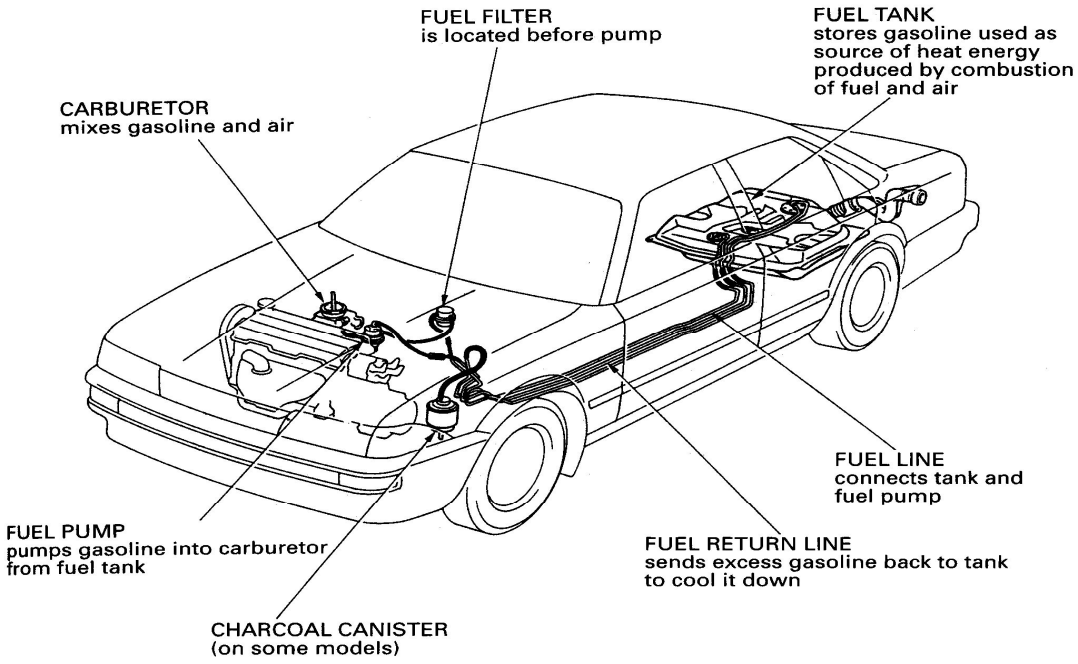
Automotive Electrical & Electronics

Level – I

Based on March 2022, curriculum Version 1



Module Title: - **Applying Automotive Mechanical System Fundamentals**

Module code: EIS AUM1 M05 0322

Nominal duration: 80Hour

Prepared by: Ministry of Labor and Skill

September, 2022

Addis Ababa, Ethiopia

Table of Content

Acknoledgment

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

OS----------Occupational Standard

LAP ---------- Learning Activity Performance test

RWD---------- Rear Wheel Drive

CV joints----------Constant Velocity joint

ECU----------Electronic Control unit

IC----------Internal combustion

EC----------External Combustion

FFWD ----------Front engine, Front wheel drive

FRWD ----------Front engine, Rear wheel drive

RR WD----------Rear engine, Rear wheel drive

MR WD----------Mishap engine, Rear wheel drive

SST ----------Special service tools

CGM---------- Crank gear mechanism

VGM ----------Valve gear mechanism

4WD----------four wheel drive

FO----------Firing Order

FI----------Firing Interval

TDC----------Top dead center

Introduction to the Module

This module covers the knowledge, skills and attitudes required to demonstrate basic knowledge and awareness of automotive mechanical system component and principles as they apply to vehicle systems, components and technologies found in modern motor vehicles.

This module covers the units:

- Identify and locate engine mechanical system fundamentals
- Basic operation, functions and principle of gasoline and diesel fuel systems
- Basic operation, functions and principle engine mechanical system fundamentals

Learning Objective of the Module

- Identifying and locate engine mechanical system fundamentals
- Basic operation, functions and principle of gasoline and diesel fuel systems
- Basic operation, functions and principle engine mechanical system fundamentals

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: Identify and locate engine mechanical system fundamentals

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

- Automotive Engine System
- Identifying Vehicle mechanical system

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:

- Suitable relevant sources of information are located to assist with mechanical fundamentals
- General automotive system fundamentals are identified in relation to modern vehicle
- Identify mechanical system terminology, principles components are referred to and identified for a particular application

1. Identify and locate engine mechanical system fundamentals

1.1. Automotive Engine System

1.1.1 Fuel system(diesel and Gasoline)

The fuel system consists of the fuel tank, pump, filter, and injection nozzles or carburetor and is responsible for supplying fuel to the engine as needed. Every component must function properly in order to achieve the expected vehicle performance and reliability.

A) Gasoline Fuel system

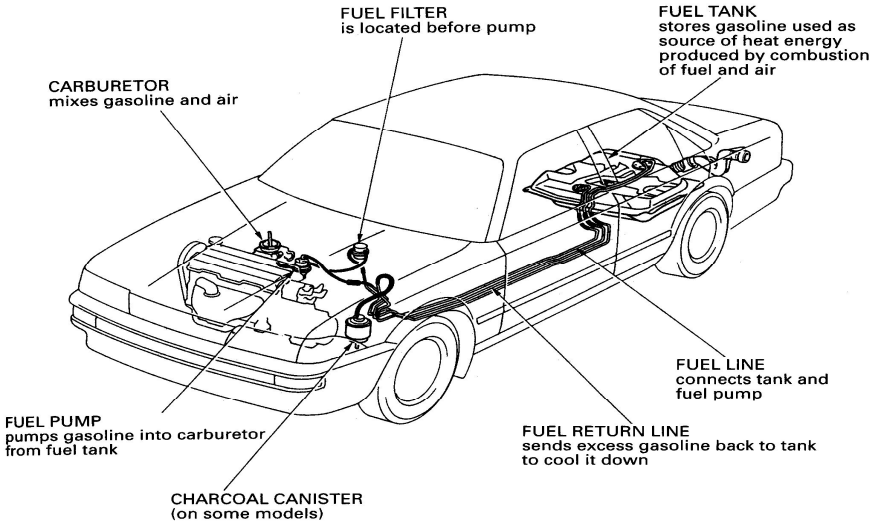


Fig.1.1 Gasoline Fuel system

The purpose of the fuel supply system for a petrol engine is to store, transfer and filter the petrol required by the float chamber of a carburetor. The most important components of this system are:

- Air cleaner
- Carburetor
- Fuel tank
- Fuel line
- Charcoal canister (some models only)
- Fuel filter
- Fuel pump

In fuel supply system, air cleaners or air filters remove dust, dirt and other foreign particles present in the air and send clean air into engine cylinder. Fuel filters filter foreign particles that may be present in the fuel. A fuel pump lifts fuel from the fuel tank and supplies the same to the carburetor through tubes and hoses (fuel lines). Correct quantity of air fuel mixture is supplied to the cylinder by carburetor. On some models, the HC (Hydrocarbon) gas generated in the fuel tank is temporarily absorbed in the charcoal canister and is burned in the engine. As a result, the amount of HC gas which leaks out of the fuel tank is reduced.

B) Diesel-Engine Fuel Systems

Figure1.2. shows a typical automotive diesel-engine fuel system.

It uses injection nozzles or injectors similar to the fuel injectors in gasoline fuel-injection systems. The gasoline injectors are solenoid operated.

When high pressure is applied, they open and spray fuel. The diesel fuel system must:

1. Deliver the right amount of fuel to meet the operating requirements.

2. Time the opening of the injection nozzles so the fuel enters the engine cylinders at the proper instant. As engine speed increases, fuel injection must start earlier. This gives the fuel enough time to burn and produce pressure on the pistons. Without the advance, the pistons would be over TDC and moving down before the fuel fully ignites. This wastes fuel and power.

3. Deliver the fuel to the cylinders under high pressure. Injection pressure must be high enough to overcome the high compression pressure in the diesel engine. At the end of the compression stroke, compression pressure may be 500 psi [3447 kpa] or higher.

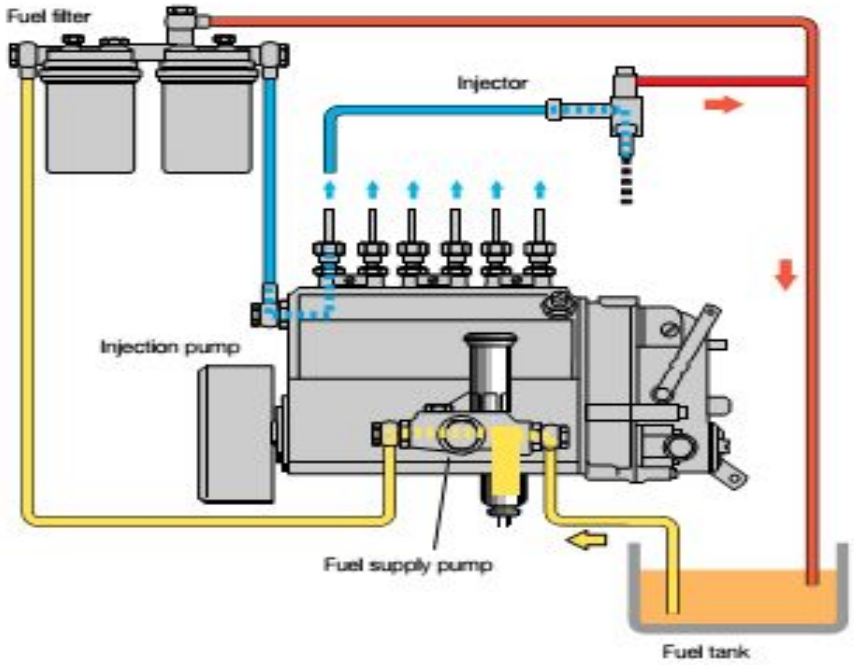


Figure 1.2.Typical fuel system for an automotive diesel engine.

FUEL delivery SYSTEM

The fuel delivery system has the important role of delivering fuel to the fuel injection system. The fuel must also be delivered in the right quantities and at the right pressure. The fuel must also be clean when it is delivered.

A typical fuel delivery system includes a fuel tank, fuel lines, fuel filters, and a pump . The system works by using a pump to draw fuel from the fuel tank and passing it under pressure through fuel lines and filters to the fuel injection system. The filter removes dirt and other harmful impurities from the fuel. A fuel line pressure regulator maintains a constant high fuel pressure. This pressure generates the spraying force needed to inject the fuel. Excess fuel not required by the engine returns to the fuel tank through a fuel return line.

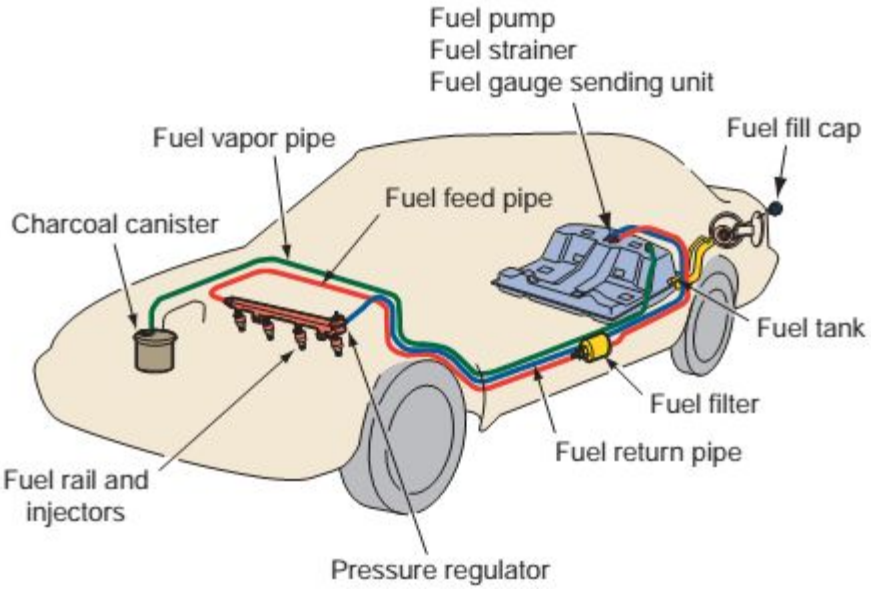


Figure1.3. the fuel delivery system for a late-model car

Fuel tank

The fuel tank on commercial vehicles is often made of aluminum or plastic for reasons of weight. It must be corrosion resistant and remain tight at double its operating pressure (legally specified minimum value = 0.3 bar overpressure). Larger tanks often incorporate baffle plates to prevent the fuel from being displaced excessively when cornering, braking and moving away. The drain plug is positioned at the lowest point in the tank.

Fuel lines

Steel pipes or plastic fuel lines are used on the diesel engines of commercial vehicles.

Fuel supply pump

The fuel supply pump transfers the fuel from the tank to the injection pump. On the inline injection pumps often used on commercial vehicles, the fuel supply pump is a piston-type pump. It is flanged onto the injection pump and usually equipped with a hand-operated pump for venting the fuel system. Its task is to deliver the fuel to the injection pump at a pressure of approx. 1 - 2.5 bar. The supply pump is driven by a cam located on the injection pumps camshaft. The higher the pressure in the supply line, the less fuel is pumped. This is known as flexible delivery. Distributor pumps have integral supply pumps which take the form of vane pumps or separate diaphragm pumps.

1.1.2 Intake System

The intake system is responsible for delivering oxygen, which is necessary for combustion.

An intake system generally comprises an air filter, a throttle, and passageways for air to reach the cylinders themselves. There are several main types of intake systems.

Which include the Air filter (air cleaner), carburetor; intake manifold and intake valve (combustion chamber) this system allows pure & fresh air to enter the engine it consists of

Air cleaner: -Which cleans & filters the air before interring the combustion chamber of an engine

Superchargers: -it increases the air pressure into the engine so that more fuel can be burnt & the engine output increases

Intake manifold: -is required to deliver into the cylinder either a mixture of fuel & air from the carburetor or only from the air Cleaner.

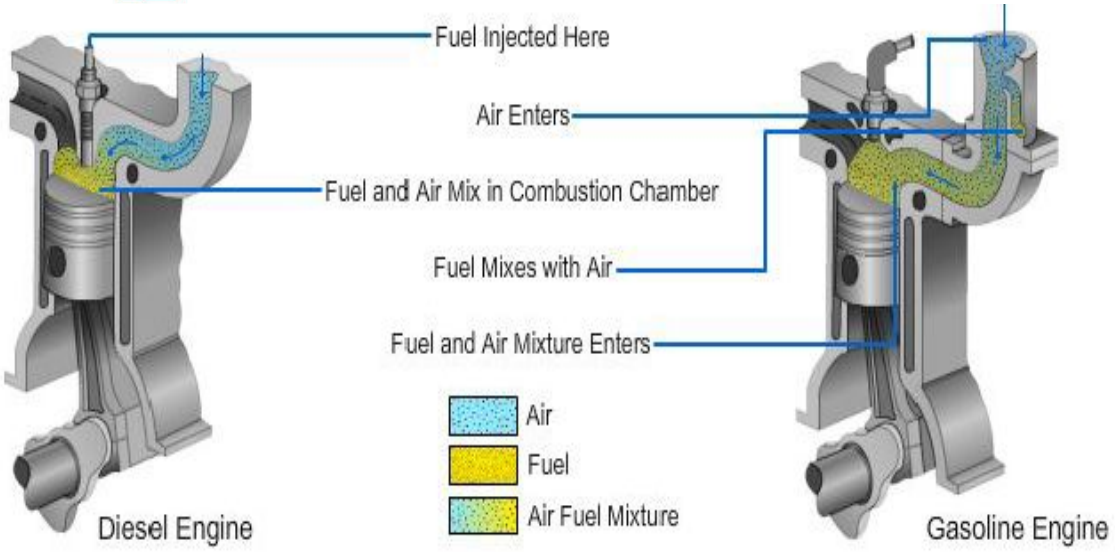


Figure 5-1 — Diesel and gasoline ingines intake strokes.

Figure 1.4 diesels and gasoline ignites intake

1.1.3 Exhaust system

The exhaust system collects exhaust gases from the engine & expels them out. It consists of: -

Exhaust Manifold: The exhaust manifold is made of cast iron and is bolted over the exhaust ports of the engine, usually alongside the intake manifold pipe. It provides heat to the intake manifold. This heat further vaporizes the fuel in the intake manifold.

Exhaust Pipe: The exhaust pipe is a long pipe leading from the exhaust manifold to the muffler.

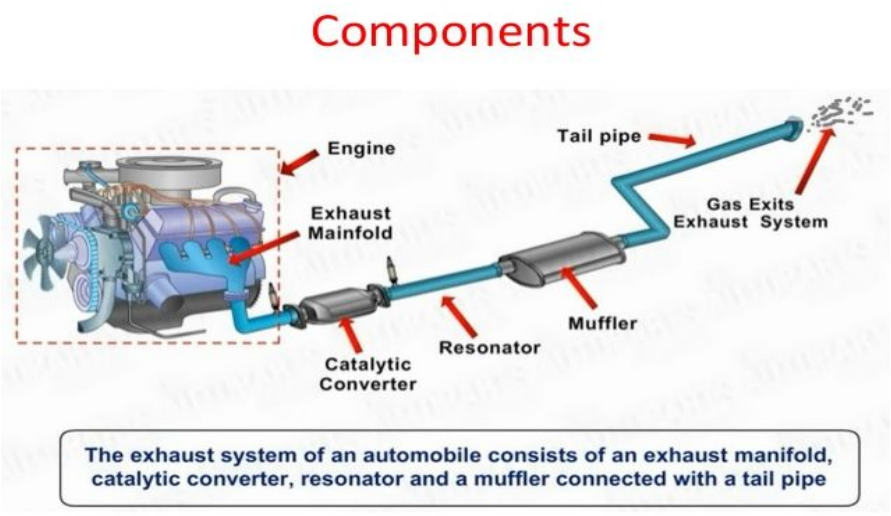
Catalytic converter it is discussed under exhaust gas treatment.

Muffler: The exhaust gas emerges in a pulsating flow and therefore causes marked vibration in the exhaust pipes and mufflers (silencers).

Resonator: It is used to further muffle the noise of the exhaust gases. It is also called secondary muffler.

Tail Pipe: The tail pipe is a pipe that carries the exhaust gases from the muffler to the rear of the vehicle. This pipe may be a separate unit or an integral part of the muffler when the muffler is located near the rear of the vehicle.

Turbo Charger: - Is an exhaust gas driven turbine which drives a centrifugal compressor wheel



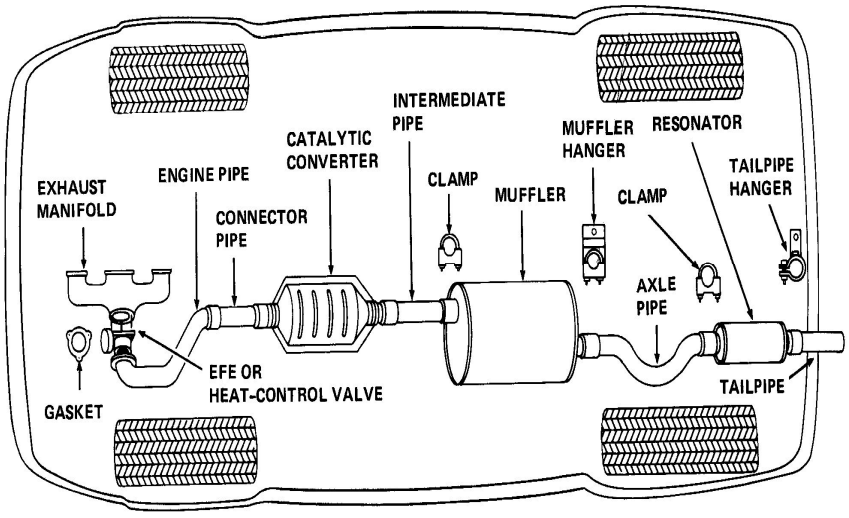


Fig 1.5.components

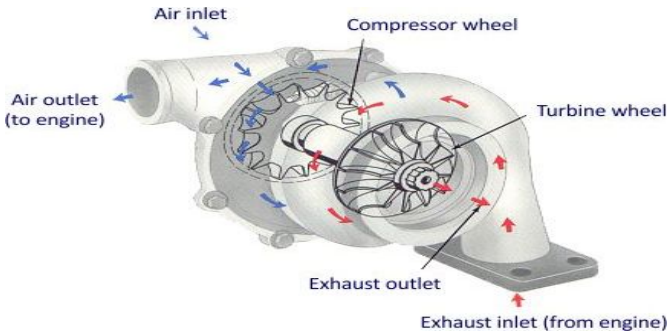


Fig.1.6.turbo charger

1.1.4 Cooling system

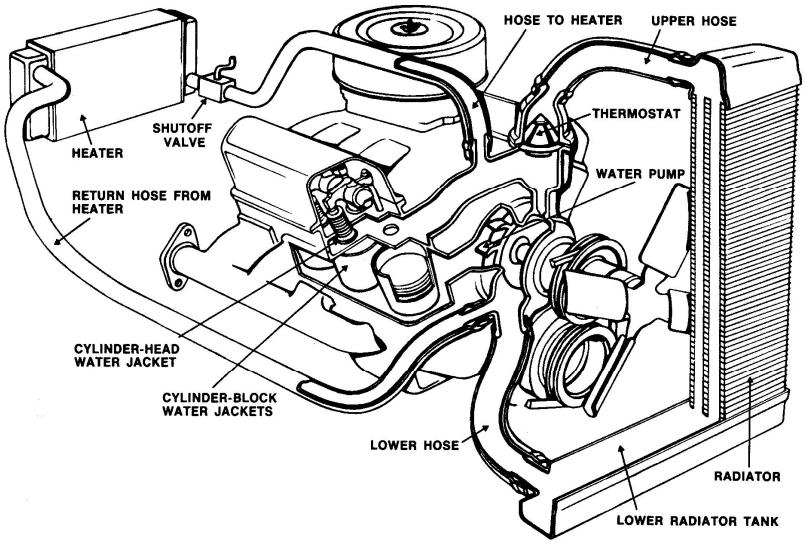


Fig.1.7. **Cooling system**

When there is fire (combustion), there is heat. Burning the air-fuel mixture raises the temperature inside the engine cylinder several thousand degrees. Some of this heat produces the high pressure that causes the pistons to move. Some heat leaves the cylinders in the exhaust gas. The lubricating oil also removes some heat. The oil gets hot as it flows through the engine. Then the oil drops into the oil pan and cools off.

The engine cooling system removes the rest of the heat. The engine has open spaces or water jackets surrounding the cylinders.

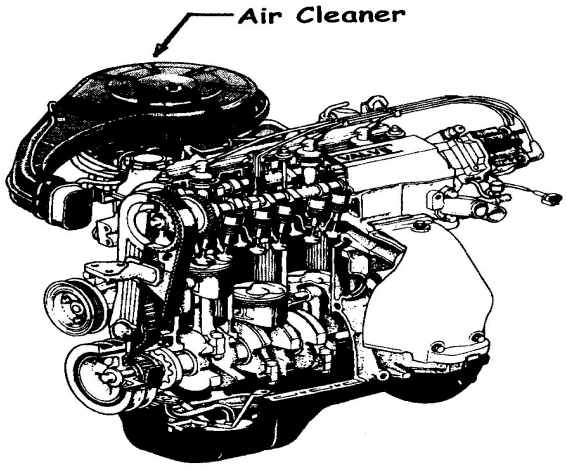
A mixture of water and antifreeze, called coolant, circulates through the water jackets.

The coolant picks up heat and carries it to the radiator at the front of the car. Air passing through the radiator picks up the heat and carries it away.

This action prevents failure of the components due to overheating and increases engine life. The coolant that abstracts heat may be either air or liquid (usually water).

Engines are normally cooled by an air-cooling system or a water-cooling system. Most automotive engines are cooled by the water-cooling system.

AIR CLEANERS



The operating life of an engine is greatly influenced by the purity of its combustion air supply. Atmosphere air naturally contains grit and dust particles. Dust in the air includes very small particles of quartz (0.005 to 0.05 mm). Depending on geographical, soil and road-surface conditions and also on the use to which the vehicle is put (high-speed main road driving, construction sites vehicles), the volume of dust in each cubic meter of air varies between 0.001 and 1g. If, for

example, a vehicle' s engines consumes 10 liters of fuel for every 100 km it covers, it will need approximately 100 cubic meters of combustion air. If this air contains 0.05 g/cubic meter of dust, 5 g of dust in all will enter the engine over this distance. The dust combines with the engine oil to form an abrasive mass which causes severe wear, particularly to the cylinder walls, pistons and valve guides. The engine life will be shortened as a result. Therefore, dust must be removed from the intake air before it reaches the cylinders.

This reduces wear of the engine components, formation of deposits and sludge, and maintenance costs. So that air cleaners are employed in the intake system topurify the air drawn in for combustion effectively without impeding the incoming airflow rate.

The dust entering with the intake air is trapped by either:

- Close-mesh screens
- Micro-pore filter materials
- Oil-wetted surfaces, or
- Use of the centrifugal force principle.

Air cleaners also perform the following functions.

It captures moisture and carbon soot that are present in the atmospheric air.

- It acts as a silencer and reduces the noise caused by the intake air as the intake valves open and close. The task of reducing intake air noise in particular makes it necessary to use a large-volume air cleaner housing containing a filter of a suitable type with the largest possible total surface area and ample dust storage capacity (to increase the intervals between filter element renewal).
- It acts as a flame arrestor if the engine backfires through the air-intake systems. Backfiring causes a momentary flashback through the carburetor. Without air cleaner, the flame could erupt from the carburetor or air intake system and cause a fire in the engine compartment.

Several types of air cleaners are available commercially including the dry paper type, pre air cleaner, oil-wetted type, oil bath type, cyclone type, thermostatic air cleaner and so on. The paper type is most often used

1.1.1 Lubrication system

The engine uses a combination pressure/splash lubrication system, delivering oil under pressure to crankshaft, connecting rod and main bearing surfaces. Other component areas are splash lubricated. A high-efficiency greater oil pump maintains high oil flow and oil pressure, even at low speeds and high operating temperatures. A pressure relief valve limits maximum pressure of system. Oil pan must be removed to service oil\ pickup and oil pump.

Components of Engine Lubrication System:

- Oil Sump.
- Engine oil filter.
- Piston cooling nozzles.
- Oil Pump.
- The Oil Galleries.
- Oil Cooler.
- The Oil pressure indicator/light.

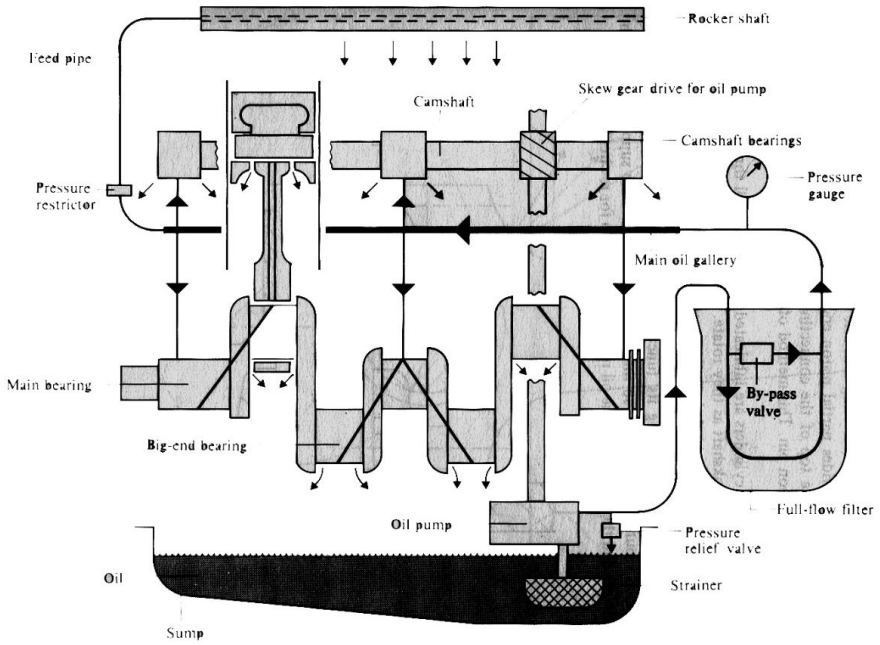


Fig.1.8. **Lubrication system**

1.2. Identifying Vehicle mechanical system

1.2.1. Transmissions and Drive Trains Systems

Definition Of Transmission System :- The mechanism that transmits the power developed by the engine of automobile to the engine to the driving wheels is called the Transmission system (or power train).It is composed of Clutch , The gear box, Propeller shaft ,Universal joints ,Rear axle Wheel Tires Requirements Of Transmission System Provide means of connection and disconnection of engine with rest of Clutch, The gear box ,Propeller shaft, Universal joints , Rear axle Wheel ,Tires.

There are two types of transmissions in use—

- Manual transmission
- Automatic transmission

Manual transmission, the driver selects all gears manually using both a movable gear selector and a driver-operated clutch. This type of transmission is also known as a "stick shift" or a "standard" transmission.

Automatic transmission that uses a torque converter, planetary gear set and clutches or bands to shift through a vehicle's forward gears automatically. Some automatics allow the driver a limited amount of manual control over the vehicle (aside from choosing a forward, reverse or neutral mode) -- for example allowing the driver to control up shifts and downshifts by utilizing buttons or paddles on the steering wheel or the gear selector. Common names for such transmissions are "shift able automatic," "Tiptronic" and "auto stick."

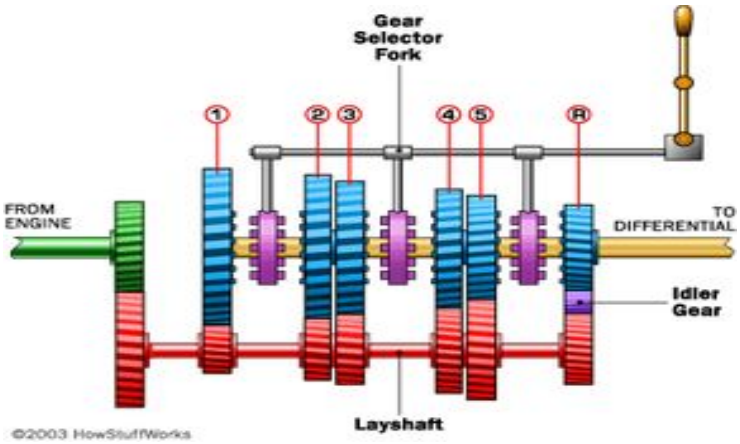


Figure 1.9. Transmissions

Drive trains:-The drive train (also called driveline) is the sum of components which are delivering the engine power to the wheels. For example, on a rear-wheel drive (RWD) vehicle, the drive train consists of: clutch (or torque converter), gearbox (manual or automatic), propeller shaft, differential and drive shafts.

The efficiency of the drive train has a significant impact on the overall efficiency of the vehicle.

The higher the efficiency of the drive train, the lower the fuel consumption of the vehicle also lowers CO_2.

1.2.2. Steering System

Functions of a Steering System

Provide precise control of the wheel direction

Maintain correct steering effort

Transmit road feel to the driver's hands

Absorb most of the road shock going to the steering wheel

Allow for suspension action

Basic Steering Systems

- Two basic kinds of steering systems are in use today:
  - ✓ Linkage (worm gear) steering systems
  - ✓ Rack-and-pinion steering systems
- Each may be operated manually or with power assist

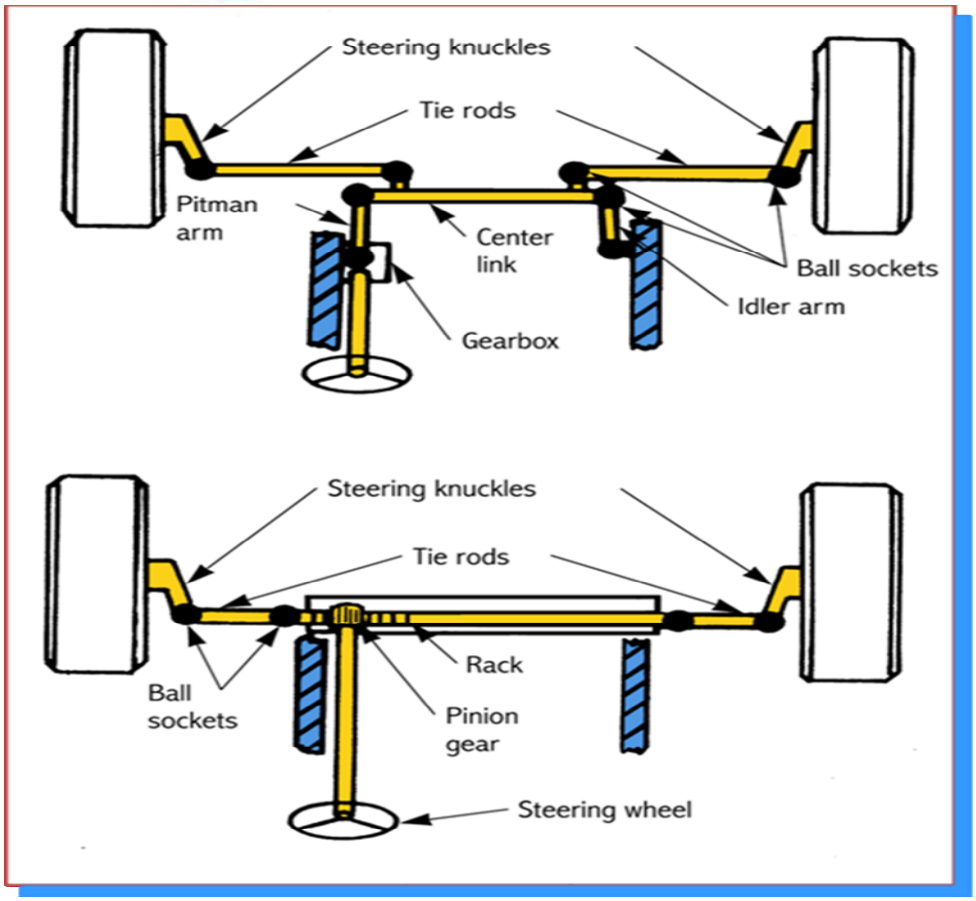


Fig.1.10. Basic linkage steering AND Basic rack-and-pinion steering

- **Steering Column Assembly**

  Consists of the steering wheel, steering shaft, column, ignition key mechanism, and, sometimes, a flexible coupling and universal joint

  Bolts to the underside of the dash

  Sticks through the firewall and fastens to the steering gear

1.2.3. **Suspension system**

The primary functions of the suspension system include maximizing the contact between the tires and the road surface, providing steering stability and good handling, evenly supporting the weight of the vehicle (including the frame, engine, and body), and ensuring the comfort of passengers by absorbing and dampening

Components of Suspension System

- Knuckle or Upright.
- Linkages.
- Wheels/tires.
- Dampers/Shock Absorbers.
- Springs.
- Struts.
- Anti Sway Bars.
- Ball Joint

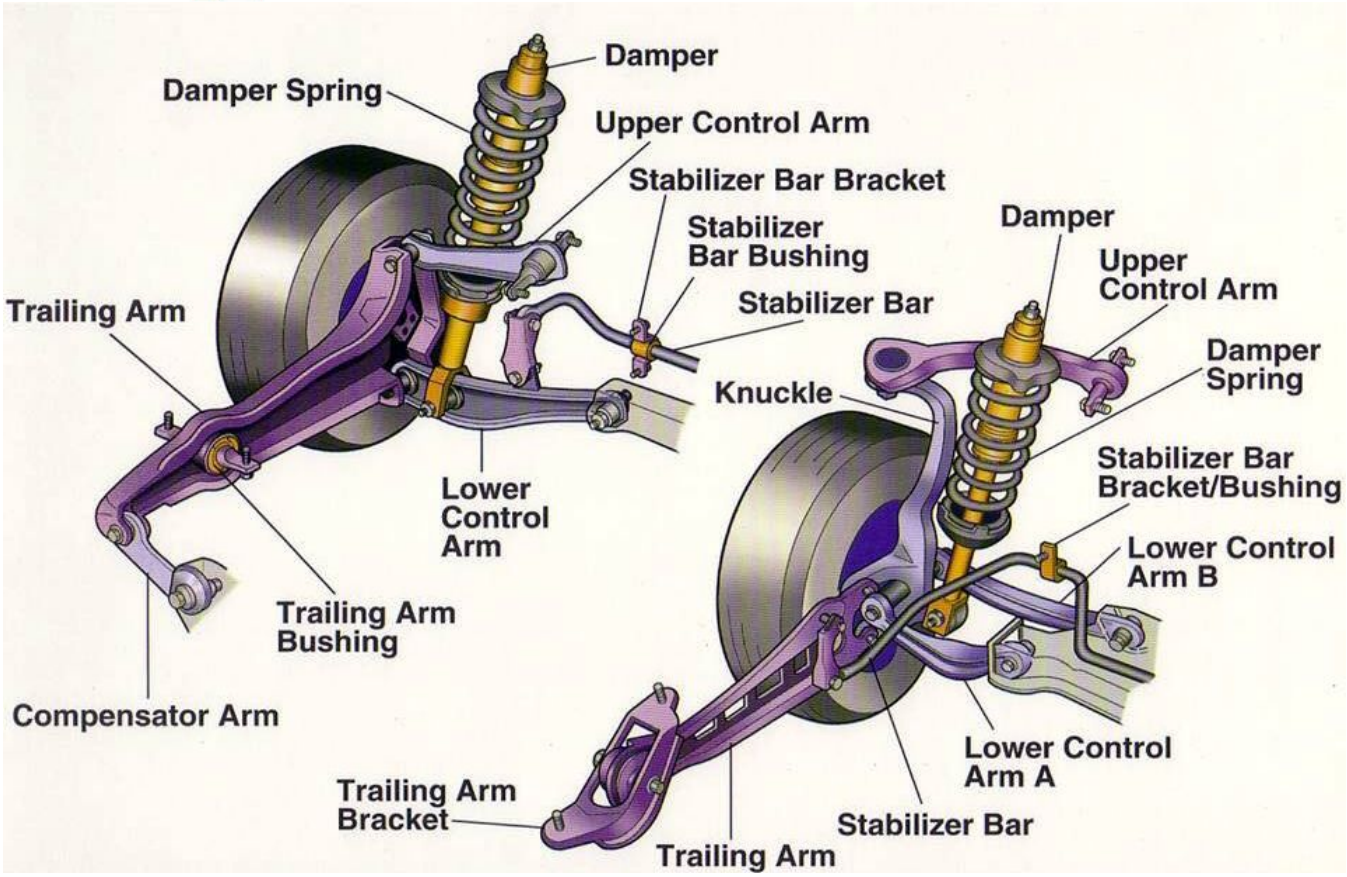


Figure 1.11. Suspension system

1.2.4. **Brake System**

Brake system enables the vehicle to stop and slowdown. Braking force takes place when the driver applies pressure and continuous application to the brakes will enable the vehicle to stop.

The following are the methods of stopping the rotational movement of the tires:

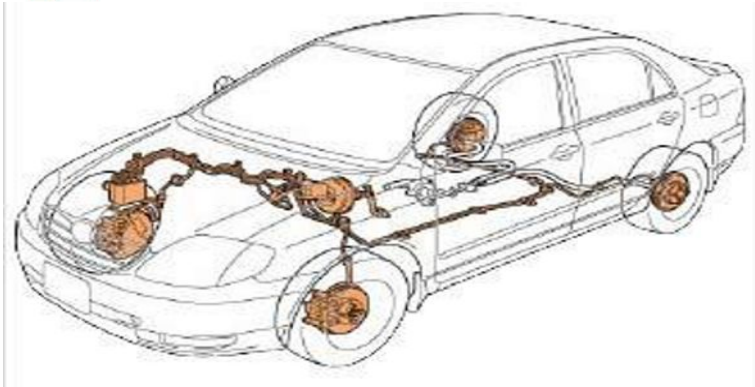


Fig.1.12. Brake System

(a) Foot brakes

Foot brakes are used to control the speed and stop the vehicle. Generally, disc brakes are used in the front wheels and disc or drum brakes are used in the rear wheels.

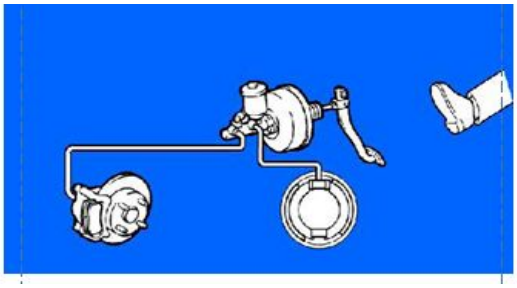


Fig.1.13.Foot brakes

(b) Parking brakes

Parking brakes or handbrakes are mainly used when the car is parked. The mechanical brake system locks the rear wheels.

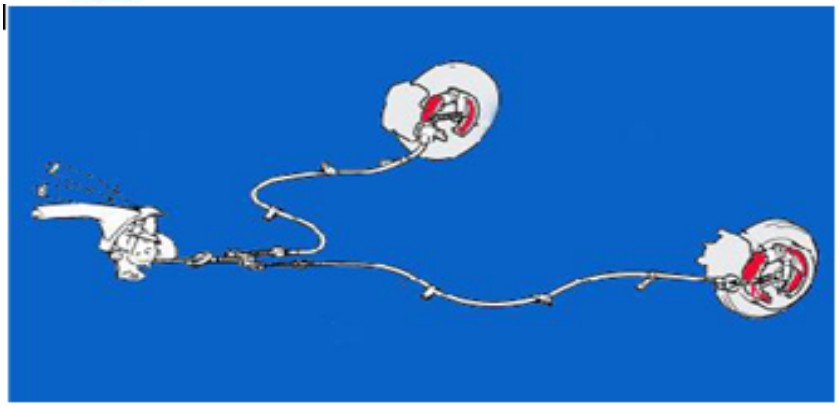


Fig.1.14.Parking brakes

(c) Engine brake

Engine brake used the retarding effect of engine when the vehicle is in gear and throttle valve is closed.

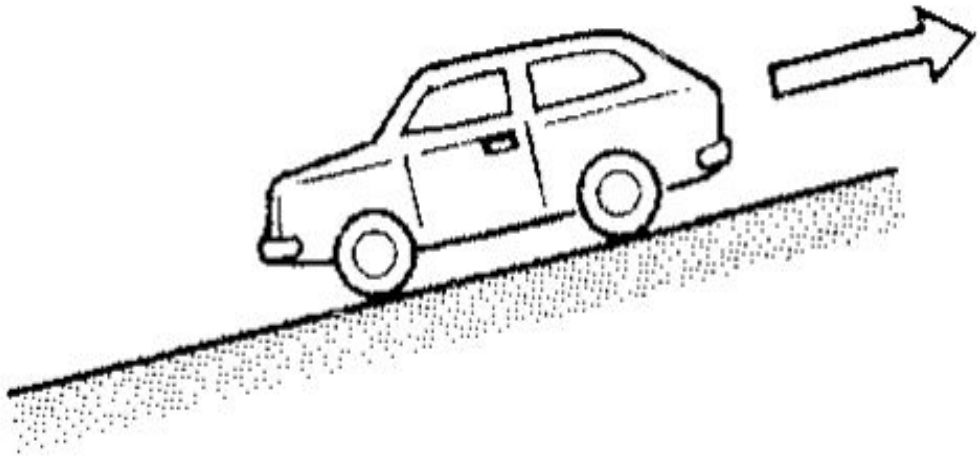


Fig.1.15.Engine brake

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Explain Brake System?
2. Write the engine system fundamental?
3. Write the vehicle mechanical system?

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: ____

1. _____
2. _____
3. _____

_____

Operation sheet 1

Operation title: Check Transmissions and drive trains

Instruction:

- ✓ make Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

Purpose: Ensure a correct inspection to operate the condition of engine, transmission and drive Trans, steering, suspension and, break systems.

Required tools and equipment: Work area, wrench, hammer, screw driver

Consumable Materials: Safety poster, first aid kit, waste bin, brake and steering fluid kerosene

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

Procedures:

1. Before road-testing the car, check the tires for specified inflation pressure and for abnormal wear.
2. Check for proper operation of the instruments-panel warning lights, gauges, and information displays.
3. Check the CV joints for noise and smooth operation. If a CV-joint boot is torn, check for grit in the grease and for joint wear.
4. Check the operation of the clutch and manual transmission or transaxle. Note the shift timing and shift quality in a vehicle with an automatic transmission or transaxle.
5. Note any unusual noise, vibrations or hardness heard or felt during the road test.
6. Hard to shift or will not shift
7. Check clutch pedal height
8. Check Clutch pedal free play
9. Check for air in clutch line
10. Check clutch line
11. Check clutch Master cylinder
12Check **TRANSMISSION OIL there is linkage or not**

Quality criteria: operate all activates within its system or component

LAP –TEST-

Name…… ID…… Date…….

Time started: _____Time finished: _____

Task 1.Inspecting brake system

Task 2.Cooling System Pressure Test

Task3. Inspecting intake system

Task4.fuelp Pressure Testing

Unit two: Basic operation, functions and principle of gasoline and diesel fuel system

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

- Gasoline fuel system
- Diesel fuel system

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:

- Suitable automotive systems and components are sourced to assist with task
- Location of system or component is confirmed in relation to modern vehicle configuration (where applicable)
- Method of operation is determined to confirm principles of system or component function

2. Basic operation, functions and principle of gasoline and diesel fuel system

2.1. Gasoline fuel system

2.1.1. Air Cleaner and its types

AIR CLEANERS

The dust entering with the intake air is trapped by either:

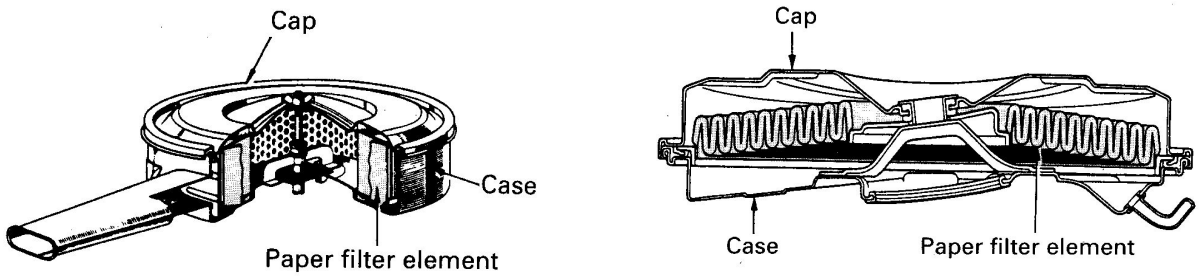
- Close-mesh screens
- Micro-pore filter materials
- Oil-wetted surfaces, or
- Use of the centrifugal force principle.

Air cleaners also perform the following functions.

- It captures moisture and carbon soot that are present in the atmospheric air.
- It **acts as a silencer** and **reduces the noise** caused by the intake air as the intake valves open and close. The task of reducing intake air noise in particular makes it necessary to use a large-volume air cleaner housing containing a filter of a suitable type with the largest possible total surface area and ample dust storage capacity (to increase the intervals between filter element renewal).
- It acts as a flame arrestor if the engine backfires through the air-intake systems. Backfiring causes a momentary flashback through the carburetor. Without air cleaner, the flame could erupt from the carburetor or air intake system and cause a fire in the engine compartment.

Several types of air cleaners are available commercially including the dry paper type, pre air cleaner, oil-wetted type, oil bath type, cyclone type, thermostatic air cleaner and so on. The paper type is most often used.

Dry (Paper) type Air Cleaner



Paper type **Axial-Flow Paper type**

Fig.2.1. Dry (Paper) type Air Cleaner

In this type, the dust is trapped by a folded-paper filter element or cartridge. The element itself is processed from resin-impregnated paper which is folded into pleats and then coiled to form a spiral. To ensure that the filter element or spiral makes an airtight seal once it is located in the air cleaner casing, a rubber or plastic sealing disc is provided on each side of the element. When installed in its casing the element encircles the air intake which ensures that all of the incoming air must pass through the filter element. When the engine is running, air is drawn through an inlet tube into the cleaner casing. The air then passes through the paper element where dust, grit and other impurities are retained, thereby ensuring that only filtered air can flow into the carburetor venture.

Characteristics

- Simple in design
- Highly efficient
- Easily maintained
- Mounted in any position to suit available under bonnet space.

Pre-Air Cleaner (Centrifugal)

A pre-air cleaner may be used to remove large dirt particles from the air before it enters the air cleaner. This highly efficient air cleaner has rotating fins that cause the air to swirl as it enters the pre-cleaner.

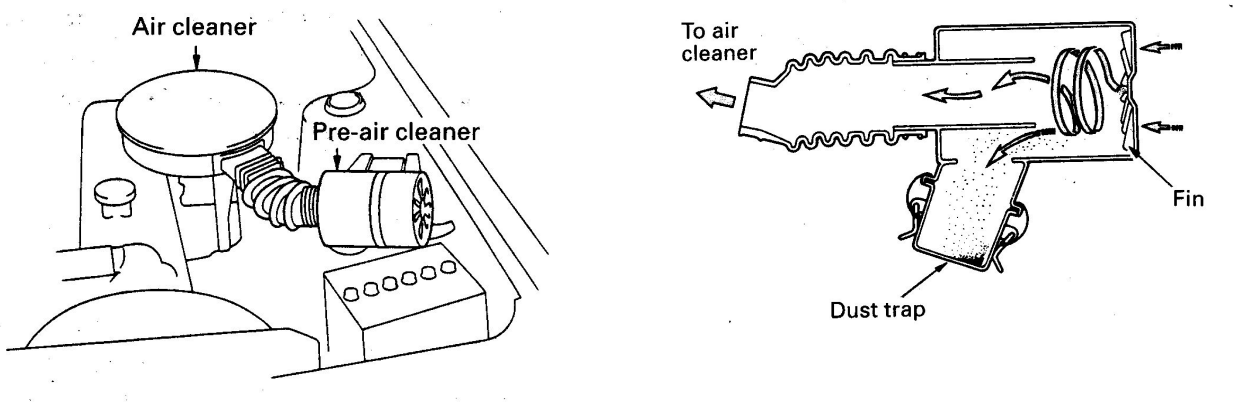


Fig 2.2.Pre-Air Cleaner (Centrifugal)

Centrifugal force and be trapped in the transparent container.

The air exits through the central pipe. Since the accumulated dirt can be seen through the transparent container, the operator can periodically remove the container for cleaning when enough dirt has accumulated.

Wet-type Air Cleaner (rarely used today)

Prior to the advent of the paper filtering element, this relatively early type of air cleaner provided sufficiently good filtration for most UK conditions, but it is not uniformly efficient. It has the advantage of allowing a fairly generous airflow for its size.

This type consists of a woven metal mesh element coated with oil. The incoming airflow passes closely over the very large quantity of metal wires in the filter and the dust is held back by the wetted surfaces. These filters operate for about 2500 km before needing attention.

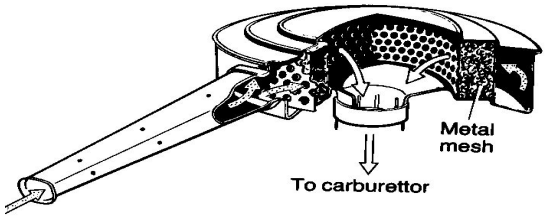


Fig.2.3 Wet-type Air Cleaner

The filter element can be cleaned by:

- Washing it in diesel oil, or
- Other acid-free solvent and blowing it dry with compressed air

It is then wetted lightly with clean engine oil and shaken firmly to dislodge excess oil.

Oil-Bath Air Cleaner

This type of air cleaner widely used for vehicles operating in dust countries.

It contains a woven metal mesh filter element with space for a quantity of oil beneath it.

Air enters at the circumferential gap of the filter and passes down the annular space to the restricted gap at the oil level. Air impinges on the oil surface at high velocity after the right angle turn due to which heavier particles of dust, dirt, sand, etc from the air are deposited in the oil bath. Oil-laden air then reverses upward into the filter element containing oil-wetted mesh of metal wool where the finer particles are arrested. Air then passes down to the vertical intake to the carburetor.

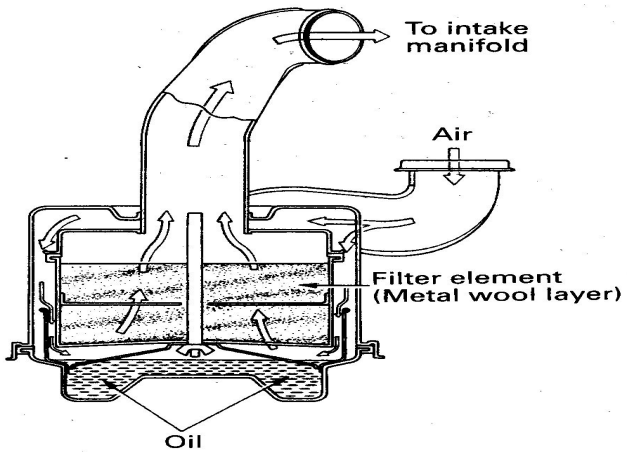


Fig 2.4 Oil-Bath Air Cleaner

The wire mesh filter should be cleaned by washing in a suitable cleaning fluid. The bath should also be cleaned and refilled with the recommended grade of oil to the correct level. Under normal operating conditions servicing intervals should be between 5000 km and 8000 km. However, under extremely bad atmospheric conditions of dirt and dust, more frequent servicing may be required.

Cyclone type Air Cleaner

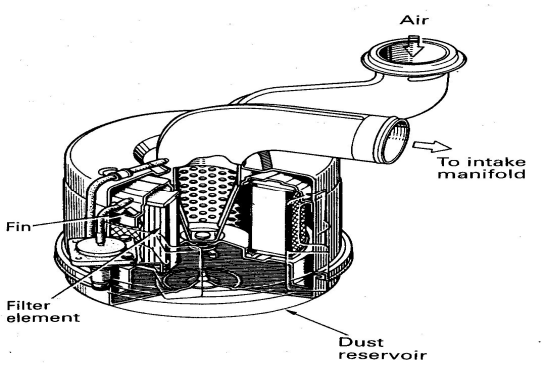


Fig 2.5. Cyclone type Air Cleaner

A cyclone type air cleaner is designed especially for very dusty, sandy areas. It has fins that create swirls of air. Large particles of dirt, sand, etc., are trapped inside the cleaner case by the centrifugal force of the air swirls (i.e. centrifugal force expels the larger dust particles). Smaller particles are trapped by the paper element. In some models, finer dust particles are trapped by a built-in oil bath air cleaner. This design minimizes clogging of the filter element and does not require maintenance as frequently as some other types.

Thermostatic Air Cleaner

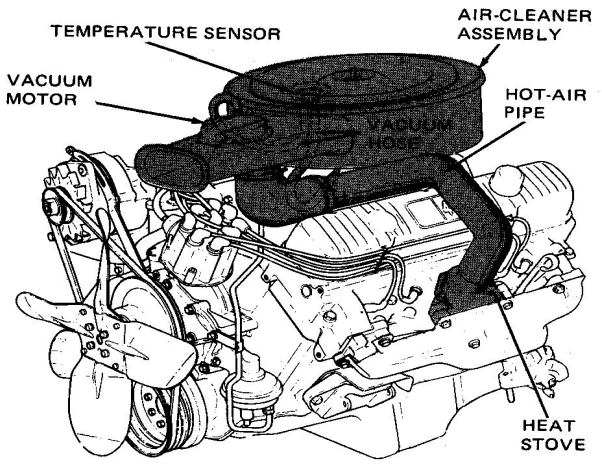
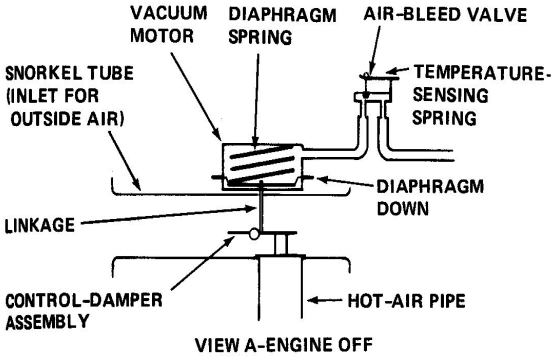
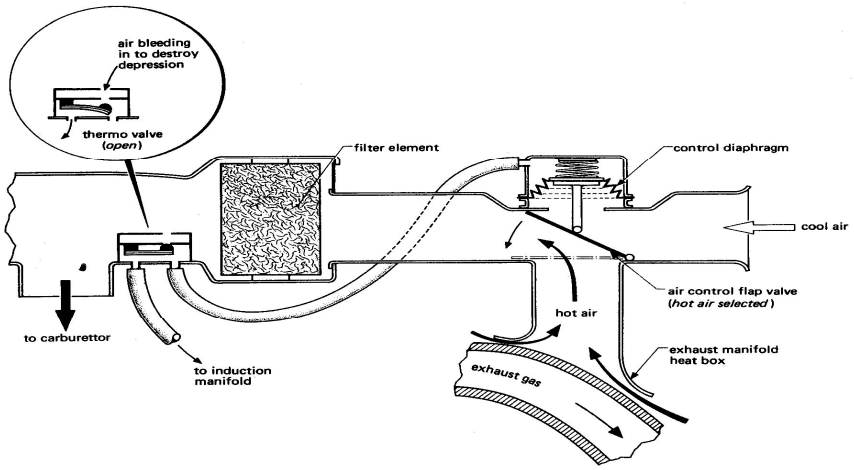


Fig2.6 **Thermostatic Air Cleaner**

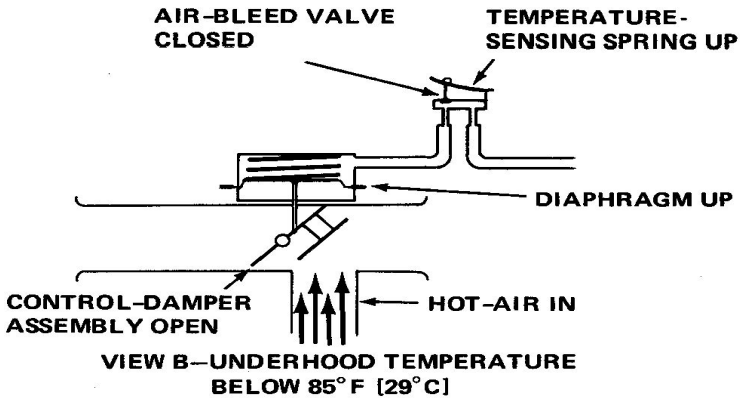
The thermostatic air cleaner is used with carbureted fuel system.

Its purpose is to improve engine performance and derivability when the engine is cold.

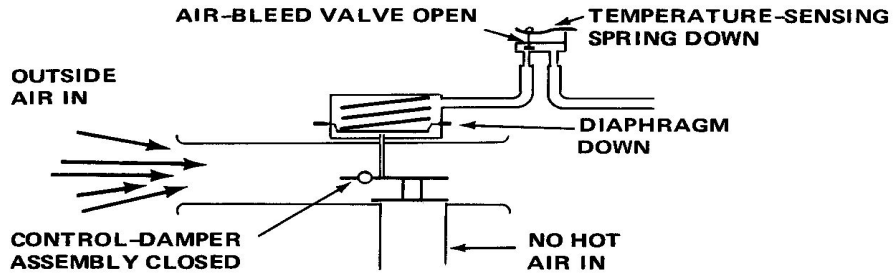




The thermostatic air cleaner includes a temperature sensor, a vacuum motor, a control damper or door, and vacuum hoses. A metal shroud or heat stove surrounds the exhaust manifold. A hot-air pipe connects the heat stove to the fresh-air duct or snorkel on the air cleaner.

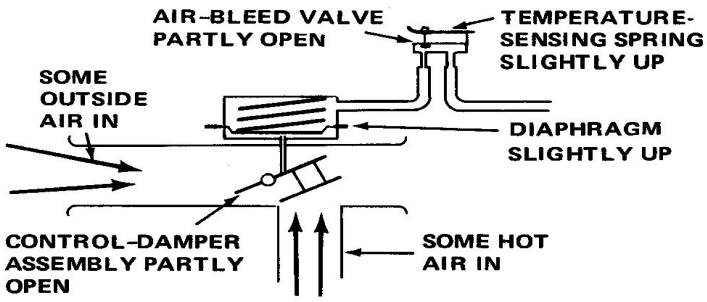


A temperature sensing spring in the thermostatic air cleaner reacts to the temperature of the air entering the air cleaner. When the air is cold, the temperature sensing spring holds the air-bleed valve closed. This applies intake manifold vacuum to the vacuum motor and raises the diaphragm in the vacuum motor. This closes the control damper assembly (or valve), preventing the flow of cool air into the air cleaner snorkel tube.



VIEW C—UNDERHOOD TEMPERATURE ABOVE 128° F [53° C]

Under hood temperature increases as the engine warms up. When the air gets hot enough, the temperature sensing spring opens the air bleed valve. This cuts off the vacuum to the vacuum motor. The diaphragm spring then pushes the diaphragm down. This lowers the control damper, which closes off the hot air pipe. All air entering the air cleaner now enters through the snorkel tube.



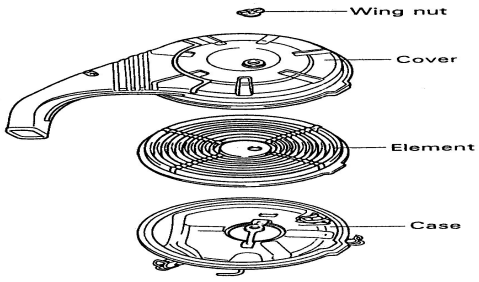
VIEW D—UNDERHOOD TEMPERATURE BETWEEN 85 AND 128° F [29 AND 53° C]

Servicing of Air Cleaners

A) Necessity for Maintenance

The air taken in by the engine contains dust and other particles which clog the carburetor passage, cause rapid engine cylinder wear and oil deterioration. The air cleaner traps the dust and dirt particles in the air with its filter, preventing them from entering the carburetor and engine cylinders.

B) Inspection of Paper type Air Cleaner



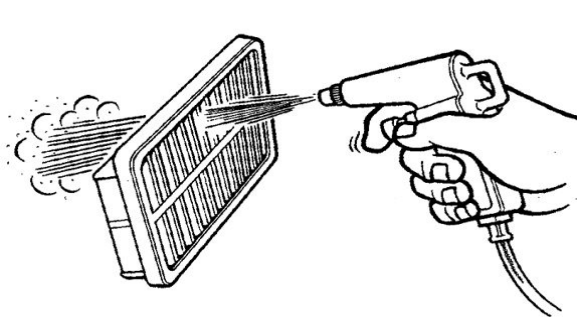
Remove Air Cleaner Element

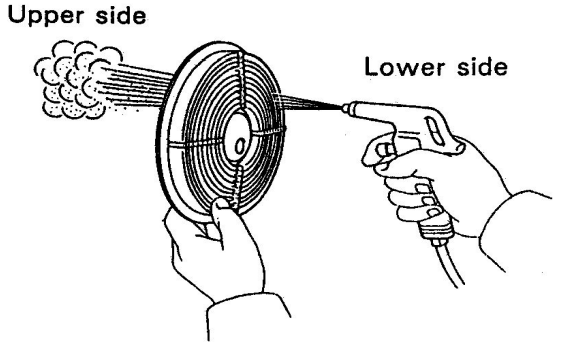
- Unscrew the wing nut and release the clips.
- Remove the air cleaner cover and take out the element.

Inspect Air Cleaner Element

- If the element is full of dirt and dust, replace it.
- The effectiveness of a filter element that is nearly ready for regular periodic replacement will not be recovered by cleaning, so it should be replaced.
- A filter element impregnated with water or oil should be replaced, as trapped dust and sand cannot be removed with compressed air.

Clean Air Cleaner Element





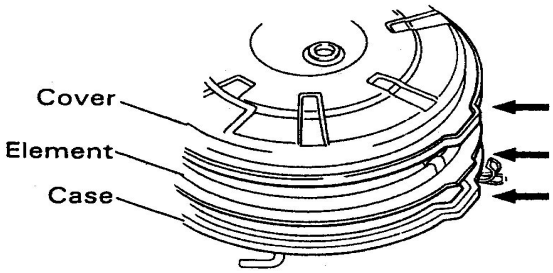
- Using an air gun, blow the dust and sand particles out from the lower surface.
- Next, clean the upper surface and once again blow evenly from the lower surface.

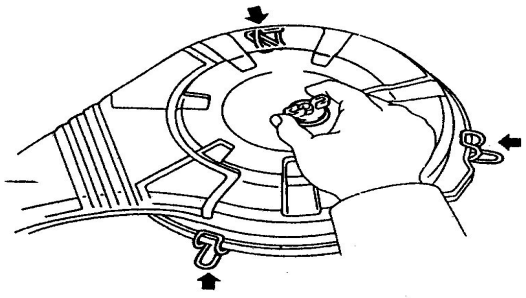
Clean Air Cleaner Case

- First use a rag to wipe out the dust from inside the case, then blow with compressed air.
- Be careful to prevent even the smallest particles from entering the carburetor.
- Check that the sealing on the case or cover is not peeling. If it is, repair it. Improper sealing will cause unfiltered air to enter the engine.

Assemble Air Cleaner

- Install the element correctly in the air cleaner case and assemble the case cover.





- To install the element, align the tabs on the case, element and cover.
- Fasten the clamps and tighten the wing nut by hand.

2.1.2. Basic operation or Principle

Introduction

The engine is the vehicle's main source of power. The engine uses fuel and burns it to produce mechanical power. The heat produced by the combustion is used to create pressure which is then used to drive a mechanical device.

The engine is the heart of the automobile. It converts fuel into the energy that powers the automobile. To operate, it requires clean air for the fuel, water for cooling, electricity (which it generates) for igniting the fuel, and oil for lubrication.

Engine system means the engine, the emission control system and the communication interface (hardware and messages) between the engine system electronic control unit(s) (ECU) and any other power train or vehicle control unit;

The engine consists fixed cylinder of and a moving piston. The expanding combustion gases push the piston, which in turn rotates the crankshaft. Ultimately, through a system of gears in the power train, this motion drives the vehicle's wheels

2.1.1 Components of gasoline fuel system and its function

Fuel Tank

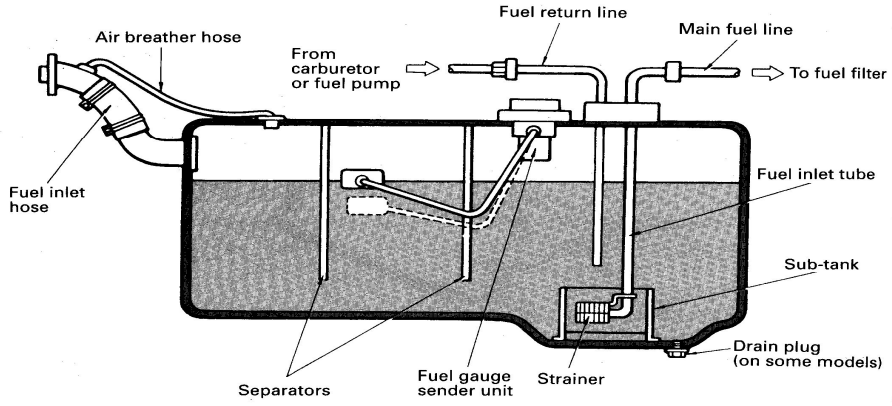


Fig 2.7.Fuel Tank

The fuel tank is located remote from the engine and it is usually located in the rear of the vehicle to prevent the leakage of gasoline in case of a collision. In a front-engine car, the fuel tank may be secured directly to the underside of the rear luggage compartment floor generally by means of setscrews through a flanged connection.

More recently, fuel tank design and installation have received attention to reduce the hazard which may follow a rear end collision and spilling of fuel from a damaged tank. For this reason the fuel tank may now be located above the rear axle, so that it is better protected by the rear wheels and the surrounding body structure. For rear-engine cars the fuel tank is usually either flange mounted on to the front luggage compartment floor or strap mounted to the same compartment bulk head.

The fuel tank is constructed of either **corrosion-protected thin sheet steel or aluminium alloy**. The advantages of using the latter material include a saving in weight and inherently good resistance to corrosion, but any repairs are more difficult to effect. A later development has been the **moulded plastics fuel tank**, which not only weighs less than a corresponding sheet metals tank, but possesses freedom from corrosion and also complies with modern safety requirements.

The inside of the sheet metal tank is plated to avoid rusting. The tank is equipped with separators to avoid changes in the fuel level when the vehicle is moving (during acceleration, braking and cornering). The mouth of the fuel inlet tube is located 2 to 3 cm above the bottom of the tank to prevent sediment and water in the gasoline from being sucked into the tube.

A fuel filler tube with cap is connected towards the top of the tank and may simply be vented to the atmosphere, so that air can enter and take the place of fuel pumped from the tank. In the absence of suitable venting, a depression would be created in the tank that could not only interfere with normal fuel delivery, but also tend to collapse the tank. Another vent pipe (air breather hose) may also be connected from the top of the fuel tank to a point near the top of the filler tube, so that air can leave the tank as fuel is pumped into it and thereby prevent an air lock.

Fuel Lines

There are three fuel lines: the main fuel line, which carries fuel from the fuel tank to the fuel pump; the fuel return line, which carries fuel back to the fuel tank from the engine; and the fuel emission line which carries HC gas (vaporized gasoline) from the inside of the fuel tank back to the charcoal canister. They usually run under the floor pan or the frame. To avoid damage to the lines by stones flying up from the surface of the road, a protector is also provided.

An obvious requirement of the fuel pipelines connecting the tank, pump, filter and carburetor is that they must be pressure tight. If this condition is not maintained, any leakage of petrol on the delivery side of the pump presents a fire hazard, while the entry of air on the intake side will reduce pumping capacity.

Rigid metal pipelines are used for those parts of the system attached either to the body structure or to a separate chassis frame. Their installation is generally such that they are positioned away from the heat of the exhaust system. Usually the fuel pipelines are supported in small metal clips that may be lined with rubber, which not only protect the pipes against vibration, but also isolate the car interior from transmitted pump noise. Due to engine vibration, rubber hoses are used where the fuel line connects with the carburetor and the fuel pump.

Fuel Filters Filtration in the fuel delivery system to the carburetor serves two purposes:

1. It must prevent foreign particles from becoming lodged in and interfering with the normal action of the fuel pump valve mechanism.
2. Similarly, it must protect not only the float valve mechanism of the carburetor, but also its fuel metering devices and internal passages.

Most fuel systems have at least two filters: Strainer and In-Line filters.

2.4.1 Strainer (or) Filter Screen

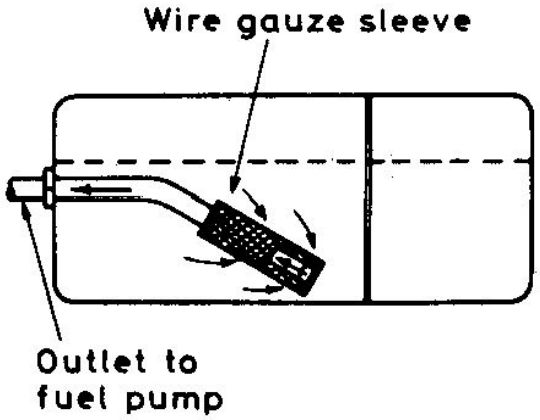


Fig.2.8.Strainer (or) Filter Screen

A strainer (or) filter screen attaches to the pickup tube in the bottom of the fuel tank. A relatively coarse surface filter or strainer, in the form of either a circular screen or an extended sleeve of wire gauge, is used. All fuel leaving the tank and entering the delivery system must first pass through this filter.

The strainer filters out relatively larger particles in the fuel. An in-line filter is between the fuel tank and the carburetor.

These units usually catch any water or foreign particles that were not filtered out previously by the strainer. The filter element is actually made of ceramic or paper. Generally a fine depth type filter of specially processed water resistant, pleated paper may be incorporated before the outlet of the pump itself or in the pipeline between the pump and carburetor. An inline fuel filter may include a magnet to catch metal particles in the fuel.

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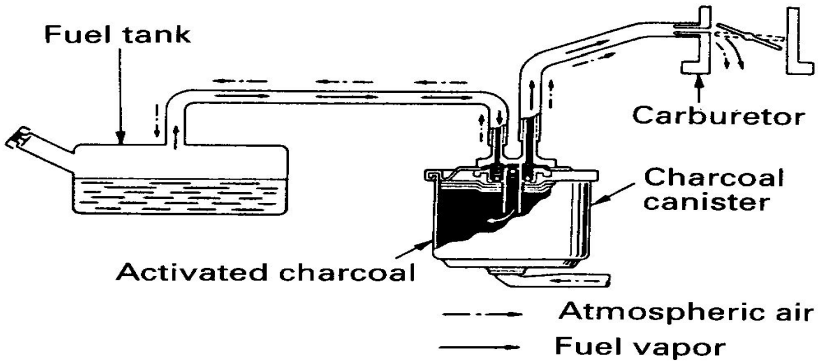
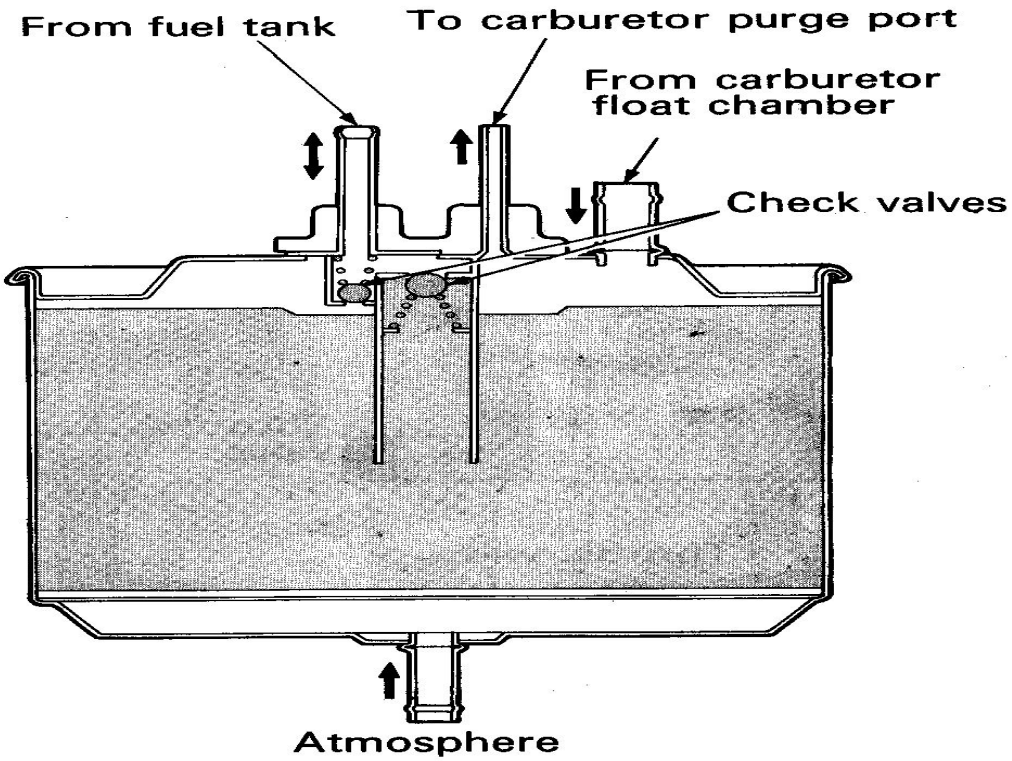
Charcoal Canister (some models only)



FLOWS OF FUEL VAPOR AND AIR



FUEL PUMPS

Since the fuel tank is positioned lower than the carburetor, the gasoline fuel does not flow naturally to the carburetor. It needs the fuel pump which lifts fuel from the tank and supplies the same to the carburetor. The pump's discharge pressure is developed by a diaphragm spring, and limited by the closing pressure of the float needle valve. This ensures a constant fuel level in the float chamber. Fuel pumps must be designed to interrupt the supply to the carburetor as soon as the correct fuel level is reached and the float closes the float needle valve. The fuel pump must deliver more fuel than the maximum volume the engine can consume.

Two types of fuel pumps are used: the mechanical type (delivery pressure 0.2-0.3 bar) and the electric type (delivery pressure 2 - 4.7 bar).

Mechanical Fuel Pump

Mechanical fuel pumps, employed mostly in carburetor-type engines, are operated by an eccentric (an off-center section) of the camshaft.

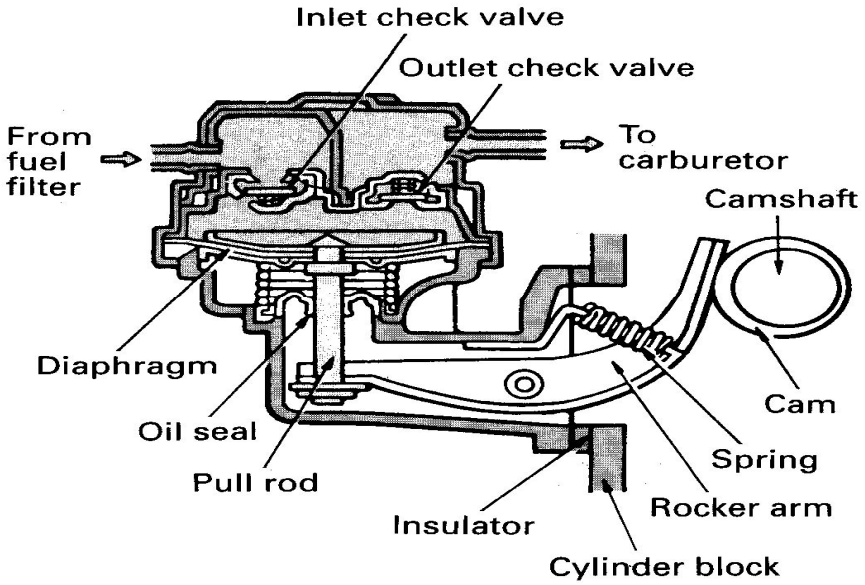


Fig 2.9.Mechanical Fuel Pump

There are two types of mechanical fuel pump: the type with a return pipe and the type without a return pipe. However, the basic construction and operation of these two types are the same.

In most previous engines, the fuel was returned to the fuel tank from the carburetor. Now, however, it is usually returned from the fuel pump via the fuel return line.

A mechanical type fuel pump has a diaphragm in the center. A pair of valves, acting in opposite directions, is located in the pump. These valves are actuated by a reciprocating movement of the

diaphragm to feed the fuel to the carburetor. The diaphragm is operated by the rocker arm, the end of which rests on the camshaft eccentric. Many V-type engines use a pushrod from the eccentric to the rocker arm.As the cam rotates, the eccentric moves the rocker arm up and down. The inner end of the rocker arm is linked to a flexible diaphragm. The diaphragm is clamped between the upper and lower pump housings. The diaphragm spring applies a force on the diaphragm. As the rocker arm rocks, it pulls the diaphragm down and then releases it. The diaphragm spring pushes the diaphragm up. This up and down movement of the rocker arm continues as long as the engine is running.

2.2. Diesel fuel system

2.1.1. Basic operation or Principle

In the diesel engine, only air is drawn into the cylinder during the air intake process, and the air is highly compressed during the compression process. Fuel is then injected into the high-temperature, high-pressure air.

Brief Description of the Diesel Engine

Theoretically, the diesel cycle differs from the Otto cycle in that combustion takes place at constant volume rather than at constant pressure. Most diesels are also four-stroke engines but they operate differently than the four-stroke Otto-cycle engines. The first, or suction, stroke draws air, but no fuel, into the combustion chamber through an intake valve. On the second, or compression, stroke the air is compressed to a small fraction of its former volume and is heated to approximately 440°C (approximately 820°F) by this compression

2.1.2. Components of diesel fuel system and its function

Fuel tank, fuel line, fuel filter, fuel feed pump, injection pump, high pressure line, injector nozzle and combustion chamber. For diesel engine (distributors type)

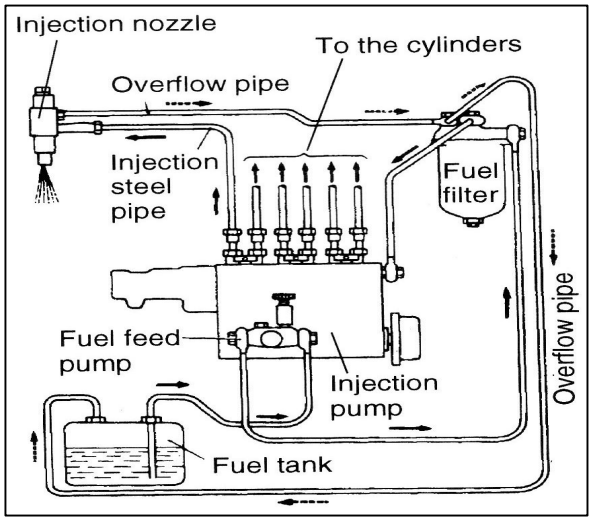
Fuel tank: - It is a reservoir of fuel which is made of sheet metal of sufficient capacity

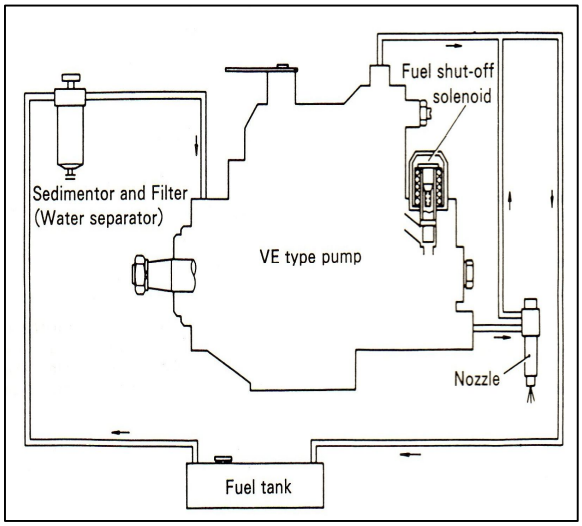
Fuel Line: - which allow fuel to reach to the pump & to the injector nozzle

Fuel Filter Feed pump It maintains the fuel pressure in the system at a sufficient high level to circulate the fuel

Injection Pump the pump supplies fuel to the injectors according to the firing order at the constant stroke correct time in the cycle.

Nozzle: - A single unit used to meter, atomize & inject the required amount of fuel into the combustion chamber of the cylinder





Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the fuel system function?
2. Write the engine system fundamental?
3. Write the vehicle mechanical system?

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1._____

2._____

3._____

Operation sheet-2

Operation title :Fuel System Testing and Correcting

Procedure

1. Disconnect the hose at the inlet to the carburetor.
2. Cranking the engine check whether there is a spurt of fuel through the hose or not.

3. If there is a spurt of fuel, you may test the fuel pump for pressure and volume before and after the fuel filter. If it is within the specification, then check the condition of the carburetor.

4. If fuel there is no fuel or pressure and volume are not within specification, and then perform a vacuum test at the inlet to the fuel pump.
5. If there is no vacuum or is less than the specification, then repair or replace the fuel pump.
6. If the vacuum is within specification, then go back to check the hoses up to the fuel tank and the fuel tank itself.

LAP EST-2

Task-1 Service Gasoline Fuel System

Task-2 Service Diesel Fuel Injection System

Unit Three: Basic operation, functions and principle engine mechanical system fundamentals
This unit to provide you the necessary information regarding the following content coverage and topics: ➢ Basic principle of engine operation ➢ Basic components of Engine ➢ Identifying Potential common faults This guide 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: ➢ System or component is examined and sub-assembly components are identified ➢ Method of operation is determined to confirm principles of system or component function ➢ system or component relationship to light vehicle operation is determined ➢ Potential common faults with system or component are identified

3. Basic operation, functions and principle engine mechanical system fundamentals

3.1. Basic principle of engine operation

(A) Internal combustion engine

An engine that produces its power by the internal burning of fuel inside the cylinders. The created combustion or pressure pushes the piston down and crankshaft mechanism force to move up the piston in a cycle. The reciprocating movement of the pistons converted into rotary motion by the crankshaft. It can be either gasoline or diesel engine depending on the fuel used.

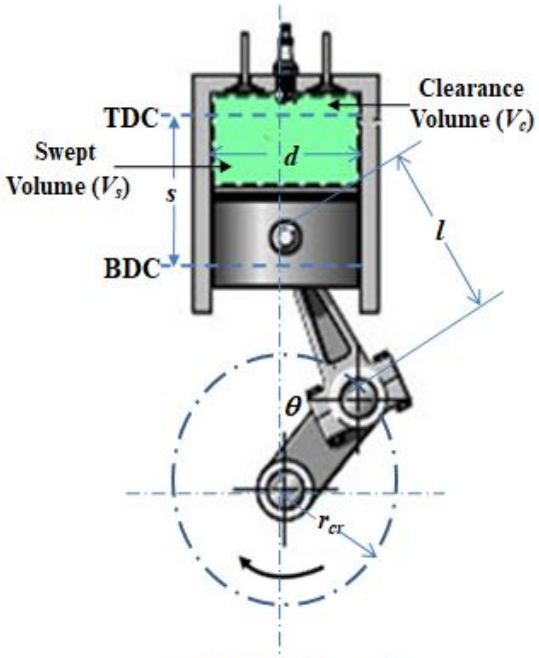
- **Gasoline engine**

A mixture of gasoline and air is burned inside the cylinders of an engine.

- **Diesel engine**

An atomized diesel fuel sprayed into the combustion chamber and self-ignited by heat of compression.

3.1.1 **Engine terminology**



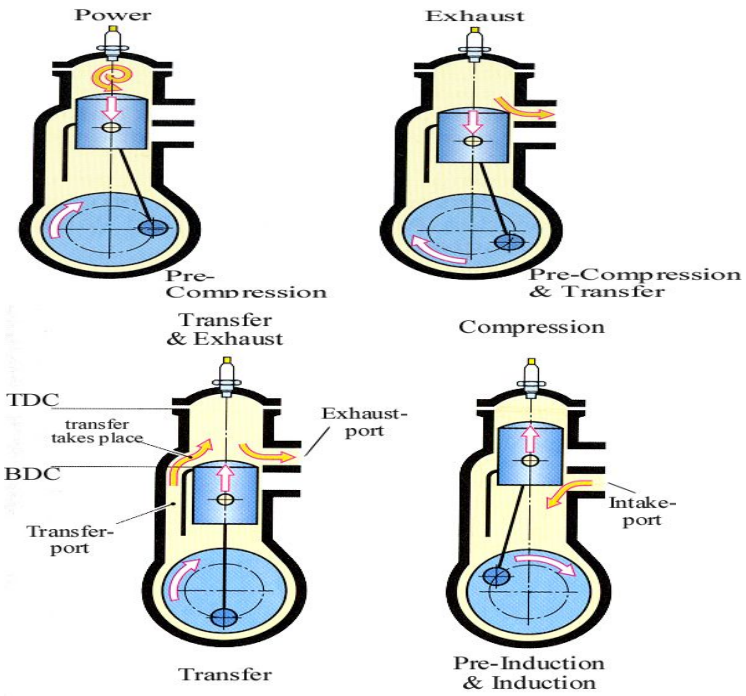
A 'Full-Sectioned' Engine 'Front View'
(both 'Valves' are being rotated by 90^0)

Engine Terminologies

TDC = Top Dead Center
BDC = Bottom Dead Center
Stroke (s)
Bore (d)
Clearance Volume (V_c) or Combustion Chamber
Swept Volume $(V_s) = \frac{\pi d^2}{4} \times s$
Cylinder Volume $(V) = V_c + V_s$
Compression ratio $(r) = \frac{V}{V_c} = 1 + \frac{V_s}{V_c}$
Con-Rod length (l)
Crank radius $(r_{cr}) = \frac{s}{2}$
Crank angle (θ)

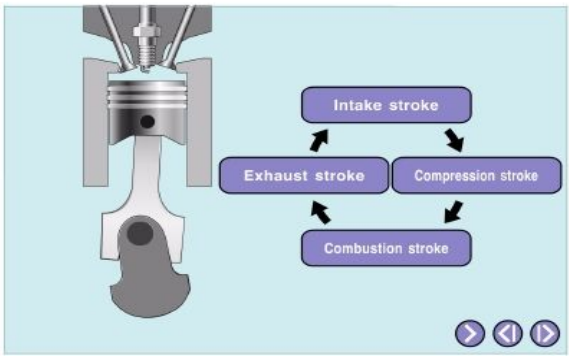
3.1.2 **2-Stroke Principle**

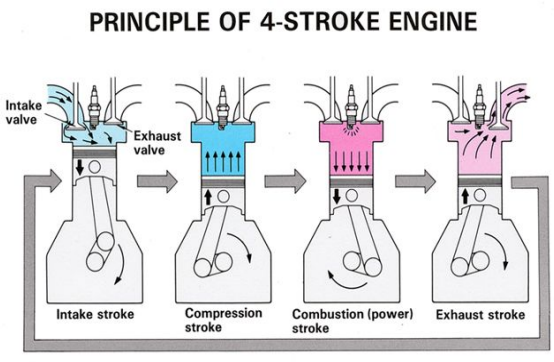
A. Two-Stroke Cycle Engines – these are engine where the cycle is completed in two (2) strokes of the piston. This means that the piston has to move two times to complete the cycle.



3.1.3 **4-Stroke Principle**

B.. Four-Stroke Engines - these are engines where the cycle is completed in four (4) strokes of the piston. This means that the piston has to move four (4) times to complete the cycle.



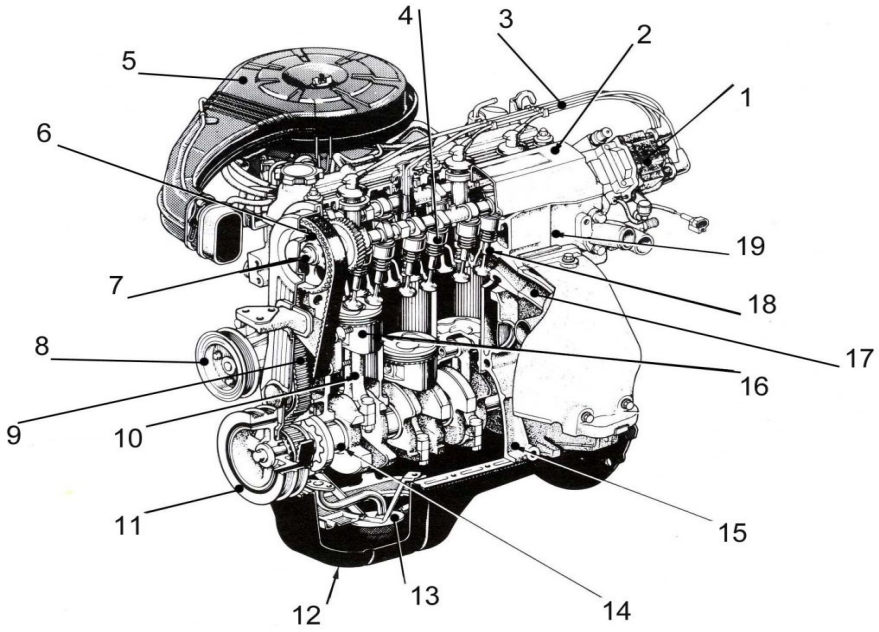


Stroke	**Movement of**	Position of the Valve		Purpose
	the Piston	**Intake Valve**	**Exhaust Valve**	
Intake	Going Down	Open	Close	✓ Sucked air/fuel mixture into the cylinder
Compression	Going Up	Close	Close	✓ Compressed the air/fuel mixture to increase its temperature
Power	Going Down	Close	Close	✓ Combustion takes place
Exhaust	Going Up	Close	Open	✓ Burned gases pushed out from the engine cylinder

3.2. Basic components of Engine

An Engine is a mechanical device used to convert heat energy into mechanical energy.

And is usually called a Heat Engine.



1 - Distributor
2 - Valve cover
3 - High tension cables
4 - Tappet
5 - Air cleaner
6 - Timing pulley
7 - Camshaft
8 - Water pump
9 - Timing belt
10 - Connecting rod
11 Crankshaft pulley
12 - Oil sump 13 - Strainer
14 – Crankshaft 15 - Engine block
16 – Piston 17 - exhaust manifold
18 – Valve 19 - Cylinder head

3.3. Identifying Potential common faults

Failure to Achieve Power Loss

A. Failure to achieve ignition and power

The ignition relay is one of the most important electronic relays found on modern vehicles. It is usually located in the fuse and relay panel beneath the hood, and is responsible for providing power to the vehicle's ignition system, and some of the fuel system's components. When the key is turned to the on position the relay is switched on and power is directed to the vehicle's ignition and fuel system components, notably the fuel pump and ignition coils. When the relay fails or has an issue it can cause major problems with the operation of the vehicle. Usually a bad or failing ignition relay will produce a few symptoms that can notify the driver of a potential issue.

B. Car suddenly stalls while operating

One of the most common symptoms of a failed ignition relay is a car that suddenly stalls while operating. If the ignition relay shorts, burns out, or otherwise fails while the engine is operating it will cut off power to the fuel pump and ignition system. This will cause the vehicle to immediately stall due to fuel and spark being cut off. In some instances of a faulty relay the vehicle will be able to restart once the relay cools off, only to stall out once again after the relay overheats.

C. Car not starting

Another symptom of a faulty ignition relay is a no power condition. If the relay fails it will cut off power to fuel pump and ignition system, which will result in a no power, and therefore no start condition. You may find that turning the key may power on the accessories, and may even crank the engine, however the vehicle will not start due to there not being any power directed to the fuel and ignition system. Similar symptoms can also be caused by a wide variety of other issues, so a proper diagnosis is recommended in order to make certain what the issue is.

D.Dead battery

A dead battery is another symptom of a faulty ignition relay. If the relay has an internal short it may keep power fed to the ignition and fuel system, even when ignition cylinder is in another position, or the key is removed. This will cause the fuel pump and ignition components to remain powered on, drawing current, at all times, which will eventually lead to a dead battery. Aside

from draining the battery this may also cause accelerated wear on the components, notably the fuel pump, due to having them powered on, but not operating.

E. Burned relay

In certain instances it may be possible for the relay to overheat to the point of burning up and melting. Apart from cutting off power to the vehicle's ignition relay and causing performance issues, a burned relay may melt onto the fuse panel. This may make it difficult to remove, and in some instances can even lead to the replacement of the entire fuse box.

While servicing the ignition relay is not generally considered routine maintenance, it can sometimes fail and cause major issues for the vehicle. If you suspect that your ignition relay may be having an issue, have the vehicle inspected by a professional technician, such as one from YourMechanic, to determine if the relay should be replaced.

3.3.1 Failure to Achieve Fuel Flow

Fuel system related problems, can be difficult to solve.

Consequently, anything that might affect the flow and pressure of the fuel system; is going to result in poorer performance.

Above all, the biggest cause of any fuel system problems is dirt.

So, the weak link in the fuel system is usually, the fuel filter. In other words, the very purpose of this usually small part is to; prevent any contaminants from getting into the fuel.

Three Major Components of Concern Are The:

- Filters
- Fuel Pump
- Injectors

The big thing to note is that most of the failure warning signs; are the same for most fuel system problems:

- Hesitating Engine
- Stalling
- Not Starting
- Hard Starting
- Different Performance at Different Speeds
- Engine Misfiring
- Engine Sputters at High Speeds

- Loss of Power When the Vehicle Is Under Load
- Surging
- Decreased Gas Mileage

We explore the three most common causes of fuel pump failures.

The fuel pump is responsible for delivering fuel from the gas tank to the engine. Aseemingly simple task that can easily be compromised when outside issues affect the performance of the pump.

The three most common causes of fuel pump failure include:

1. **Fuel contamination:** Fuel is jeopardized from corrosion, debris and moisture, which can all bring visible contaminants into the tank.
2. **Clogged strainers/filters:** The aforementioned contaminants eventually clog critical components including strainers, filters and the fuel pump itself. This blockage ultimately impairs the flow of fuel, which may affect the vehicle during acceleration, among other long-term impairments.
3. **Electrical issues:** Electrical faults are also significant contributors to fuel pump failures. The most common electrical issues are rusted connectors, loose connectors, or melted wiring and connectors. To help identify issues of poor electrical connections, a high quality digital volt/ohm/meter should be used to test for voltage drops and continuity.

3.3.2 Excessive Exhaust Smoke or Noise

What does excessive exhaust smoke mean?

If your car is emitting a lot of exhaust smoke there's a solid chance that the vehicle has suffered some sort of engine issue. If a vehicle's engine is not properly cared for, meaning it is denied scheduled maintenance such as oil changes and cooling system flushes, it will eventually bite the dust earlier than one that does have these services completed. Depending on the color of the smoke coming out of the tailpipe you can generally tell what kind of problem the motor is suffering from. It is necessary to have your car looked at by an auto mechanic as when you first notice an increase in the amount of colored exhaust in order to avoid more extensive engine trouble. These are the most common colors of exhaust smoke and the trouble that they may be a sign of.

Blue Exhaust

An oil leak that causes oil to be burnt up in the combustion chamber will result in blue exhaust smoke. This needs to be taken care of immediately because if the motor becomes starved of oil it will not be lubricated properly and it will likely result in massive engine damage.

White Exhaust

If your car is creating white clouds of exhaust smoke there is likely cooling system trouble. The white smoke is produced by coolant burning up in the engine. This can occur if there's an internal coolant leak within the motor. Cooling system problems may cause additional problems for the motor, including blown head gaskets or burnt piston rings. If the issue is not dealt with in a quick manner you may find your car in need of extensive and expensive engine repair on your hands.

Black Exhaust

A vehicle that produces excessive black smoke is likely burning too much gasoline. There are a number of issues that can cause this, which include:

- *Leaking fuel injector(s)* - Leaking fuel injectors can drip extra fuel into the combustion chamber.
- *Stuck fuel pump relay* - This is a rare problem but if the relay for the fuel pump is stuck in the "on" position it may feed extra amounts of gas to the engine.
- *Bad o2 of MAF sensor* - A bad oxygen sensor mass air flow sensor may result in the car burning extra fuel because it cannot properly calculate the correct air/fuel mixture needed to make the car run properly.

- *Clogged air filter* - Another less common problem is a clogged air filter. If the air filter is clogged the engine will not be able to produce the right air/fuel mixture and the car's computer system will compensate by burning extra gas.

3.3.3 Unusual Engine Noises or Vibrations

There are several common causes of **engine vibration** in a car, and they all result in shaking and noises that can be quite alarming and sometimes scary. However, if you know what some of the most frequent caused of engine vibration are, you can not only avoid too much stress and worry, you can know how to explain the problem and symptoms to a car mechanic when the time comes to correct the problem. So, here is a list of some of the most common reasons your car's engine might shake or vibrate.

- **Worn Out Spark Plugs**

In many vehicles a common cause of engine vibration is worn out or faulty sparkplugs. Worn out or dirty sparkplugs will cause the car's engine to misfire or not properly fire on each and every cylinder. When this occurs, it is commonly referred to as the engine missing or not firing on all cylinders. This can usually be corrected by installing new sparkplugs or correcting other spark or compression-related issues.

- **Loose or Disconnected Hoses**

Loose or disconnected hoses can also be a common cause of many types of engine vibration. A loose or disconnected air hose or vacuum hose can cause quite a bit of violent shaking and vibration in your car's engine. To correct the problem, simply look for any loose or disconnected hoses and reattach them and replace them as needed.

- **Broken Motor Mounts**

If the vehicle shakes violently or the engine vibrates excessively when stopped at a red light or when parked with the engine on, this may be a good indicator that the motor mounts or transmission mounts on the vehicle are damaged or broken. A good way to tell if this is the problem is to simply put the car in neutral and see if the vibration or shaking decreases a bit. If it does, this is a good sign that there may be problems with your engines motor mounts and you should have the engine inspected by a qualified repair shop or professional mechanic.

- **Faulty or Poorly Adjusted Fuel Intake System**

Another common problem that causes engine vibration and nasty shaking is a poorly adjusted fuel intake system. Sometimes, idling problems that cause engine vibration may be as simple as

adjusting the idle on a carburetor or cleaning components in the fuel intake system so that fuel passes through the engine more easily creating cleaner and more efficient combustion your car's engine.

- **Faulty Timing Belt**

Problems with your vehicle's timing belt, or other belt driven accessories, are another common cause of engine vibrations in vehicles. Timing belts and other belts that are loose or damaged will cause components controlled by belts such as fans and other parts to not rotate or turn a consistent speeds which will result in strange sounds and vibrations from your car's engine. To avoid these types of problems, you should frequently inspect all of the belts in your vehicle to make sure that they are free from cracks and ribbing and also make sure that the belts are tight and operating as they should.

3.3.4 Excessive Play or Vibration through Steering

- **How to Diagnose a Shaking Steering Wheel**

During normal operation, your car should drive smoothly and consistently across the streets you navigate. As drivers, we barely feel bumps, cracks or imperfections in the roads due to the advanced technology that comprises the suspension and drive systems on modern vehicles. However, there are times when we feel a vibration in the steering wheel that shows up on certain roads, at a particular speed or anytime the vehicle moves forward.

Because there are multiple components on today's vehicles that can cause shaking in the steering wheel, trying to find the exact source can be frustrating and time-consuming, even for the most experienced mechanics. Add the fact that multiple front end components could be worn out or out of alignment at the same time, and you'll understand why the process of discovering the exact cause of steering wheel vibration can be a time consuming and extremely detailed process.

Part 1 of 3: Diagnosing tire and wheel balance issues

The most common cause of steering wheel vibration is due to tires and wheels that fall out of balance. Tire/wheel balance is the process of adding weight to the wheel after a new tire has been installed. Every tire that comes off the factory floor has some imperfections in the construction or the weight distribution, and requires weights to balance it.

The best way to determine if the steering wheel shaking is caused by your front tires and wheels being out of balance is to have a professional tire technician complete a balance check.

Typically the warning signs that lead to this issue include:

- The steering wheel vibrates when the vehicle reaches highway speeds (55 mph and above)
- The shaking progressively gets worse the faster the vehicle drives
- The shaking goes away when you decelerate below highway speeds

You can also perform some inspections yourself to determine whether or not your tire/wheel balance is causing the steering wheel vibration.

Check the sides of your tires for marks. The most common cause of tires and wheels falling out of balance is due to the tire striking a curb. If you see scuff marks on the side of your tire, it's a good indication that the tire and wheel are out of balance. Hitting an object will shift the weight balance of the tire to where the tire struck the object.

Another simple check is to inspect the side of the wheel where the weights were initially installed. If you see a clean spot in the shape of a wheel weight on the side of your wheel, it's likely that the weight fell off. This check is hard to complete on the inside of the wheel, but if you can, turn the wheel to the left and inspect the inside as well.

Part 2 of 3: Diagnosing wheel bearing issues

The wheel bearings secure the wheel hub to the vehicle’s suspension. Inside the wheel bearing housing is lubricant designed to keep the bearings cool and reduce the buildup of heat as the wheel spins. Over time, the wheel bearings tend to lose lubricity, and if the bearings are not replaced in a timely manner, they can cause the wheel hub to loosen.

As the vehicle drives down the road, the loose wheel will vibrate, which may be felt in the steering wheel. If the wheel bearings are not replaced soon, they can break, causing the entire wheel/hub assembly to fall off the vehicle and create a dangerous driving situation.

There is a very simple test that any novice mechanic can perform to check whether or not the wheel bearings are causing the vibration. To perform this inspection, you'll need to follow these basic steps.

Step 1: Raise the front end of the vehicle on jack stands. Using a hydraulic lift or a jack and jack stands, raise the front end of the vehicle.

Make sure to jack the front wheel from the lower control arm or the side body mount.

Step 2: Check the tire/wheel for loose wheel bearings. As noted in the image above, the inspection for loose or worn out wheel bearings is rather simple to complete and is done by touch. Place both hands on the tire, preferably with one hand at 3 o’clock position and the other at 9 o’clock.

Push and pull the tire in and out with both hands. If you do this and hear a clunking sound, or the wheel moves freely while shaking the tire, it's a good indication that the wheel bearings are worn out and need to be replaced.

Step 3: Replace the wheel bearings or have a mechanic complete this task. If you have the right tools and experience, replacing the wheel bearings is a rather simple job to complete.

But if you don't, or simply do not feel comfortable completing this task, contact a mechanic who can replace your wheel bearings for you. This is a dangerous situation that you don't want to delay fixing.

Part 3 of 3: Inspecting suspension component issues

There are multiple components that comprise the modern front end suspension. Each of these parts are connected to providing steering input, power the front wheels and keep the front wheel in line so the vehicle will drive straight down the road.

Improper alignment of suspension parts can impact the stability of the vehicle, and can also cause shaking in the steering wheel. The shaking is typically caused by suspension parts that are worn out or loose, which causes the alignment issues.

In order to find out if suspension parts are worn out or the suspension alignment is faulty, you'll have to complete the following inspections:

Step 1: Check the tie rods for wear. The first items you want to inspect for wear and tear in regards to steering wheel vibration are the tie rods. Refer to your service manual for exact instructions and steps on how you should inspect them, as each vehicle's tie rod construction and location is unique.

Step 2: Check the bushings. A common cause of steering wheel vibration at lower speeds is when the bushings of the tie rods, spindles, or control arms are worn out.

First, jack up your vehicle's front end and place the front end on jack stands (make sure to put wheel chocks behind the rear wheels).

Using a flashlight, inspect the bushings for cuts, frays, pinching, signs of excess grease or the bushings being pushed out of the brackets. Try to move or wiggle the suspension part that is connected by the bushings. If the part moves, the bushings have failed and must be replaced.

Step 3: Check the shocks, struts and springs. Most vehicles have front struts or shock absorbers that are connected to the lower control arm and are a part of the suspension.

To check for wear and tear that could cause vibration in the steering wheel, complete the following inspections:

- Look for signs of grease: When a shock or strut is leaking, you'll usually find grease along the strut or the shock mounts. This could mean that the shocks or struts are loose, causing the vibration.
- Check the spring for damage: In some cases, the spring will become detached from the coil-over shock/strut. This can also cause vibration issues.
- Check the shock mounts: If the mounts are loose, it will definitely cause the front end to rattle and steering wheel to vibrate. This is noticed immediately as soon as the vehicle moves forward or backward.

If you've completed all of these checks and still can't find the source of the problem, or need an extra set of professional hands to help fix the problem, contact Your Mechanic to find a local

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 **.**What does excessive exhaust smoke mean?

2. Write the basic operation of gasoline fuel system?

3 Write the basic operation of gasoline fuel system?

Score = _____

Rating: _____

Answer Sheet

Name: _____ Date: _____

1._____

2._____

3._____

Operation sheet-3

Operation title Inspect Steering system

Procedure

Step 1: Raise the front end of the vehicle on jack stands

Using a hydraulic lift or a jack and jack stands, raise the front end of the vehicle.

Step 2: Check the tire/wheel for loose wheel bearings

Step 3: Replace the wheel bearings or have a mechanic complete this task.

Inspecting suspension component issues

Procedure

Step 3: Check the shocks, struts and springs

Step 2: Check the bushings.

Step 1: Check the tie rods for wear

LAP –TEST

Task-1Check diesel injection pump timing

Task-2 Check fuel lines for leaks or restrictions

Task-3 Inspect the exhaust manifold visually

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