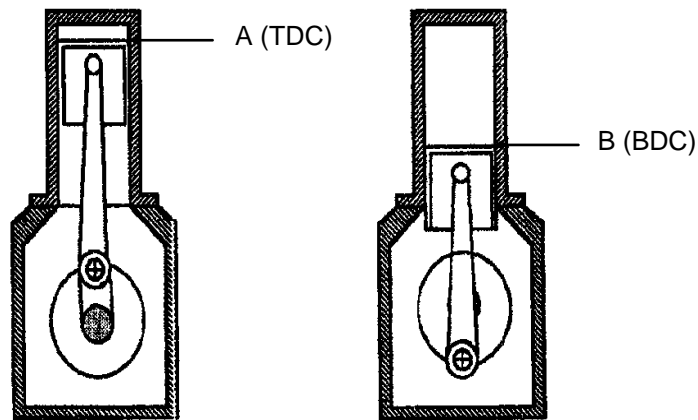


Fig. 4

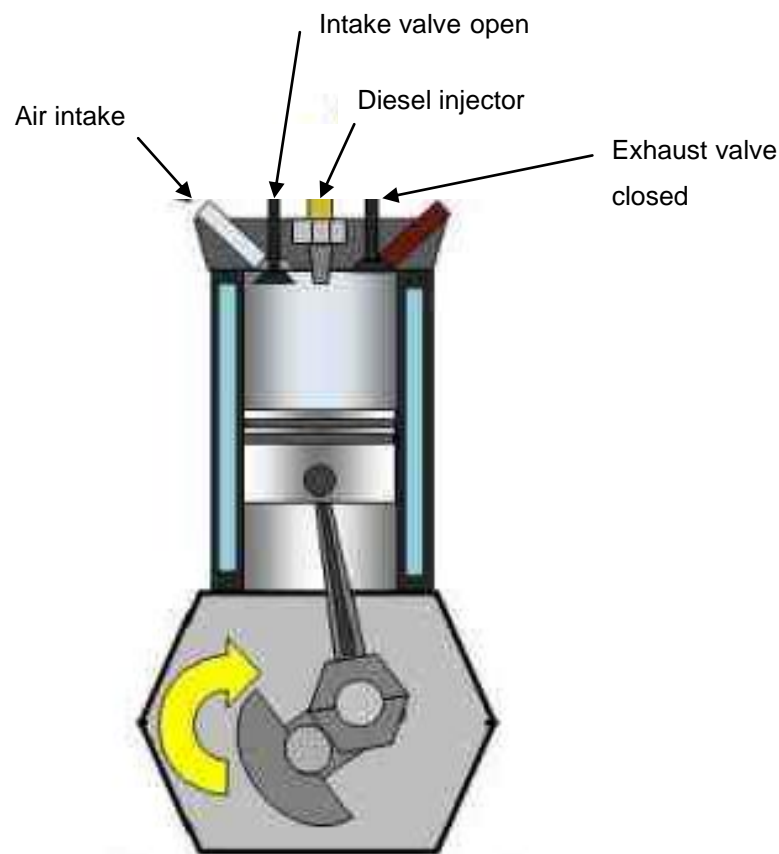
- In a diesel engine the air enters the cylinder through a hole called the inlet port. Once inside the cylinder the air is compressed, which increases its temperature enough to ignite the diesel fuel when the latter is injected into the cylinder. After the diesel fuel has ignited and the resulting pressure has pushed the piston down the cylinder, the waste gases are released through the exhaust port. The inlet and exhaust ports are normally closed, but are opened at the correct times to allow the gases to pass through them.
- The operation (running) of the engine involves the continuous repetition of four strokes, which make up what is called the cycle of operation. As long as the engine is running the strokes are repeated continuously in the order described below.

4. OPERATION CYCLES OF A FOUR-STROKE ENGINE

ITEM / TASK: Induction stroke.

DESCRIPTION:

The descending piston increases the cylinder volume and decreases the pressure. Atmospheric pressure forces air through the open inlet port into the cylinder.



INDUCTION STROKE

Fig. 4

ITEM / TASK: Compression stroke.

DESCRIPTION:

During this stroke both valves are closed and, therefore, the ascending piston compresses and raises the temperature of the air. The final pressure and temperature will be about 3450 kPa and 650° respectively.

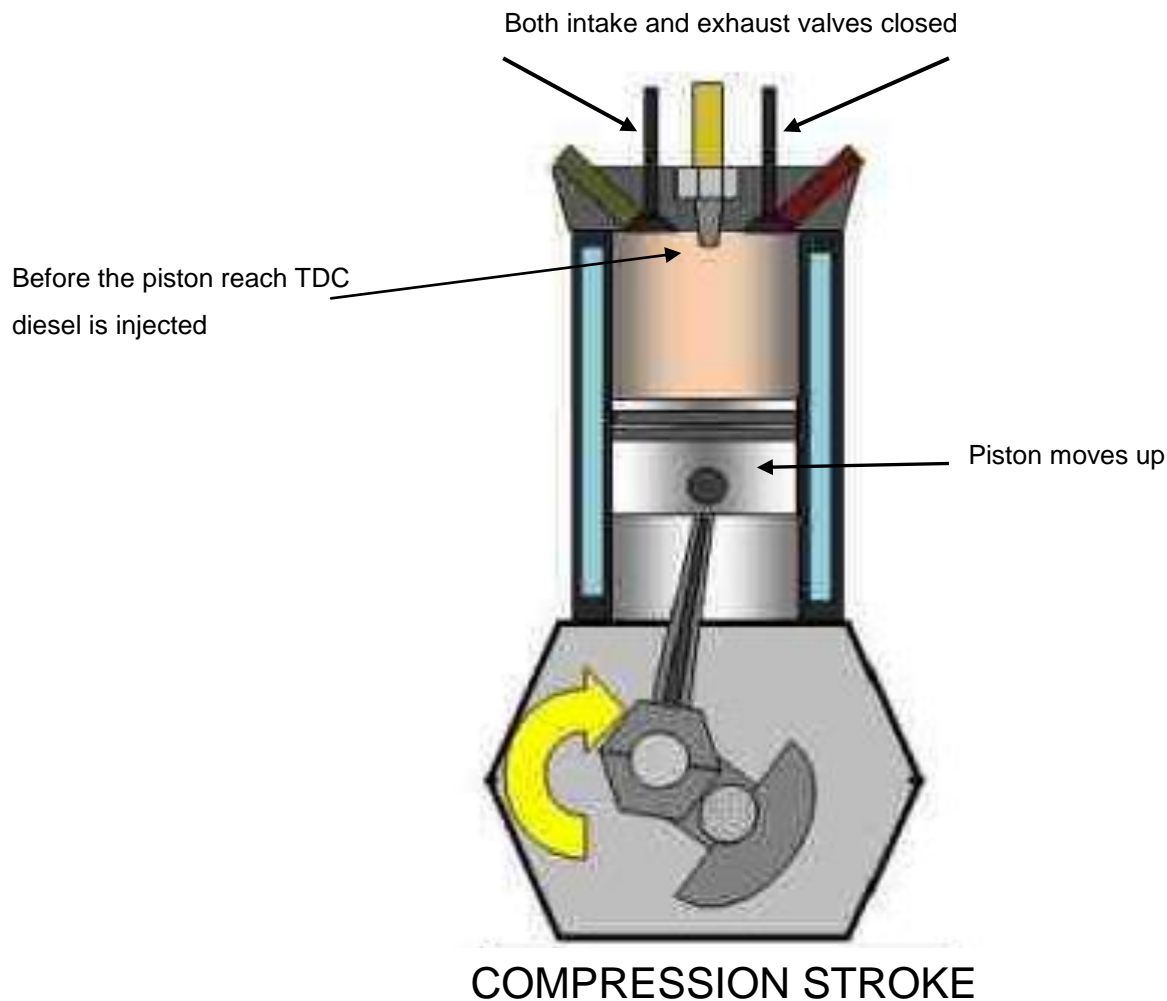


Fig. 5

ITEM / TASK: Power stroke.

DESCRIPTION:

Just before TDC (top dead centre), diesel fuel, having a self-ignition temperature of 400°C , are injected into the cylinder at a high pressure by means of an injector pump. After a short delay, the fuel begins to burn and give off heat, which raises the pressure thus providing the thrust necessary for the power stroke. The amount of power is controlled by the period of injection, i.e. the quantity of fuel injected.

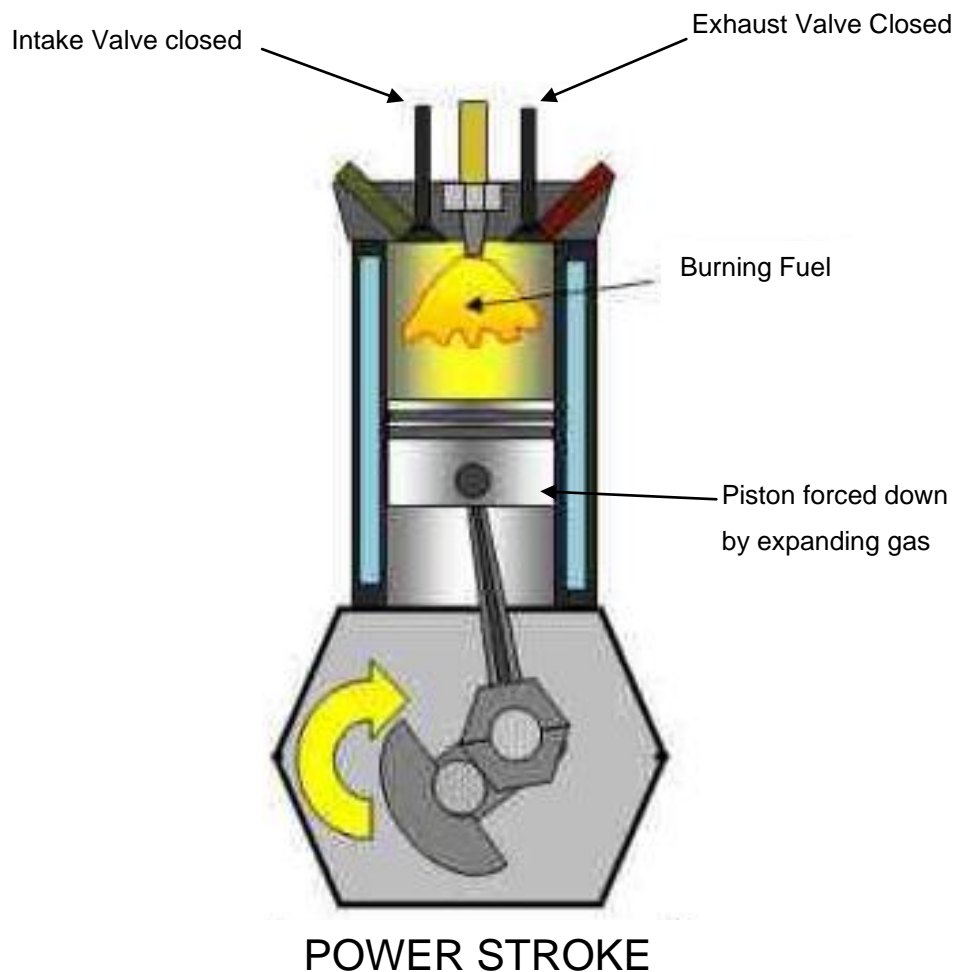


Fig. 6

ITEM / TASK: Exhaust stroke.

DESCRIPTION:

As the piston nears the end of the power stroke, the exhaust valve is opened. The ascending piston pushes out the waste gas in readiness, for the new cycle. (Fig. 7)

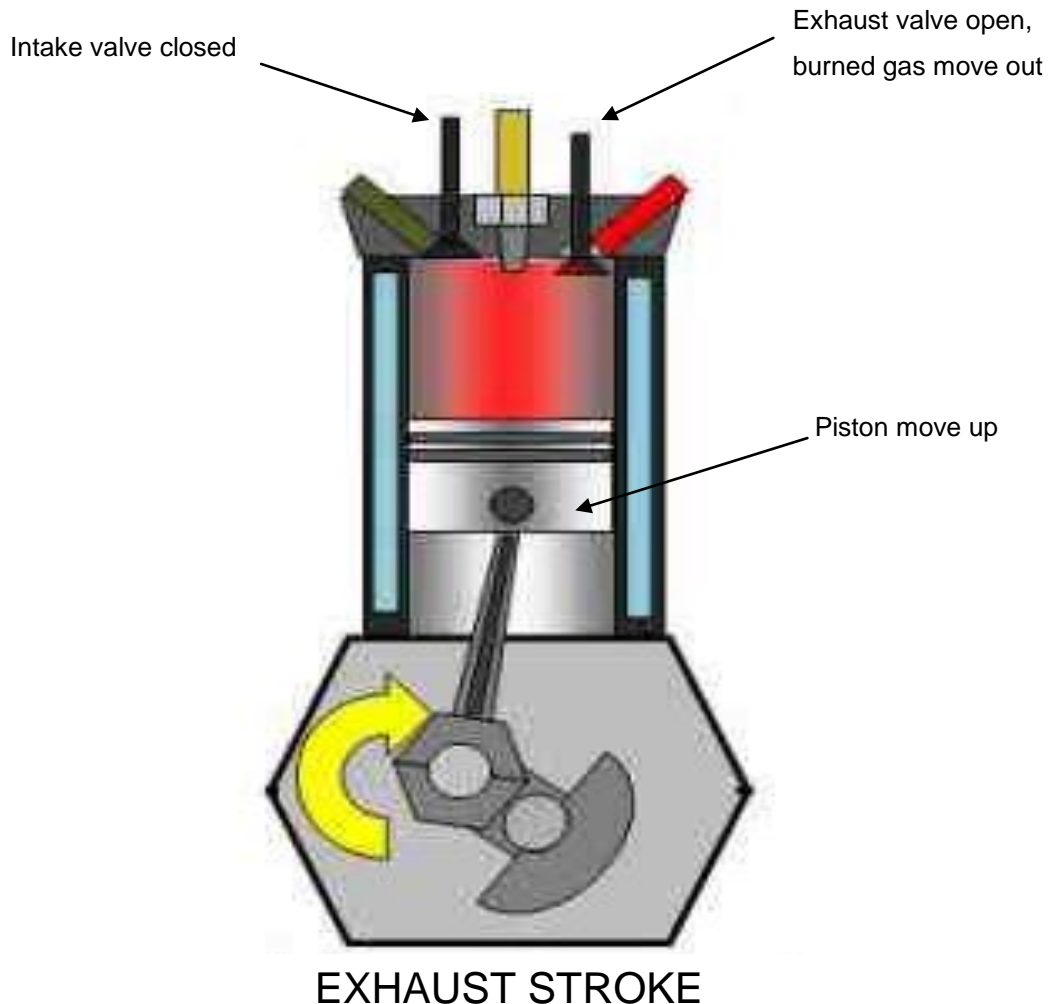


FIG. 7

Note: The expanding gas help the piston on its way during only one of the strokes, namely the power stroke. During the remaining strokes it gives no direct help, and actually impedes the piston's movement, particularly during the compression of the air. Thus the work of the flywheel is not merely to push the piston back up the cylinder, but to keep the crankshaft turning as steadily as possible between one impulse on the piston and the next.

DO THE SELF-TEST BEFORE CONTINUING WITH THE REST OF THE MODULE.



SELF TEST 1

Answer the following questions without referring back to your notes.

1. What are the names of the four strokes in one cycle of a four-stroke diesel engine?

- _____
- _____
- _____
- _____

2. Briefly describe the action that takes place at each stroke.

- _____

- _____

- _____

- _____

3. What are the positions of the inlet and exhaust valves at each stroke?

- _____
- _____
- _____
- _____

Now check your answers against the notes to see if they are correct.

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. PRE-START CHECKS

ITEM / TASK: Pre-start checks.

DESCRIPTION:

The engine must be prepared in the following manner before it is started.

1. FUEL LEVEL

- Make sure there is enough fuel in the tank.

NB: If the engine stops because of lack of fuel in the tank, you cannot merely refill the tank. You also have to bleed the fuel system. The method of doing this is described in detail in module PDF.

2. OIL LEVEL

- Check that the sump is filled with oil up to the "full" mark. The oil level is normally indicated by a dipstick situated on the side of the engine

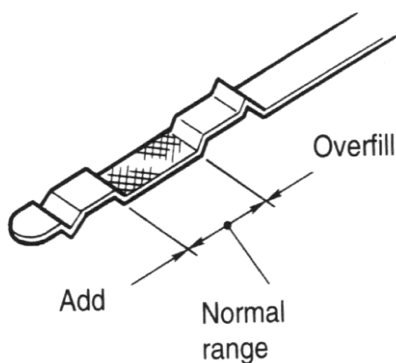


Fig. 8

NB: To get a true reading:

- The vehicle must be level.
- The engine must be stopped to check the oil level, wait a few minutes for the oil in circulation to drain back to the sump.
- The dipstick must be pushed as far as it will go before it is removed.

Note: Always top up the sump with the grade oil recommended by the manufacturers.

3. RADIATOR LEVEL

- Check that the radiator is filled with clean water.
- Visually inspect the radiator hoses, radiator cap and water pump for any water leaks.

Note: Pressure is generated in the system by the normal expansion of water as it is heated. The pressure is maintained by the radiator pressure cap. If the engine has been running just

prior to the check, it is advisable to let the engine cool down before you remove the radiator cap. This will lower the pressure in the system.

4. BATTERY CHECK

- If the vehicle is fitted with a battery it must also be checked and maintained (Fig. 9).

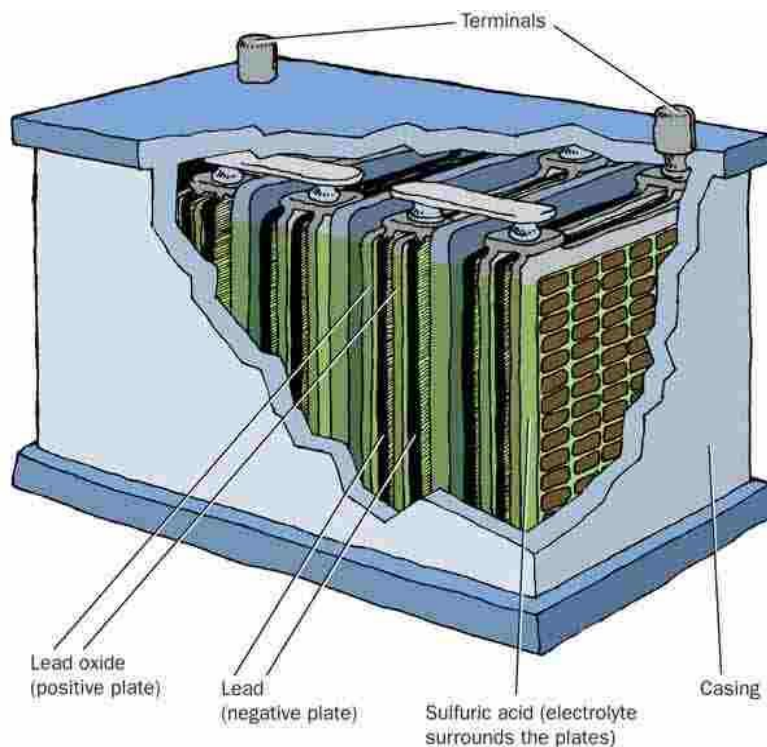


Fig. 9

- A battery is made of plates, which are immersed in a chemical solution called electrolyte. The level of the electrolyte must be approximately 6mm above the plates. Add distilled water if the level is incorrect.
- The battery terminals and cables must be kept clean of any sulphate deposits. The sulphate can be removed with a solution of bicarbonate of soda and water. The terminals can be coated with petroleum jelly (grease) to retard corrosion. You must also ensure that all electrical connections are tight
-

5. SAFETY



- Make sure that there are no tools, materials or waste lying in or around the engine. They may be caught in the moving parts or thrown into them by vibration. **(Refer to item 1 on the HIAC form.)**
- If the engine is started in a confined space, check that there is sufficient ventilation to prevent you and your fellow workers from inhaling the exhaust fumes. **(Refer to item 1 on the HIAC form.)**

6. STARTING A DIESEL ENGINE

ITEM / TASK: Warm start.

DESCRIPTION:

If the engine is warm, turn the starter switch in a clockwise direction to the "HS" position (Fig. 10). As soon as the engine starts, release the switch to the "R" position.

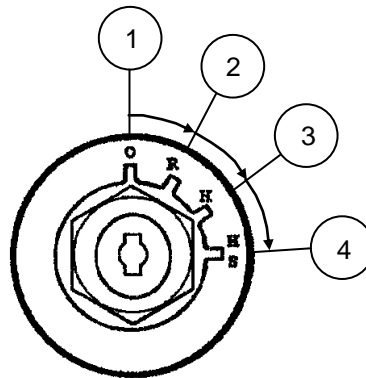


FIG. 10

ITEM / TASK: Cold start.

DESCRIPTION:

- If the engine is cold turn the starter switch to the "H" position (Fig. 10) and hold it there for fifteen to twenty seconds. This brings the **cold starting aid** in to operation (see description below).
- Then turn the starter switch to the 'HS' position, thereby engaging the starter motor.
- As soon as the engine starts, release the switch to the "R" position.

NB: Immediately after the engine has started check the oil pressure indicated on the oil pressure gauge. The oil pressure must be approximately 280 KPa.

Operation of the cold starting aid. Refer to Fig. 11

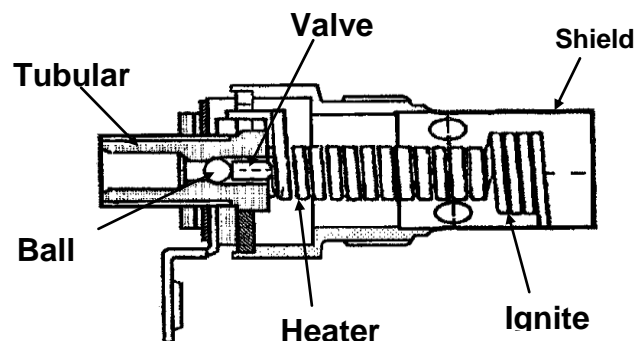


FIG 11

- The cold start unit comprises a tubular valve body carried in a holder which screws into the inlet manifold. The inlet manifold is surrounded by a heater coil, an extension of which forms an igniter coil. The valve body houses a needle, the stem of which holds a ball valve in position against its seating. The unit is surrounded by an open perforated shield. Fuel oil from the container enters through an adaptor.
- When the unit is cold, the ball valve is held closed. When the coil is switched on the valve body is heated and expands, opening the ball valve and permitting the fuel to enter. The fuel is vaporised by the heat of the valve body and, when the engine is cranked and air is drawn into the manifold, the vapour is ignited by the coil extension and continues to burn, thus heating the inlet air. When the coil is switched off, the flow of air in the manifold cools the valve body rapidly and the valve closes.
- The cold start aid is a sealed unit and cannot be dismantled. If the unit ceases to function, it must be renewed.

ITEM / TASK: Glow Plugs.

DESCRIPTION:

Glow plugs are used to create heat in a diesel engine. To understand why there is a need for a glow plug you need to understand the workings of a diesel engine. In cold weather diesel engines can be difficult to start. The cold cylinder block and cylinder head draw out the heat in the cylinder during the compression stroke. This prevents ignition. This is where a glow plug comes into play. When starting a diesel engine you do not crank the key all the way the first time. The key is just to right before ignition to start the glow plugs. This is called glowing or pre heating. An indicator panel will light up with (wait to start) on the display until the glow plugs have sufficiently heated the cylinder. When the temperature is high enough the (wait to start) light will go off and the (start) light will come on. At this point you can start the vehicle. If you stop the vehicle for a short time and turn the key you will usually get the (start) light as there is enough ambient heat from the previous running.

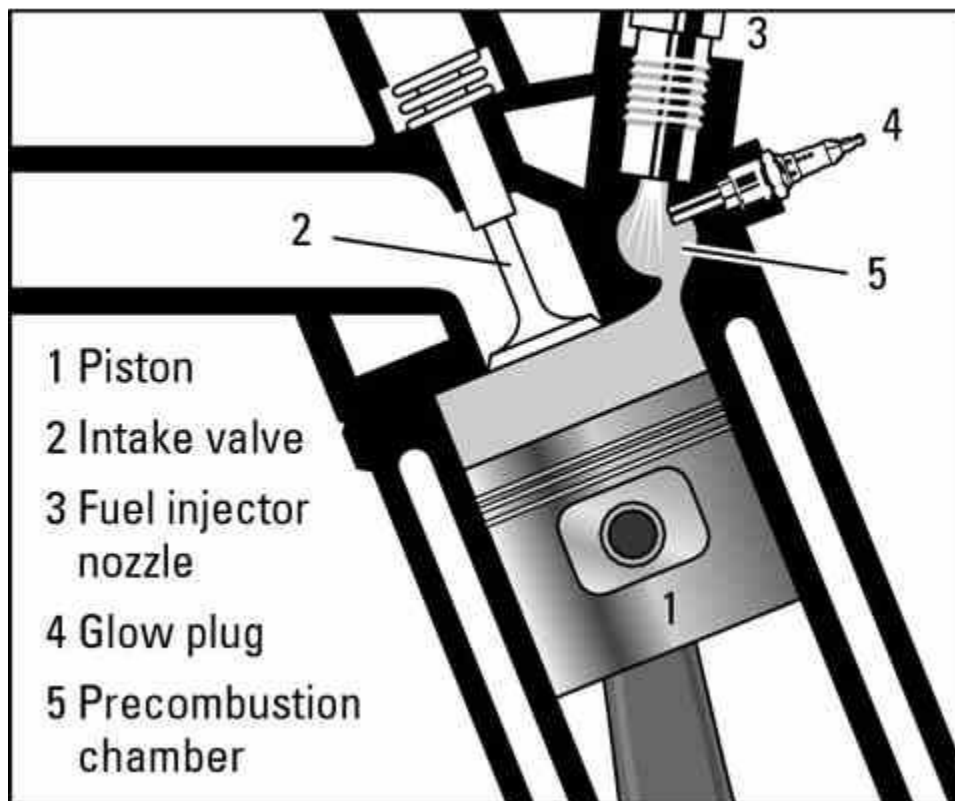


Fig. 12

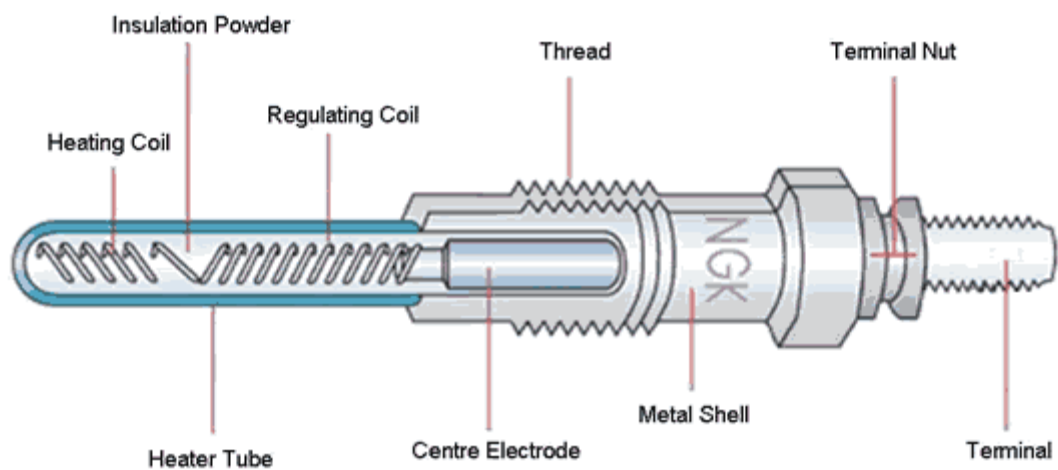


Fig.13

7. STOPPING A DIESEL ENGINE

ITEM / TASK: Stopping a Diesel Engine

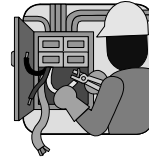
DESCRIPTION:

- A spring-loaded **stop control** that cuts off the fuel supply is located in the injection pump. To operate it, the knob must be pulled and held out until the engine ceases to rotate.
- In newer diesel engines, simply turn the ignition key back to the “off” position.

NB: Once the engine has stopped, ensure that the stop control returns to the run position, otherwise difficulty may be experienced when re-starting the engine.

DO THE PRACTICE ON THE NEXT PAGE.

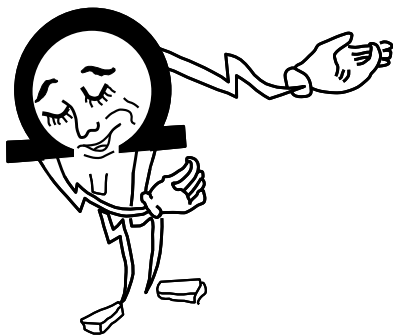
PRACTICE



Start and stop the diesel engine provided in the training centre by doing all the pre-checks.

Ask your Training Officer to check your work

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

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