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Ministry of Labor and Skills

Automotive Mechanics

Level-III

Based on October 2023, Curriculum Version II

Module Title: Engine Overhauling

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Acronym

°C	Degree centigrade
ICE	Internal compassion engine
H_2O	Hydrogen oxide
LAP	Learning activity
OHS	Occupational Health Safety
PPE	Personal Protective Equipment

Introduction to Module

This module covers the knowledge; attitudes and skills required to overhaul engines and its components on an engine removed from chassis. The module includes preparation for work; cleaning, inspecting, remove from vehicle and dismantling of parts; measure engine components, recondition/replace, assemble, adjustment and final testing. .

This module covers the units:

- Preparing to Engine Overhauling
- Removing and Disassembling Engine
- Inspecting and Measuring engine component
- Reassembling and Verifying Engine

Learning Objective of the Module

- Understand Engine Overhaul
- Remove and Disassemble Engine
- Inspect and Measure engine component
- Reassemble and Verifying Engine

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Carry Out Engine Overhaul

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Introduction to engine overhauling
- Engine cleaning
- Applying OHS and environmental protection
- Measuring and special service tools

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understanding Purpose and engine overhauling
- Performing Engine cleaning
- Apply OHS and environmental protection
- Measuring and special service tools

1.1. Overview of engine

An engine is some machine that converts energy from a fuel to some mechanical energy, creating motion in the process. Engines such as the ones used to run vehicles can run on a variety of different fuels, most notably gasoline and diesel in the case of cars. The engine is known as the heart of the vehicle. During the engine operation, it generates extreme heat. Therefore, engine parts need to bear extreme heat and wear and tear due to that they may damage over time. As the engine parts are damaged, you need engine overhauling.

1.1.1 Basic Engine Components

A. Cylinder head

Engine head is casted in the same way as engine block. Its mold is made such that the casted piece must have an opening for air to flow into engine cylinder and an exhaust opening from where the burnt gases will go out. This passage of air flowing in and going out of engine cylinder is controlled by inlet and outlet valves. So engine head also has cylindrical holes to insert valve stem.

1.1-1 cylinder Head

B. Valves

As we have already know that they control the inlet and exhaust air to go into and out of engine cylinder. Material used to make valves is nickel-chromium iron alloy. It can resist high temperature and have great strength**.** . Valve is mounted upside down means valve head is facing engine

Figure 1.2 valve

cylinder. It is so because when there would be high pressure in engine cylinder it would press the valve head against its seat in engine head and thus pressure will be maintained at best.

C. Camshaft

It is a shaft with a number of cam profiles along its length. So it regulates the valves opening and closing time. It does so by pressing the end of valve stem by its cam profile. But we still need a mechanism which would return the valve back to its

Figure 1.3 camshaft

position once pressed by the cam profile of camshaft.

D. Engine Block

Engine block is an important parts of an engine. It is made by pouring the molten iron or aluminum alloy into a mold. The mold is made such that we should have required number of holes in the casted block, which are said to be the number of cylinders of an engine or engine cylinders. The diameter of these holes is called the bore of an engine.

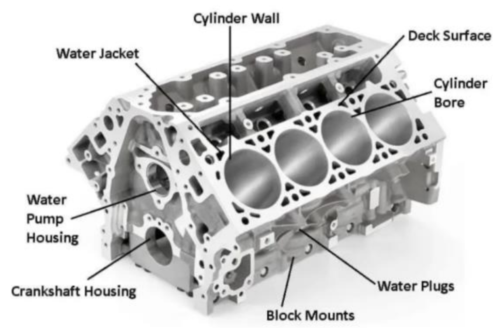


Figure 1.4 cylinder block

E. Piston

Piston is a cylindrical structure with a flat surface called crown at the top. Piston is the component that moves up and down in an engine cylinder. Wait what it would cause?, friction if one cylinder (piston) moving up and down in another cylinder? Yeah to overcome this problem groves are made on the circumference of this cylindrical structure (piston). And we place rings in these groves called piston rings. So now the whole cylindrical structure is not rubbing with engine cylinder and only piston rings are in contact with engine cylinder thus reducing friction to a great extent.

Figure 1.5 Piston

F. Connecting Rod

It is an 'I' shape structure whose one end is connected to piston and other one to crankshaft. The piston side end of connecting rod has hole in it. And we have also got a hole in piston's cylindrical structure just beneath the piston rings. So we align this hole with connecting rods hole and put a wrist pin through it. Wrist pin act as a bearing and connecting rod can move like pendulum beneath piston, though piston's cylindrical structure is gonna limit its motion.

Figure 1.6 connecting Rod

G. Crankshaft

to convert linear (up and down) motion of piston into rotational motion. It works same as slider- crank mechanism. Material used for making crankshaft is cast iron generally but we also use forged steel in high power engines where load on crankshaft is too high.Casting a crank-shaft seems to be an easy task, but it’s not. Once crankshaft is casted it is then machined, which is not that easy considering its shape. Then after machining it requires proper balancing to work properly.

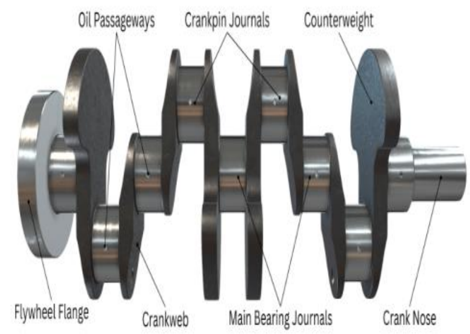


Figure 1.7 crankshaft

H. Crankshaft Casing or Oil Sump

It is also called as oil sump. It is a casing which is bolted to engine block, which covers engine from bottom thus called crankshaft casing. It retains lubricating oil in it which is pumped to different engine parts. Crankshaft has got small holes which spills oil towards piston, to remove piston heat and lubricate the piston rings, so it also prevents oil from splashing. We have got a bolt at the bottom of this casing from where we remove used lubricating oil during maintenance.

Figure 1.8 Oil sump

1.2. Introduction to Engine Overhauling

Most commonly, the engine overhaul is performed when the car engine parts have some severe problems. The engine overhaul of your car engine has the ability to restore the dead engine. This module explains the engine overhaul meaning, causes, signs, and how to prevent it. The engines in automobiles are all internal combustion engines. Internal combustion engines can be of two types, reciprocating and rotary. The type used in most automobiles is the reciprocating or piston engine. In this engine, pistons move up and down, or reciprocate. The other kind of IC engine is the rotary type, in which rotors rotate or turn.

An engine overhaul is a process of removing, stripping, checkup, cleaning, and repairing the faulty internal parts of the engine. In the overhauling process, the technician removes the engine parts and then inspects the parts to find the problem. For example, if your engine piston, head gasket, camshaft, crankshaft, connecting rod, or bearing has been damaged, the technician repairs it.

For example, if your engine piston, head gasket, camshaft, crankshaft, connecting rod, or bearing has been damaged, the technician repairs it.

Figure 1.9 Overhauling Engine

An overhaul is a service that returns an engine to like-new condition. During the overhaul process, engines are removed from equipment, completely disassembled, fully inspected and cleaned, repaired in places where repairs are needed, then tested for performance. Once the testing has confirmed that the engine is operating like a new model, the engine is returned to the equipment and put to work.

Overhaul is one of the most cost-effective ways to improve equipment performance. There are significant cost savings compared to buying new and even used engines, engine overhaul can sometimes provide even better performance than find with a new option. An overhaul isn't the perfect solution for all equipment operators, but it's important to consider engine overhaul solutions before making a buying decision.

1.3. Symptom of Engine Fault

One or more of the below-given common symptoms indicate that your engine overhaul is need an engine overhaul:

A. White Exhaust Smoke

As the engine oil or coolant enters the cylinder, it mixes and burns with the air-fuel mixture; due to that, engine emits white smoke from the vehicle tailpipe. This white smoke indicates that vehicle has a damaged gasket or piston ring. As continuously observe the white smoke, drive vehicle to a mechanic and ask for an engine overhaul. However, do not confuse it with the white smoke that the vehicle emits at the initial start-up.

Figure 1.10 white exhausts

B. High Oil Consumption

One of the major signs car engine requires an overhaul is extreme oil consumption. If the engine oil level goes down very quickly or the low oil pressure warning light comes on, it means engine has a leaky or damaged part. A damaged head gasket, a damaged hose, or a damaged piston ring can cause a quick reduction in the engine oil level.

C. Black Exhaust Smoke

The engine emits black smoke due to carbon deposits on the intake valve and piston. Constant emission of black smoke usually indicates that the engine needs an overhaul. It generates problems in air-fuel mixture combustion. As a result, engine performance and fuel efficiency are reduced.

During the combustion process, especially when accelerating the vehicle, the accumulated carbon escapes from the exhaust gases in the form of black smoke. This build-up of carbon can lead to severe damage to the engine.

Figure 1.2-11 black smoke

D. Engine Overheating

Engine overheating means cooling system is not working properly. The engine most commonly overheats due to a faulty water pump, leaky hoses, insufficient engine oil, insufficient coolant, a damaged combustion chamber, or a leaky radiator. It may also cause due to leaky head gaskets.

As the head gasket leaks, the engine oil starts burning into the combustion chamber, which leads to many mechanical problems. The car dashboard also has a temperature gauge that indicates the engine temperature. If this gauge goes into the red zone, you need to contact a mechanic for the engine overhauling.

Figure 1.12 Overheating

E. Reduction in Engine Performance

Engine misfiring issues occur when the air/fuel ratio in the engine cylinders is incorrect or when the spark plug doesn’t properly ignite the air/fuel mixture. The engine misfiring reduces the acceleration of the vehicle and reduces engine performance. If the cause of the problem is a worn spark plug, it can be easily replaced.

F. Coolant Level

A quick reduction in the coolant level is a clear sign that your engine has a leaky part and it needs an overhaul. The leaky head gasket, damaged piston ring, or cracked engine cylinder may lead to a quick reduction of the coolant level.

G. Strange Noises from the Engine

A strange engine noise usually means that your engine has a broken, cracked, loose, or worn part. The knocking noise may represent that there is excessive clearance between the piston rod and the crankshaft or that there is a problem with the valve train. This unpleasant noise may also cause due to a damaged piston ring.

H. Check Engine Light

The latest vehicle models contain a check engine light. When something goes bad with your engine, the check engine light starts to illuminate. This warning light may also indicate a severe engine issue. A faulty spark plug, a damaged fuel injector, a low coolant level, insufficient engine oil, a damaged engine cylinder, or a faulty engine sensor are the most common causes of the check engine light illumination.

I. Oil Sludge

The oil sludge on the fuel cap or dipstick is one of the clear signs of an engine issue. The oil sludge may accumulate due to one or more of the following causes:

- Coolants
- Wrong engine oil
- Old engine
- Grime

The oil sludge accumulation shows that the parts of your engine are not lubricated properly.

J. Compression Loss

Compression loss is a situation commonly associated with reduced performance and a decrease in power. An engine coolant or fuel leak may lead to engine oil contamination, leading to a higher oil level in the crankcase.

However, the compression loss often suggests leaks occurring elsewhere within the engine as well. An engine cylinder is usually leaked due to excessively worn components that require replacement. Deteriorating performance and a leaking engine cylinder signal that an overhaul is necessary.

K. Dropped Valve

A dropped valve takes place if the valve head of the vehicle engine becomes bent and severed, leading it to fall into the engine cylinder. This event can inflict significant damage on the whole engine.

1.4.Engine cleaning

Automobile engines attract and accumulate particles during its operation and these deposits could come in these forms: - water soluble deposits, organic soil, rust or scale. Effectively cleaning these deposits require the use of the most appropriate cleaning method, bearing in mind that cleaning takes a very significant part of the running budget of an automobile workshop.

- **Types of Contaminants**

Being able to recognize the type of dirt you are to clean will save you time and effort. Basically there are four three types of dirt.

1. **Water-Soluble Soils**

The easiest dirt to clean is water-soluble soils, which includes dirt, dust, and mud.

Organic Soils Organic soils contain carbon and cannot be effectively removed with plain water. There are three distinct groupings of organic soils:

- Petroleum by-products derived from crude oil, including tar, road oil, engine oil, gasoline, diesel fuel, grease, and engine oil additives
- By-products of combustion, including carbon, varnish, gum, and sludge
- Coatings, including such items as rust-proofing materials, gasket sealers and cements, paints, waxes, and sound-deadener coatings

2. **Organic Soils:**

Organic soils contain carbon and cannot be effectively removed with plain water. There are three distinct groupings of organic soils:

a) Petroleum by-products derived from crude oil including road oil, engine oil, gasoline, diesel fuel, grease, and engine oil additives.

b) By-products of combustion like carbon deposit.

c) Coatings including such items as rust-proofing materials, gasket sealers and cements, paints and waxes.

3. **Rust**

Rust is the result of a chemical reaction that takes place when iron and steel are exposed to oxygen and moisture. Corrosion, like rust, results from a similar chemical reaction between oxygen and metal containing aluminum. If left unchecked, both rust and corrosion can physically destroy metal parts quite rapidly. In addition to metal destruction, rust also acts to insulate and prevent proper heat transfer inside the cooling system

4. **Scale**

When water containing mineral and deposits is heated, suspended minerals and impurities tend to dissolve, settle out, and attach to the surrounding hot metal surfaces. This buildup of minerals and deposits inside the cooling system is known as scale. Over a period of time, scale can accumulate to the extent that passages become blocked, cooling efficiency is compromised, and metal parts start to deteriorate.

1.4.1.Methods Engine Cleaning

1. **Cleaning with Chemicals**

There are three basic processes for cleaning automotive engine parts. The first process that is discussed is chemical cleaning. This method of cleaning uses chemical action to remove dirt, grease, scale, paint, and/or rust. Unfortunately, the most traditional line of defense against soils involves the use of cleaning chemicals. Chlorinated hydrocarbons and mineral spirits may have some health risks associated with their use through skin exposure and inhalation of vapors. Hydrocarbon cleaning solvents are also flammable. The use of water-based nontoxic chemicals can eliminate such risks.

Hydrocarbon solvents are labeled hazardous or toxic and require special handling and disposal procedures. Many water-based cleaning solutions are biodegradable. Once the cleaning solution

Figure 1.2-1 chemical cleaning machine

has become contaminated with grease and grime, it too becomes a hazardous or toxic waste that can be subject to the same disposal rules as a hydrocarbon solvent.

2. Chemical Cleaning Machines

➢ **Parts Washers**

Parts washers (often called solvent tanks) are one of the most widely used and inexpensive methods of removing grease, oil, and dirt from the metal surfaces of a seemingly infinite variety of automotive components and engine parts. A typical washer setup might consist of a tank to hold a given volume of solvent cleaner and some method of applying the solvent. These methods include soaking, soaking and agitation, solvent streams, and spray gun applicators.

Figure 1.13 Chemical Cleaning Machines

➢ **Soak Tanks**

There are two types of soak tanks: cold and hot.

➢ **Cold Soak**

Tanks are commonly used to clean carburetors, throttle bodies, and aluminum parts. A typical cold soak unit consists of a tank to hold the cleaner and a basket to hold the parts to be cleaned. After soaking with or without gentle agitation is complete, the parts are removed, flushed with water, and blown dry with compressed air.

Figure 1.2-14 cold soak tank

Cleaning time is short, about 20 to 30 minutes, when the chemical cleaner is new. The time becomes progressively longer as the chemical ages. Agitation by raising and lowering the basket (usually done mechanically) will reduce the soak period to about 10 minutes. Some more elaborate tanks are agitated automatically.

Figure 1.2-15 hot spray tanks

- **Hot soak**

tanks are actually heated cold tanks. The source of heat is electricity, natural gas, or propane. The solution inside the hot tanks usually ranges from 71°C to 93°C. Most tanks are generally large enough to hold an entire engine block and its related parts. Hot tanks use a simple immersion process that relies on a heated chemical to lift the grease and grime off the surface. Liquid or parts agitation may also be used to speed up the job. Agitation helps shake the grime loose and also helps the liquid penetrate blind passageways and crevices in the part. Generally speaking, it takes one to several hours to soak most parts clean.

- **Hot Spray Tanks**

The hot spray tank works like a large automatic dishwasher and removes organic and rust soils from a variety of automotive parts. As with the hot soak method, spray washers soak the parts, but they also have the benefit of moderate pressure cleaning. Using a hot jet spray washer can cut cleaning time to less than 10 minutes. Normally, a strong soap solution is used as the cleaning agent. The speed of this system, along with lower operating costs, makes it popular with many Spray washers are often used to pre-clean engine parts prior to disassembly

- **Thermal Cleaning**

The second basic process for cleaning engine parts is thermal cleaning. This process relies on heat to bake off or oxidize dirt and other contaminants. Thermal cleaning ovens, especially the paralytic type, have become increasingly popular. The main advantage of thermal cleaning is a total reduction of all oils and grease on and in blocks, heads, and other parts.

Figure 1.2-16 thermal cleaning

- **Abrasive Cleaners**

The third process used to clean engine parts involves the use of abrasives. Most abrasive cleaning machines are used in conjunction with other cleaning processes rather than as a primary cleaning process itself.

Figure 1.2-17cleaning by hand

- **Cleaning by Hand**

some manual cleaning is inevitable. Heavy buildups of grease and/or carbon should initially be removed by scraping or wire brushing. Cleaning aluminum and other soft metals with either technique should be done with extreme care, especially while using a steel scraper or brush. Steel or plastic scrapers are used to remove old gasket material from a surface and heavy sludge. Power tools with a small sanding disc (normally emery cloth) are available.

These are designed to remove all soft materials without damaging the hard metal sur-face. After the item has been scraped, an additional cleaning method is used to finalize cleaning.

Carbon can be removed with a handheld wire brush or a wire wheel driven by an electric or air drill motor.

Figure 1.2-18 power tools small sanding

Moving the wire wheel in alight circular motion against the carbon helps to crack and dislodge the carbon. Some shops use a wire brush in addition to another cleaning method.

Wire brushes are also used to clean the inside of oil and coolant galleries. The brushes are soaked in a cleaning solvent and then passed through the passages in the block. To do this, the gallery plugs must be removed.

- **Abrasive Blaster**

Compressed air shot and grit blasters are best used on parts that will be machined after they have been cleaned. Two basic types of media are available: shot and grit. Shot is round; grit is angular in shape. Parts must be dry and grease-free when they go into an abrasive blast machine.

Otherwise, the shot or beads will stick. Steel shot and glass beads are used for cleaning and/or penning the part’s surfaces. Penning is a process of hammering on the surface.

Figure 1.2-19 abrasive blaster

This packs the molecules tighter to increase the part’s resistance to fatigue and stress. Steel shot is normally used with airless wheel blast equipment, which hurls the shot at the part by the centrifugal force of the spinning wheel. Glass beads are blown through a nozzle by compressed air in an enclosure.

- **Parts Tumbler**

A cleaning alternative that can save considerable labor when cleaning small parts such as engine valves is a tumbler. Various cleaning media can be used in a tumbler to scrub the parts clean. This saves considerable hand labor and eliminates dust. In some tumblers, all parts are rotated and tilted at the same time.

Figure 1.2-20 vibratory cleaning

- **Vibratory Cleaning**

Shakers, as they are frequently called, use a vibrating tub filled with ceramic, steel, porcelain, or aluminum abrasive to scrub parts clean. Most shakers flush the tub with solvent to help loosen and flush away the dirt and grime. The solvent drains out the bottom and is filtered to remove the sludge.

3. **Alternative Cleaning Methods**

Three of the most popular alternatives to traditional chemical cleaning systems are ultrasonic cleaning, citrus chemicals, and salt baths.

A. **Ultrasonic Cleaning**


Figure 1.2-21 Ultrasonic cleaning

This cleaning process has been used for a number of years to clean small parts like jewelry, dentures, and medical instruments. Recently, however, the use of larger ultrasonic units has expanded into small engine parts cleaning. Ultrasonic cleaning utilizes high-frequency sound waves to create microscopic bubbles that burst into energy to loosen soil from parts. Because the tiny bubbles do all the work, the chemical content of the cleaning solutionis minimized, making waste disposal less of a problem..

B. Citrus Chemicals

Some chemical producers are starting to develop citrus-based cleaning chemicals as a replacement for the more hazardous solvent and alkaline-based chemicals currently used.

Because of their citrus origin, these chemicals are safer to handle, easier to dispose of, and even smell good.

C. Salt Bath

The salt bath is a unique process that uses high-temperature molten salt to dissolve organic materials, including carbon, grease, oil, dirt, paint, and some gaskets. For cast iron and steel, the salt bath

1.5. Applying OHS and environmental protection

1.5.1. Tool and Equipment Safety

An automotive technician must adhere to the follow-ing shop safety guidelines when using all tools and equipment

- **Hand Tool Safety**

Careless use of simple hand tools such as wrenches, screwdrivers, and hammers causes much shop accidents that could be prevented. Keep in mind the following tips when using hand tools:

- Keep all tools grease-free. Oily tools can slip out of your hand, causing broken fingers or at least cut or skinned knuckles.
- Inspect your tools for cracks, broken parts, or other dangerous conditions before you use them.
- Never use broken or damaged tools.
- Hand tools should only be used for the purpose they were designed for. Use the right tool for the job. Never use a wrench or pliers as a hammer, also never use screwdrivers as chisels.
- Make sure the tool is of professional quality.
- When using a wrench, always pull it, not push it, toward you. When using an adjustable wrench; pull the wrench so that the force of the pull is on the nonadjustable jaw.
- Always use the correct size of wrench.
- Use a box-end or socket wrench whenever possible.
- Do not use deep-well sockets when a regular size socket will work. The longer socket develops more twist torque and tends to slip off the fastener.
- when using an air impact wrench, always use impact sockets.

1.5.2. Power Tool safety

Many shops have areas specifically marked as special safety areas. These safety areas or zones often contain equipment such as bench grinders, solvent tanks, welding equipment, and drill presses, which present special hazards in the shop. Working within or even near these areas often requires additional PPE over and above standard safety glasses, uniforms, and boots. For example, when using a bench grinder, a full face shield should be used to prevent debris from flying into your face. Be sure to identify what forms of PPE are necessary when working in and around these area

Figure 1.22 Automotive Work Shop

1.1.1. Jack and Jack Stand Safety

A vehicle can be raised by a hydraulic jack A handle on the jack is moved up and down to raise a vehicle and a valve is turned to release the hydraulic pressure in the jack to lower it. The jack has a lifting pad, which must be positioned under an area of the vehicle's frame or at one of the manufacturer's recommended lift points. Never place the pad under the floor pan or under steering and suspension parts, because they can be dam-aged by the weight of the vehicle. Always position the jack so that the wheels of the vehicle can roll as the vehicle is being raised

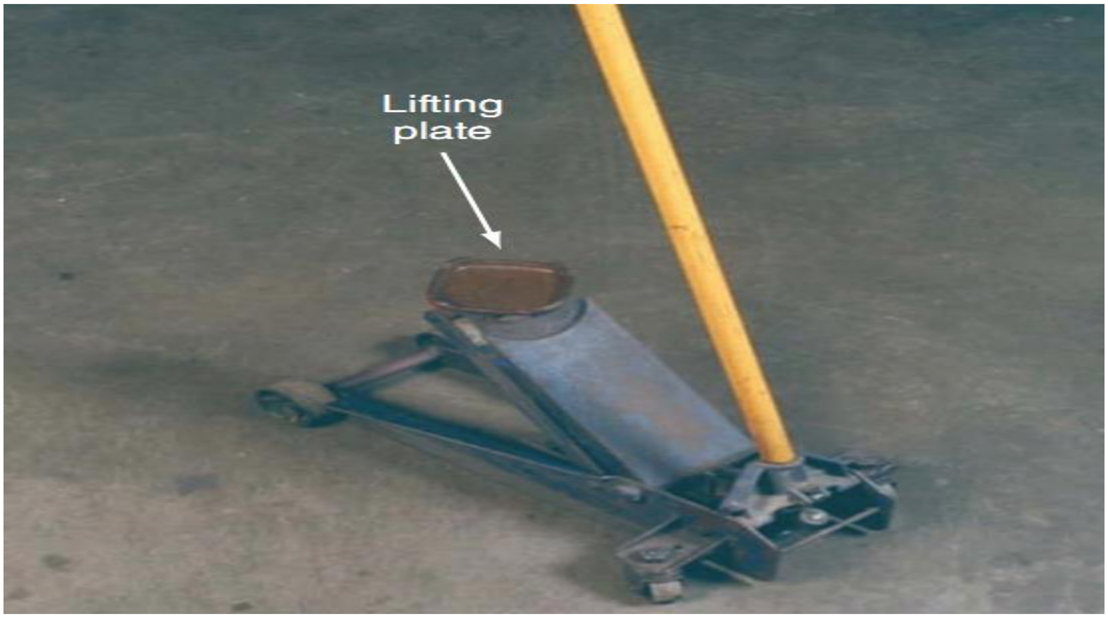


Figure 1.23 hydraulic Jack

1.1.2. Cleaning Equipment Safety

A part cleaning is a necessary step in most repair procedures. Cleaning automotive parts can be divided into three basic categories.

1. **Chemical cleaning** relies on chemical action to remove dirt, grease, scale, paint, or rust a combination of heat, agitation, mechanical scrubbing, or washing may be used to remove dirt. Chemical cleaning equipment includes small parts washers, hot/cold tanks, pressure washers, spray washers, and salt baths.
2. **Thermal cleaning** relies on heat, which bakes off or oxidizes the dirt. Thermal cleaning leaves an ash residue on the surface that must be removed by an additional cleaning process, such as airless shot blasting or spray washing.
3. **Abrasive cleaning** relies on physical abrasion to clean the surface. This includes everything from a wire brush to glass bead blasting, airless steel shot blasting, abrasive tumbling, and vibratory cleaning

1.2. Measuring and Special Service Tools

1.2.1. Engine Overhauling Hand Tools

- **Oil filter wrench:-** used to remove and tag the oil filter.

F igure1.2-24 oil filter wrench

- **Torque wrench:-**It is a spanner, which measures the tightening torque applied to a nut or bolt, so that it can be correctly tightened

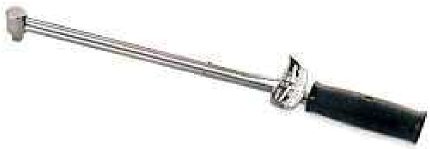


Figure 1.2-25 torque wrench

- **Spark plug wrench:-** Spark plug wrenches are designed for fitting and removing spark plugs

Figure 1.2-26 spark plug wrench

- **Valve spring compressor:-**is used to remove and install valve assemblies.
- **Piston ring expander:-** used to remove the ring from piston ring groove.

Figure 1.2-27 valve spring compressor

Figure 1-28 piston ring expander

- **Piston ring compressor**:- used to compress the ring in the piston ring groove during assembling of piston assembly in the cylinder

sor

Figure 1.29 piston ring compressor

- **Valve Lapping Tool:** Lapping can be used to obtain a specific surface roughness; it is also used to obtain very accurate surfaces, usually very flat surfaces..

Figure 1-30 valve lapping

1.2.2. Measuring Tools:

Measuring tools are precise and delicate instruments.

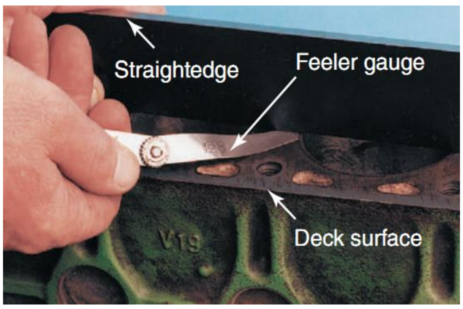
Precision measuring instruments; such as: micrometers, vernier caliper, thickness gauge, bore gauge etc.

Figure 1.31 Micrometer

- **Micrometer:** It is a device used to measure the cylinder bore outside, inside diameter and depth measurements of a thing.

- **Feeler Gauge: It** refers to a set of thin hard metal strips of different thickness used for measuring the clearance between two components like between valve and its rocker or between the distributor points.

Figure 1.32 Feeler Gauge



- Vernier Caliper: It is a measuring tool used for taking internal and external and depth measurements up to 150 mm.

Figure 1.2-33 vernier caliper

- **Dial indicator:-** is used to measure thrust (side) clearance ,run out, end play backlash of cam shaft and crankshaft

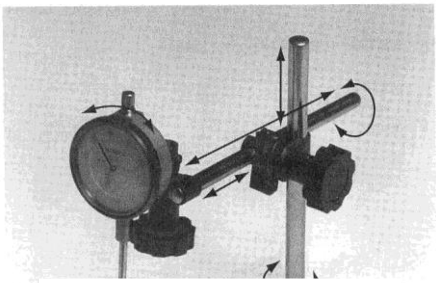


Figure 1.2-34 dial indicator

- **Telescopic gauge:** used to measure smallest bore diameters, such as an engine cylinder and small bores, such as an engine valve guide. A micrometer is used to read the telescoping gauge setting

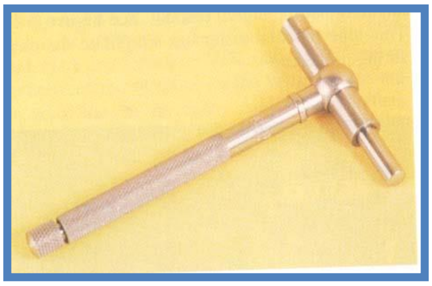


Figure 1.35 telescopic gauge

- **Bore gauge** Is a quick & accurate method of checking holes & bore cylinder diameter, roundness and for size Out- roundness, taperness

Figure 1.36 bore gauge

- **Plasti gauge** Used to measure primarily oil clearance

Self-Check 1.1

Directions: Answer all the questions listed

Part I: Answer the following questions accordingly.

1. What Is Engine Overhauling?
2. Write The Method Of Engine Cleaning ?
3. Write Sings Of Engine For Overhaul?
4. Describe Alternative Cleaning Method
5. Explain Types Of Contaminants
6. __________Is Used To Measure Larger Bore Diameters, Such As An Engine Cylinder And Small Bores, Such As An Engine Valve Guide
7. __________Is Used To Remove The Ring From Piston Ring Groove
8. ________ A Set Of Thin Hard Metal Strips Of Different Thickness Used For Measuring The Clearance Between Two Components

Part II Say True Or False

1. Dial Indicator Is Used To Measure Thrust (Side) Clearance ,Run Out, End Play Backlash Of Cam Shaft And Crankshaft
2. Lapping Can Be Used To Obtain A Specific Surface Roughness; It Is Also Used To Obtain Very Accurate Surfaces, Usually Very Flat Surfaces..
3. Compression Loss Is A Situation Commonly Associated With Reduced Performance And A Increase In Power.
4. It Mixes And Burns With The Air-Fuel Mixture; Due To That, Engine Emits White Smoke From The Vehicle Tailpipe
5. The Engine Emits White Smoke Due To Carbon Deposits On The Intake Valve And Piston

Part III Chooses the Correct Answer from the given alternatives

1. The Oil Sludge May Accumulate Due To One Following Causes:
   A. Coolants
   B. Wrong Engine Oil
   C. Old Engine
   D. Grime
2. Which Of The Following Used To Measure Smallest Bore Diameters, Such As An Engine Cylinder

A. Vernier Caliper
B. Micrometer
C. Plastigauge
D. Telescopic Gauge

3. The Engine Most Commonly Overheats Due To
   A. A Faulty Water Pump,
   B. Insufficient Engine Oil
   C. Leaky Hoses,
   D. All
4. One Of The Major Signs Car Engine Requires An Overhaul Is
   A. Extreme Oil Consumption.
   B. Engine Over Heating
   C. Oil Sludge
   D. All
5. Which Types Engine Cleaning Process Relies On Heat To Bake Off Or Oxidize Dirt And Other Contaminants
   A. Thermal Cleaning
   B. Abrasive Blaster
   C. Vibratory Cleaning
   D. Abrasive Cleaners

Unit Two: Remove and Disassemble Engine
This unit is developed to provide you the necessary information regarding the following content coverage and topics: • Removing Engine from Vehicle • Disassembling Engine This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Perform Remove Engine from Vehicle • Apply Disassemble Engine

2.1 Removing Engine from Vehicle

Before removing the engine, clean it and the area around it. Also, check the service information for the correct procedure for removing the engine from a particular vehicle. Make sure you adhere to all pre-cautions. Make sure you have the tools and equipment required for the job. In addition to hand tools and some special tools, you will need an engine hoist or crane and a jack.

2.1.1 General Procedures

The following are General Procedures

1. **Disconnect the battery cables**

The ground cable (usually the negative) should be disconnected first. Disconnecting the ground cable first eliminates the danger of a spark when disconnecting the positive cable

2. **Label Wires and Vacuum Lines**

- Use masking tape to label any electrical wiring that must be disconnected.
- Use different color masking tape to label vacuum lines of a carburetor in case of gasoline engine.

3. **Drain Coolant and Oil**

- Detach lower coolant hose from pipe and drain all coolant from the radiator and block.
- If the block is equipped with a coolant drain plug, the engine block should also be drained.
- Drain engine oil and remove the oil filter.

Note

The oil filter is made from thin sheet metal that is easily crushed or torn if the filter wrench is not held as close to the filter base as possible.

4. **Remove the Hood before Removing the Engine**

Mark the location of the hood to the hood hinges so that it can be properly reinstalled.

5. **Remove the Radiator**

- Disconnect the radiator hoses from the engine
- Remove the radiator from the car.
- If the car has an automatic transmission, it is probably equipped with a heat exchanger (Transmission oil cooler) in the bottom of the radiator. The two lines leading to the radiator from the transmission must be removed and plugged.

- Modern turbo charged heavy-duty vehicles have inter-cooler in front of the radiator. Disconnect it and remove it.

1. **Remove Distributor and Spark Plug Wires (Gasoline Engine)**
    - Remove the distributor and spark plug wiring before removing the engine to prevent damage to them.
    - Don't remove the spark plug wires from the distributor cap. They are already in the correct firing order and need not be disturbed.
2. **Remove the Alternator and Necessary Wiring**
    - Remove the fan blades, belts, and alternator to prevent possible damage to them before removing the engine.
3. **Remove Cooling System Switches**

- Most engines use a coolant temperature operated device to control vacuum to emission control devices. These switches, often called thermal vacuum switches (TVS), are very easily damage so remove it carefully.

4. **Remove the Carburetor, Air Cleaner and Intake Manifold (If Necessary)**

- Remove air cleaner
- Carefully remove the fuel line from the carburetor.
- Remove or disconnect the throttle linkage or cable.
- Then, remove the carburetor and cover it up.
- If the space is limited for engine removal, the intake manifold also be removed.

5. **Mark Accessory Brackets and Remove Accessories**

- Any accessory brackets (such as for air conditioning) that are attached to the head or block may be removed.
- Label the brackets to show their locations on the head or block if there are many accessories.
- Wired up out of the way air conditioning compressor with the lines still attached (if so equipped). When air conditioning lines must be disconnected, be sure to plug all openings immediately.
- Remove the power steering pump (if so equipped) without disconnecting the lines and wire it in a position so that fluid can't leak out.

6. **Remove Exhaust Components**

- Because of rust, exhaust manifold and exhaust pipe bolts will be difficult to remove and have a tendency to break so before loosening the bolts, spray penetrating oil on them. (Tighten a rusted fastener slightly to help the penetrating oil get into the threads).

- If possible, use impact wrench to successfully remove manifold bolts.

7. **Remove and Plug the Fuel Line**

- Disconnect the fuel line from the fuel tank.
- To prevent fuel leakage from the line, plug it with a bolt and hose clamp.

8. **Remove the Fuel Pump (If Necessary)**

- Loosen the bolts that hold the mechanical fuel pump to the block. (Gasoline engine)
- Then turn the engine until all spring tension is removed from the pump rocker arm.
- The eccentric will then be in its low position so the fuel pump can be easily removed.

9. **Remove Engine to Transmission Bolts**

- On rear wheel drive vehicles; these bolts are easily loosened by using a very long extension and a universal socket from underneath the car.
- The transmission must be supported during the after engine removal.
- Determine whether the transmission must be removed with engine or not.

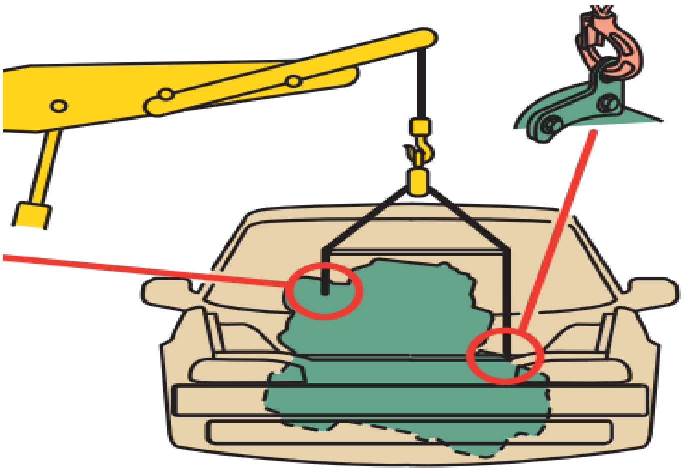


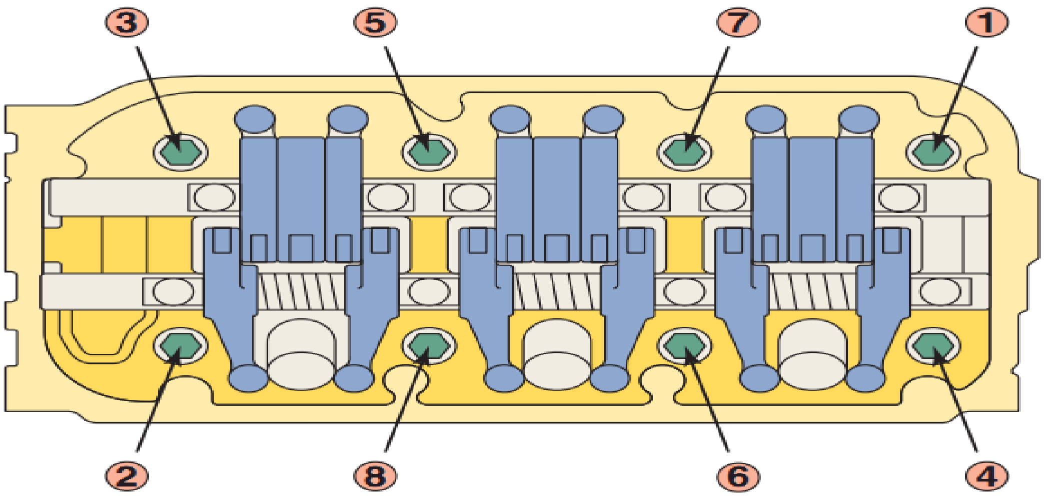
Figure 2: 1 Remove engine from the vehicle

2.2 Disassemble Engine

Once the engine is securely mounted to the engine stand, remove the sling or lifting chain. The engine can now be disassembled and cleaned. Always refer to the service information before you start to disassemble an engine slowly disassemble the engine and visually inspect each part for any signs of damage. Look for excessive wear on the moving parts. Check all parts for signs of overheating, unusual wear, and chips. Look for signs of gasket and seal leakage

2.2.1 Remove cylinder head

The first step in disassembly of an engine is normally the removal of the intake and exhaust manifolds. On some inline engines, the intake and exhaust manifolds Unscrew the cylinder head bolts according to the correct sequence (usually start from the outside bolt and go to the inside), On most engines all head bolts are identical. In some engines they have differences in length. If you find differences, keep them in order so that they can be returned back to their original places.



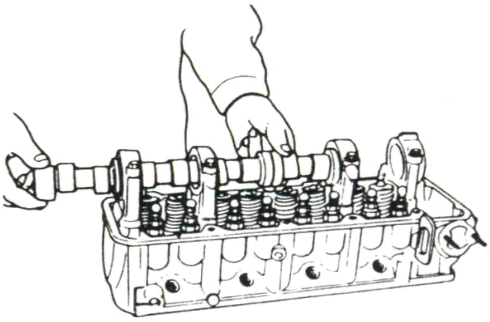
6. **Figure 2:2 Sequence Loosening Cylinder Head Bolts,**

1. **Sequence of unscrewing cylinder head bolts**
   - If the cylinder head is difficult to lift off, pry between the cylinder head and block with a wooden handle of a hammer or such.
   - Finally, after removing the head, inspect the head gasket and desk surfaces for signs of leakage, for oil in the combustion chambers, indicating seal or ring problem.
2. **Removing rocker arm assembly**
   - When loosening bolts, evenly loosen from outside a little at a time in sequence.
   - Remove the rocker arm assemblies:- With v-type, push rod engines, you may need to remove the valve train components before the intake manifold. The push rods can pass through the bottom of the intake.

- If lifters, push rods and rocker arms are to be reused, keep them in exact order - use an organizing tray.

3. **Removing camshaft**

   If the camshaft is located using locating plate, remove the plate and withdraw the camshaft. When removing the camshaft, exercise care note to damage camshaft bearings. If the camshaft is located on the cylinder head and fastened by bolts, evenly loosen from outside a little at a time in sequence



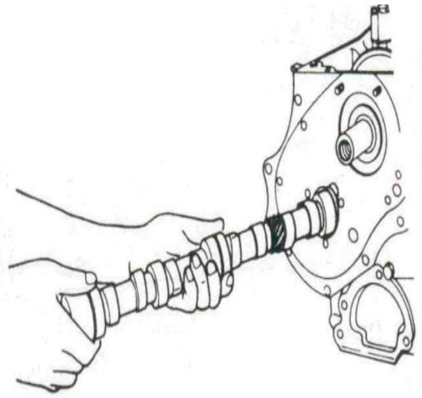
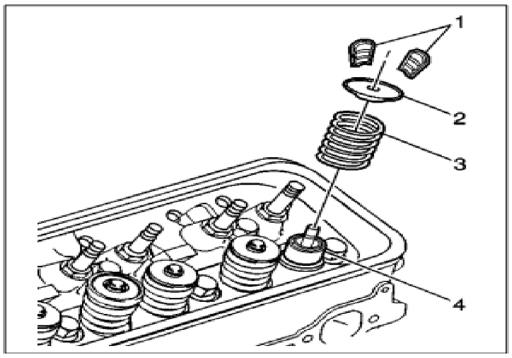


Figure 2: 3 Removing camshaft

4. **Removing valves**

   - Compress valve springs using valve spring compressor
   - Remove spring retainers, valve springs, valve oil seal and valves.
   - Place removed parts in correct order.



Procedures:

1. Use the valve spring compressor in order to compress the valve springs.
2. Remove the valve stem keys (1).
3. Remove the J 8062 from the cylinder head.
4. Remove the valve spring cap (2).
5. Remove the valve spring (3).
6. Remove the valve stem oil seal (4).
7. Discard the valve stem oil seal.
8. Remove the valve.

Important:

Mark, sort and organize the components so that the Components can be reinstalled it heir original location and position.

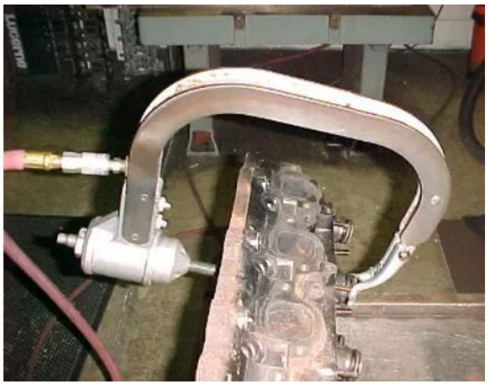


Figure 1.4 valve spring remove

2.2.2 Cylinder Block Disassembly

Rotate the engine on its stand so that the bottom is facing up. Remove the oil pan if it was not previously removed. Then remove the oil pump. Be careful not to lose the drive shaft while pulling the pump off the engine

If the engine has balance shafts, check the thrust clearance of the shafts before removing the assembly. Set a dial indicator so that it can read the back-and-forth movement (end play) of the shaft. Measure the total distance that the shaft is able to move in the housing. Compare that reading to specifications. If the reading is more than the specified maximum, the balance shaft housing and bearings should be replaced. Unbolt the housing following the sequence given in the specifications (Figure 2-4)

- **Procedure Cylinder Block Disassembly**

1. **Remove Piston Sub-Assembly With Connecting Rod**

Figure 2-5 remove carbon deposit

A. Using a ridge reamer, remove all the carbon from the top of the cylinder

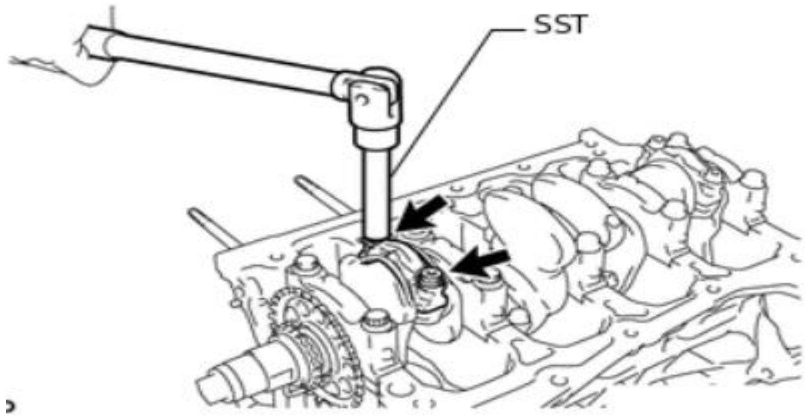


Figure 2.4 uniformly loosen the 2 connecting rod bolts

B. Using SST, uniformly loosen the 2 connecting rod bolts

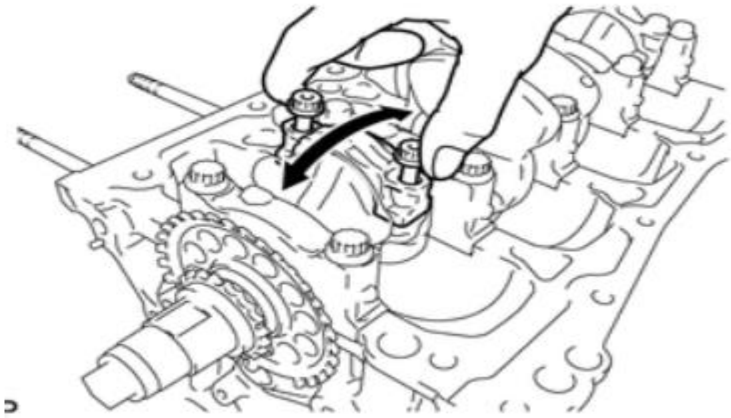


Figure 2: 5 removed connecting rod bolts,

C. Using the 2 removed connecting rod bolts, remove the connecting rod cap and lower connecting rod bearing by wiggling the connecting rod cap back and forth

Tip: Keep the lower connecting rod bearing inserted in the connecting rod cap.

D. Push the piston, connecting rod and upper connecting rod bearing through the top of the cylinder block sub-assembly.

Note: Do not disassemble the piston, piston pin and connecting rod. If the piston pin is removed, the piston, piston pin and connecting rod cannot be reused.

Tip: Keep each connecting rod bearing, connecting rod and connecting rod cap as a set. Arrange the removed parts in the correct order.

2. Remove Connecting Rod Bearing

A. Remove the connecting rod bearings from the connecting rod cap and connecting rod.

Tip: Arrange the removed parts in the correct order.

3. Remove Piston Ring Set

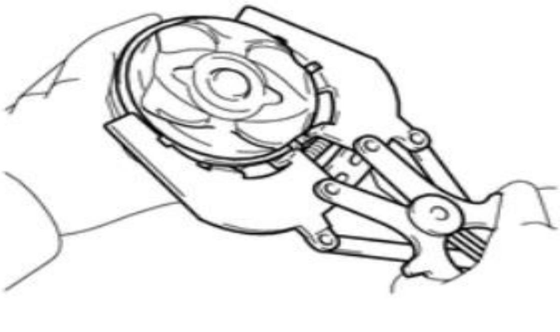


Figure 2,6 Remove Piston Ring Set

A. Using a piston ring expander, remove the No. 1 ring and No. 2 ring.

B. Remove the oil ring and oil ring expander by hand.

Tip:

Arrange the removed parts in the correct order.

4. **Remove Crankshaft**

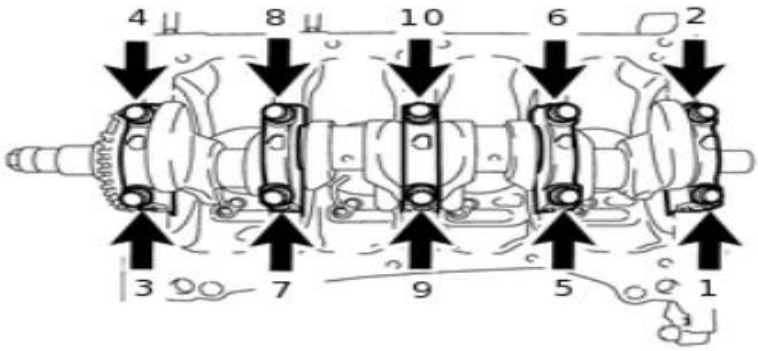


Figure 2.7 Remove Crankshaft

A. Uniformly loosen and remove the 10 crankshaft bearing cap set bolts in the order shown in the illustration.

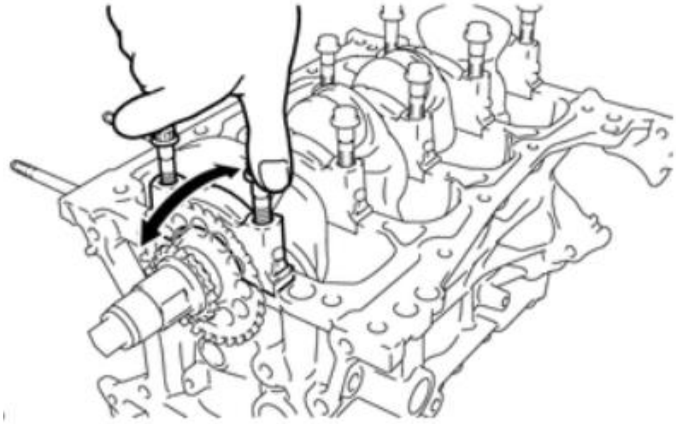


Figure 2.8 removed crankshaft bearing cap

B. Using the 2 removed crankshaft bearing cap set bolts, remove the 5 crankshaft bearing caps and 5 lower crankshaft bearings.

Note:

Insert the crankshaft bearing cap set bolts into the crankshaft bearing caps in turn. Ease the crankshaft bearing cap out by gently pulling it up while wiggling it back and forth, as shown in the illustration. Be careful not to damage the contact surfaces of the crankshaft bearing cap and cylinder block sub-assembly.

Tip:

- Keep each lower crankshaft bearing and crankshaft bearing cap as a set.
- Arrange the crankshaft bearing caps in the correct order.

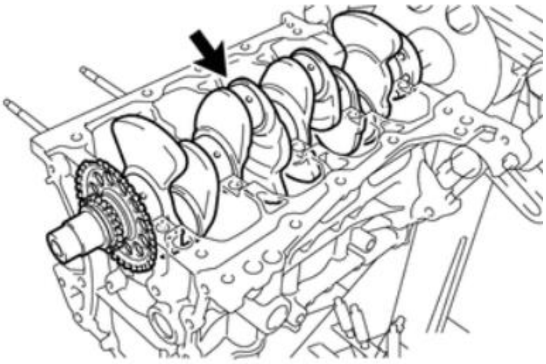


Figure 2.9 Remove the crankshaft

C. Remove the crankshaft

5. Remove Upper Crankshaft Thrust Washer

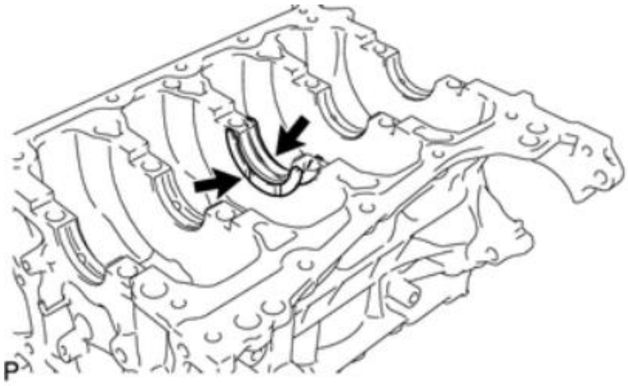


Figure 2.10 Remove Upper Crankshaft Thrust Washer

A. Remove the 2 upper crankshaft thrust washers from the cylinder block sub-assembly.

6. Remove Crankshaft Bearing

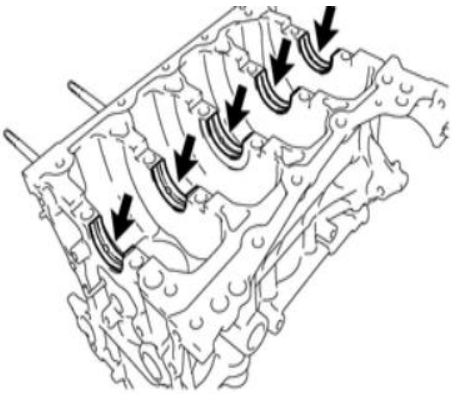


Figure 2.10 Remove Crankshaft Bearing

A. Remove the 5 upper crankshaft bearings from the cylinder block sub-assembly.

Tip: Arrange the removed parts in the correct order.

Self-Check 2.1

Directions: Answer all the questions listed

Part I Answer all the following questions accordingly

1. What should be worn when working with any type of cleaning solvent or chemical?
2. Why should a memory saver be installed before disconnecting a vehicle's battery?
3. Write There are three common methods for detecting cracks
4. In which type of cleaning method clean carburetors, throttle bodies, and aluminum part

Part II Say true or false

1. Dial Indicator Is Used To Measure Thrust (Side) Clearance ,Run Out, End Play Backlash Of Cam Shaft And Crankshaft
2. Lapping Can Be Used To Obtain A Specific Surface Roughness; It Is Also Used To Obtain Very Accurate Surfaces, Usually Very Flat Surfaces..
3. Compression Loss Is A Situation Commonly Associated With Reduced Performance And A Increase In Power.
4. It Mixes And Burns With The Air-Fuel Mixture; Due To That, Engine Emits White Smoke From The Vehicle Tailpipe
5. The Engine Emits White Smoke Due To Carbon Deposits On The Intake Valve And Piston

Part II choose the correct answer

1. What is the best way to lift a vehicle when pre-paring to remove an engine?
   A. Drive on lift C. Engine hoist
   B. Hydraulic jack and safety stands D. Frame contact hoist

2, Which of the following is not a common way to identify the location of cracks in.
A. the engine block or cylinder head? C. Pressure checks
B. Vacuum test Magnetic particle inspection D. Penetrant dye

3.Which of the following is not considered part of the organic soil grouping?
A. Petroleum by-products derived from crude oil, including tar, road oil, engine oil, gasoline, diesel fuel, grease, and engine oil additives
B. Rust that is a product of coolant and aluminum

C. By-products of combustion, including car-bon, varnish, gum, and sludge
D. Coatings, including such items as rust- proofing materials, gasket sealers and
E. cements, paints, waxes, and sound-deadener coating

4 After removing the vehicle's hood in preparation for removing the engine: Technician A places the hood on the roof of the vehicle. Technician B sets the hood aside in a safe place on fender covers or cardboard. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

5. Technician A uses a crane to remove an engine from its compartment. Technician B uses an engine cradle to remove an engine from its compartment. Who is correct?

A. Technician A
B, Technician B
C. Both A and B
D Neither A nor B

Operation Title: Disassembling the engine

Purpose: For inspecting the engine (to be repaired or replace)

Conditions; The engine must tag on repair stand safely.

Equipment Tools and Materials:

- Wrenches
- Hydraulic lifters
- Safety stands
- Hydraulic jacks
- Repair stand

Quality Criteria: To make the shop accident free.

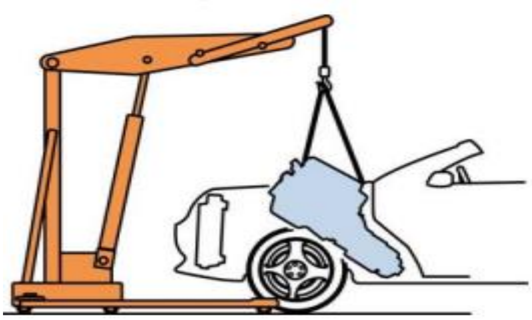
Precautions:

- No slippery floor,
- Good ventilation,
- Sufficient lighting
- Shop equipped with fire extinguishers

Procedures

1. Mark hinge locations at hood panel for alignment during installation.
2. Remove hood from hinges.
3. Disconnect or remove the battery.
4. Remove air cleaner assembly.
5. Drain the cooling system and disconnect the lower and upper hoses.
6. If equipped with automatic transmission disconnect cooler lines from radiator.
7. Drain the oil.
8. Remove oil filter. 8. Remove radiator and radiator fan.
9. If equipped, remove power steering pump and drive belt from the engine.
10. Disconnect electrical wires from starter motor, ignition coil, alternator, oil temperature and pressure gauges etc
11. Disconnect fuel lines.
12. .Disconnect exhaust pipe.
13. Disconnect accelerator linkage at engine.
14. Support transmission with a floor jack.
15. .Support the weight of the engine with a lifting device.
16. Remove engine support cushion frame retaining nuts.

17. Remove engine by pulling forward and upward.



18. Mount the engine securely to an approved engine stand.

Unit Three: Inspect and Measure Engine Component
This unit is developed to provide you the necessary information regarding the following content coverage and topics • Engine component failure • Inspect and checking engine component • Measuring engine components This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to: • Understand Engine component failure • Inspect and check component • Measure engine components

3.1 Engine Component Failure

Engine failure can be one of the most expensive and frustrating problems a car owner can face. It can result in costly repairs and even the need to replace the entire engine. While some engine failures are unpredictable, many are preventable. In this blog post, we will explore the top 6 most common causes of engine failure and provide tips on how to avoid these costly repairs.

A. **Lack of Regular Maintenance**

The most common cause of engine failure is simply neglecting to perform regular maintenance on the vehicle. Failure to change the oil, inspect and replace worn belts and hoses, and neglecting other routine maintenance can lead to engine damage over time. To avoid engine failure, it is crucial to follow your vehicle's recommended maintenance schedule

B. Overheating

Overheating is another common cause of engine failure. When an engine overheats, it can cause damage to the internal components of the engine, such as the pistons and cylinder walls. To prevent overheating, make sure to check the coolant levels regularly and replace any worn or damaged components that could cause your engine to overheat.

C. **Ignoring Warning Signs**

Many engine failures can be prevented if you pay attention to the warning signs. If the vehicle starts making unusual noises, runs poorly, or produces unusual smells, it could be a sign of an impending engine failure. Ignoring these signs can lead to more significant engine damage and a higher repair bill

D. Improper Lubrication

Proper lubrication is crucial to the health of engine. If the engine lacks proper lubrication, it can lead to excessive wear and tear on the engine's internal components. Make sure to use the recommended grade and type of oil for vehicle, and replace the oil on a regular schedule to avoid engine failure

E. **Driving Habits:**

Finally, driving habits can also contribute to engine failure. Driving the vehicle aggressively, such as accelerating and braking abruptly or towing heavy loads, can put excessive strain on engine and lead to damage. To avoid engine failure, drive responsibly and follow vehicle's recommended guidelines for towing and load capacity. In conclusion, engine failure can be costly and frustrating, but many cases are preventable. By following a regular maintenance schedule, paying attention to warning signs, using proper lubrication, and driving responsibly, it can avoid the most common causes of engine failure and keep the vehicle running smoothly for years to come. For high-quality auto parts and expert advice on how to keep the engine running smoothly

F. Detonation:

This means that abnormal combustion (fuel is combusted when it should not be) is producing excessive heat and pressure in the combustion chamber, typically accompanied by a knocking sound. It can also be caused by bad fuel, poor ignition timing, worn spark plugs, or a hot engine

3.2 Inspecting engine component

3.2.1 Crack Detection

Once engine parts have been cleaned, everything should be carefully inspected. This inspection should include a check for cracks, especially in the engine block and cylinder head. If cracks in the metal casting are discovered during the inspection, they should be repaired or the part replaced

Figure 1-1 crack detection

Cracks in metal castings are the result of stress or strain on a section of the casting. This stress finds a weak point in the casting and causes it to distort or separate at that point. These stresses can be caused by the following:

- Pressure or temperature changes during the casting process can cause internal material structure defects, inclusion, or voids.
- Fatigue may result from fluctuating or repeated stress cycles. It might begin as small cracks and progress to larger ones due to the stress.
- Flexing of the metal may result because of its lack of rigidity.
- Impact damage may occur by a solid, hard object hitting a component.
- Constant impacting of a valve against a hardened seat may produce vibrations that could possibly lead to fracturing a thin-walled casting.
- Chilling of a hot engine by a sudden rush of cold water or air over it.
- Excessive overheating is due to improper operation of an engine system.

A. Methods to Crack Detection

1. Cracks can be found by visual inspection; however, many are not easily seen. Therefore, engine rebuilders use special equipment to detect cracks, especially if there is reason to suspect a crack
2. **Pressure checking** a cylinder block or head is done in the same way a tire is checked for leaks. All of the coolant passages are plugged with rubber stoppers orgaskets. Compressed air is injected into a water jacket and the point of air entry is sealed. The block or head is then submerged into water. Bubbles will form in the water if there is a leak. The spot where the bubbles are forming is the location of the leak.
3. **Magnetic Checks**

Magnetic particle inspection (MPI) uses a permanent or electromagnet to create a magnetic field in a cast iron unit. When the legs of the detector tool are placed on the metal, the magnetic field travels through the metal. Iron filings are sprinkled in the surface to detect a secondary magnetic field resulting from a crack. Because the secondary magnetic field will not form if the crack is in the same direction as the magnet, the magnet must be rotated and the metal checked in both directions.

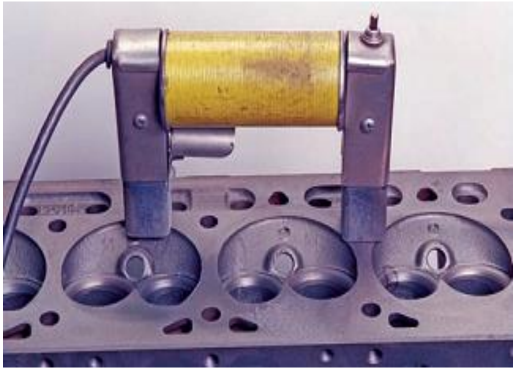


figure 3.1 Magnetic check

4. **Dye Penetrate**

Another common way to detect cracks is by using three separate chemicals: penetrate cleaner, and developer. The part to be checked must be clean and dry. This check must be done according to the following sequence:

figure 3.2 Dye Penetrate

1. Spray or brush the penetrate onto the surface.
2. Wait 5 minutes.
3. Spray the cleaner onto a clean cloth.
4. Wipe off all visible penetrate.
5. Spray the developer on the tested area.
6. Wait until the developer is totally dry.

7. Inspect the area. Cracks will appear as a red line

3.2.2 Inspecting cylinder head

With the cylinder head off from the cylinder block and all the attached parts removed, clean the head thoroughly so that it can be inspected properly. Remove any gasket material from the cylinder head and manifold mounting surfaces.

1. Check The Cylinder Head For Cracks Or Scoring.

Before investing the time and effort required reconditioning cylinder heads and blocks, it is wise to check for cracks. Cracks may be caused by: -

- Extremely high or low temperature
- Too rapid a change in temperature
- Overloading of parts

Crack can be checked visually. But most of the time crack cannot be detected properly

- **Crack Detection methods**

The following are some methods in crack detection:

1. Visual

Visually observe if there is any sign of crack at different parts of the cylinder head.

2. Magnetic Particle Inspection

This method can be used with iron and steel engine parts. Common areas checked by this method include combustion chamber, and ports, core holes, and main bearing webs. But it is most appropriate for checking cracks in block and head surfaces.

The area being tested is dusted with magnetic powder and then the magnetic field is set up in the part. Interruptions in the magnetic field due to crack cause magnetic lines of force to form on the parts, the powder will collect at the line of forces paralleling the crack.

3. Wet Magnaflux Method Penetrate

This method is used usually to detect cracks in connecting rods and crankshafts. The operation involves magnetic particles and fluorescent light. The chemical solution is sprayed over the part. The part is then placed in a magnetic field and viewed under a black light. The chemical will collect in any crack. The concentration in the crac will glow under the light.

or brushing. A few minutes are allowed for the penetrant to enter any pores or cracks. Then clean the surface and apply a powder like developer. This will make the penetrant turn red if it has collected in any crack or casting flaw. You will be able to find any block cracks or flaws more easily.

2. Checking the cylinder head for war page

Using a precision straight edge and feeler gauge check in several directions and record the results. Common limit is 0.10mm. In some cylinder heads the limit may be up to 0.2 mm.

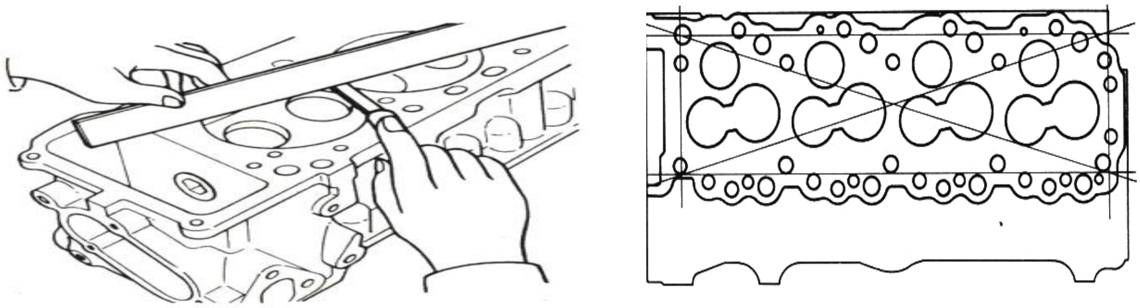
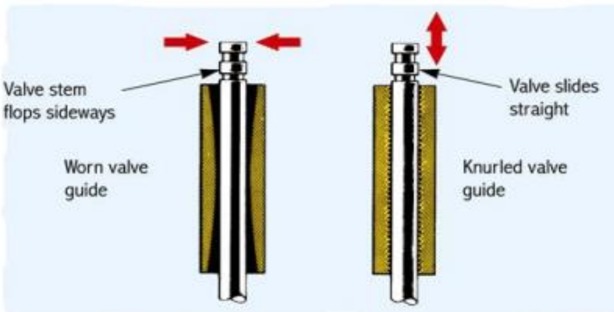


Figure 3.3 cylinder war page

If found beyond the specified limits, resurfacing may be required. Surface grinding has a limit. In some models, if the warpage exceeds the limit, replacing the cylinder head is required.

3.2.3 Reparing Method Valve

1. Knurling



Knurling valve guide: is one of the fastest ways to restore the inside diameter of a worn valve guide. Knurling raises the surface of the guide inside diameter by cutting tiny furrow through the surface of the metal. Knurling is ideally suited to engines with integral valve guides. It is recommended that knurling not be used to correct exceeding 0.15 mm.

2. Grinding

Valve grinding is done by machining (by valve grinding machine) a fresh, smooth surface on the valve faces and valve stem tip. Valve faces can burn, pit and wear as the valves open and close during engine operation.

3. Lapping

Smoothing a metal surface to high degree of refinement or accuracy using a fine abrasive. Lapping process will remove excessive amounts of the hardened surface. Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached. Valve lapping is a method of reseating valve heads to valve seats. During valve lapping of recent designed valves, be sure to follow manufacturers recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

4. **Reaming**

Reaming increases the diameter of the guide's hole so it can be fitted with an oversized valve (valve with a larger stem). Reaming can also be used to restore the guides to its original diameter after installing inserts or knurling. The advantage of reaming for an oversized valve is that the finished product is totally new. This guide is straight, the valve is new, and the clearance is accurate. Installing an oversized valve is generally considered to be superior to knurling. The process is also relatively quick and easy. The only tool required is a reamer.

3.2.4 Cylinder Bore Inspection

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Dirt can accelerate ring and cylinder wall wear. Scuffed or scored pistons, rings, and cylinder can act as pas-sages for oil to bypass the rings and enter the combustion chamber. Scuffing and scoring occur when the oil film on the cylinder wall is ruptured, allowing metal-to-metal contact of the piston rings on the cylinder wall. Cooling system hot spots, oil contamination, and fuel wash are typical causes of this problem. If the cylinder walls show light scratches, inspect the air induction system for leaks.

Figure 3.4 Cylinder Bore Inspection

3.2.5 Repair Methods of Cylinder Block

1. **Crack repair methods**

Cracks in the cylinder head will allow coolant to leak into the engine, or allow combustion gases to leak into coolant. Cracks across the valve seat cause hot spots on the valve, which will burn the valve face. A cracked head will either have to be replaced or the crack will have to be repaired. Two methods of crack repair are: Crack welding and Crack Plugging

A. **Crack-welding**

Crack-welding cast iron It takes a great deal of skill to weld cast iron. The cast iron does not flow as steel does when it is heated. Heavy cast parts, such as the head and block, conduct heat away from the weld so fast that it is difficult to get the part hot enough to melt the iron for welding.

Crack-welding; Aluminum In many cases, these problems result in head replacement. However, some heads are repairable. Tungsten inert gas (TIG) welding is the preferred way to repair aluminum heads. Welding aluminum is often considered difficult because it welds differently than iron or steel. When exposed to air, aluminum forms an oxide coating on the surface that helps protect the metal against corrosion. A TIG welder prevents the formation of the oxide by bathing the weld with inert gas (normally argon)

B. Crack-plugging

In the process of crack plugging, a crack is closed using interlocking tapered plugs. This method can be performed to repair both aluminum and cast-iron engine components.

2. Resurfacing:

In precision engine rebuilding, both the head and the block deck are resurfaced as a standard practice. The head will usually have some warpage, when the engine is disassembled.the head should be resurfaced, if there is any roughness caused by corrosion of the head gasket. Always check the cylinder head thickness and specifications to be sure material can be safely removed from the surface. Some manufacturers do not recommend machining, but require cylinder head replacement if cylinder head surface flatness is not within specifications. Aluminum cylinder heads are usually straightened before resurfacing

3. Cylinder Honing

Honing cylinders is used to break the glaze (polished surface) on a used cylinder and smooth a very rough cylinder surface after boring. Most ring manufactures recommend deglazing before new ring installation. A cylinder hone produces a precisely textured, cross-hatched pattern on the cylinder to air ring seating and sealing. Tiny scratches from the hone cause initial ring and cylinder wall break-in wear. This makes the ring fit in the cylinder after only a few minutes of engine operation. Honing cylinders after reboring and use the recommended grit size for the honing stone to produce the specified smooth finish.

4. Cylinder Re-boring

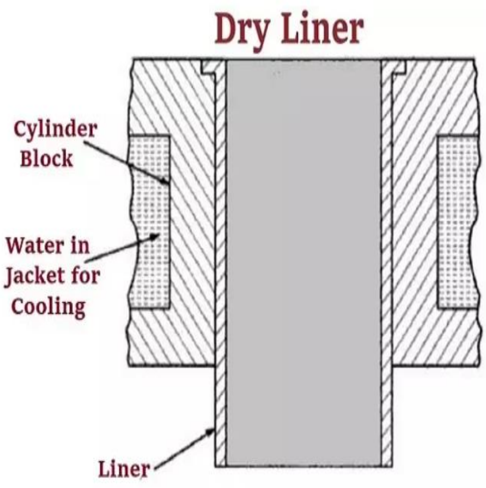
Liners for larger engines and all integral cylinders are commonly rebored. They are sized to smallest standard oversize diameter at which they will clean up. Oversize pistons must then be fitted to provide the correct piston to liner clearance. The final finish should then be obtained by honing. A number of boring bars are available which can produce a good finish (ready for honing) in the cylinders. To install a dry liner, bore the cylinder oversize. Press the liner into place. Then bore the liner to the proper size to take the new piston-and-ring se

3.2.6 Types Cylinder liners or Sleeves

The cylinder liners or sleeves are of two types:

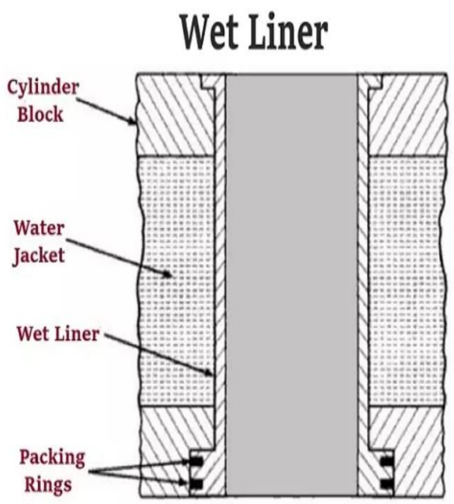
1. Dry liners.
2. Wet liners.

1. Dry liners.



Dry liners are made in the shape of a barrel having a flange at the top. The flange keeps the liner in position in the cylinder block. The liner fits accurately in the cylinder. The perfect contact of the liner with the cylinder block is necessary for the effective cooling of the liner. Also, the gas pressure, piston thrust and impact loading during combustion are resisted by the combined thickness of the liner and the cylinder. Therefore, dry liners are thinner, having wall thickness varying from 1.5 mm to 3 mm and are used mostly for reconditioning worn liners. the dry liners are not in direct contact with cooling water.

2. Wet Liners



A wet liner is so-called because the cooling water comes in contact with the liner. This liner is provided with a flange at the top, which fits into the groove made in the cylinder block.
To stop leakage of cooling water in the crankcase, the lower end of the wet liner is sealed with the help of sealing rings or packing rings. As the wet liner has to withstand gas pressure, thrust and impact loading, the wall thickness of the liner is increased and is made more than that of the dry liner. Generally, the wall thickness of the wet liner ranges from 3 mm to 6 mm. The

outside of the liner is coated with aluminum so that it is protected from rust. The wet liner is better cooled than the dry liner. It is easily removable when it is worn-out or damaged.this involves machining or boring one or more of the cylinders oversize and pressing in a cylinder liner. Sleeving is needed,

- after part breakage has severely damage the cylinder wall.
- to allow the bad cylinder to be restored to its original diameter

The same size piston can be reused. If only one piston and cylinder are damaged, all of the other pistons and cylinders may be good and usable; sleeving would save the customer money on the repair. Sleeve or liner protrusion is the distance the sleeve sticks up above the deck of the block. This measurement is critical to head gasket sealing.

3.2.7 piston Inspection

Each piston should be carefully checked for damage and cracks. Pay attention to the ring lands and the pin boss area. Look for scuffing on the sides of the piston (Figure 3.5). Minor up and down scuffing is normal. Excessive, irregular, or diagonal scuff marks indicate lubrication, cooling system, or combustion problems. Scuffing may also be caused by a bent connecting rod, seized piston pin, or inadequate piston-to-wall clearance. If any damage is evident, the piston should be replaced.

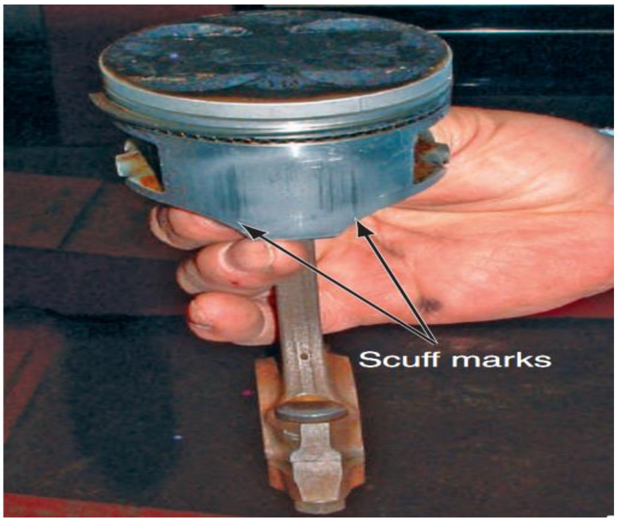


Figure 3.5 piston Inspection

3.2.8 Flywheel Inspection

Check the run out of the flywheel and carefully inspect its surface. Replace-ment or resurfacing may be required. Excessive run out can cause vibrations, poor clutch action, and clutch slippage. With both manual shift and automatic transmissions, inspect the flywheel for a damaged or worn ring gear. Many ring gears can be removed and flipped over if they are damaged on one side

3.2.9 Bearing Inspection

As shown in Figure 3.6, bearings can fail for many reasons. Dirt and oil starvation are the major reasons for bearing failure. Other engine problems, such as bent or twisted crankshafts or connecting rods or out-of-shape journals, can also cause bear-ings to wear irregularly.

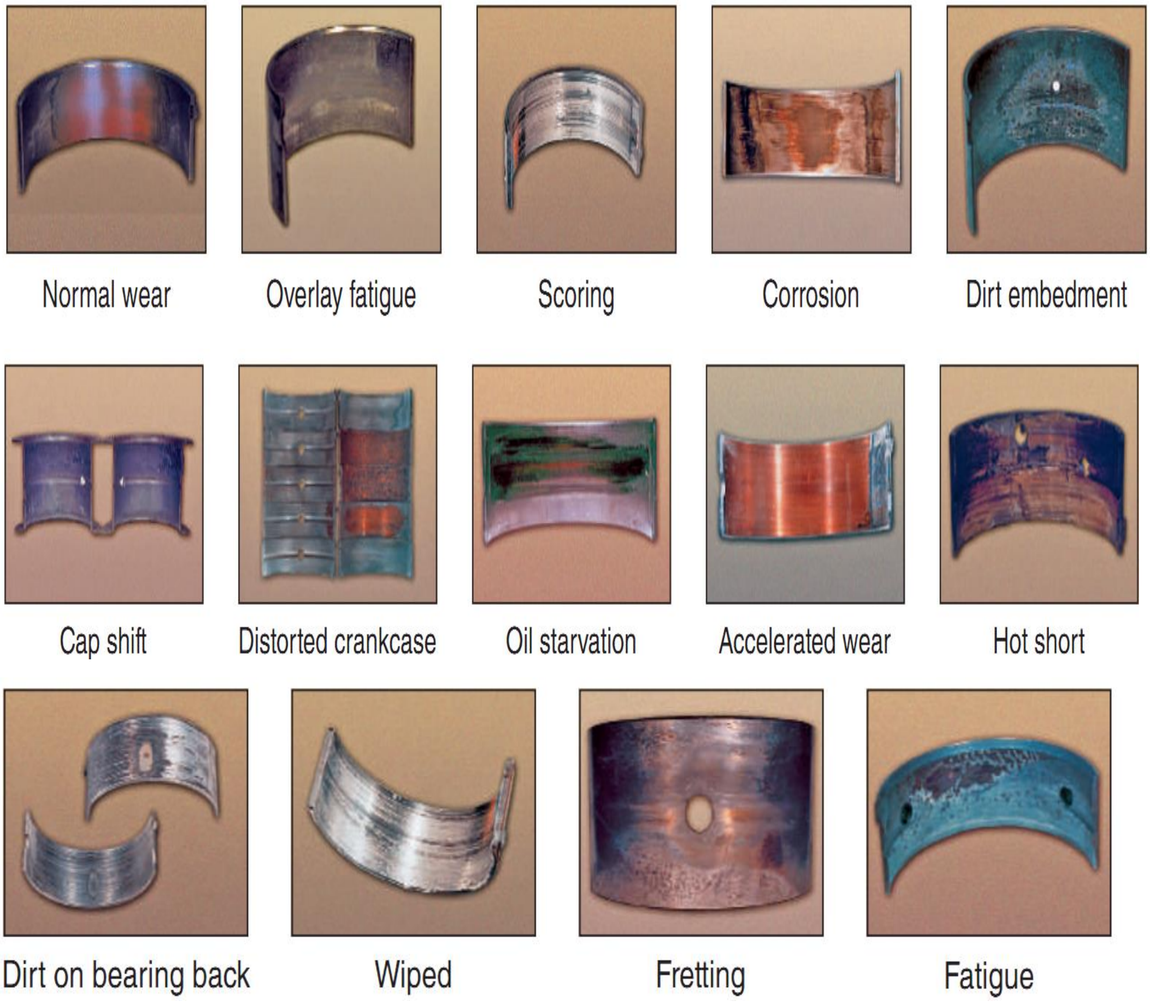


Figure 3.6 Common forms of bearing distress.

3.2.10 Connecting rod inspection

Before assembling piston and connecting rod and installing the assembly in the cylinder and to the crankpin, it should always be checked for alignment. That means that the rod has to be checked for parallelism of the axis or centerlines of the small end and big end. If this parallelism is not obtained the rod must be bent, twisted or offset.The old piston and the bearing inserts will indicate the condition of the connection rod. These conditions cause abnormal wear and stress on piston, cylinder wall, piston pin and connecting rod bearing.

Connecting Rod Big end Service

Remove the bearing insert and bolt the rod cap to the rod to a specified torque. Then measure the rod bore diameter on both edges and in both


Figure 1.7 Connecting Rod Twist

direction to check taper and out-of-round. If more than specification, have a machine shop rebuild the rod or replace it.

Checking rod bend, twist and offset

A special rod aligner (rod alignment fixture) is needed. The check is usually executed once with piston assembled and without piston assembled. A service limit for bend and twist is less than 0.050mm/100mm length. A slightly bent, twisted or offset rod can be corrected by using a notched pry bar provided with special rod aligner. At first the bend is corrected, and then twist, because a bent rod will always check out as if it were twisted, whether or not it actually is.

3.3 Measuring engine components

3.3.1 Measuring Cylinder Head,

A. cylinder head for warpage

Using a precision straight edge and feeler gauge check in several directions and record the results. Common limit is 0.10mm. In some cylinder heads the limit may be up to 0.2 mm.

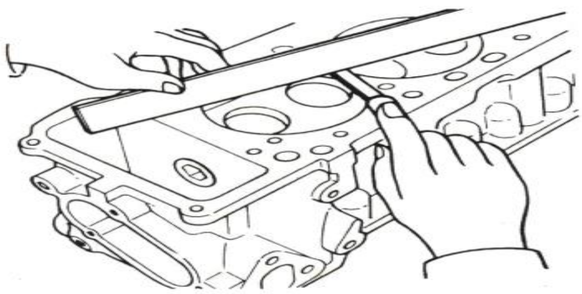
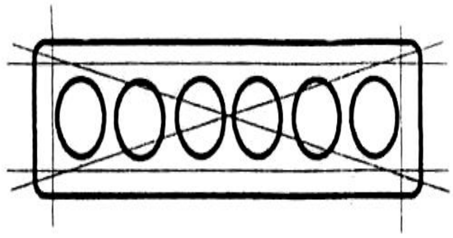


Figure 1.8 Cylinder Head War Page 1



If found beyond the specified limits, resurfacing may be required. Surface grinding has a limit. In some models, if the warpage exceeds the limit, replacing the cylinder head is required.

B. Measuring Valve Guides for Wear

Measure the inside diameter of the guide with inside micrometer. And then measure the valve stem at lower, middle and upper part. Finally subtract the maximum stem diameter from the guide inside diameter.

- **Checking valve stem diameter**

If the wear of valves exceeds the specifications, the valves should be replaced.

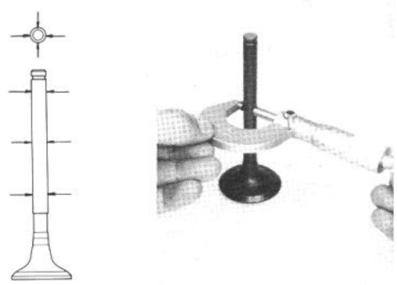


Figure 3.9 Valve Steam

- **Checking valve guides by measuring valve**

rock

The valve guide can be checked for wear by rocking the valve. With this method, place the valve at the correct position to obtain the proper measurement with the dial indicator.

The dial indicator is fastened to the cylinder head and at right angles to the valve stem being measured. Move the valve to and from the indicator. The total reading should not exceed specifications.

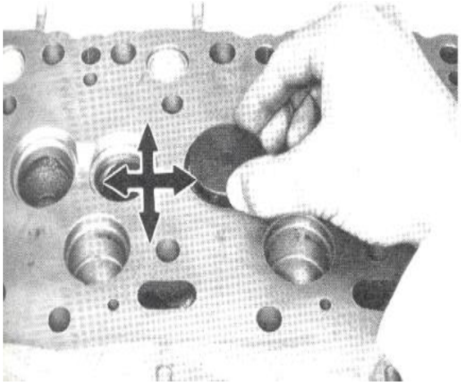


Figure 3.10 valve Rock

Note Because the valve extends out of the guide, valve rock readings will exceed specified guide – to – stem clearance. Be sure not to confuse specifications for guide-to-stem clearance with valve rock method.

If the valve-guide wear is excessive, the guide should be reamed for a valve with an oversize stem. Select the correct size reamer and slowly turn it by hand in the valve-guide bore. Clean the guide thoroughly before installing the new valve. Never attempt to ream a valve guide from a standard size directly to the maximum oversize. Instead, ream in steps using successively larger reamers so the guide will be reamed true in relation to the valve seat.

Valve-guide insert replacement (in cars so equipped) is necessary when the old insert is worn beyond specifications. The insert can be removed and a new one installed by means of special tools and an arbour press, or by special tools and a hammer.

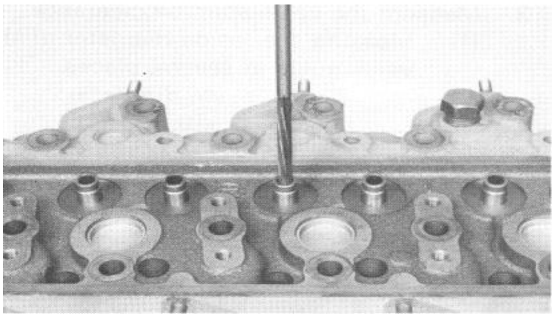


figure 3.11 **Removing valve guide insert**

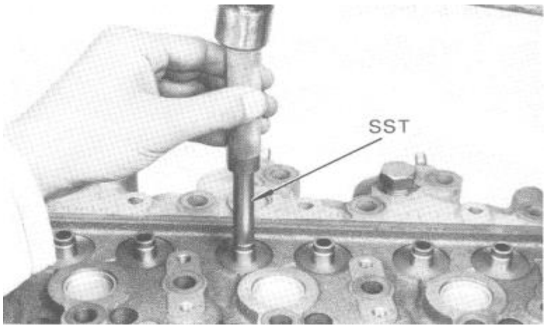


Figure 3.12. Reaming valve guide

C. Measure camshaft

- **Measure camshaft lobe height as follows**

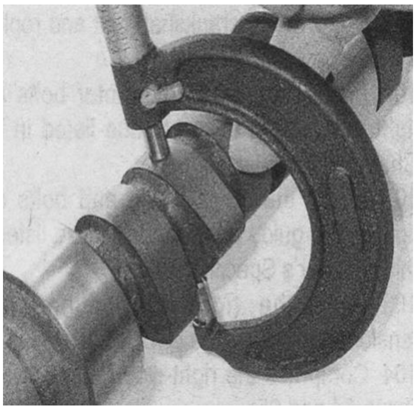


Figure 3.13 camshaft lobs height

A. Measure and record height at widest point on camshaft lobe and height at narrowest point on camshaft lobe using micrometer
B. Calculate and record camshaft lobe height by subtracting height at narrowest point on camshaft lobe from height at widest point on camshaft lobe.
C. (c)Record camshaft lobe height and compare with specifications
D. Repeat steps a and b for all camshaft lobes. Replace camshaft and camshaft followers if anycamshaft lobes are not within specifications.

- **Cam shaft run out procedure**

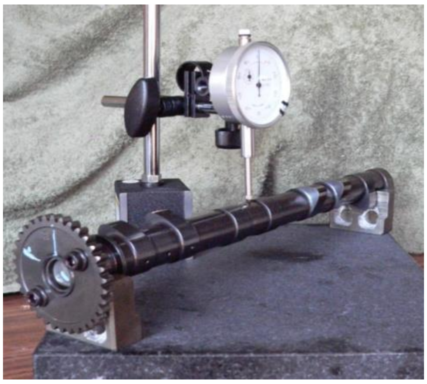


Figure 3.14 crank shaft run out

1. **Reaming valve guide** Remove the camshafts.
2. Wipe oil from camshaft. The V blocks are placed on the surface plane supporting the two outermost camshaft journals. The travel gauge is placed with its piston resting on the center journal.
3. The travel gauge is roughly set to the proper height using the adjustable arm of the magnetic base so that the dial displays 0.
4. Turn the cam shaft to the lowest point in the its rotation. There is an adjustment spring on the arm of the magnetic base which may be used to fine tune the height of the travel gauge. With the shaft turned to it's lowest point, set the the needle so that it is at 0".
5. The camshaft is turned in the v blocks and the travel indicated on the gauge is noted. Be careful to avoid running the travel gauge piston over the oil holes in the camsha

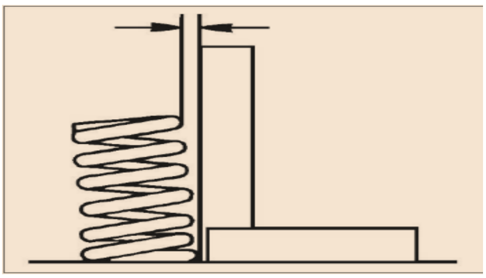


Figure 3.15 valve spring squareness

- **Measure Valve spring squareness**

Checking for squareness is a test of the general condition of the spring to compress and load the valve evenly during operation. The spring is placed on a perfectly flat surface and a try square is placed next to it. Rotate the spring around its axis to check for deformation.

- **Measure the free height of the springs.**

The Springs must be replaced if the free height is below the specified limit.

Standard: 44.6 mm (1.756 in) Limit : 43.6 mm (1.717 in)

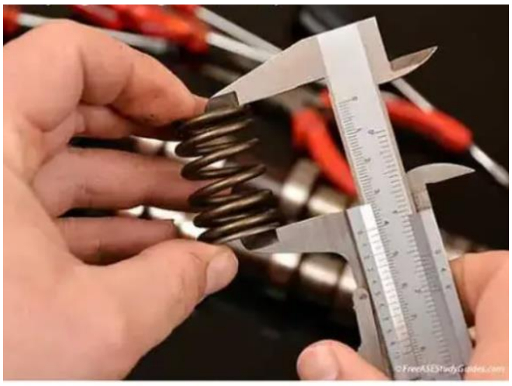


Figure 3.16 valve spring free height

- **Measure the Valve spring load**

Measure the compressed spring tension using a spring tester to compress the springs to the installed height,

Figure 1.17 valve spring load

- **Measure the Checking cylinder block for war page**

If the war page is less than recommended, it is acceptable and reconditioning is not required. If the war page is greater than recommended, engine block should be resurfaced. The most precise reconditioning work is done by surface grinding on a surface grinding machine. Since the volume of the combustion chamber decreases when grinding, a thicker cylinder head gasket should be installed for compensation when removing a larger amount of material from the block surface. The causes for war page are engine overheating and improper cylinder head bolt tightening and loosening.

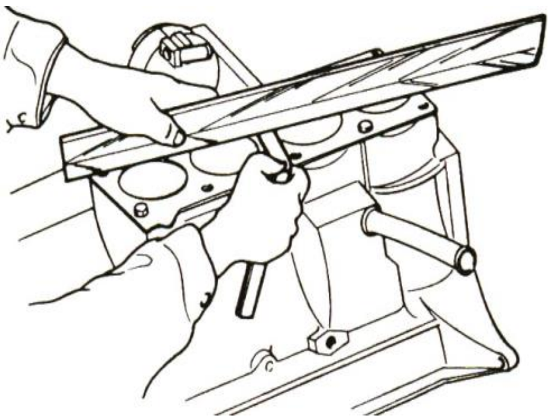


Figure 3.18 cylinder war page

3.3.2 Measuring Cylinder bore

If the cylinder is not badly scratched or scored, you must measure cylinder wear to assure that the new rings will seal properly. The following instruments are used alternatively to measure cylinder diameter.

- a dial bore gauge with an outside micrometer
- a telescopic gauge with an outside micrometer
- large inside micrometer

Figure 3.19 Measuring cylinder bore gauge

A dial bore gauge is a fast and precise tool for measuring cylinder wall wear.

- Procedure to use the dial bore gauge:-

1. Refer the STD diameter from the manual or measure the cylinder diameter at the ridge area with caliper.
2. Transfer this measurement into the micrometer.
3. Select appropriate dial bore gauge rods for the cylinder diameter
4. Transfer the micrometer reading to the dial bore gauge
5. Then insert the dial bore gauge inside the cylinder
6. Slide the bore gauge up and down in the cylinder. Indicator movement equals cylinder taper.
7. Check both parallel and perpendicular to the bore centerline to determine out-of-round.
8. Determination of Taper, Out-of-Round and Wear

Table 3.1 cylinder taper and out of roundness

Cylinder diameter	Parallel to piston pin centerline	Perpendicular to the piston pin centerline
Cylinder diameter at top	Ax	Ay
Cylinder diameter at middle	Bx	By

Cylinder diameter at bottom	Cx	Cy

1. Cylinder taper = Ax - Cx; Ay - Cy } take the largest
2. Cylinder out-of-round = Ax - Ay; Bx - By; Cx - Cy } take the largest

Cylinder wear= Maximum cylinder diameter minus standard cylinder diameter.

- **Measuring piston Wear**

Large outside micrometer is used to measure piston wear. Piston size is measured at skirts, just below and perpendicular to the piston pin hole. Check the manufacturers' manual for the exact location of the measurement

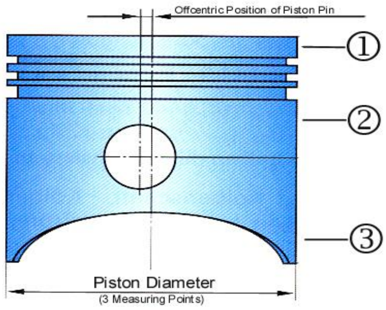


Figure 3.20 piston

3.3.3 Measuring piston wear using outside micrometer

- **Measuring Piston Clearance**

Piston clearance is the difference between minimum cylinder diameter and maximum piston diameter. Average piston-to-cylinder clearance is about 0.001 to 0.003 inch (0.025 - 0.080mm).

When piston-to-cylinder clearance is excessive, you must either:-

a. Knurl the piston

b. Install new standard size piston (providing cylinders are not worn beyond specification).

c. Bore the cylinders and purchase oversize pistons.

d. Sleeve the cylinders and use the same standard piston.

Note Manufacturer's specification should be checked for service limits on piston-to-cylinder clearance

Table 3.2 piston oil clearness

Piston Number	**1**	**2**	**3**	**4**
Maximum Cylinder diameter in mm				
Minimum piston diameter in mm				
Piston clearance in mm				

- **Measuring Pin Clearance**

Measure the piston pin diameter with an outside micrometer. Measure in the middle and at both ends of the pin. Measure connecting rod small end and pin boss inner diameters with small dial bore gauge and outside micrometer or with a telescopic gauge and a micrometer.

Table 3.3 piston pin clearance

Piston pin assembly	1	2	3	4
Pin boss diameter (DP)				
Connecting rod small end diameter (DR)				
Pin diameter at middle (DB)				
Pin diameter at one end (DA)				
Pin diameter at other end (DC)				

Piston pin clearance = DP - DA or DP - DC in mm

Small end bushing clearance = DR - DB in mm

If the clearance is beyond the limit, replace the assembly - sometimes-oversize piston pins may be available. They can be used in reamed piston boss.

3.3.4 Measuring Connecting rod bearing clearance

Main bearings of such type are called flange main bearings. Connecting rod bearings provide rotating motion of the crank pin within the connecting rod, which transmits cycling loads applied to the piston. Connecting rod bearings are mounted in the Big end of the connecting rod.

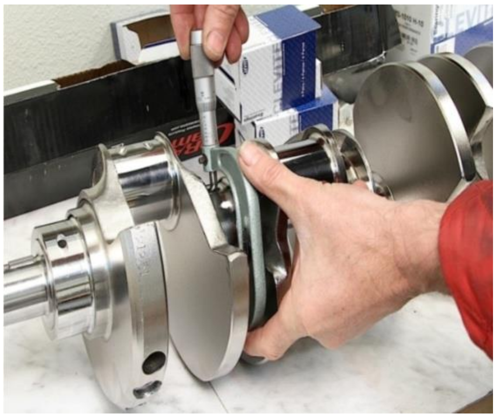


Figure 3.21 Connecting Rod journal Diameter

- **Methods to Measure Bearing Clearance**

1. Bridge with Depth Gaug
2. Bridge With Feeler Gauge.
3. Telescopic or Swedish Feeler Gauge.
4. Dial type Depth Gauge.

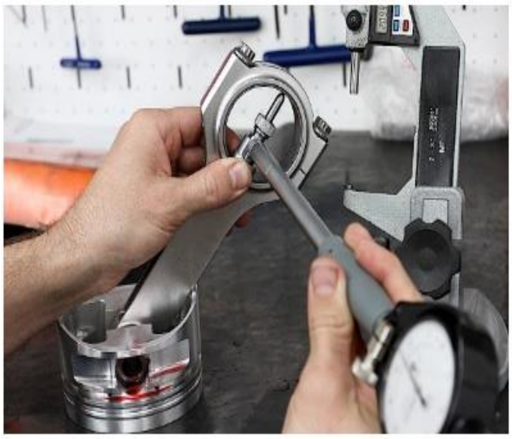


Figure 3.22 connecting rod bearing diameter

First step is measuring the crankshaft main and rod journals. Advice for selecting, using and accurately reading micrometers can take up an entire story. Get familiar with your tools before tackling an important engine project. The key to using a mic is not to tighten it too much on the shaft surface. When measuring the crank, stayaway from oil holes and take multiple measurements from different angles to determine if the journal is out of round or tapered.

Again, transfer the measurement from the crankshaft rod journal to the dial bore gauge and zero the dial indicator. Then check the clearance inside the rod bearing shell, measuring 90 degrees from the parting line.

Measuring Piston Ring Gap

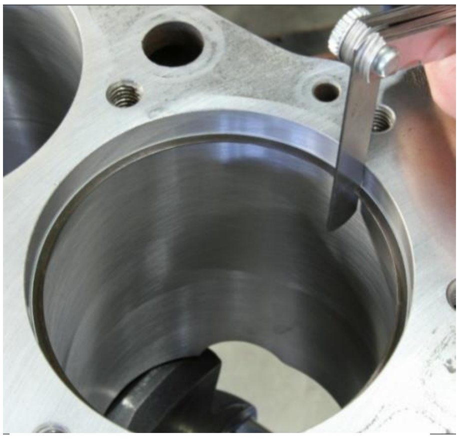


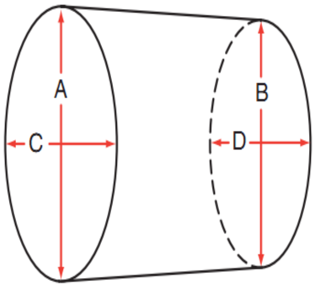
Figure 3.23 Measuring ring gap

Piston ring gap is the clearance between ends of ring when installed in cylinder. It is measured with feeler gauge. If the gap is too small, the ring could lockup or scores the cylinder upon heating and expanding. If the ring gap is too large, ring tension against the cylinder wall may be low, causing blow by. To check ring gap, compress and place a compression ring in its cylinder. Then push the ring to the bottom of normal ring travel (refer to the manufacturers recommendation) with the head of the piston. This will square the ring in the cylinder and locate it at the smallest diameter.

Figure 3.24 crank shaft journals

3.3.5 Measure crank shaft journals

To measure the diameter of the journals, use an out-side micrometer. Measure them for size, out-of-roundness, and taper. Taper is measured from one side of the journals to the other. The maximum taper is 0.001 inch. Compare these measurements to specifications to determine if the crankshaft needs to be reground or replaced



A vs. B = Vertical taper

C vs. D = Horizontal taper

A vs. C = Out of round

B vs. D = Out of round

- **Checking Crankshaft Run out**

A bent crankshaft can ruin new main bearings or cause the engine to lockup when the main caps are tightened. To measure bend, mount a dial indicator against the center main journal and check proper mounting of the crankshaft in lathe, on v-blocks, or in the engine block main bearings. Slowly turn the crankshaft while watching the indicator. Journal run-out is twice of a bend. If it is out-of-specification, replace the crankshaft or have it straightened and turned by a machine shop.

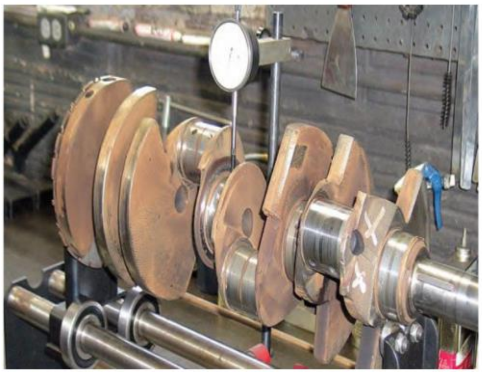


figure 3.26 Crankshaft Run out

Measuring Crankshaft End Play

Crankshaft end play can be measured with a feeler gauge by prying the crankshaft rearward and mea-suring the clearance between the thrust bearing flange and a machined surface on the crankshaft. Insert the feeler gauge at several locations around the rear thrust bearing face (Figure 3.27). You may also position a dial indicator so that the fore and aft movement of the crankshaft can be measured.

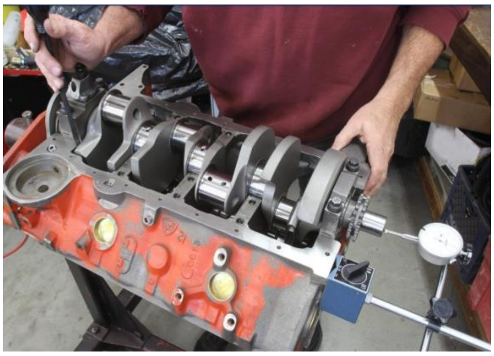


Figure 3.27 Crankshaft End Play

Figure 3.25 Crank journals out-of-round, and taper

Measuring Crankshaft Oil or Bearing Clearance

Oil or bearing clearance is necessary to compensate radial heat expansion of the crankshaft. A minimum clearance of 0.04mm for main and connecting rod bearings has proven suitable.

To measure the clearance the following tools are needed:-

- Inside and outside micrometers or
- Plastic gauge

A Using inside and outside micrometers

- Install all main bearings to the cylinder block and main bearing caps.
- Tighten the cap nuts to the recommended torque with torque wrench.
- Measure the bearing inside diameter with inside micrometer
- Measure the main journal outside diameter with an external micrometer
- Compare the inside diameter (D) to the shaft outside diameter (d)
- Oil clearance Sm=D-d

Table 3.4 crankshaft journal

Main bearing no.	1	2	3	4	5
D in mm					
d in mm)					
Sm in mm					

B. Using Plasti gauge

Wipe off oil from the surface of the bearing journal, crank pin and bearing caps Place the plastic strip across the crankshaft journal or crank pin.Tighten bearing caps to the specified torque. Then remove the bearing cap and check the clearance against the graduated scale on the Plastic gauge package.

Figure 3.28 measure oil clearance by plastigauge

Regrind crankshaft if journals and crankpins heavily scored and taper or out-of-roundness measured in found below specified limits. Replace crankshaft if cracked (hair cracks!) or heavily bend.

- **Measuring crankshaft thrust clearance**

Crankshaft thrust clearance is the end movement of the crankshaft in the block. It can be measured with a dial gauge or with a feeler gauge.

Measure the space between the thrust face of the crankshaft and the flanged thrust bearing while prying the crankshaft to one side. The space between them is measured by inserting the blade of feeler gauge. If dial gauge is used, keep the tip of the dial indicator to one end of the crankshaft and pry the crankshaft to one side then to the opposite. Indicator movement is equal to crankshaft endplay. If the clearance is greater than the recommended amount, replace the thrust washers or thrust bearings as a set.

Self Check 3.1 Write

Directions: Part I Answer all the questions liste

1. Describe how to inspect an oil pump.
2. What is cylinder taper?
3. Describe how to measure main bearing oil clearance.
4. Where does maximum cylinder bore wear occur and why?
5. List three types of compression rings.
6. What is the purpose of a thrust main bearing?

Directions: Part II choose the correct answer

1 Most pistons used today are made of ___.

A. Cast Iron
B. Aluminum
C. Ceramic
D. None Of The Above

2. Cam bearings in OHV engines are typically which type?

A. Split Insert
B. Full-Round
C. Thrust
D. None Of The Above

3. Which of the following is not of concern when checking a piston?

A. Diameter
B. Surface Finish
C. Groove Wear
D. Pin Boss Wobble

4. Each half of a split bearing is made slightly larger than an exact half. What is this called?

A. Spread
B. Crush
C. Both A And B
D. Neither A Nor B

5. The connecting rod journal is also called the ___.

A. Balancer Shaft
B. Vibration Damper
C. Plastigage
D. Crankpin

6. Which of the following are not typically found in the block of a modern engine?

A. Pistons
B. Crankshaft
C. Valves
D. Oil Pump

7. All of the following are functions of the flywheel, except it ___ .

A. Provides A Mounting Place For The Clutch Assembly

B. Smooth Out Cylinder Firing Pulsations

C. Has Marks Used To Set The Valve Timing

D. Meshes With The Starter Drive Gear

8 Which type of oil ring is slotted so that excess oil can pass through it?

A. Cast Iron
B. Segmented
C. Both A and B
D. Neither a nor b

9. Technician A uses a micrometer to measure the connecting rod journal for taper. Technician B uses a micrometer to measure the connecting rod journal for out-of-roundness. Who is correct?

A. Technician A
B. Technician B
C. Both A And B
D. Neither A Nor

10. Technician A says that piston ring end gaps should be the same for each ring on a piston. Technician B says that piston ring end gaps should be aligned before installing the piston into its bore. Who is correct?

A. Technician A
B. Technician B
C. Both A And B
D. Neither A Nor B

11 Technician A checks crankshaft oil clearance with a feeler gauge. Technician B uses a dial indicator to check crankshaft oil clearance. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A Nor B

12. When removing the piston and rod assemblies from a cylinder block: Technician positions the throw of the crankshaft at the top of its stroke and removes the connecting

nuts and cap. Technician B covers the rod bolts with protectors and pushes the piston and rod assembly out with the wooden hammer handle or wooden drift and supports the piston as it comes out of the cylinder. Who is correct?

A. Technician A
B. Technician B
C. Both A And B
D. Neither A Nor B

Operation Sheet 3.1

Operation Title: Measuring of Warpage/ Flatness of cylinder head

Purpose: To know the flatness surface of head will be warped or not..

Conditions; The cylinder head and block must be washed and cleaned.

Equipment Tools and Materials:

- Micrometer Vernier caliper
- Telescopic gauge/ small hole gauge
- Dial indicator/ gauge
- Protractor
- Feeler gauge
- Valve spring tension tester
- Steel square

Precautions:

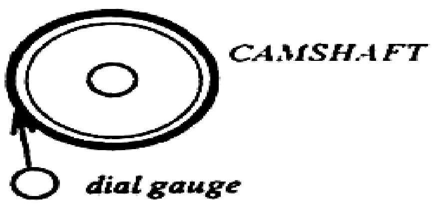
- No slippery floor,
- Good ventilation,
- Sufficient lighting
- Shop equipped with fire extinguishers

NB:- Before disassembling the engine get hold of the repair manual

A) Cylinder Head, Manifold Mounting Surface Warpage

Procedure:-

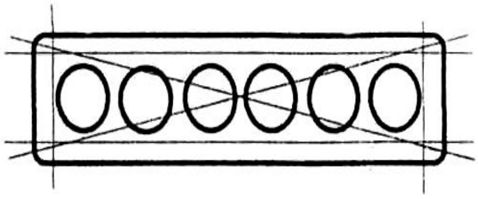
Timing gear backlash or timing chain slack



Measurement ______________(mm)

Limit _______________(mm)

- Cylinder head warpage



Measurement _______________(mm)

Limit _______________(mm)

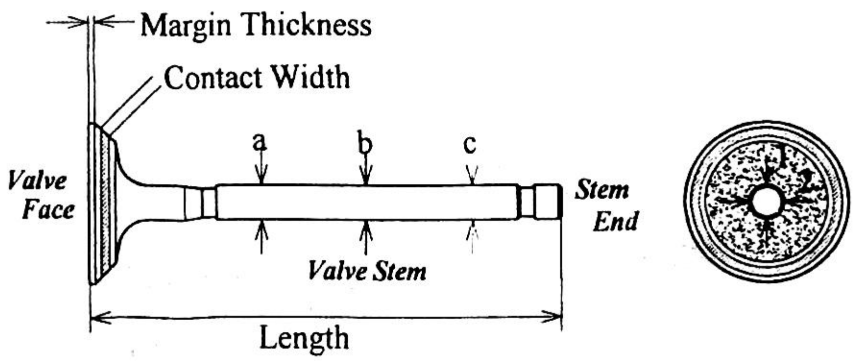
- **Manifold mounting surface warpage**

Measurement _______________(mm)

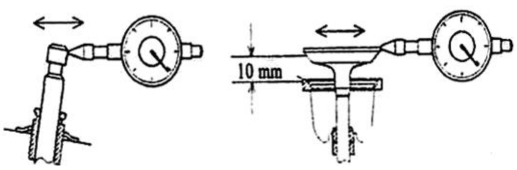
Limit _______________(mm)

B) Valve Oil Clearance, Stem Diameter, Bending, Margin Thickness, Overall Length

Procedure:



- Oil clearance



	1	2	3	4	5	6
IN.						
EX.						

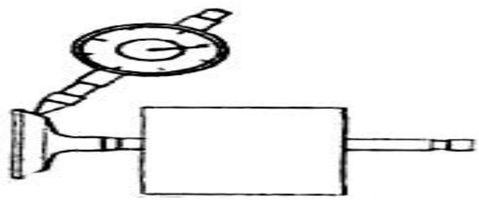
*Oil clearance limit:

IN. ____________________(mm)

EX. ____________________(mm)

- Valve stem diameter

	1	2	3	4	5	6
In. min.						
In. max.						
Ex. min.						
Ex. max.						



- **Valve bending**

	1	2	3	4	5	6
Intake						
Exhaust						

- **Head margin thickness**

	1	2	3	4	5	6
Intake						
Exhaust						

- **Overall length**

	1	2	3	4	5	6
Intake						
Exhaust						

- **Valve contacting position and width**

	1	2	3	4	5	6

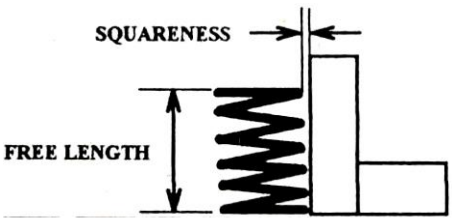
Intake						
Exhaust						

- **Valve seat contacting position and width**

	1	2	3	4	5	6
Intake						
Exhaust						

- **Valve spring installed length**

	1	2	3	4	5	6
Intake						
Exhaust						

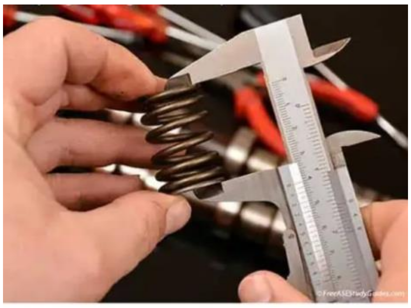


- **Valve spring squareness**

	1	2	3	4	5	6
Intake						
Exhaust						

- **Valve spring free length**

	1	2	3	4	5	6
Intake						
Exhaust						



	1	2	3	4	5	6
Intake						
Exhaust						

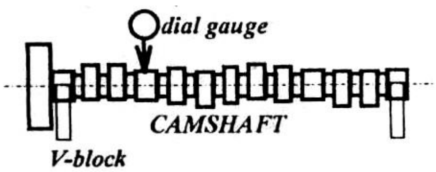
- **Valve face angle**

	1	2	3	4	5	6
Intake						
Exhaust						

C) Camshaft Circle Run out, Journal Diameter, Cam Lobe Height, Oil Clearance,

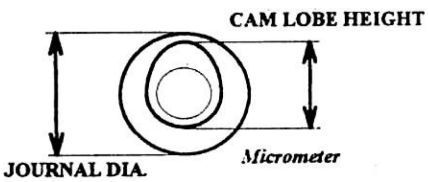
<u>Procedure:-</u>

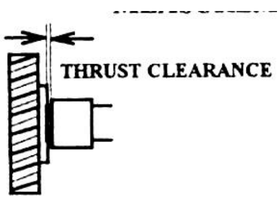
- **Camshaft *circle run out***



measurement _______________(mm)

* limit _______________(mm)





- **Cam lobe *height***

	1	2	3	4	5	6
Intake						
Exhaust						

* limit IN______________(mm

EX______________(mm)

- **Camshaft *thrust clearance***

measurement _____________(mm)

*limit ______________(mm)

- **Camshaft *oil clearance***

	1	2	3	4	5	6
Bearing inner diameter						
Journal diameter						
Oil clearance						

* limit ______________(mm)

Operation Sheet 3.2

Operation Title: Measuring of cylinder block

Purpose: To know the flatness surface of head will be warped or not..

Conditions; The cylinder head and block must be washed and cleaned.

Equipment Tools and Materials:

- Micrometer Vernier caliper
- Telescopic gauge/ small hole gauge
- Dial indicator/ gauge
- Protractor
- Feeler gauge
- Valve spring tension tester
- Steel square

Precautions:

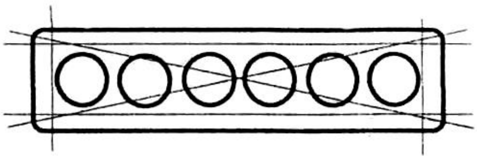
- No slippery floor,
- Good ventilation,
- Sufficient lighting
- Shop equipped with fire extinguishers

NB:- Before disassembling the engine get hold of the repair manual !

A) Cylinder Block Warpage,

Procedure:-

Cylinder block warpage



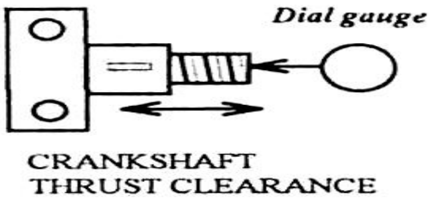
Measurement _______________ mm

Limit ______________ mm

Connecting rod thrust clearance

1	2	3	4	5	6

limit ______________ mm



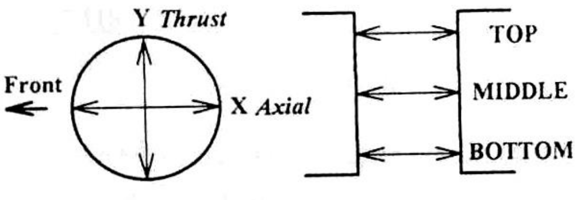
Crankshaft thrust clearance

Measurement _______________ mm

* Limit ______________ mm

B) Cylinder Bore Diameter

- **Cylinder bore diameter**



Standard cylinder bore _________________ mm

- Max. Taper = Maximum measurement - Standard cylinder bore
  Out-of-round = Y - X

Cyl. No. 1	Top	Middle	Bottom
Y			
X			

Max. Taper _______________ mm

Max. Out-of-round ______________ mm

Cyl. No. 2	Top	Middle	Bottom
Y			
X			

Max. Taper __________ mm

Max. Out-of-round _______ mm

Cyl. No. 3	Top	Middle	Bottom
Y			
X			

Max. Taper _______________ mm

Max. Out-of-round ______________ mm

Cyl. No. 4	Top	Middle	Bottom
Y			
X			

Max. Taper __________ mm

Max. Out-of-round _______ mm

Cyl. No. 5	Top	Middle	Bottom

Cyl. No. 6	Top	Middle	Bottom

Y			
X			

Max. Taper ______________ mm

Max. Out-of-round _____________ mm

Y			
X			

Max. Taper _________ mm

Max. Out-of-round _______ mm

*limit (Taper) _____________ mm

*limit (Out-of-round) _____________ mm

B) Crankshaft Runout, Bearing Clearance, Piston Diameter, Piston Ring End Gap, Connecting Rod Bend, Twist,

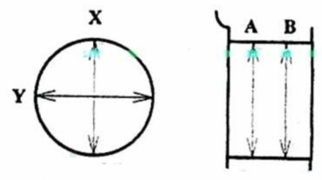
Procedure:-

- Crankshaft run out

measurement ______________ mm

*limit ______________ mm

- Crankpin out-of-round and taper



- Taper = A - B
- Out-of-round = X - Y

No. 1	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm

Max. Out-of-round ___________ mm

No. 2	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper _________ mm

Max. Out-of-round _______ mm

No. 3	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm

Max. Out-of-round ___________ mm

No. 4	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper _________ mm

Max. Out-of-round _______ mm

No. 5	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm

Max. Out-of-round ___________ mm

No. 6	X	Y	Out-of-round
A			
B			
Taper			

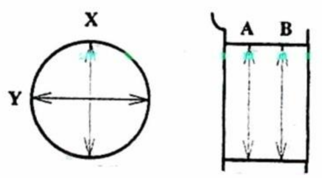
Max. Taper _________ mm

Max. Out-of-round _______

*limit (Taper) ______________ mm

*limit (Out-of-round)______________ mm

- main journal out-of-round and taper



- Taper = A - B
- Out-of-round = X - Y

No. 1	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm

No. 2	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper _________ mm

Max. Out-of-round ___________ mm　　　　Max. Out-of-round _______ mm

No. 3	X	Y	Out-of-round
A			
B			
Taper			

No. 4	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm　　　　Max. Taper _________ mm

Max. Out-of-round ___________ mm　　　　Max. Out-of-round _______ mm

No. 5	X	Y	Out-of-round
A			
B			
Taper			

No. 6	X	Y	Out-of-round
A			
B			
Taper			

Max. Taper ______________ mm　　　　Max. Taper _________ mm

Max. Out-of-round ___________ mm　　　　Max. Out-of-round _______ mm

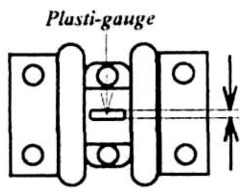
*limit (Taper) ______________ m

it (Out-of-round)____________ mm

- **Crankshaft main bearing clearance**

1	2	3	4	5	6

*limit _____________ mm

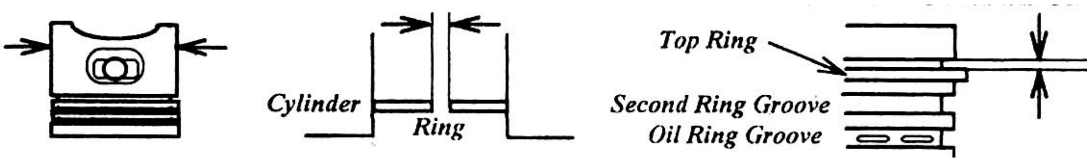


OIL CLEARANCE

- **Connecting rod *bearing clearance***

1	2	3	4	5	6

*limit _______________ mm



Piston diameter

1	2	3	4	5	6

*limit _______________ mm

- **Piston ring *end gap***

	1	2	3	4	5	6
Top						
Second						
Oil						

*limit Top _______________ mm

Second _______________ mm

Oil _______________ mm

- **Piston ring groove clearance**

	1	2	3	4	5	6
Top						
Second						

*limit Top _______________ mm

Second _______________ mm)

Connecting rod alignment (Bend and Twist

	1	2	3	4	5	6
Twist						
Bend						

* limit Twist _______________ mm

Bend _______________ mm

Unit Four: Reassembling Verifying Engine

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Engine Assembling
- Engine Tuning
- Mounting Engine On Vehicle
- Post Repair Test

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform Engine Assembling
- Apply Engine Tuning
- Mounting Engine On Vehicle
- Apply Post Repair Test

4.1 Engine Assembling

4.1.1. Preparation for reassembling the engine

Reassembling an engine, the sequence is essentially the reverse of the disassembling sequence. Always refer to the service manual before assembling an engine. Before beginning engine assembly:

- Prepare and interpret shop/service manual, that enables you to follow correct procedure of engine reassembly
- Have all tightening specifications handy.
- Obtain all replacement parts.
- Prepare and set in order component parts that has been cleaned
- Make sure you have all the necessary new parts, gaskets and seals, as well as the following items on hand: common hand tools, torque wrench, piston ring refitting tool, piston ring compressor, short lengths of rubber or plastic hose to fit over connecting rod bolts, plastic gauge, feeler gauges, fine-tooth file, engine oil, gasket sealant, thread-locking compound.

Parts of an entire engine, cleaned, machined, and ready for assembly.

Figure 4.1 dismantle engine

4.1.2. Assembling procedures

A. Cleaning engine components check and clean for abrasives or any burns and carbon deposits if there is, also check sharp edges and chamfered or rounded. Clean parts of threaded for bolts.

B. Selecting and replacing gasket, seals and bearings Gasket and seals: used between to make the joint tight against water oil and pressure. Some auto manufacturers recommend a no-setting gasket cement to ensure a tight joint. Many manufacturers utilize valve stem oil seals. Leakage between the valve stem and guide. Crankshaft rear and front oil seals prevent leakage of oil at the rear and front of the engine Bearings:

The purpose of bearings is to support, guide and locate moving parts such as rotating shaft and axle. Bearings can be classified according to

I. The load they support: they are;
   - Radial bearings
   - Axial/thrust bearings,
   - Axial and radial

II. Type of friction: they are;
   - Friction or plain bearing one piece such as (bushing),
   - Split type (crankshaft and rod bearings) and
   - Anti-friction bearing (ball bearing, roller bearing and needle bearings)

C. Lubricate engine components: such as

- Crankshaft shell bearings
- Crankshaft main and rod journal
- Piston big end shell bearings,
- Small end bushings and gudgeon pin,
- Piston skirt and piston rings
- Cylinder wall
- Camshaft bushings and journal

D. Reassemble engine components

Install main bearing Install upper thrust washer→ Place crankshaft on cylinder block→ Install main bearing cap and lower thrust washer→ Install piston and connecting rod assemblies→ Install connecting rod caps→ Install connect rod cap nuts→ Install rear oil seal retainer→ Install oil cooler→ Install oil pump and oil pan→ Install water pump→ Install cylinder head→ Install pulleys and timing be lt→ Install rear end plate→ Install flywheel→ Bench test→ Install engine→

4.2 Engine Tuning

4.2.1 Valve Clearance Adjustment

Valve clearances are the small gaps between the tops of the valve stems and the part of the mechanism which presses on them to open the valves . Check the clearances at

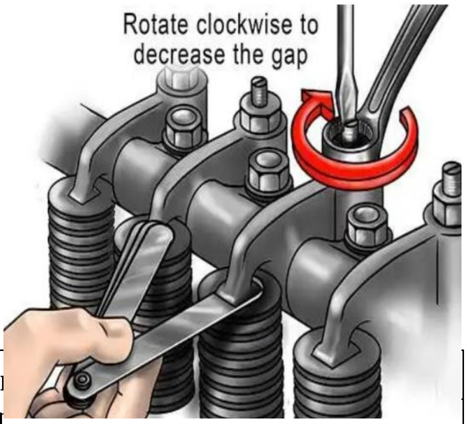


Figure 4.2 valve clearance

regular intervals as specified in the car service schedule, and adjust if necessary. Reset the clearances whenever the cylinder head has been removed. The job is commonly called adjusting the tappets .On a pushrod engine without a rocker shaft, the clearance is adjusted by a nut on the pivot post; this example has a self- locking nut. A few cars have hydraulic tappets, which are self adjusting and do not need checking. Before starting, make sure you know the type of valve mechanism commonly called valve gear - fitted to your engine , and the relative valve clearances. The car handbook should tell you the clearances - if not, consult a dealer or the car service manual. The valve gear fitted to your engine will be either pushrod (OHV) or overhead camshaft (OHC) There are two types of OHC valve gear direct acting and indirect acting. T he tappets on an OHC engine are usually adjusted by placing shims of a predetermined size under them

4.2.2 Checking and adjusting timing belt tension

Check the tension by twisting the belt with your thumb and forefinger, midway along the longest straight run between the two main sprockets. If the belt tension is correct, you should just be able to twist it through 90 degrees. If you can twist it more or less than this, the tension needs to be adjust

4.2.3 Checking and adjusting injection timing

The injection timing is a very important parameter to ensure better combustion, and this depends on valve timing and ignition timing; those are main factors to optimize the heat release which has effects on the performance of the engine

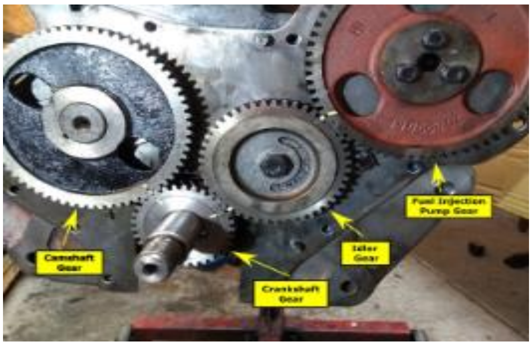


Figure 4.3 injection Timing

4.3 Mounting Engine On Vehicle

If the engine mounting is maintained properly, then you can be comfortable when driving. Not only does it play a role in dampening a vibration, but the engine mount can also keep various engine components from sticking to the chassis.

There are 9 steps of Mounting Engine On Vehicle

Step 1: Check for clearance against the firewall before attempting to raise the engine. Tearing radiator hoses, crimping AC lines or cracking distributor caps should be avoided

Step 2: Secure the engine on a jack with various blocks of wood. Never jack an engine directly by the oil pan. The pan will bend and rupture

Step 3: Loosen the engine from the mount bolts. Sometimes a long extension and universal joint is the way to go

Step 4: Next, crawl under the vehicle and loosen the mount-to-frame bolts.

Step 5: Jack-up the engine a little at a time and remove the motor mount

Step 6: Compare the old and new motor mounts. Transfer any heat or drip shields to the new mount

Step 7: Thread in the mount-to-frame bolts before lowering the engine. This will simplify mount alignment

Step 8: Lower the engine and fully tighten all bolts

Step 9: Front-wheel-drive vehicles often have third "dog-bone" motor mount

4.4 Post Repair inspection

A post-repair inspection is an evaluation performed by a qualified third-party, in which they examine the quality of the repairs that have been performed after a car accident. The inspector will check that manufacturer guidelines were followed to ensure that the vehicle will perform as it was intended, and that it has been restored to pre-accident safety standards

Why get a Post-Repair Inspection

A Post-Repair Inspection is intended to protect you from improper repairs that can compromise your vehicle's structural integrity and resale value. With the pressure from insurance companies on engine repairing shops, engine repairing are pushed to work at a faster rate that often produces a cheap, fast repair. In many Post-Repair Inspections we have performed, we have found that repairs were not made properly and unsafe vehicles were put

Self-check 4.1

Directions: part I Answer all the questions listed below.

1. During assembling the engine, what should be followed?
2. Why you replace old/ existence component parts

3. What will happen if you reinstall parts without lubrication
4. After overhauling the engine and assembling, what are the adjustments that performed?
5. Do you use old cylinder head gasket 6) What is the roll of engine support?
6. Why you follow safety precaution during reinstalling of engine components

True/False part II

1. Damage parts should be replace by new one
2. Service manual must be available during engine reassemble
3. Reassembling procedure is not reverse procedure of disassemble

Part III choose the correct answer

1. What is the best way to lift a vehicle when preparing to remove an engine?

A. frame contact hoist C. hydraulic jack and safety stands

B. drive on lift D. engine hoist

2. The buildup of minerals and deposits inside the cooling system is called.

A. Organic Soil B. Rust C. Scale D. Grime

3. Hydrocarbon solvents are.

A. Flammable B. Both A And B C. Toxic D. Neither A Nor B

4. Which Cleaning Method Uses High-Frequency Sound Waves To Create Microscopic Bubbles That Loosen Dirt From Parts?

A. Ultrasonic B. Thermal C. Salt Bath D. Caustic

8. Parts Must Be When They Go Into An Abrasive Blast Machine.

A. Wet B. Grease-Free C. Dry D. Both B And C

9. An Engine Block Should Be Mounted To An Engine Stand Using A Minimum Of Bolts.

A. Four B. Three C. Six D. Five

Operation Sheet 4.1

Operation Title: Valve clearance adjustment

Purpose: to know how to check the tappet clearance

Equipment Tools and Materials:

- Manual
- Set wrench,
- Screw driver
- Rags,
- Detergents,

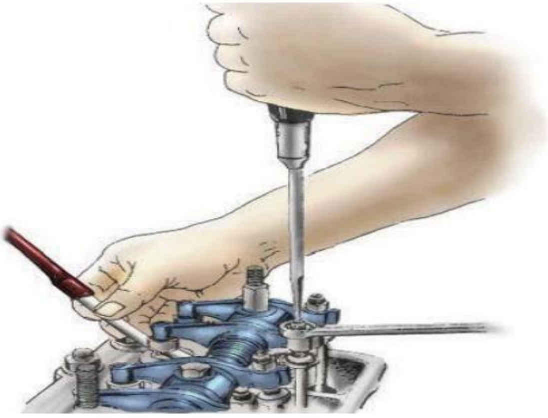
Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- ✓ Wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment

Procedure:

1. Remove the valve cover
2. Rotate the crankshaft until piston #1 is at TDC.
3. Measure the clearance between the valve stem tip and rocker arm.
4. Loose the lock nut and turn the adjusting screw in the rocker arm



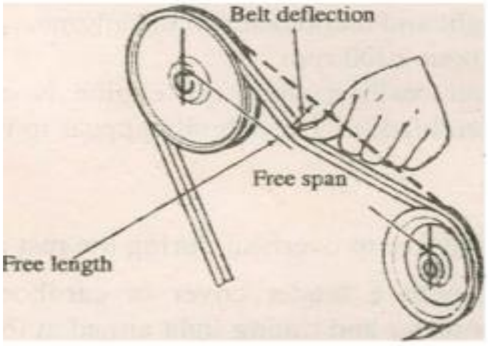
- **Adjusting timing and drive belts**

Procedures

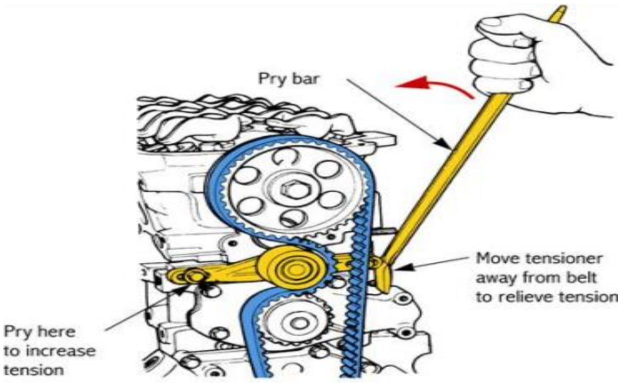
1. Install the belt and adjust it to new belt tension.
2. Run the engine at idle for 10 to 15-minutes.

3. Stop the engine, measure belt tension with a gauge, and readjust it to used - belt specifications.

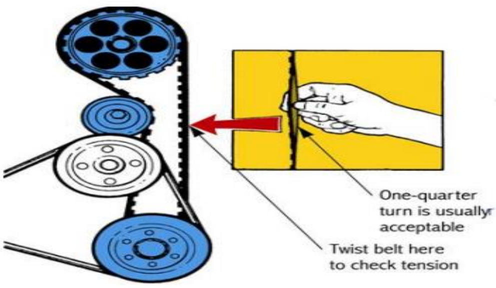
4. Checking belt tension by pressing on the belt midway



5. Using a pry bar adjust the tensioned



6. Twist the belt using moderate finger and thumb pressure



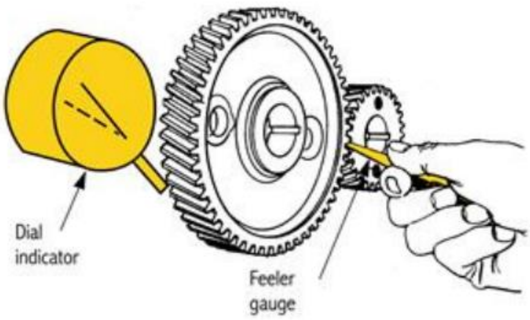
Operation Title: Measuring backlash

Purpose: to check the amount of clearance

Tools and equipments

- Dial indicator or
- feeler gauge
- Wrench
- Procedures

1. Install a dial indicator with the stem on a cam gear tooth
2. Wiggle the camshaft, while watching the indicator
3. The needle movement equals the backlash



LAP Test

Practical Demonstration

Name: ___________________________**Date:** _____________

Time started: _____________________ **Time finished:** ________________

Instruction: Perform the following tasks

1.1. Request your teacher to have manuals.

1.2. Then perform the following tasks

Task 1 Prepare to overhaul engine Prepare the shop

- Prepare tools and equipment's
- Prepare engine

Task 2 Remove the engine from the vehicle

A. Disassemble the engine Dismantle cylinder head component parts

- Dismantle cylinder block component parts
- Clean component parts
- Inspect component parts

Task 3 A. Prepare to overhaul engine Prepare the work area

- Prepare testing and measuring tools
- Prepare component parts in order to measure

Task 4 Measure component parts

- Measure valve train components
- Measure cylinder block components

Task 5 Rebuild and recondition components with Serviceability and repair methods

- Resurface the cylinder block and head
- Grind the valve
- Lap the valve
- Hone the cylinder

Reference

Books

- Automotive Technology 7the Edition
- Automotive Technology; A Systems Approach; 5 T H E D I T I O N; Jack Erjavec
- Modern Automotive Technology; by Russell Krick; power point presentation; chapter52: Engine Front End Service and Engine Installation
- Toyota Service manual 18R engine page 12-04 (retrojdm.com)
- Environmental Instruction; Best Practices for Construction Activities (EI-04)
- Automobile Mechanical and Electrical System; Automotive Technology: Vehicle
- Maintenance and Repair; Tom Denton BA FIMI MSAE MIRTE Cert E

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