DIESEL MECHANIC

MINING QUALIFICATIONS AUTHORITY

CODE: OCA

OVERHAUL A CYLINDER HEAD

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TRG 9

INDEX

The following elements are contained in this learning guide:

OBJECTIVE

To enable the learner to overhaul a cylinder head.

WHAT YOU MUST DO

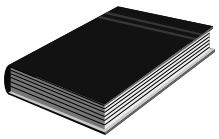
- Dismantle, assess and assemble the cylinder head.
- Check the head for cracks or leaks by using the water and air pressure method.
- Check the head for warpage.
- Complete a Condition Report (see page 6) on the assembly.
- You must also be able to state the major causes of valve failures.

WHAT YOU WILL BE GIVEN

- A cylinder head.
- All the necessary tools and equipment.
- A condition report.

HOW WELL YOU MUST DO IT

- There must not be any damage to the fasteners.
- There must not be any damage to the equipment.
- All the measured sizes and clearances of the different parts must be within the limits of $\pm$ 0,01 mm.
- All the specified technical data in the Condition Report must comply with the data given in the Workshop Manual.
- Valves must be refitted to the same valve guides from which they were removed.
- The damper coils of the valve springs must be installed in accordance with the procedures in the Workshop Manual.
- All carbon deposits must be removed from the different parts.
- There must not be any file marks on the valve heads.
- All the bolts and nuts must be torqued to specifications.



SOURCE REFERENCES

- A demonstration by a competent person, e.g. your Instructor.
- Appropriate Workshop Manual.
- Audiovisual aids if available.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM

OCA

OVERHAUL AND MAINTAIN A CYLINDERHEAD ASSEMBLY

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
• Use hand tools	• Using damaged tools or wrong tools for the job can cause injury and damage to equipment.	• 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.

NOTE:Before doing the practical work contained in this module, the learnermust 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: _____

CONDITION REPORT ON CYLINDER HEAD

Cylinder No. ..... (stated by Instructor)

	Actual	Specified
1.Clearance on valve guides: Inlet Valve Exhaust Valve		
2.Angle of valve face: Inlet Valve Exhaust Valve		
3.Angle of valve seat : Inlet Valve Exhaust Valve		
4.Outside diameter of valve head: Inlet Valve Exhaust Valve		
5. Load of valve spring at fitted length: Inlet Valve Outer Spring Inner Spring Exhaust Valve Outer Spring Inner Spring		
6.Clearance between rocker arm and rocker shaft:		
Inlet Valve	YES	NO
Exhaust Valve	YES	NO
7.Valve head is concentric with valve stem:		
Inlet Valve	YES	NO
Exhaust Valve	YES	NO
8.Valve head is square with valve stem:		
Inlet Valve	YES	NO
Exhaust Valve	YES	NO
9.Valve stem is straight: Inlet Valve	YES	NO
Exhaust Valve	YES	NO
10.End of valve stem is pitted or worn:		

	Inlet Valve Exhaust Valve	YES YES	NO NO
11.Valve spring is straight:	Inlet Valve Exhaust Valve	YES YES	NO NO
12. Cylinder head is warped:		YES	NO
13. Cylinder head is cracked:		YES	NO
14. Oil ports in the cylinder headand rocker shaft are clear:		YES	NO

15. Briefly describe the condition of the valve face.

Inlet Valve:

_____

_____

_____

Exhaust Valve:

_____

_____

_____

16. Briefly describe the condition of the adjusting screw and locknut on the rockers:

_____

_____

_____

1. INTRODUCTION

ITEM/TASK: Cylinder Heads

DESCRIPTION:

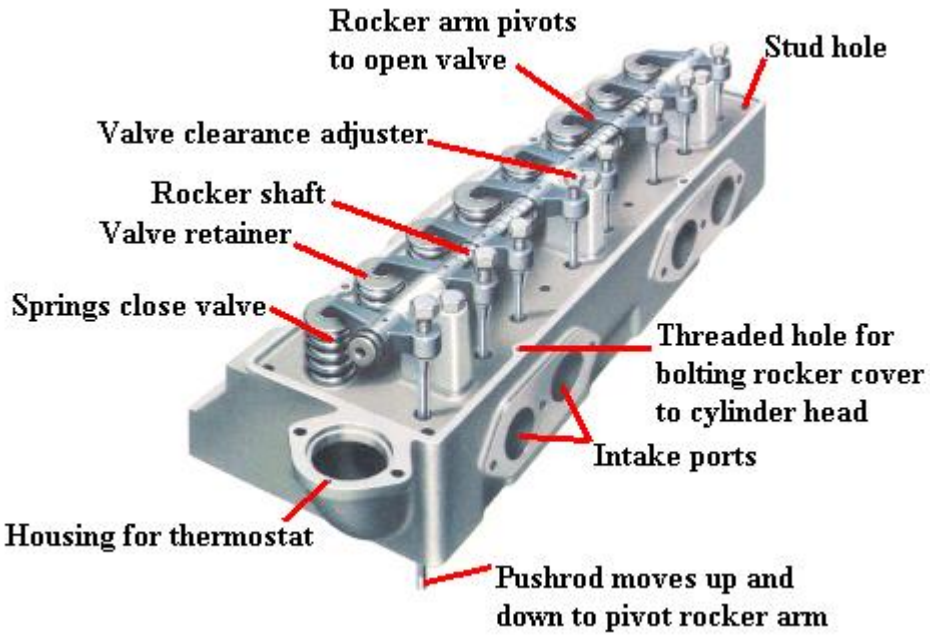


Fig.1

The cylinder head assembly is normally fitted with one intake valve assembly and one exhaust valve assembly per cylinder. On all engines the valve arrangement can be determined by inspecting the branches of the intake and exhaust manifolds (Fig. 1).

It is important to distinguish between intake and exhaust valves during various engine repair operations.

The valves stem operates through valve stem guides which are fitted in the cylinder head (see Fig. 2 next page). These guides are usually a separate piece and are press fitted into the holes in the cylinder head.

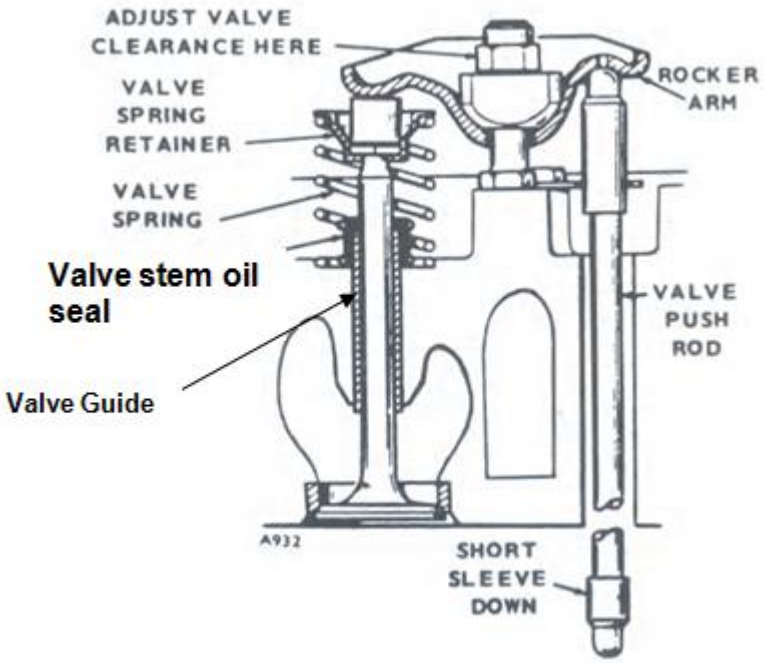


Fig.2

The exhaust ports and the inlet ports are sealed off from the cylinders by the seal formed between the valve face on the valve head and the valve seat on the cylinder head.The angle between seat and the valve is usually 45°, although on some engines it is 30°.

The valves are opened by means of the camshaft which is fitted in the sub-assembly. The camshaft moves the push rod and one end of the rocker arm upwards.

The other end of the rocker arm will push the valve down against the spring to open the inlet or exhaust port to the cylinder (Fig 3 next page). The valves are closed by the spring force.
The lower end of the spring presses against the cylinder head while the upper end presses against the spring retainer attached to the valve stem.

2. CAMSHAFTS

ITEM / TASK: Camshaft with pushrods

DESCRIPTION:

The OHV system, operated by pushrods, has the camshaft adjacent and parallel to the crankshaft in the cylinder block.
As the camshaft rotates, each valve is opened by means of a tappet, pushrod and rocker arm. The valves are closed by spring pressure.
The camshaft drive-chain sprocket has twice as many teeth as the crankshaft sprocket, so that the camshaft rotates at half the engine speed.

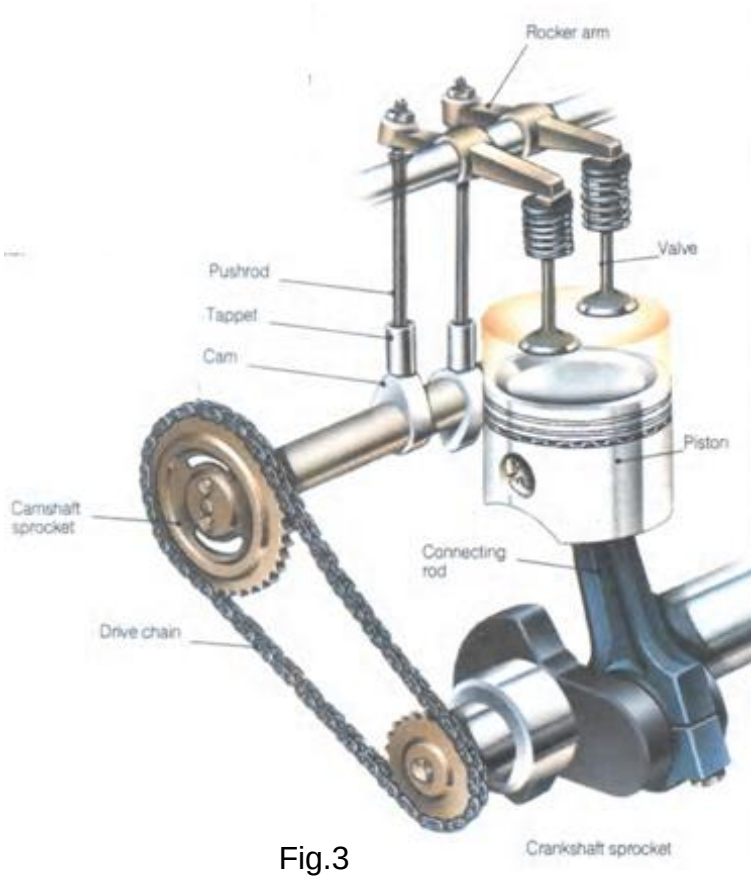


Fig.3

Camshaft Location

There are two basic locations for the engine camshaft: in the block and in the cylinder head. Both locations are common.
A cam-in-block engine uses push rods to transfer motion to the rocker arms and valves.

The term overhead valve (OHV) is sometimes used when referring to a cam-in-block engine.

In an overhead cam (OHC) engine, the camshaft is located in the top of the cylinder head. Push rods are not needed to operate the rockers and valves. This type of engine is a refinement of the overhead valve engine.
A four-valve combustion chamber uses two exhaust valves and two intake valves. The extra valves increase flow and engine power. This setup is now used on many modern passenger car engines.(Fig.4)

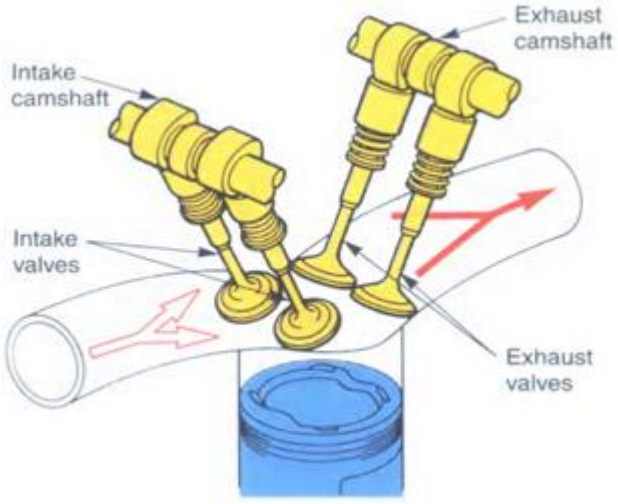


Fig.4

A single overhead cam (SOHC)
Engine has only one camshaft per cylinder head. The cam may act directly on the valves, or rocker arms may be used to transfer motion to the valves.(Fig.5)

A dual overhead cam (DOHC)
Engine has two camshafts per cylinder head. One cam operates the intake valves; the other operates the exhaust valves. The dual overhead cam arrangement is frequently used in engines equipped with four-valve combustion chambers.(Fig.4)

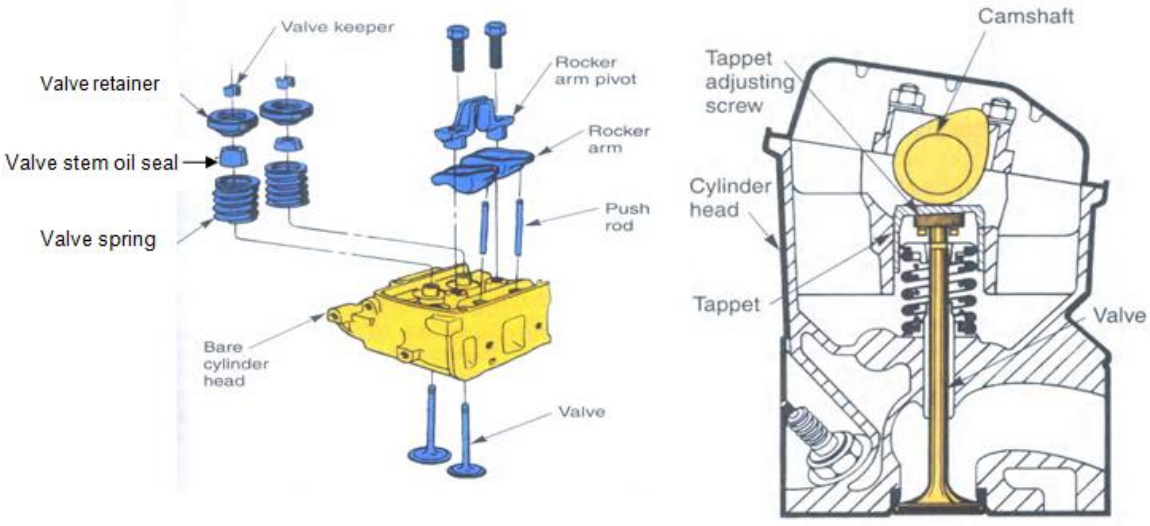


Fig.5

3. COMBUSTION CHAMBERS

ITEM / TASK: Combustion Chamber Shape

DESCRIPTION:

The shape of the combustion chamber provides still another method of classifying an engine. The three basic combustion chamber shapes for gasoline engines are pancake, wedge, and hemispherical. These are pictured in Figure

The pancake combustion chamber, also called the bath tub chamber, has valve heads that are almost parallel to the top of the piston. The chamber forms a flat pocket over the piston head, Figure 6A

A wedge combustion chamber, or wedge head, is shaped like a triangle or a wedge when viewed as in Figure 6B

- Valves are placed side-by-side, and spark plug is located next to the valves.
- A squish area is commonly formed inside a wedge- type cylinder head. When the piston reaches TDC, it comes very close to the bottom of the cylinder head.
- This squeezes the air-fuel mixture in that area and causes it to squirt, or squish, out into the main part of the chamber.
- Squish can be used to improve air-fuel mixing at low engine speeds.

A hemispherical combustion chamber, nicknamed hemi-head, is shaped like a dome. The valves are canted (tilted) on each side of the combustion chamber.

The spark plug is located near the center of the chamber. A hemi head is shown in Figure 6C. Compare it to the others.

A hemispherical combustion chamber is extremely efficient.

There are no hidden pockets, minimizing the chances of incomplete combustion.

The surface area is very small, reducing heat loss from the chamber. The centrally located spark plug produces a very short flame

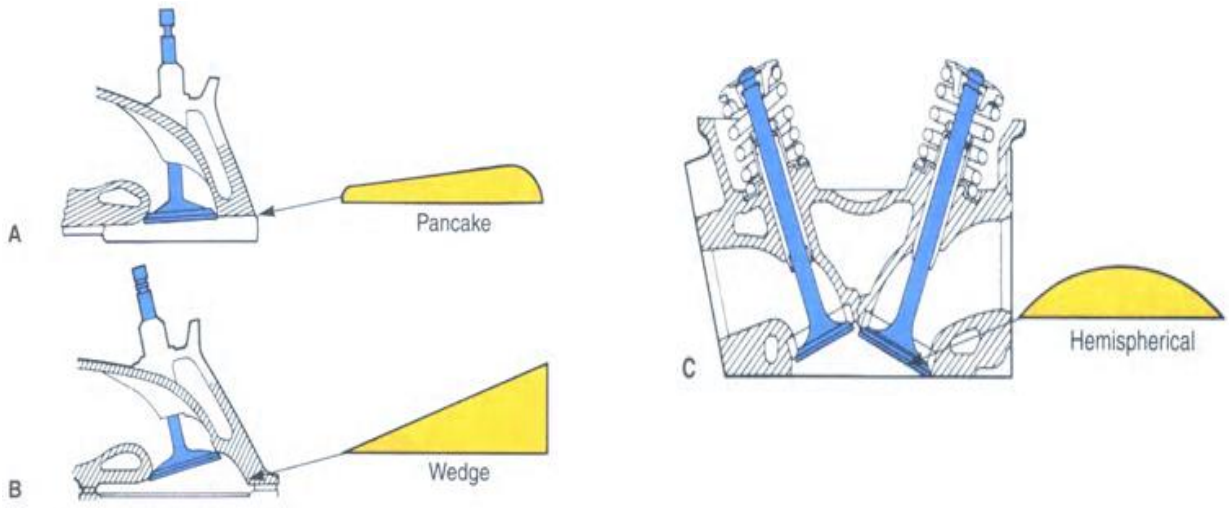


Fig.6

A pre-combustion chamber is commonly used in automotive diesel engines.

- It is similar in shape to the stratified charge chamber used in gasoline engines.
- Also called a diesel pre-chamber, the pre-combustion chamber is used to quiet engine operation and to allow the use of a glow plug (heating element) to aid cold weather starting. Figure 7 shows a cutaway view of a diesel pre-chamber.
- During combustion, diesel fuel is injected into the pre-chamber. If the engine is cold, the glow plug heats the air in the pre-chamber.
- This heat, along with the heat produced by compression, causes the fuel to ignite and burn. As it burns, the flame expands and moves into the main chamber to burn the remaining diesel fuel.

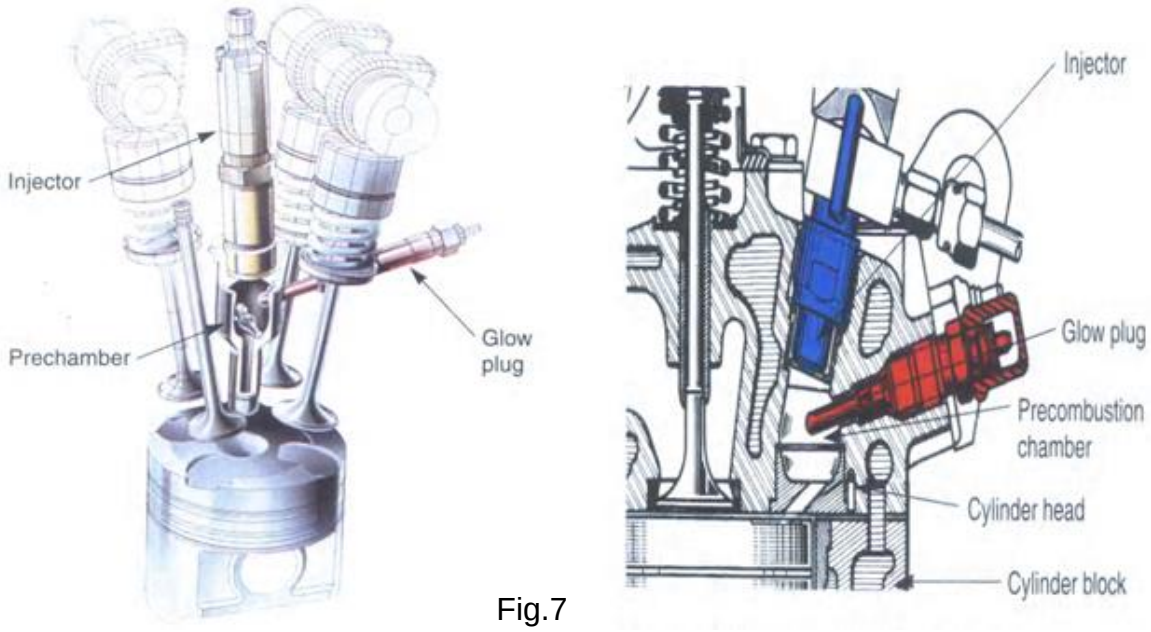


Fig.7

4. VALVE STEM SEALS

ITEM / TASK: Valve Stem Seal Construction

DESCRIPTION:

Two styles of valve stem seals are used. Most engines employ umbrella, or deflector, seals as shown in Fig.8 next page. Some manufacturers, such as GM and Toyota, back up the umbrella seal with a 0-ring just under the valve keepers. Positive seals, which seat against the valve guide boss, give improved oil control. These seals can often be retrofitted to engines that were originally equipped with umbrella seals.

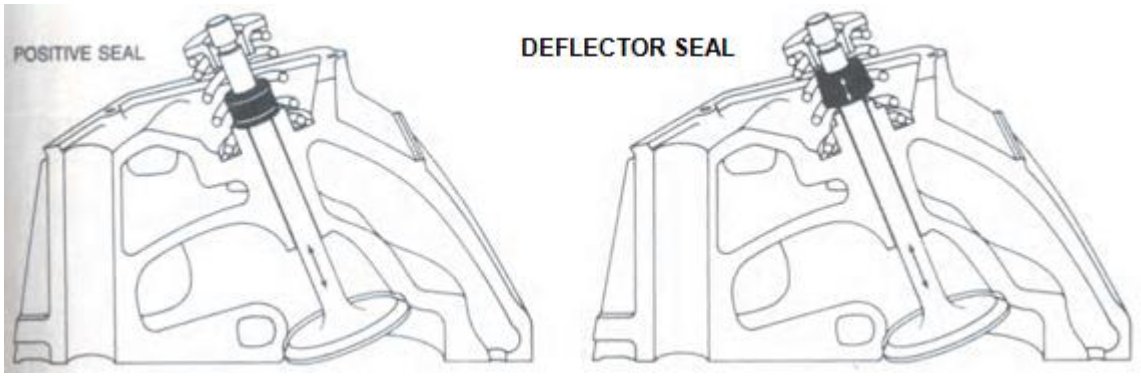
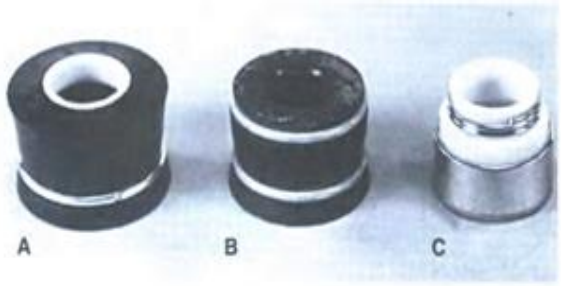


Fig.8

An **umbrella- positive valve seal** is shaped like a cup and can be made of neoprene rubber or plastic. Three are shown in Fig. An umbrella valve seal slides down over the valve guide before the spring and retainer. It covers the small clearance between the valve stem and guide. This keeps oil from being drawn into the cylinder head port and combustion chamber.



Umbrella valve seals form a covering over the opening at the top of valve guides. A—Synthetic rubber seal with a plastic shedder insert. B—All synthetic rubber seal. C—Plastic valve seal.

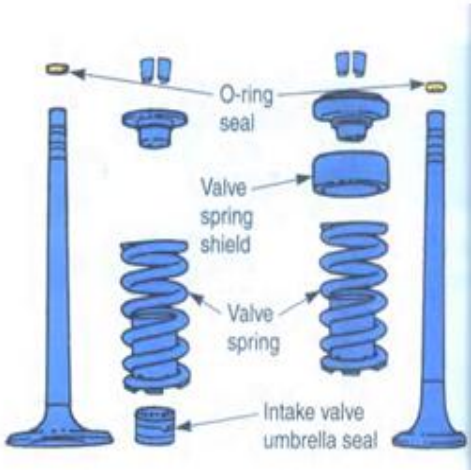


Fig.9

5. VALVE SPRINGS

ITEM / TASK: Valve Springs

DESCRIPTION:
The retainer is held in position by a tapered split key (collet.) A U-shaped washer will be found on some engines (Fig.10).

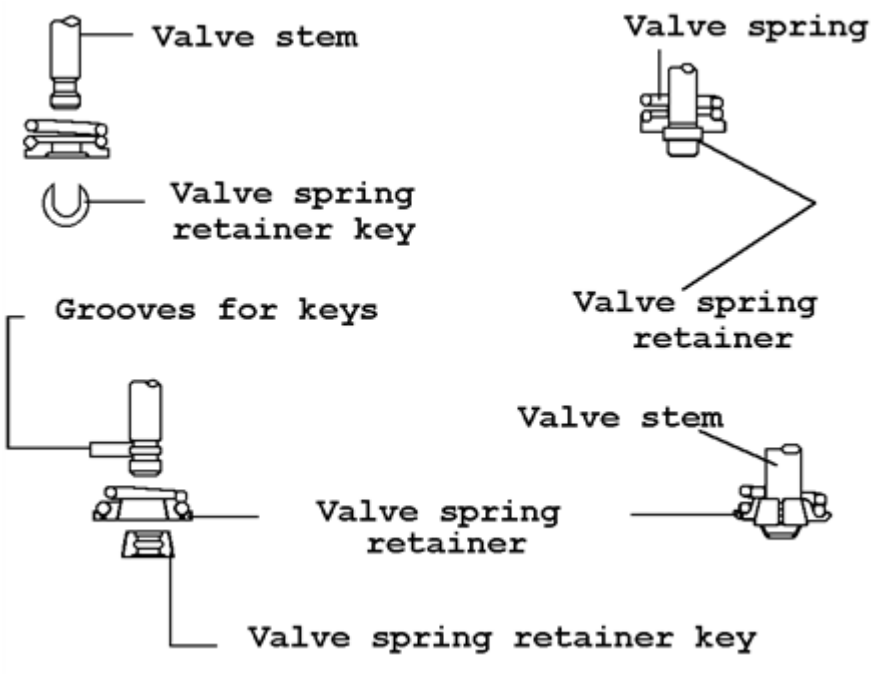


Fig.10

The valve springs are made of round steel wire about 3 mm in diameter. The wire is wound as shown in Fig.11.

Fig.11

The spring is ground flat on both ends so that it seats squarely. A valve spring may break for two reasons stated

i) It may be overstressed.

ii) It may have a tiny crack in its surface.

Overstressing of a spring is usually caused by an up and down vibration in the spring (see Fig. 12), which occurs at certain engine speeds.

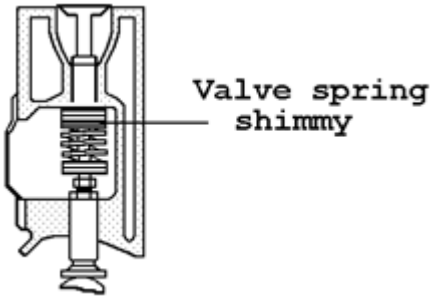


Fig.12

This phenomenon is called spring surge or shimmy. There are various ways of preventing or suppressing spring shimmy. One method is to provide a frictional vibration damper (see Fig. 13 next page).

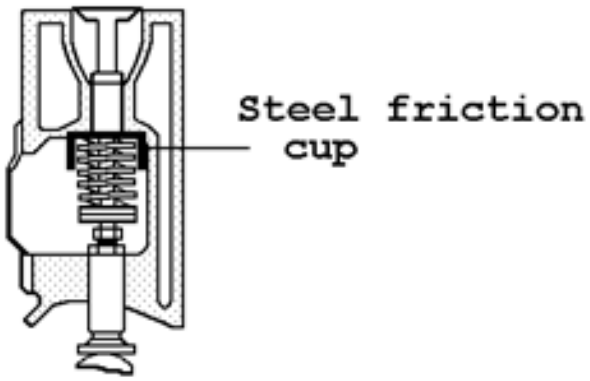


Fig.13

Another method is to use a spring with unevenly spaced coils called damper coils (Fig. 14 next page). Each coil will vibrate at a different engine speed with the result that the spring as a whole is unable to vibrate at any speed.

Fig.14

On engines with two intake and two exhaust valves per cylinder, the rocker arm contacts a crosshead instead of the valve stem tip. The crosshead then contacts both exhaust valves and causes two valves to open simultaneously (see Fig. 15).

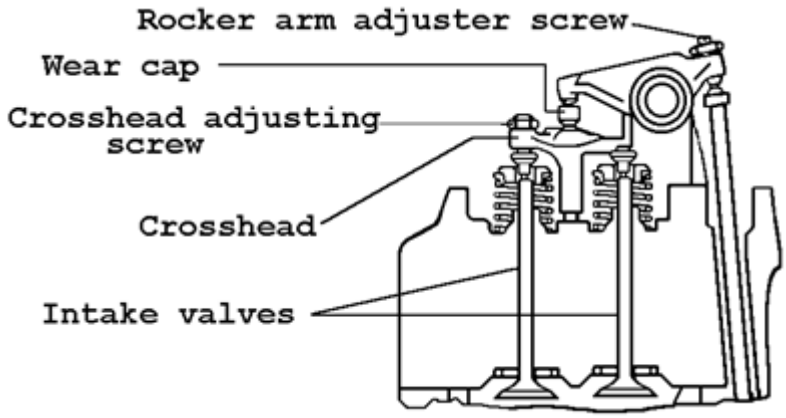


Fig.15

SELF TEST 1

1. What is meant by spring surge or shimmy?

_____

_____

_____

2. Explain two methods which are used to prevent or suppress spring shimmy.

_____

_____

_____

_____

_____

Check your answers with the Notes. If your answers are wrong, read the Notes again until you can answer the questions correctly without referring to the Notes.

Ask your Instructor to sign you off when you have achieved this and then carry on with the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

6. DISMANTLING THE CYLINDER HEAD ASSEMBLY

ITEM/TASK: Dismantling the Cylinder Head

DESCRIPTION:
The following main steps must be followed:

- For more details refer to your Workshop Manual.
- Clean the outside of the cylinder head.
- Remove the inlet and exhaust manifolds.
- Remove the valve rocker arm assembly (Fig.16).

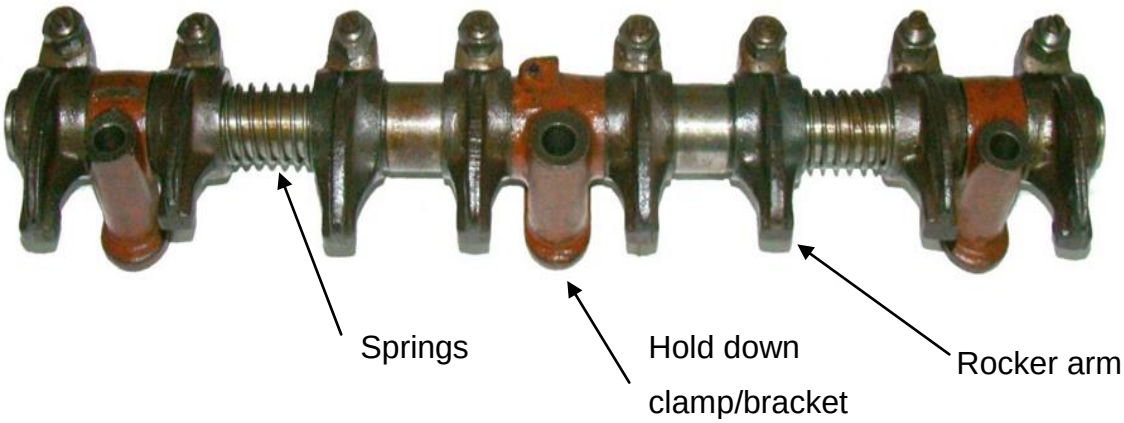


Fig.16

- Remove the rocker shaft retaining device.
- Remove the rockers arms, brackets and springs from the shaft.

NB: Mark and lay-out the rocker arms, brackets and springs so that you will be able to refit them in the correct sequence.

- Mark the valves before they are removed to ensure that the valves will be refitted to the same valve guides from which they were removed.

NB: Do not mark the valves with a file. Use a prick punch.

- Use the valve lifter to remove the valves from the cylinder head (Fig.17).

- Clean all the parts thoroughly in a solvent to prepare them for assessment.

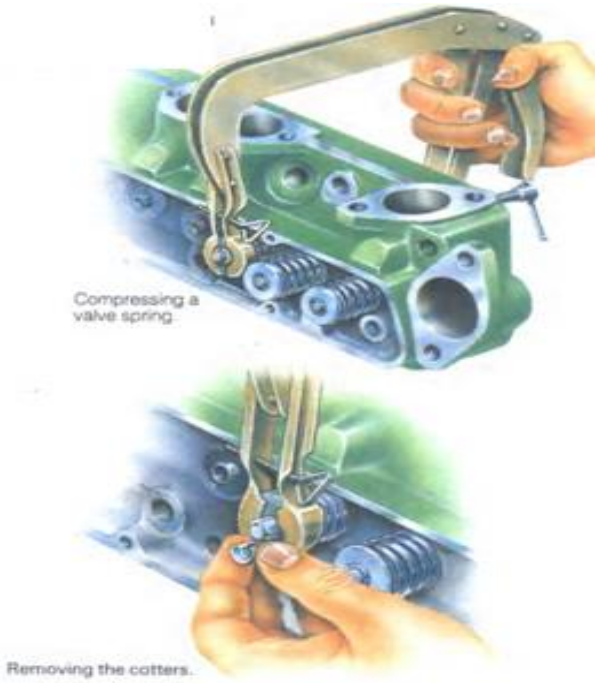
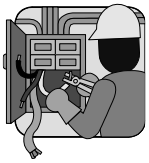


Fig.17

GO ON TO THE NEXT PAGE FOR THE PRACTICE.

PRACTICE



Go to the cylinder head and dismantle the assembly.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off and go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

7. ASSESSMENT OF THE CYLINDER HEAD

ITEM/TASK: Assessing the Cylinder head

DESCRIPTION:
a) Check the cylinder head for cracks

The water and air method will be used to check if the cylinder head is cracked.

- Seal off the water holes in the head with steel plates and suitable rubber gaskets secured in place with bolts and washers as shown in Fig.18. One cover plate must be fitted with an air hose connection.

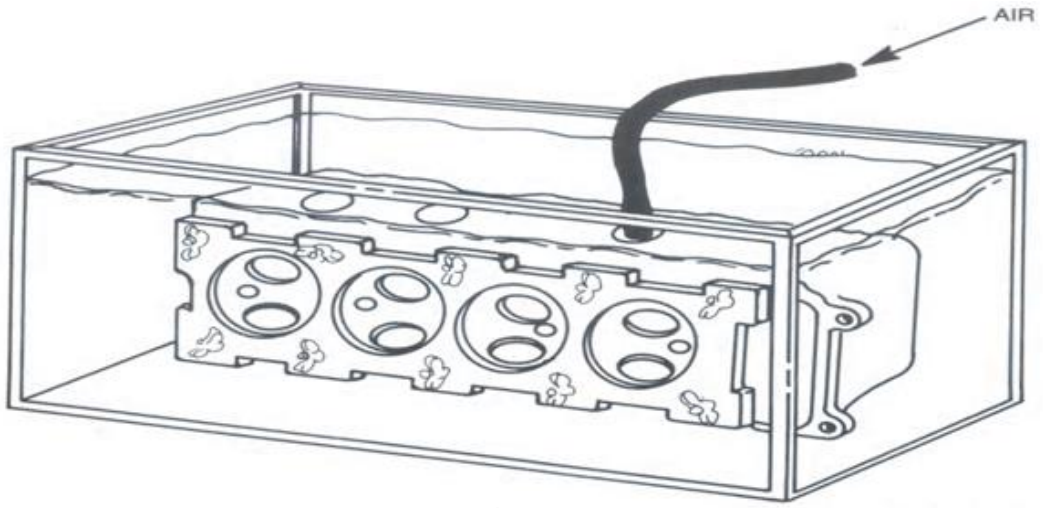
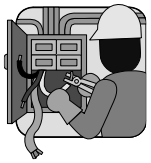


Fig.18

- Connect the air hose to the cover plate with the air hose connection.
- Apply the pressure specified in the Workshop Manual to the water jackets.
- Immerse the cylinder head in a tank of water previously heated to 82° - 90° for about twenty minutes to thoroughly heat the head.
- Observe the water in the tank to check for bubbles which indicate that there is a leak or crack.

GO ON TO THE NEXT PAGE FOR THE PRACTICE.

PRACTICE



Take the cylinder head and use the water and air method to determine if it is cracked.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off and go on to the next section

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

b) Checking the cylinder head for warpage

Use a heavy, accurate straight edge and feeler gauge to check for warpage at each end and between all cylinders. Also check for end-to-end warpage in at least six places (Fig.19).

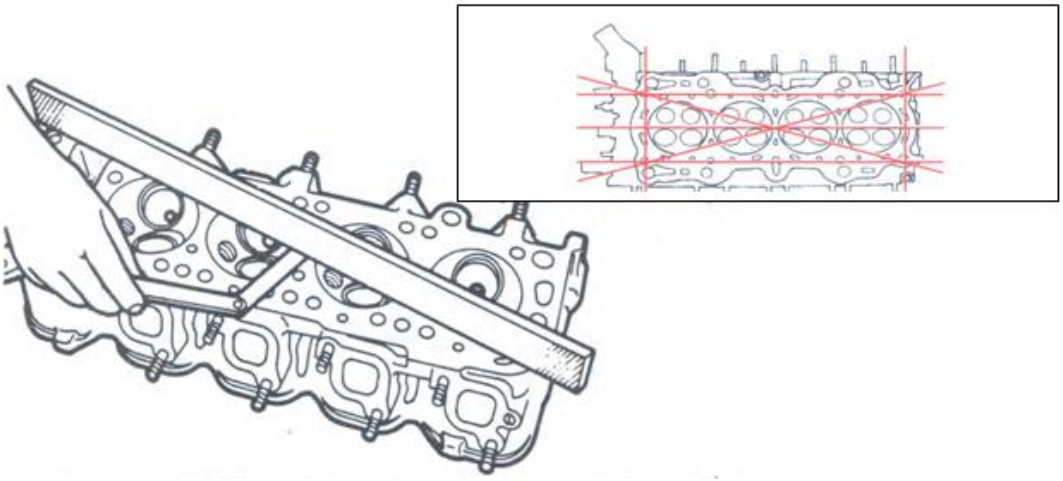


Fig.19

NB: The specification for flatness is 0,067 mm in any 150 mm.

c) Checking the clearance on valve guides

- Measure the inside diameter of the valve guide "D" using a small hole gauge and outside micrometer (Fig. 20).

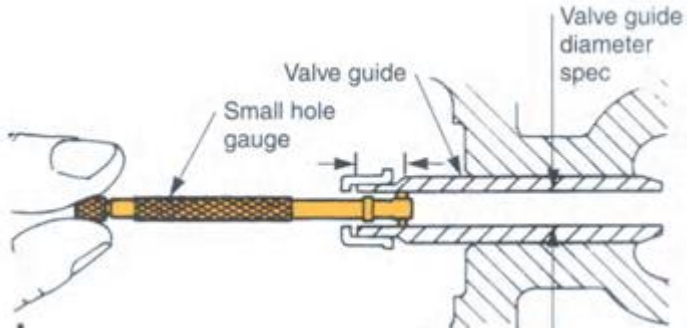


Fig.20

- Measure the outside diameter of the valve stem "d" using an outside micrometer (Fig. 21).

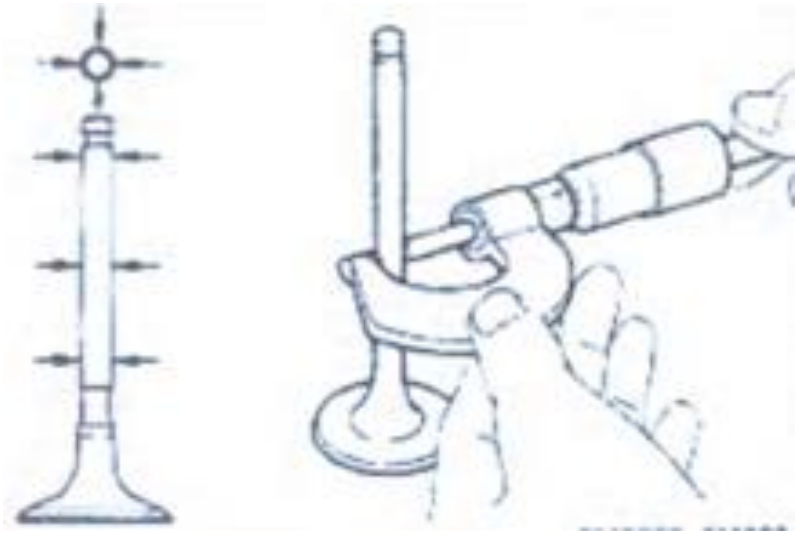


Fig.21

- Obtain the clearance by subtracting "d" from "D", i.e. Clearance = D - d.
- Compare the actual clearance with the clearance specified in the WorkshopManual.
- If the valve stem-to-guide clearance is less than specified, the speed of the valve closing may be retarded or there may be insufficient clearance for an adequate oil film.
- If the valve clearance is greater than specified, the guide is no longer able to properly guide the valve onto its seat.
- The extra clearance permits the valve stem to move crosswise. This results in the valve head being eccentric to the seat when it makes contact, as shown in Fig. 22

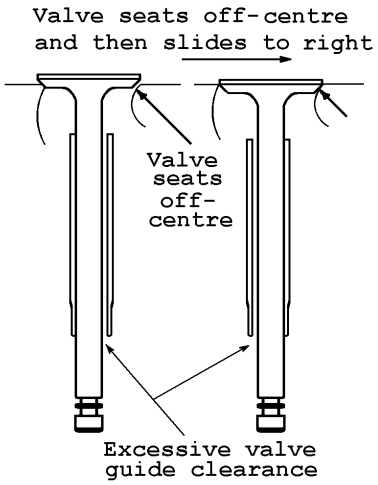
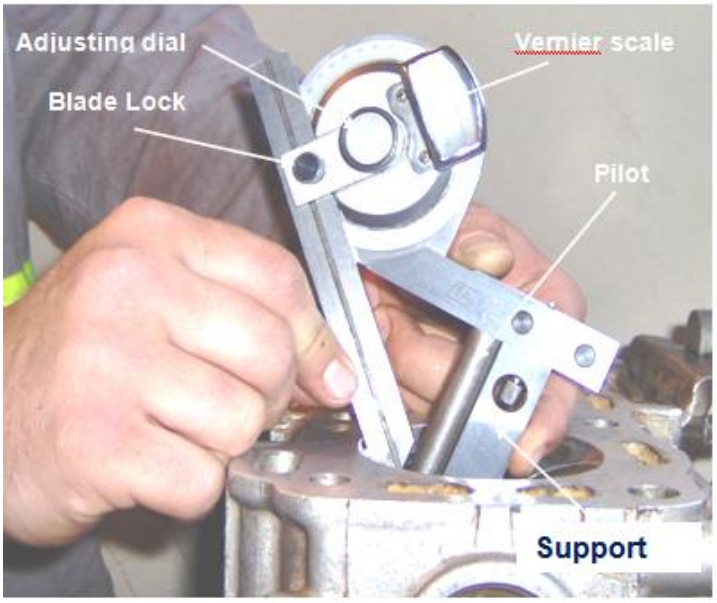


Fig.22

d) Checking the valve seat angle

- Use a protractor to check the angle of the valve seat (Fig. 23).



Measure the Valve Seat Angle with a bevel protractor

1) Insert a pilot in the valve guide
2) Place the support of the protractor against the pilot shaft.
3) Ensure that the protractor is aligned squarely to the pilot.
4) Lower the measuring blade of the protractor so that there is just enough clearance between the pilot and the blade.
5) Ensure that the blade rests on the valve seat to reflect the angle of the seat.
6) Lock the blade in position and adjust the dial on the protractor, until no light can be observed between the blade and the seat.
7) Take the reading on the vernier scale in degrees and minutes.

Fig.23

- Compare it with the angle prescribed in the Workshop Manual.

e) Deposits of scale in the water jacket

- Under normal operating conditions the seat will not depart from its circular shape sufficiently to cause leakage. Serious seat distortion and leakage may occur if the seat temperature becomes considerably higher than its normal maximum operating temperature.

- During engine operation the valves are cooled as shown in Fig. 24 next page. When the valve is closed, heat in the valve head is transferred to the cylinder head, then to the water passage as shown.

- Heat is always transferred from the valve stem to the valve guide

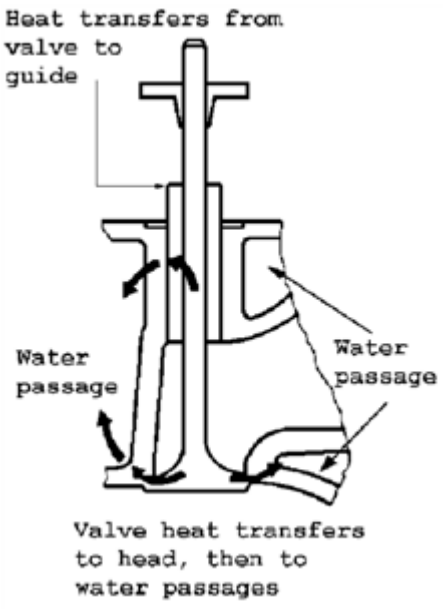


Fig.24

- Any defects in the cooling system which reduce its ability to remove heat from the seats, may result in over-heated seats. The most serious defect of all is scale deposit in the water passages surrounding the valve seats (see Fig. 25). The scale insulates the valve seats from the water and thus prevents proper cooling of the seats. The seat temperature rises and excessive distortion and leakage make occur.

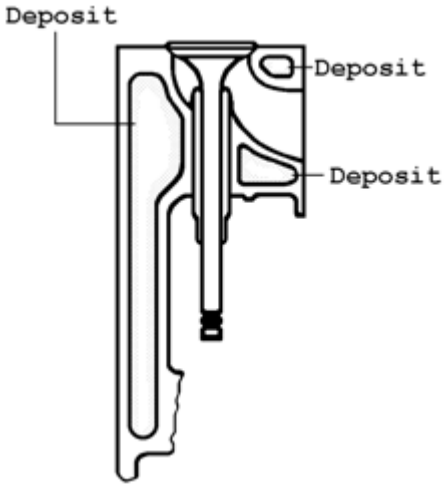


Fig.25

GO ON TO THE NEXT PAGE TO DO THE SELF TEST.

SELF TEST 2

1. What will happen if the valve stem-to-guide clearance is:

   a) Too little

   _____

   _____

   b) Excessive

   _____

   _____

2. What are the causes for excessive valve seat distortion on a cylinder head?

   _____

   _____

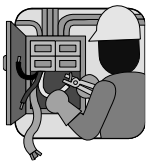
   _____

   _____

Check your answers with the Notes.

GO ON TO THE NEXT PAGE FOR THE PRACTICE.

PRACTICE



Take the cylinder head and:

1. Check the head for warpage.

2. Determine the valve stem-to-guide clearance and compare it with the specifications in the Workshop Manual.

3. Measure the valve seat angle and compare it with the specifications in the Workshop Manual.

4. Check to see if any deposits of scale are present in the water jackets.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off and go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

8. ASSESSMENT OF THE VALVES AND VALVE SPRINGS

ITEM/TASK: Assessment of the Valves and Valve Springs

DESCRIPTION:
The following must be assessed.

a) Valve face must be circular and concentric with the stem

- The face of the valve must be concentric with the stem if the valve is to fit snugly into the valve seat and to have an absolute leak proof contact (Fig. 26).

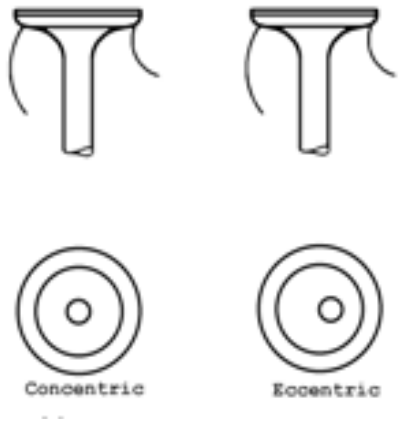


Fig.26

- This can be checked by fitting the valve stem into the chuck of the pedestal drill and running it at a high speed to see if the head runs true with the stem.

b) The valve head must be square with the stem

- Obviously the valve will leak if the head is not at right angles to the stem (see Fig. 27 next page).

- This can be checked by placing the valve in a V-block, with a dial gauge mounted squarely on the stem as indicated. Rotate the valve head 360º and note the reading on the dial gauge. If the maximum run-out is more the specified- the valve needs to be replaced or run the valve at a high speed in the chuck of a pedestaldrill. If the head wobbles in comparison with the stem then the head is not square with the stem.

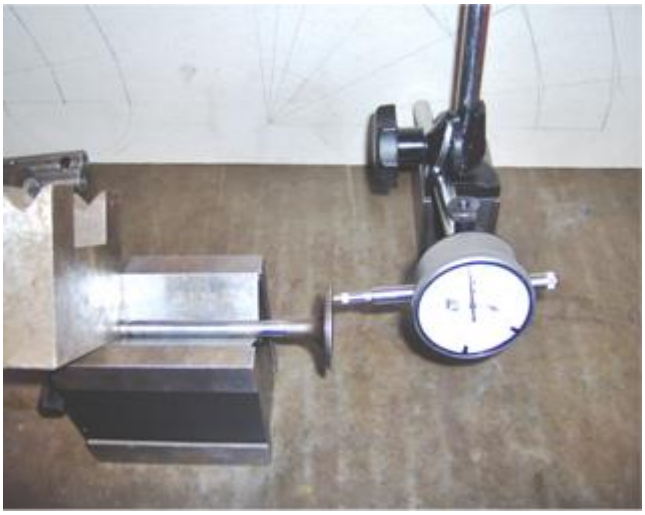


Fig.27

c) The valve stem must be straight

- A valve stem with even a slight bend in it will retard valve closure by bending in the guide (Fig. 28).

Check if Valve Stem is bent
This can be checked by placing the valve in a V-block, with a dial gauge mounted squarely on the stem as indicated. Rotate the valve head 360º and note the reading on the dial gauge. If the maximum run-out is more the specified- the valve needs to be replaced

Fig.28

- The bend may also be sufficient to cause the valve to stick open.
- This can be checked by running the valve stem over the edge of a marking-off table.

d) Valve dimensions

- Check the following dimensions of the valve head and compare them with the specifications in the Workshop Manual (Fig. 29):

  I) Angle of the valve face.

  ii) Outside diameter of the valve head D.

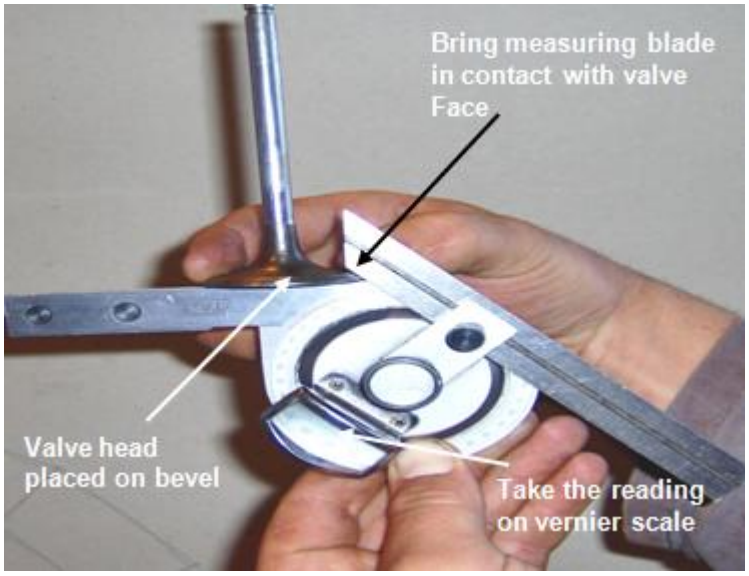


Fig.29

e) Condition of valve stem and face

- Check if the end of the valve stem is pitted or worn (Fig. 30).

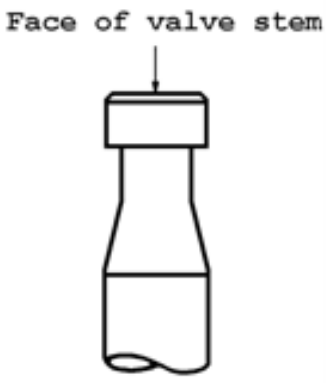


Fig.30

- Check if the face of the valve is burnt or cracked (Fig. 31).

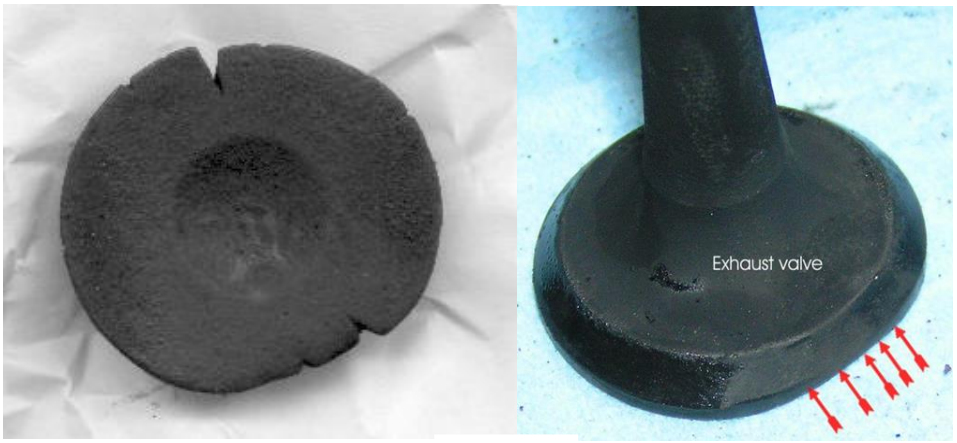


Fig.31

- Also check if the seat on the valve face is not hollow. This is caused by excessive spring tension.

f) The valve springs must be straight

- A valve spring which does not stand at 90° (perpendicular) to a flat surface will bulge as shown in Fig. 32 when the valve is open.

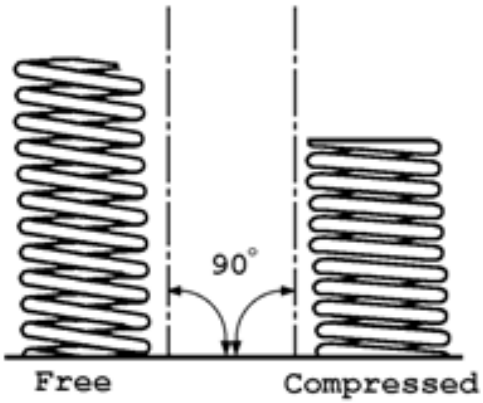


Fig.32

- This places a side thrust on the valve stem and gradually wears the guide thus preventing the valve from closing properly (see Fig. 33 next page).

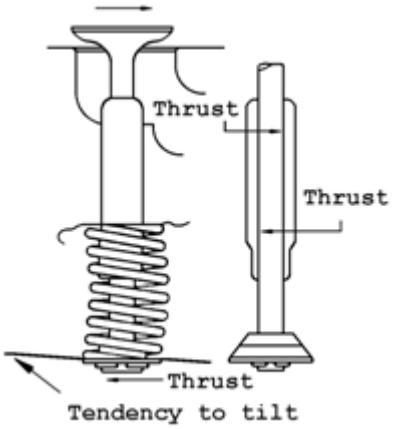


Fig.33

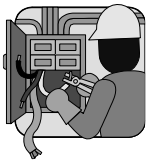
- This can be checked by placing the spring on a flat surface and against a square.

g) The tension of the valve spring must be correct

- If the valve springs have become weak, valve closure will be delayed, especially at full engine speed.
- A weak spring also lacks force and the valve will not close promptly. Springs that are too strong will cause undue wear on the valve mechanism and valve seat.
- The spring tension is checked with a spring tester (see Fig. 34 next page).
- When the spring is compressed to the fitted length (see Workshop Manual), the reading of the tester will give the tension of the spring.
- Compare this reading with the tension specified in the Workshop Manual.

Fig.34

GO ON TO THE NEXT PAGE FOR THE PRACTICE.



PRACTICE

Take all the valves and valve springs and check to see if:

1. The valve heads are concentric with the valve stems.

2. The valve heads are square with the valve stems.

3. The valve stems are straight.

4. The valve measurements compare with the specifications.

5. The condition of the valve stems and valve faces are satisfactory.

6. The valve springs are straight.

7. The tension of the valve springs is within that specified.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off and go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

9. ASSESSMENT OF THE ROCKER SHAFT ASSEMBLY

ITEM/TASK: Assessment of the Rocker Shaft Assembly

DESCRIPTION:
The following must be checked.

a) Clearance between rocker arm and rocker shaft

- Measure the inside diameter "D" of the bush of the rocker arm with a telescopic gauge and outside micrometer (Fig. 35).

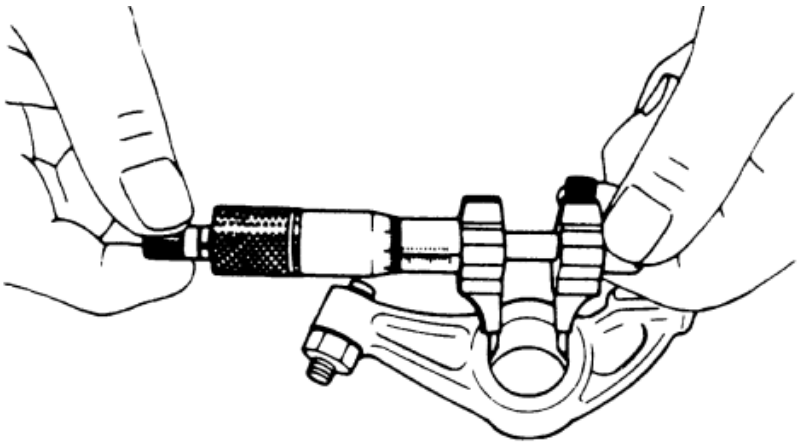


Fig.35

- Measure the outside diameter "d" of the rocker shaft at the bearing area of the rocker arm with an outside micrometer.Fig.36

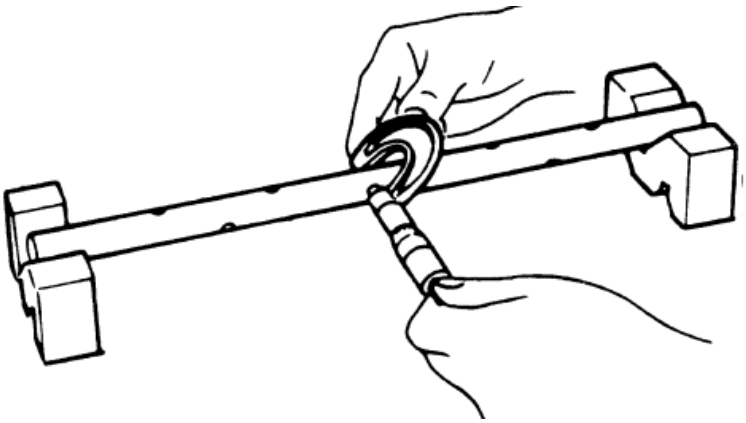


Fig.36

- Determine the clearance by subtracting the shaft diameter "d" from the rocker arm bush diameter "D" i.e. D - d = clearance.

- Compare the clearance with that specified in the Workshop Manual.
- Check for scores or scratches on the bearing areas of the shaft.

b) Condition of adjusting screw and locknut on rocker arm

- Check to see if the threads of the screw are damaged (see Fig. 37).

Fig.37

- Check to see if the screwdriver grooves are damaged (Fig. 37).
- Check to see if the corners of the hexagon of the locknut are damaged.

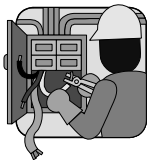
c) Oil ports in rocker shaft and rocker arm

- Check to see if the oil ports in the rocker shaft and rocker arms are clear and not blocked (Fig. 38).

Fig.38

GO ON TO THE NEXT PAGE FOR THE PRACTICE

PRACTICE



Take the rocker shaft assembly and check:

1. The clearance between the rocker arms and rocker shaft.

2. The conditions of the adjusting screws and locknuts.

3. The oil ports in the rocker shaft and the rocker arms are clear and not blocked.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off and go on to the next section.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :

10. MAJOR CAUSES OF VALVE FAILURES

ITEM/TASK: Valve Failure

DESCRIPTION:
The major causes of valve failures are discussed below.

a) Distortion of valve seat (Fig. 39)

Fig.39

- This is caused by failure in the cooling system and excessive deposits of scale in the water jackets

b) Deposit on valves (Fig. 40)

Fig.40

- Deposits on valves are caused by weak valve springs, by too small tappet clearances, and by valves sticking in the valve guides

c) Burnt valves (Fig. 41)

Fig.41

- Burnt valves are caused by too little tappet clearance, and improper timing.

d) Valves cracked by heat (Fig. 42)

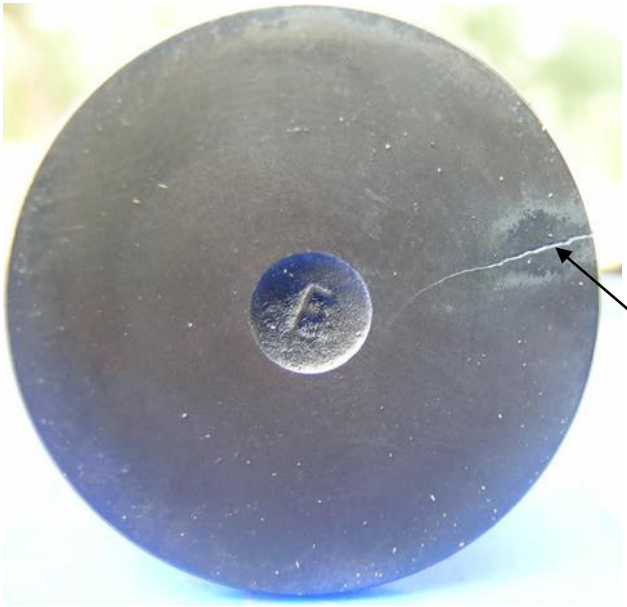


Fig.42

- This is caused by distorted seats and worn valve guides.

GO ON TO THE NEXT PAGE TO DO THE SELF TEST.

SELF TEST 3

Name the 4 major causes of valve failures:

a) _____

b) _____

c) _____

d) _____

Check your answers with the notes.

11. ASSEMBLING THE CYLINDER HEAD

ITEM/TASK: Assembling the Cylinder Head

DESCRIPTION:
The following main steps must be followed when assembling the cylinder head. For more details refer to your Workshop Manual.

- Clean all the parts thoroughly with solvent.
- Replace the rocker arms, brackets and springs to the rocker shaft (Fig. 43).

Fig.43

NB: They must be refitted in the correct sequence as they were removed from the shaft.

- Refit the rocker shaft retaining device.
- Smear a thin film of oil on the valve stems.
- Refit the valves to the valve guides from which they were removed. Use the valve lifter (see Fig. 44 **on next page**).

Fig.44

NB: The damper coils must face in the direction described in the Manual.

- Pop each valve assembly with a soft hammer to ensure proper seating of the collets.
- Replace the rocker shaft assembly.
- Tighten the bracket bolts to the specified torque.
- Replace the inlet and exhaust manifolds.
- Tighten the manifold bolts to the specified torque.

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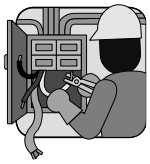
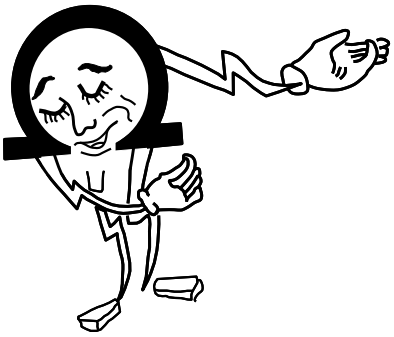
PRACTICE



Assemble the cylinder head.

Call your Instructor to check your work. When you have reached the required standards, ask him to sign you off.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

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