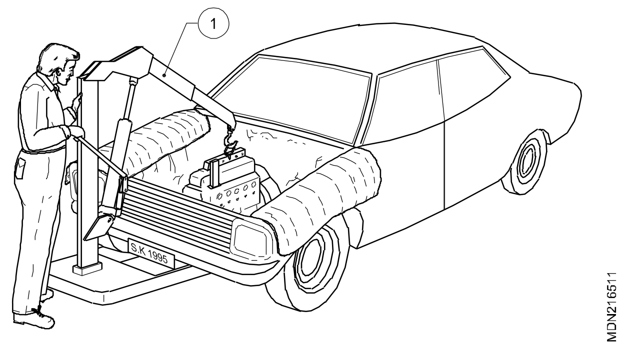
Procedure for dismantling of diesel engine from the vehicle

Objective: At the end of this lesson you shall be able to
- **remove the engine from the vehicle.**

Remove the engine from the vehicle

- Park the vehicle on a level surface.
- Choke all the four wheels with wooden blocks.
- Unscrew the bonnet mountings and remove it along with the grill.
- Disconnect the battery connections and take out the battery.
- Drain the radiator.
- Drain the engine oil.
- Remove the air cleaner.
- Remove the lower and upper hoses of the radiator.
- Remove the radiator mounting bolts/bracket bolts and remove the radiator without damaging the radiator core.
- Disconnect the wire connections of the starting motor, generator/alternator and heater plugs, oil pressure unit and other electrical connections to the dashboard instruments.
- Remove athe oil pipe to oil pressure gauge conenctions (if provided).
- Remove the exhaust pipe from the exhaust manifold. (The pipe hole to be covered by a cardboard to prevent foreign material getting into it.)
- Disconnect the fuel supply pipes at the feed pump, filter connectuons, fuel return lines to the tank.
- Disconnect the oil pressure and air pressure gauge connections.
- Disconnect the temperature gauge connections.
- Disconnect the accelerator connections.
- Remove the accelerator control shaft.
- Disconnect the engine stop connections.
- Remove the air compressor and its connections.
- Remove the clutch and gear linkages.
- Disconnect the propeller shaft at the gearbox end and support it at a convenient point on the chassis.
- Support the engine at the rear by wooden blocks.
- Disconnect gearbox mounting bolts and remove the gearbox with flywheel housing.
- Remove the dip stick.
- Fit a suitable engine lifting bracket.
- Align the left hook of the crane with engine lifting bracket.
- Support the engine at the front with wooden blocks.
- Remove the engine's mounting brackets and bolts and nuts.
- Attach the engine lifting bracket to the engine hoist (1).Fig 1

Fig 1



- Lift the engine slightly.
- Pull the engine forward until it comes out from the gearbox side.
- Lift the engine. Avoid oscillations and jerks. Ensure that the engine hoist does not shift/oscillate while removing it from the vehicle and does not hit the body of the vehicle or any accessories.
- Place it on a suitable workbench/engine stand. If placed on the floor, provide sufficient support below the front and rear brackets so that the engine does notmrest on the oil sump.

Description and constructional feature of cylinder head

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of the cylinder head**
- **state the importance of cylinder head design.**

Cylinder head (Fig 1)

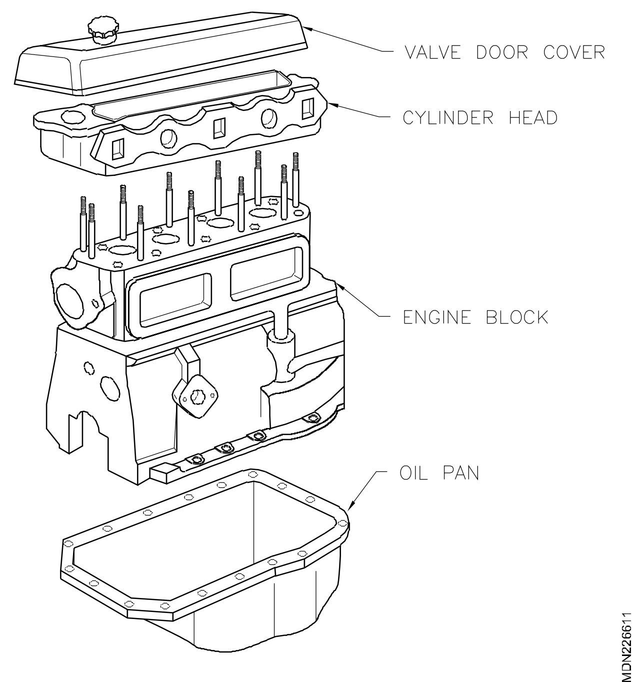
The cylinder head is made of a single casting. It is bolted on the top of the cylinder block. It has passages for oil and water circulation. It accommodates valves, spark plugs/ injectors (in the case of diesel engines) and heater plug. A combustion chamber is also provided in some cylinder heads. In the case of the overhead valve system, the cylinder head supports the rocker shaft assembly.

The lower surface of the cylinder head is machined to the specified accuracy and a gasket is used in between the cylinder head and cylinder block to avoid leakage.

The head also provided spaces for the passages that feed air, water fuel to the cylinder and that allow the exhaust to escape.

Material: Cast iron, aluminium alloy.

Fig 1



Types of cylinder heads

Four types of cylinder heads are used in an automobile engine as per the valve arrangements.

They are as follows.

In diesel engine fuel is injected into the combusion chamber against hight compressions pressure in the combusion chamber of the C.I. engine cyliner. The combusion depends upon the following factor.

- Fine atmization
- High temperature for quick ignitor
- High relative vabeity between air and fuel particles
- Good relative of air and fuel particles.

Atomization, prepearation and spreading of fuel depends on injection system, cylinder bore and stroke compression ratio and cooling system determine operating temperature miscing depends upon air intake system, injection pattern and combusion chamber design.

The design of combusion chamber plays an important part in the combusion process. In diesel engines, the following types of combustion chambers have been used.

a Open combustion chambers (Fig 2)

b Turbulence chambers (Fig 3)

c Precombustion chamber (Fig 4)

d Air cells (Fig 5)

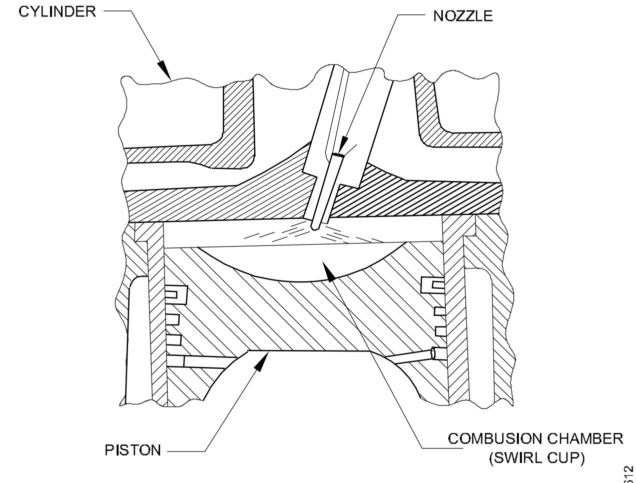
e Energy cells (Fig 6)

a **Open combustion chambers :** An open type of chamber is that in which all thte air is contained in a single space at the time of injection. It is the simpest form of combustion chamber in which the injection nozzle sprays fuel direct into the combustion chamber. This arrangement is known as open system or direct injection system.

In this type of chamber, the fule motion is greater than air upon which the nature of combusion largely depends. In order to bring fuel and air together, the flat head pistion has been replaced by concave head pistion in modern engines. The deep cut-out swirl cup on the piston crown is being widely used.

Open system combustion chambers are widely used in medium and large-bore engines operating at low and medium speeds.

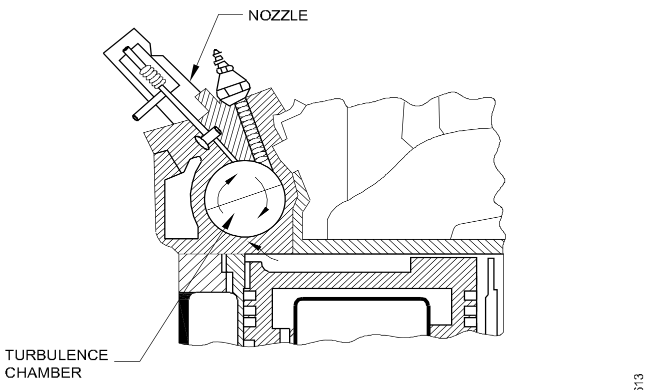
Fig 2



OPEN COMBUSTION CHAMBER WITH SWIRL CUP

b **Turbulence chambers:** In this type of chamber, the fuel is injected into an auxiliary chamber known as turbulence chamber with the cylinder by an orifice. The auxiliary chamber houses almost full charge at the end of compression and is nearly spherical in shape. The pistion forces air charge into the turbulence chamber and sets uo a rapid rotary motion. As the piston rises up, the velocity of air increases through the throat of orifice and reaches at the peak somewaht befre T.D.C. Near T.D.C. the injector nozzle injects fuel into the turbulent air currents which results in goold mixing during combusion.

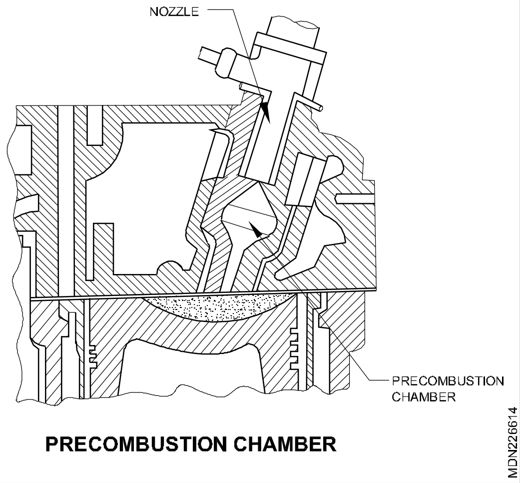
Fig 3



TURBULENCE CHAMBER OF WAUKESHA DESIGN

C Precombustion chamber: This chamber is located at the cylinder head and is connected to the engine cylinder by small holes. It occupies 40% of the total cylinder volume. During the compression stroke, air from the main cylinder enters the precombustion chamber. At this moment, fuel is injected into the precombustion chamber and combustion begins. Pressure increases and the fuel droplets are forced through the small holes into the main cylinder, resulting in a very good mix of the fuel and air. The bulk of the combustion actually takes place in the main cylinder. This type of combustion chamber has multi-fuel capability because the temperature of the prechamber vaporizes the fuel before the main combustion event occurs.

Fig 4



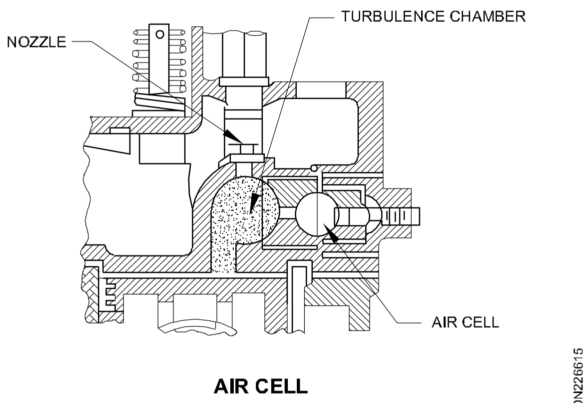
PRECOMBUSTION CHAMBER

d Air cells: Combustion chamber an air cell is a space provided in the cylinder head or pistion crwon in which a large part of air is trapped during compression. In air cell systems, the injector nozzle sprays fuel direct into the main chamber where combstion takes place.

When the piston moves down on its working or power stroke, air pressure is at its maximum in the cell and pressure in the main combustion chamber starts to fall down. The higher pressure in the air cell causes its air to expand and blow out into the main chamber. Thus an additional turbulence is created and complete combustion of fuel charge is ensured.

As a portion of air remains trapped without combustion in the cell so in improved designs, air cell is used in combination with turbulence or precombustion chamber to obtain better performance.

Fig 5

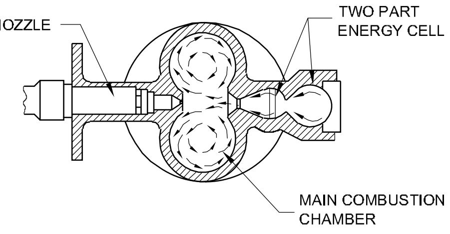


AIR CELL

e Energy cells: The difference between air cell and energy cell is that fuel is blown into the energy cell where it burns using air in the cell. In air cell system, thte cell simply stores and given up an air charge. The combustion in the energy cell creates a high pressure and grater turbulence and leaves no idle air in the cell.

The energy cell system consists of two rounded spaces cast in the cylinder head. The intake and exhaust valves open into the main combustion chamber. The horizontal the nozzle sprays fuel across the main chamber in the direction of energy cell mouth. While the fuel charge is passing across the centre of main chamber, nearabout half the fuel mixes with hot air and burns at once. The remaining fuel enters the energy cell and starts to burn there. At this point, the cell pressure rises rapidly, tending the combustion products to flow back into the main combustion chamber at a high velocity. As a result of this, a sharp swirling movement of fuel and air is set up in each lobe of main chamber, promoting final mixing of fuel and air and ensuring complete combustion. The two restricted openings of energy cell control the time and rate of expulsion of blast from energy cell into main combustion chamber.

Fig 6



ENERGY CELL

The energy-cell combustion systems fulfil the requirements of high speed engines and give high power output without high excessive pressures in the main combustion chamber.

Effect on size of intake and exhaust passages

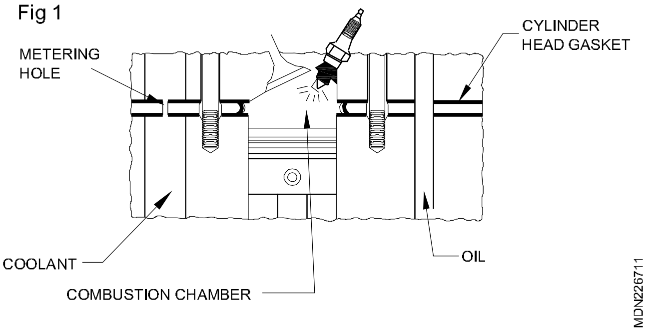
Objectives: At the end of this lesson you shall be able to
- **state the effect and size of intake of exhaust passages**
- **importance of cylinder head gasket**
- **types of cylinder head gasket materials.**

The size of inlet valve: Is too larger than exhaust valve. Beacuse they want to fill more quantity of Air/Fuel mixture (petrol) or Air (Diesel) in the conbustion chamber to requlate the engine efficiency. Beacuse engine efficiency depends upon VOLUMETRIC EFFICIENCY of an combustion chamber (Fig 1). There are two reasons behind the inlet valve larger than exhaust valve. One main reasin is to INCREASE THE VOLUMNETRIC EFFICIENCY OF AN ENGINE.Another one is acting pressure behind the inlet valve. Exhaust gas pressure only react to the face portion of the valve. But in an inlet valve, the inlet air pressure are reacted to the behind /Rear portion the inlet valve face & larger face can withstand this pressure without any damage. For that reason also the inlet valve face are designed to larger size than exhaust valve.

The main reason for the size difference is to avoid preignition and knoking.

Cylinder head gaskets: Form the most critical sela on an engine - between the cylinder head and the engine block deck.

Fig 1



The head gasket must seal combustion pressures up to 1,000 psi (689.5 kPa) in gasoline engines and 2,700 psi (1,862 kPa) in turbocharged diesel engines. In addition, the head gasket must withstand combustion temperatures that are in excess of 2,000°F (1,100°C).

The head gasket also must seal coolant and hot, thin oil flowing under pressure between the block and head. Modern coolant formulas and oil detergents and additives tend to cling to surfaces and soak into gaskets. Gaskets materials must be chosen carefully to resist these fluids and maintain an effective seal. many head gasket coolant holes also meter the coolant flow to ensure proper circulation.

Head gaskets must resist the forces that tend to scuff gasket surfaces and inhibit proper sealing. One factor is engine vibration and head sifting and flexing that result from combustion pressures.

Another factor is the differing expansion rates of bi-metal (aluminum head and cast iron block) engines. Aluminium expands about twice as much as cast iron . The uneven expansion rates create a shearing action that the head gasket must accommodate.

Head gaskets also must resist crushing from cylinder claiming forces that may be unevenly distrubuted across the head. These claiming forces run as high 200,000 lbs (90,800 kg).

The following materials are used in cylinder head gasker

1 Copper - as bestor gasket
2 Steel - as bestor - copper gasket
3 Steel - as bestor gasket
4 Single steel ridged gasket

Valves

Objectives: At the end of this lesson you shall be able to
- **describe the function of the engine**
- **state the constructional features of valves**
- **list out the different types of valves and their material.**

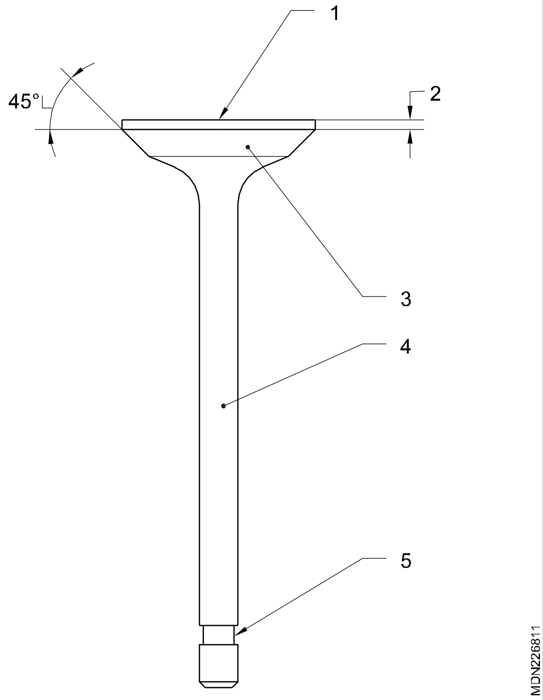
Functions of valves

- To open and close the inlet and exhaust passages of the cylinder.
- To dissipate heat, through its seat to the cylinder head.

Construction of a valve

The head (1) of the valve is ground with a margin (2) to provide strength. (Fig 1)

Fig 1



The valve face (3) is ground to 30° or 45° angle which matches with the seat angle to avoid leakage. The valve stem (4) is of a round shape. The length of the stem varies from engine to engine. At the end of the stem a groove (5) is provided to hold the spring lock.

In some heavy duty engines, the valves are hollow, and sodium is filled inside, which helps in the quick cooling of the valve.

Types of valves

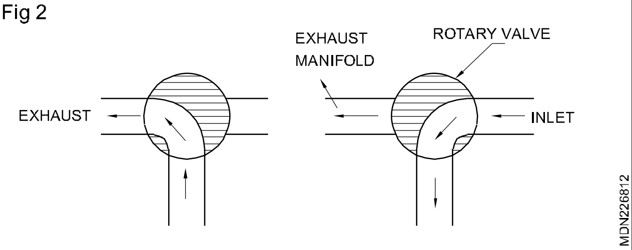
- Poppet-valves
- Rotary valves
- Reed valves
- Sleeve valves

Poppet-valves

As the name indicates these valves pop on their seat. Three types of poppet-valves are in use.

- Standard valve
- Tulip valve
- Flat top valve

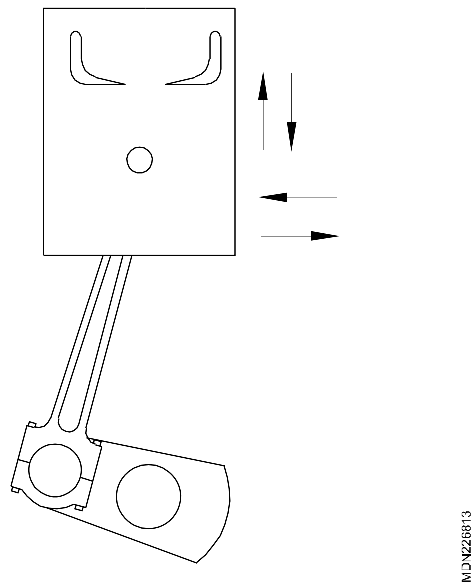
Fig 2



Rotary valve

In this type a hollow shaft runs in the housing which is attached to the cylinder head. This hollow shaft has two ports cut in it, and it aligns the opening in the cylinder head with the inlet manifold, and at the time of the exhaust stroke its opening aligns with the exhaust manifold. (Fig 2 & Fig 3)

Fig 3



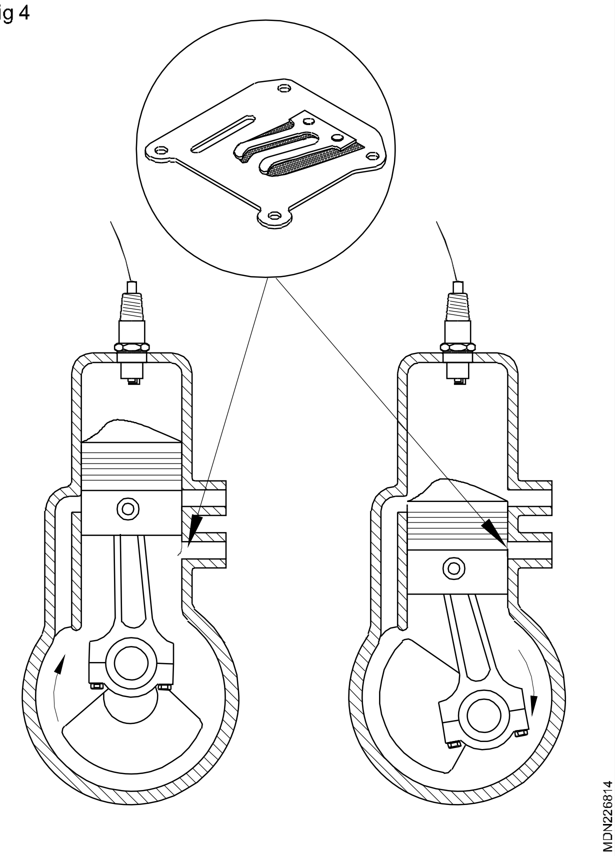
Reed valve

It is a metallic strip hinged at one end. It covers the passages and allows air or charge to flow in one direction only. It is normally used in two-stroke engines and air compressors. (Fig 4)

Sleeve valve

In this type, ports are cut in the cylinder liner. It runs with a slight up and down motion. It is also having rotary motion in another sleeve. This aligns with the inlet and exhaust ports at a set time when the inlet and exhaust manifold open.

Fig 4



valve operating mechanism

Objectives: At the end of this lesson you shall be able to
- **state the requirements of valve operation**
- **state the types of value operating mechanism**
- **list out the parts of the valve mechanism**
- **state the importance of value seats**
- **method of value seats insets in cylinder heads.**

Requirements for valve operation

1 Valve must seat tightly and properly on its seat.

2 Value must be properly timed.

3 Value must be operate without log.

4 Value tappet clearance must be correct.

5 Valve steam and guide clearance must be correct.

Value operating mechanisms

Two types of value operating mechanism are used in engines. They are as follows.

- Slide valve mechanism
- Overhead valve mechanism

In overhead valve mechanism, the position of camshaft is considered as the types of valve mechanism i.e.,

1 Single overhead camshaft mechanism

2 Double overhead camshaft mechanism

Side valve mechanism (Fig 1): In the side value mechanism both the inlet and exhaust valves are fitted in the cylinder block.

Overhead valve mechanism (Fig 2): In this mechanism, the valves are located in the cylinder head. Push-rods and rocker arms are used in addition to the side valve mechanism.

Working

When the cam shaft rotates, the cam lobe (1) lifts the tappet (2) upward. When the tappet (2) moves up, it pushes the push-rod (3) and one end of the rocker arm upwards. The other end of the rocker arm's (4) tip, moves downward and the valve (5) opens against the spring's (6) tension.

Fig 1

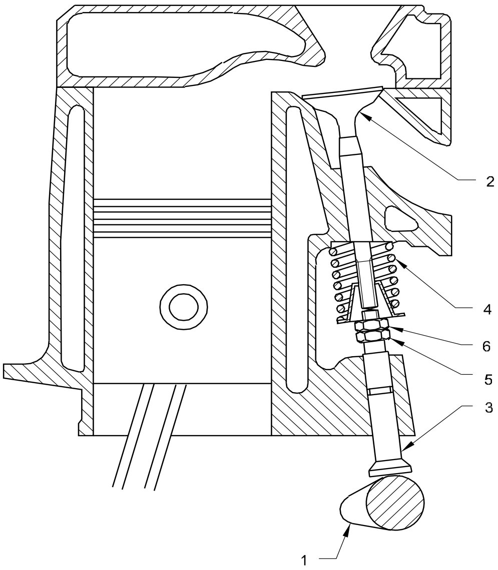
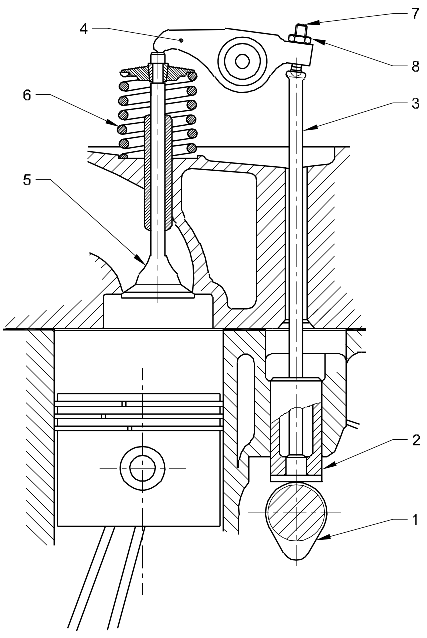


Fig 2



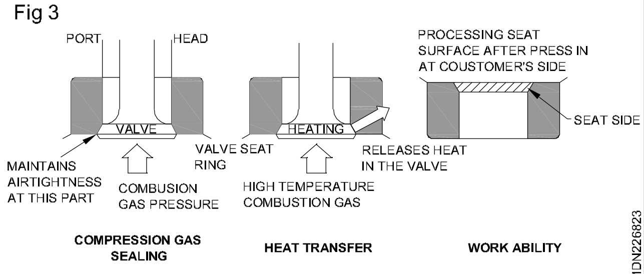
Wen the cam lobe (1) reaches the maximum height, the valve opens fully. Further rotation of the cam shaft causes the tappet (2) to move down and the valve is closed by the tension of the spring (6).

Tappet clearance is provided in between the valve (5) tip and the rocket arm's (4) tip. This clearance can be adjusted by the adjusting screw (7) and the lock-nut (8).

In many cases, even these rockers or followers (Fig 3) and their pivots are dispensed with and the valves are actuated directly by the camshaft (Fig 4) through bucket type.

Importance of value seats: Valve and valve seats are ground to correct and shape so that the valve may seat properly on the seat for effective valve seating and seating. The value face angle must be match the value seat angle. Value seating and sealing is closely realted to the engine performance.

Fig 3



Function of value seats

1 Compression gas sealing prevents compressed gaseous bodies and combustion gas from leaking into the manifold.

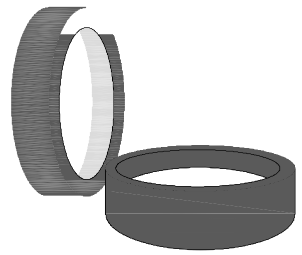
2 Heat transfer releases heat in the valve to the cylinder head.

3 Strength holds tight when the valve is mounted.

4 Wear-resistance hard to wear down under high heat and high load.

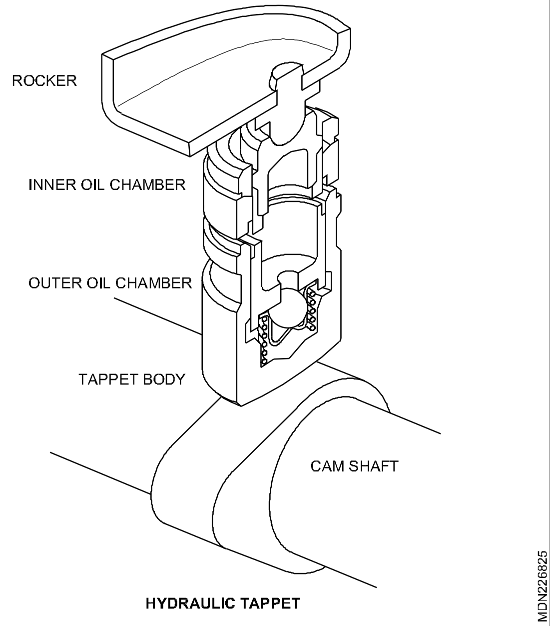
Importance of vale seats inserts in cylinder head

Fig 4



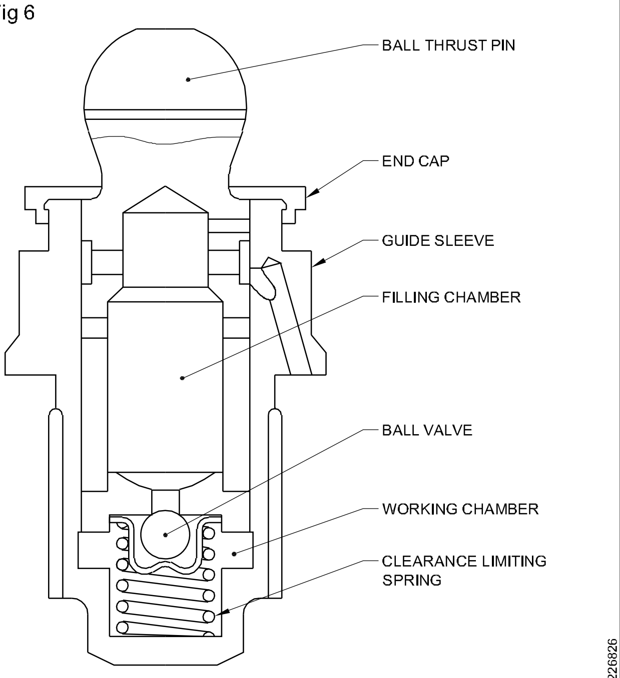
Hydraulic tappet : Hydraulic tappets (Fig 5) enable the valve gear to operate without fixed clearances. They consist of the tappet body, the tappet pistion, a ball valve with spring and the clearance eliminating spring. When the engine is running, lubricating oil from the oil from the oil pump is forced through an oil way to the tappet. It flows through the outer chamber (to lubricate the tappet itself) and hence to the inner chamber (plunger lubrication) and to the interior of the piston. By way of a filling bore, the oil passes through the ball (check) valve to the pressure chamber. The clearance eliminating spring (Fig 6) forces the tappet piston to prevent any valve clearance from occuring. When the camlifts the tappet, the ball valve closes and the oil-filling the pressure chamber acts as an almost rigit link. Thermal expansion of valve gear componets is compensated for by precisely calculated oil loss as a result of tappet piston operating clearance. Although hydraulic tappets are heavier and therefore suffer from increased inertia, this drawback can be compensated for an engines which operate the valves by followers from the overhead camshaft. On these engines, the hydraulic clearance adjuster an be installed in the follower mount instead of in the tappet; it is of similar design to the hydrualic tappet just described.

Fig 5



HYDRAULIC TAPPET

Fig 6



CLEARANCE ELIMINATING ELEMENT

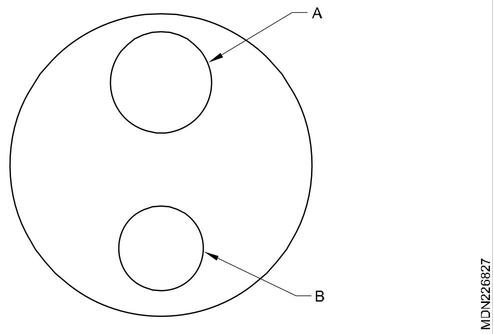
Types of valve arrangement

1 Two valve arrangement in one cylider Fig 7

A One inlet valve

B One exhaust valve

Fig 7

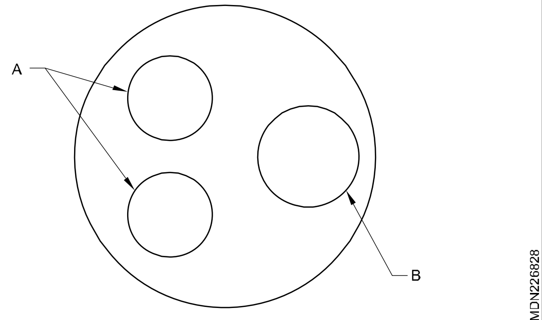


2 Three valve arrangement in one cylider Fig 8

A Two inlet valves

B One exhaust valves

Fig 8

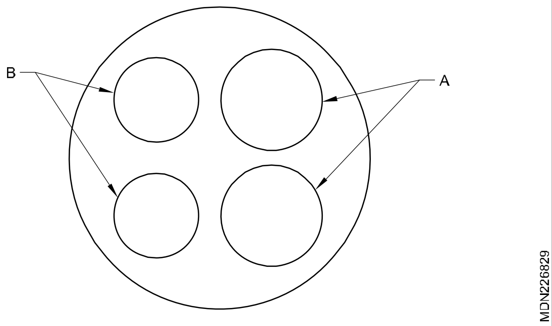


3 Four valve arrangement in one cylider Fig 9

A Two inlet valves

B Two exhaust valves

Fig 9

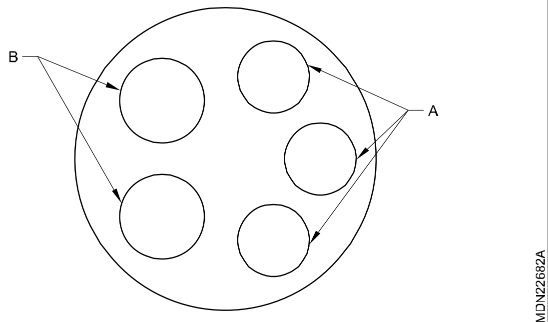


4 Five valve arrangement in one cylider Fig 10

A Three inlet valves

B Two exhaust valves

Fig 10



Valve contructional features and valve timining

Objectives: At the end of this lesson you shall be able to
- **state the function of valve rotation**
- **state the function of valve stem oil seals**
- **state the size of intake value**
- **describe the valve trains**
- **explain valve tunning**
- **concept of variable valve timing.**

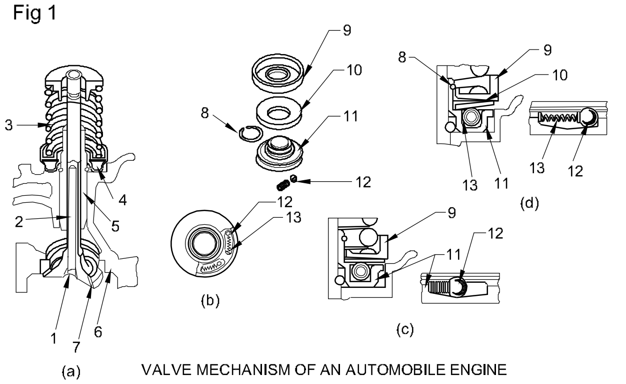
Valve rotation

The main scope of the value and tappet rotation is to reduce the wear, the friction and to increase the life period of the components and maintain the conical value face and seat clean of carbon or soot deposit that might appear on surfaces during valve opening. To uniform the thermal stress of the value head because of the asymmetry exhaust mainfold and uniform the wear of the conical face providing a good scaling of the cylinder.

If the valve is rotating the contact point between value head and seat will varying and in this way the wear marks or crank can be avoided.Value rotation is the uniformity of the oil film in the valve guide on the valve stem. Auxilary rotation system is rotate the value during opening or closing period on those systems components are rotocap, turnomat, rotocoil, rotomat, duomate.

The tapper rotation reduce the wear caused by the contact with the , improves the lubrication of those two surfaces and increases the tapper lift.

Fig 1



VALVE MECHANISM OF AN AUTOMOBILE ENGINE

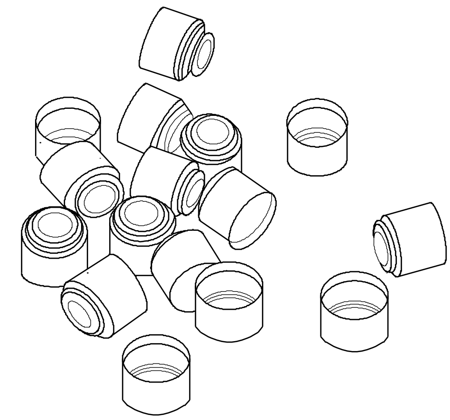
(a) EXHAUST VALVE COMPELETE WITH VALVE ROTATOR:
(b) VALVE ROTATOR:
(c) VALVE ROTATOR POSITION WITH CLOSED VALVE:
(d) VALVE ROTATOR POSITION WITH OPEN VALVE:

1-STOPPER
2-HOLLOW VALVE STEM
3-VALVE SPRING
4-VALVE ROTATOR
5-VALVE GUIDE
6-INSERT VALVE SEAT
7-VALVE FACE
8-SNAP RING
9-SEATING COLLAR
10-FLEXIBLE WASHER (CONE SPRING)
11-VALVE ROTATOR HOUSING
12-STEEL BALL
13-RETURN SPRING

Function of value stem oil seal

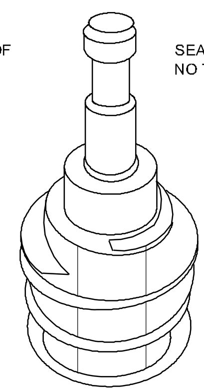
The purpose of the value stem oil seal is to prevent the oil form the cylinder head entering the combusion chamber value stem seals play a critical role in controlling value lubrication as well as oil consumption.

Fig 2



VALVE STEM OIL SEAL

Fig 3



Causes the engine suck will down the guides and into the cylinder

- Seal worn
- Seal cracked
- Scal missing
- Seal broken
- Seal improperly installed

When stem oil seals lose thier ability to control the oil that enters oil though the gude, that can cause a variety of problem.

- Excessive smoke
- High oil consumption
- Carbon deposited in valve and piston
- OFF - throttle braking
- Idel run stop running engine

Vaue train: The valve train of an internal combustion engine includes components required to control the flow of gases into and out of the combustion chamber values and related component required to allow the air or air fuel mixture to enter the combustion chamber, the combustion cahmber during compression and combustion and evacuate exhaust gases when combustion is compete valve train used for a reciprocating engine depends on the engine design and whether the engine is a four /two stroke cycle unit.

There are two basic valve stem seal designs

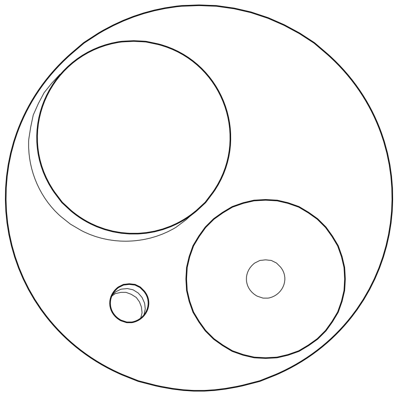
1 Deflector seals - also called umbrella seals, deflect oil away from the valve stem. They are secured to the valve stem and move with the valve to shield the valve guide from excess oil. Umbrella type seals were commonly used prior to the development of positive type seals.

2 Positive seals - attach to the valve guide boss and function as squeegees, wiping and metering oil on the stem as they pass through the seals.State the size of in take valve State the size of intake valve

Fig 4

State the size of intake valve

Fig 5



In order to get adequate air flow into the glinders inlet valve need enough opening with bigger diameter of valve because over come air flow restriction, reduce the intake air heat, allow excess air for complete the combustion to increase the volumetric efficiency and scavanging effect. For exhaust, because you have the pistion during out the exhaust using higher positive pressure so don't need quite as big of valves.

Valve timing

Each manufacturer specifies the timings of the opening and closing of the valves as per the design of the engine to give the maximum output under all loads and speeds.

The opening and closing of the valves in an IC engine in relation to the movement of the piston and flywheel is called valve timing.Fig 6

The opening and closing of the valves exactly at TDC & BDC do not improve the volumetic efficiency of an engine. Burnt gases also are not driven out fully.

Practically, the valves are arranged to open early and close late to fill the cylinder fully and to allow all burnt gases to escape from the cylinder.

Inlet valve

Lead

Inlet valves are made to open certain degrees earlier than T.D.C. This enables aur/air fuel mixture to fill the cylinder to its capacity. It also helps in scavenging burnt gases by using the momentum of intake air/air fuel mixture.

Lag

Inlet valves are made to close certain degrees after B.D.C. to increase the volumetric efficiency by allowing more charge.

Exhaust valve

Lead

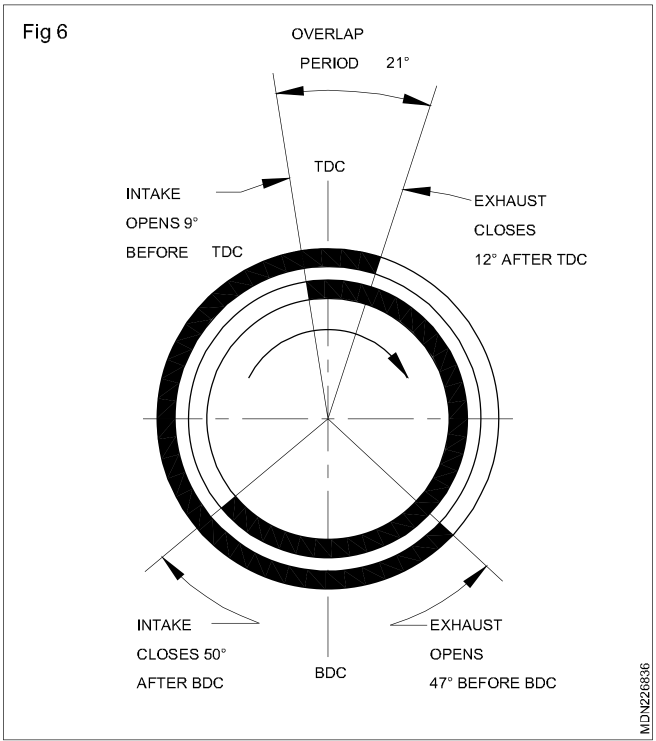
Exhaust valves are made to open certain degrees earlier tham B.D.C.

Lag

Exhaust valves are made to close certain degrees after T.D.C. to develop a suction effect by the outgoing gases. It also helps in the scavenging of the exhaust gases by using the intake charge's momentum.

Overlap period

At the end of the exhaust stroke and the beginning of the suction stroke, both the valves remain open for certain degrees. This period during which both the valves remain open is called the valve overlap.



Graphical representation of valve timing

The valve timing is represented by a diagram drawn on the face of the flywheel in defrees of the crankshaft rotation.

Valve timing (Jeep)

- Inlet valve open 9 degrees before T.D.C.
- Inlet valve closes 50 degrees after B.D.C.
- Exhaust valve opens 47 degrees before B.D.C.
- Exhaust valve closes 12 degrees after T.D.C.
- Over lap period 21 degrees

Valve timing varies from one make of engine to another valves are exposed to various chemical, mechanical and thermal stresses during operation. They must maintain their basic shape and dimensions throughout the expected life of the engine. In addition. the integrity of the sealing surface of the valve and mating valve seat is critical to durability and performance. Engineers determine the valve material, shape, specifications, and surface coatings to match the specifica engine family, expected operating environment, and projected length of service. Valves commonly used in small engines are classified as one-piece, projecton-tip welded, or two-piece-stem welded-stem valves.

Variable valve timing (VVT)

Basic theory

After multi-valve technology became standard in engine design, variable valve timing becomes the net step to enhance engine output, no matter powe or torque.

As yoi know, valves activate the breathing of engine. The timing of breathing, that is, the timing of air intake and exhaust, is controlled by the shape and phase angle of cams. To optimse the breathing, engine requires different valve timing at different speed. When the rev increases, the duration of in take and exhaust stroke decreases so that fresh air becomes not fast enough to enter the combustion chamber, while the exhaust becomes not fast enough to leave the combustion chamber. Therefore, the best solution is to open the inlet valves earlier and close the exhaust valves later. In other words, the overlapping between intake period and exhaust period should be increased as rev increases.

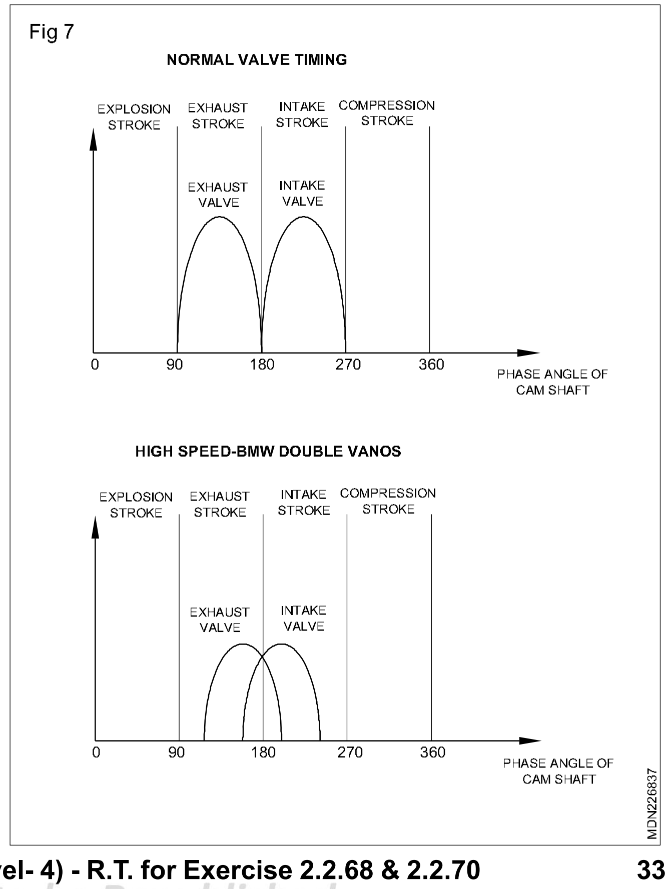
With variable valve timing, power and torque can be optimised across a wide rpm band. The most noticeable results are:

- The engine rev higher, thus raises peak power. For example, Nissan's 2-litre neo VVl engine output 25% more peak power than its non-VVT version
- Low -speed torque increases, thus imporves drivability. For example, Flat barchetta's 1.8 VVT engine provides 90% peak trorque between 2,000 and 6,000 rpm.

Moreoer, all these benfits come without any drawback.

Variable lift

In some designs, valve lift can also be varied according to engine speed. At high speed higher lift quickness air intake and exhaust, thus further optimise the breathing. Ofcourse, at lower speed such lift will generate counter effects like deteriorating the mixing process of fuel and air, thus decease outpur even leads to misfire. Therefore the lift should be variable according to engine speed.



Cam-changing VVT

Honda pioneered road car-used VVT in the late 80s by launching its famous VTEC sysem (Valve timing electronic control).

It has 2 sets of cams having different shapes to enable different timing and lift. One set operates during normal speed, say, below 4,500 rpm. Another substitutes at high speed.

However, cam-changing system remains to be the most powerful VVT, since no other system can vary the Lift of valve as it does.

Example - Honda's 3-stage VTEC

Cam-phasing VVT

Cam-phasing VVT is varies the valve timing by shifting the phase angle of camshafts. For example, at high speed, the inlet camshaft will be rotated in advance by 30° so to enable earlier intake. This movement is controlled by engine mangement system according to need, and actuated by hydraulic valve gears.

Camshaft

Objectives: At the end of this lesson you shall be able to
- **state the function of the camshaft**
- **state the constructional features and material of the camshaft.**

Functions of the camshaft

The camshaft is used to convert the rotary motion into reciprocating motion with the help of the cam lobe. This reciprocating motion is transmitted to the valve through the tappet, push-rod and rocker levers. The camshaft is driven by iron shaft and it rotates half the speed crankshaft. The camshaft also drives the oil pump shaft. In petrol engines the fuel pump and the distributor get their drive from the camshaft.

Construction of the camshaft

The camshaft (2) (Fig 1) is either forged or cast with the cam lobes (1) one for each valve. The camshaft has a series of support bearings along its length.

Fig 1

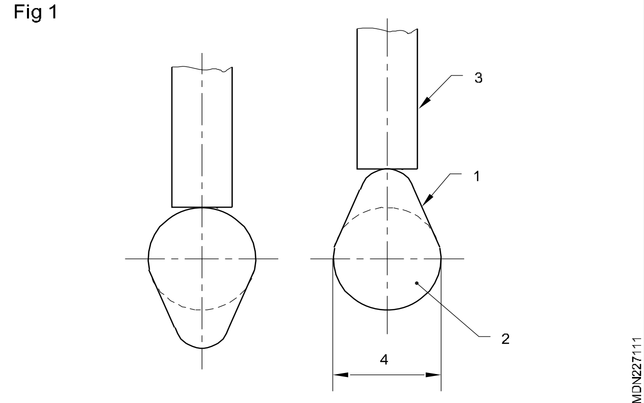
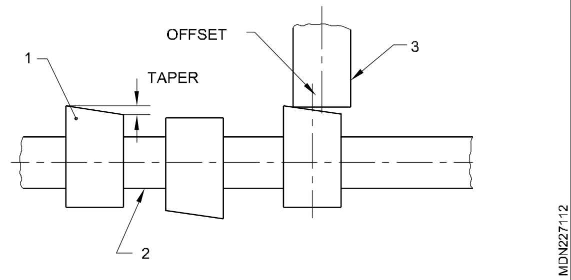


Fig 2



The cam surface (Fig 2) is hardened for longer life. In some engines the axis of the tappet/lifter (3) is slightly offset from the axis of the cam lobe (1). This off set gives a little rotation to tappet/lifter, when it moves up. So the bottom of the tappet/lifter (3) wears out uniformly. The lifter/tappet (3) rests on the cam lobe (1). The lifter (3) remains in its position on the base circle (4). When the cam rotates the lobe lifts the lifter (3).

Material for camshaft

Forged alloy steel

Camshaft drive mechanisms

Objective : At the end of this lesson you shall be able to
- **state the different types of camshaft drive mechanisms.**

The camshaft gets the drive from the crankshaft and rotates at half the crankshaft speed, since each valve opens once in every two revolutions of the crankshaft. There are three types of camshaft drive mechanisms.

- Gear drive
- Chain drive
- Belt drive

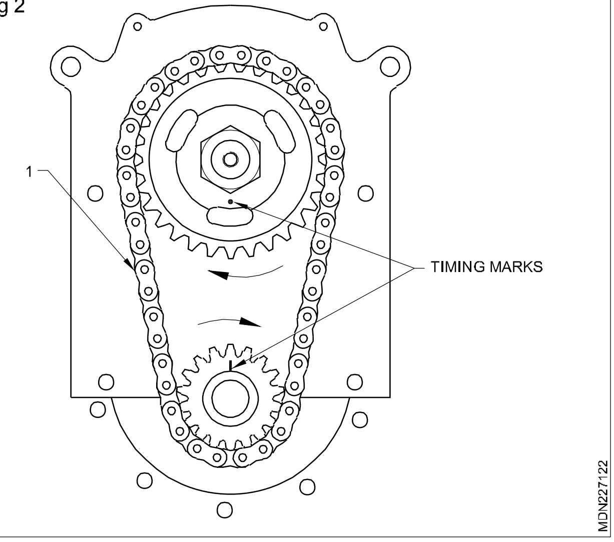
Gear drive

This direct drive (Fig 1) P No 58 is used where the crankshaft and the camshaft are very close to each other. Since the r.p.m. of the camshaft is half of the crankshaft speed, the camshaft gear (1) teeth is twice as many as the crankshaft gear (2) teeth. In this, the engine's camshaft rotates in the reverse direction of the crankshaft. In some engines an idler gear is used to have the same direction of rotation for the crankshaft and the camshaft.

Chain drive

The timing gear sprockets (Fig 2) are driven by a chain (1). Hence this drive is called a sprocket drive. The direction of rotation of the crankshaft and camshaft is the same. It is used when the distance between the crankshaft and the camshaft is more. No idler gear is used in the chain drive.

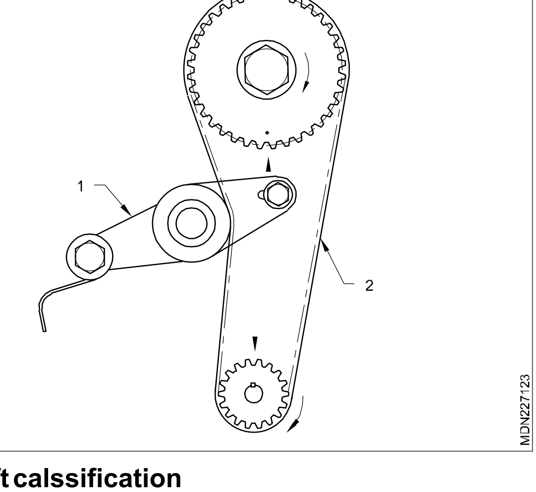
Fig 2



Belt drive

This drive (Fig 3) is similar to a chain drive. Instead of a chain a belt (2) is used to drive the camshaft. The belt drive is mostly used in overhead camshaft design. The direction of rotation of the camshaft and crankshaft is the same. An automatic belt tensioner (1) is used to avoid slipping of the belt.

Fig 3



Cam shaft calssification

Cam shaft are clssified based on its location and number of shafts

1 Bottom mounted traditional cam shaft (OHV Engine)

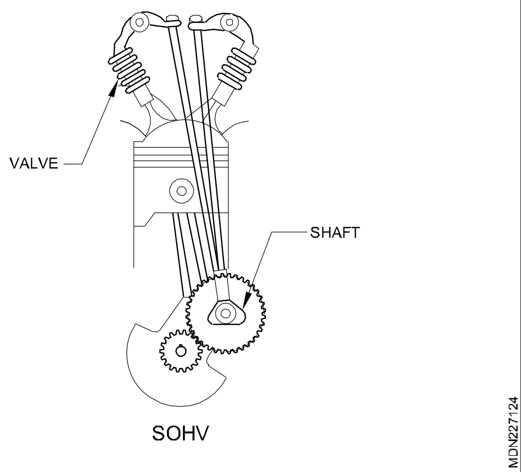
2 Over head cam / Single over head cam shaft (OHC / SOHC)

3 Doube over head cam shaft (DOHC)

The main disadvantages of an OHV design is that it'sdifficult to control precisely the valve timing at high rpm.

Advantages of an OHV engine include lower cost, proven durability, low-end torque and compact size. OHV design is better suited for slow speed engines. In heavy duty engines iffers higher torque at lower rpms. (Fig 4)

Fig 4

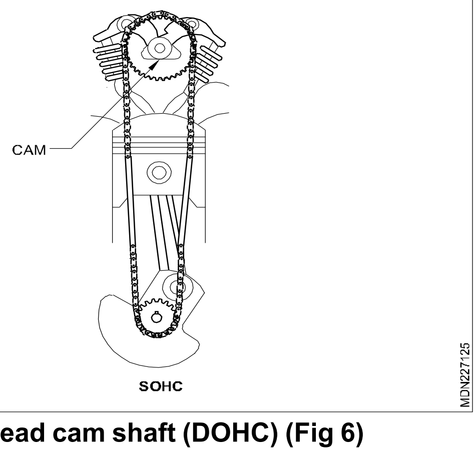


Over head cam/single over head cam shaft (OHC/ SOHC) (Fig 5)

OHC means over head cam in general, while SOHC means single over head cam or single cam. In SOHC engine the camshaft is installed in the cylinder head and valves are operated either by the rocker arms or directly through the lifters.

The main advantage of an OHC design is that valves are operated almost directly by the camshaft, which makes it easier to maintain precise timing at higher rpms. It's also possible to install three or four valves per cylinder.

Fig 5



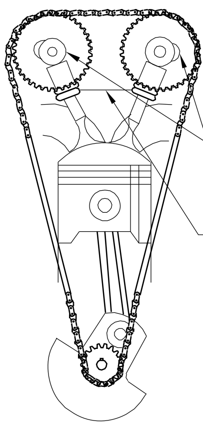
Double over head cam shaft (DOHC) (Fig 6)

DOHC means double over head cam. Most modern vehicles have DOHC engines. DOHC engine has two camshafts and 4 valves per cylinder. One camshaft operates intake, while another camshaft controls exhaust valves. This allows the intake valves to be at a larger abgle from the exhaust valves, so the vlumetric efficieency increases and produces more horse power out of smaller engine voulme.

The main advantage of the DOHC design allow th technologies like direct injection, variable valve timing and variable valve lift cab be easily implemented in a DOHC engine, further improving fuel efficiency.

The main disadvantage of the DOHC technology inclides a larger size and more compex design with additional timing belt or chain components. A timing belt needs to be replaced at recommended intervals, adding to maintenance costs.

Fig 6



Bottom mounted traditional cam shaft (OHV Engine) (Fig 7)

OHV in general means oer head valve, or valves are fitted in the cylinder head. Oftern the term "OHV is used to describe the engine design where the camshaft is fitted inside the engine block and vlves are operated through lifters, pushrods and rocker arms. This design is alos known as a "Pushrod" engine. The OHV design has been successfully used for decades.

Fig 7