بسم الله الرحمن الرحيم

Islamic University of Technology (IUT)

The Organization of the Islamic Cooperation

(OIC)

Gazipur-1704, Dhaka, Bangladesh

DESIGNING A SINGLE PASSENGER CAR: A THREE-WHEELER

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A Thesis Presented to
The Academic Faculty

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ABSTRACT

The world **automobile industry** had experienced near constant growth through to the mid-1980's. The transition from horse carriages to automobiles brought about uncertainty over the development of the product during the industry's infant years. As the automobile evolved, demand for automobiles soared at different points in time throughout the world. However, as the price of gasoline continues to climb and the consequences of unabated gas consumption become direr, the benefits of alternatives to single passenger car transport are becoming more obvious. Aside from reducing their carbon footprints, commuters who utilize alternative transports also save money and regain time lost concentrating on driving by utilizing the many different services available. Furthermore, those who are either too old to drive safely or are disabled may specifically benefit from SPV - Single passenger vehicle. With skyrocketed fuel prices, we need a more efficient mode of transportation. The SPV is the future vehicle. It has high mpg and low cost. With three wheels instead of four it is like a hybrid of an automobile and a motorcycle. The aptera is an example of three wheel SPV (single passenger vehicle) and it gets 330mpg.

ACKNOWLEDGEMENT

Praise and thanks to the Sustainer of the worlds, grace, honour and salutations on the Chief of Apostles and Seal of Prophets, Muhammad, his family and companions till the Day of Resurrection. May Allah grant him a seat of honour and nearness to Him on the Day of Resurrection. And Peace on the messengers! All Praise be to Allah with whose blessings all good affairs are accomplished. We Praise Allah, the Lord of the worlds for His favour to us in completing this Project, praying Him to increase us in knowledge and grant us knowledge, which is beneficial.

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Table of Contents

Topic

Page Number

Chapter 1:

The Starting System

2

Engine

3

Transmission System

4

Running System

(Suspension)

5

Comfort System

Chapter 1:

The Starting System

1.1 Introduction:

Since the engine is not capable of starting by itself, it requires external power to crank it and help it start. Among the various means available, automobiles now use an electric motor that has been combined with a magnetic switch that shifts a rotating pinion gear into and out of mesh with the ring gear on the circumference of the engine flywheel.

The starter motor must generate a large torque from the limited amount of power available from the battery. At the same time, it should be light and compact. For these reasons, a DC (direct current) series motor is used.The engine is not completely started until it can continuously repeat its operational cycle of intake, compression, combustion, and exhaust strokes on its own. The first step for starting the engine, then, is to crank the engine and induce the initial combustion cycle. The starter motor must therefore be at least capable of cranking the engine at the minimum rotational speed that is required to induce initial combustion.

1.2 How a starting system works:

When you turn the ignition key to the Start position, the battery voltage goes through the starter control circuit and activates the starter solenoid, which in turn energizes the starter motor. At the same time, the starter solenoid pushes the starter gear forward to mesh it with the engine flywheel. The flywheel is attached to the engine crankshaft. The starter motor spins, turning the engine crankshaft allowing the engine to start.

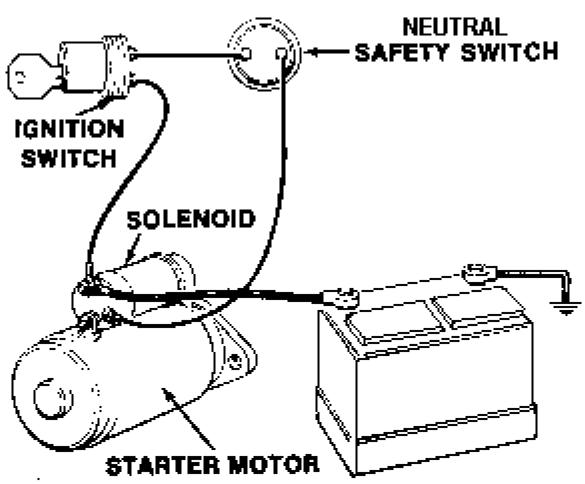


Fig 1.1 The Starting System

The starting system includes the battery, starter motor, solenoid, ignition switch, and in some cases, a starter relay. An inhibitor (neutral safety) switch is included in the starting system circuit to prevent the vehicle from being started while in gear.

When the ignition key is turned to the **start** position, current flows and energizes the starter's solenoid coil. The energized coil becomes an electromagnet which pulls the plunger into the coil, the plunger closes a set of contacts which allow high current to reach the starter motor. On models where the solenoid is mounted on the starter, the plunger also serves to push the starter pinion to mesh with the teeth on the flywheel/flexplate.

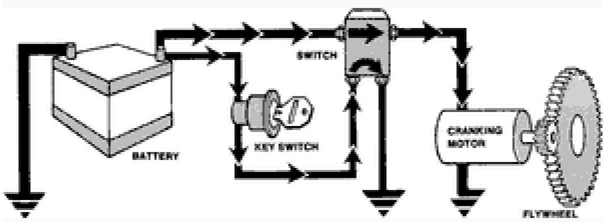


Figure 1.1.1 typical starting system converts electrical energy into mechanical energy to turn the engine. The components are: battery, to provide electricity to operate the starter; ignition switch, to control the energizing of the starter relay or solenoid; starter relay or solenoid, to make and break the circuit between the battery and starter; starter, to convert electrical energy into mechanical energy to rotate the engine; starter drive gear, to transmit the starter rotation to the engine flywheel.

1.2.1 Starter

A **starter** is an electric motor, pneumatic motor, hydraulic motor, or other device for rotating an internal-combustion engine so as to initiate the engine's operation under its own power.

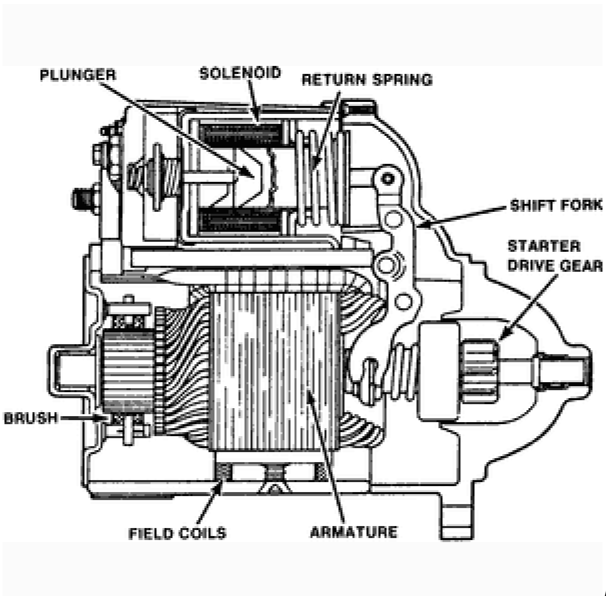


FIG 1.2 Exploded view of a common starter motor with the solenoid mounted on the motor itself.

1.2.2 Battery

Provides the current to turn the starter motor.

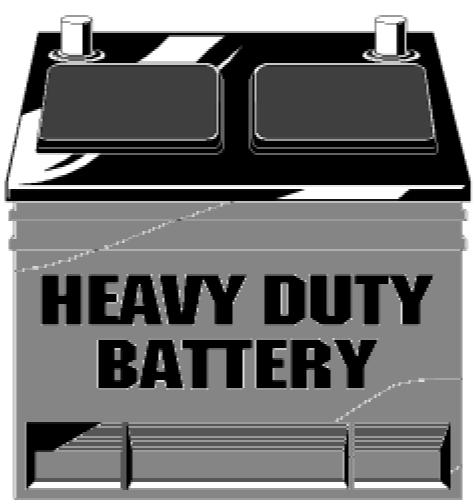


Fig 1.3 Battery

1.2.3 Ignition Switch

The ignition switch allows the driver to distribute electrical current to where it is needed.

Fig 1.4 Ignition Switch

1.3 Solenoid

does the same thing as relay, but performs mechanical operation. It is an electromagnetic switch.

1.3.1 Starter Relay

A relay is a device that allows a small amount of electrical current to control a large amount of current.

1.3.2 Neutral Safety Switch

This switch opens (denies current to) the starter circuit when the transmission is in any gear but Neutral or Park on automatic transmissions.

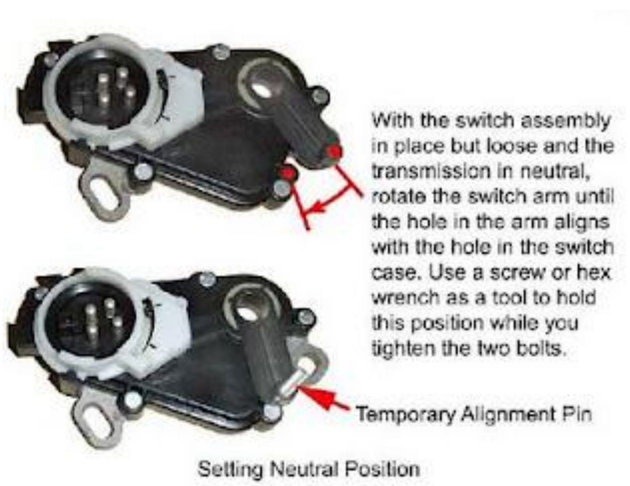


Fig 1.5 Neutral Safety Switch

1.3.3 Charging System

The charging system performs two basic functions:

1. Maintains the battery's state of charge

2. Provides power for all of the car's electrical systems while the engine is running It's a fairly simple system, consisting of a battery, alternator, voltage regulator, indicator gauge or warning light, and the wiring that connects the components to each other and to the units they serve.

The purpose of the charging system is to maintain the charge in the vehicle's battery, and to provide the main source of electrical energy while the engine is running.

1.3.4 The Alternator

The alternator uses the principle of electromagnetism to produce current. The way this works is simple. If you take a strong magnet and pass it across a wire, that wire will generate a small voltage. Take that same wire and loop it many times, than if you pass the same magnet across the bundle of loops, you create a more sizable voltage in that wire.There are two main components that make up an alternator. They are the rotor and the stator. The rotor is connected directly to the alternator pulley. The drive belt spins the pulley, which in turn spins the rotor. The stator is mounted to the body of the alternator and remains stationary.

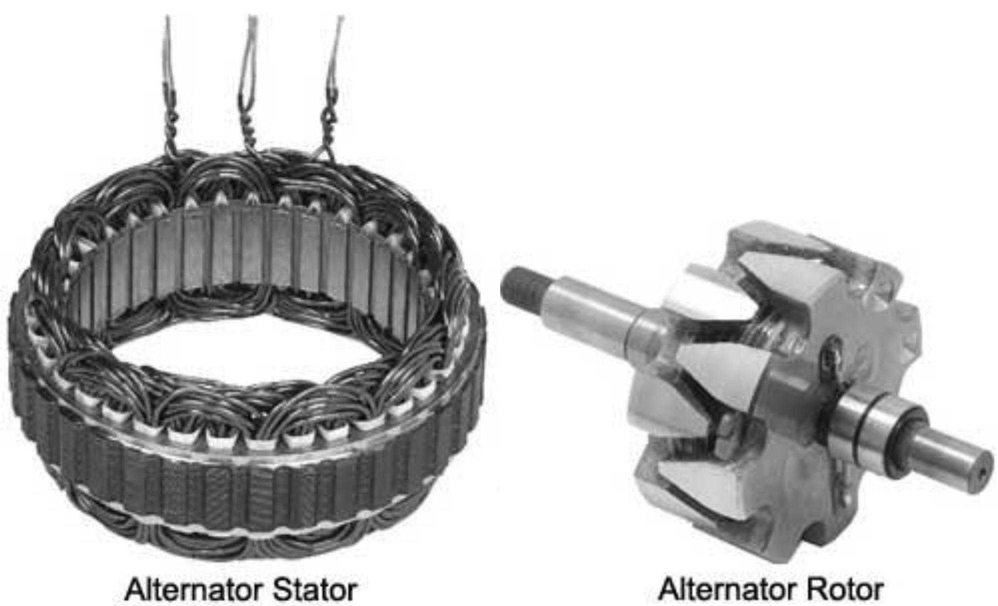


Fig 1.5 Alternator Stator and Alternator Rotor

1.3.5 The Voltage Regulator

The voltage regulator can be mounted inside or outside of the alternator housing. If the regulator is mounted outside (common on some Ford products) there will be a wiring harness connecting it to the alternator.

The voltage regulator controls the field current applied to the spinning rotor inside the alternator. When there is no current applied to the field, there is no voltage produced from the alternator. When voltage drops below 13.5 volts, the regulator will apply current to the field and the alternator will start charging. When the voltage exceeds 14.5 volts, the regulator will stop supplying voltage to the field and the alternator will stop charging. This is how voltage output from the alternator is regulated.

1.3.6 Charging system gauge or warning lamp

The charging system gauge or warning lamp monitors the health of the charging system so that you have a warning of a problem before you get stuck.

2

Engine

2.1 Introduction:

The **internal combustion engine** is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and high -pressure gases produced by combustion apply direct force to some component of the engine. This force is applied typically to pistons, turbine blades, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy. The first functioning internal combustion engine was created by Étienne Lenoir. The term *internal combustion engine* usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described

2.1.2 Diesel Engine

A **diesel engine** (also known as a **compression-ignition engine**) is an internal combustion engine that uses the heat of compression to initiate ignition to burn the fuel, which is injected into the combustion chamber. This is in contrast to spark-ignition engines such as a petrol engine (gasoline engine) or gas engine (using a gaseous fuel as opposed to gasoline), which uses a spark plug to ignite an air-fuel mixture.

In today's world, where fuel prices are increasing as a consequence of spiraling demand and diminishing supply, you need to choose a cost effective fuel to meet your needs. Thanks to the invention of Rudolph Diesel, the diesel engine has proved to be extremely efficient and cost effective. Diesel fuel is priced moderately higher than gasoline but diesel has a higher energy density, i.e. more energy can be extracted from diesel as compared with the same volume of gasoline. Therefore, diesel engines in automobiles provide higher mileage, making it an obvious choice for heavy-duty transportation and equipment. Diesel is heavier and oilier compared with gasoline, and has a boiling point higher than that of water. And diesel engines are attracting greater attention due to higher efficiency and cost effectiveness.

Fig 2.1 Diesel Engine

2.1.3How Does a Diesel Engine Work?

The distinction lies in the type of ignition. While gasoline engines operate on spark ignition, diesel engines employ compression - ignition for igniting the fuel. In the latter, air is drawn into the engine and subjected to high compression that heats it up. This results in a very high temperature in the engine, much higher than the temperature attained in a gasoline engine. At peak temperature and pressure, diesel that is let into the engine ignites on account of the extreme temperature

In a diesel engine, air and the fuel are infused into the engine at different stages, as opposed to a gas engine where a mixture of air and gas are introduced. Fuel is injected into the diesel engine using an injector whereas in a gasoline engine, a carburetor is used for this purpose. In a gasoline engine, fuel and air are sent into the engine together, and then compressed. The air and fuel mixture limits fuel compression, and hence the overall efficiency. A diesel engine compresses only air, and the ratio can be much higher. A diesel engine compresses at the ratio of 14:1 up to 25:1, whereas in a gasoline engine the compression ratio is between 8:1 and 12:1. After combustion, the combustion by-products are removed from the engine through the exhaust. For starting during cold months extra heat is provided through 'glow plugs'.

Diesel engines can either be two cycle or four cycle and are chosen depending on mode of operation. Air-cooled and liquid-cooled engines are the variants to be chosen appropriately. It is preferable to use a liquid-cooled generator as it is quiet in operation and has evenly controlled temperature.

2.1.4 Advantages of a Diesel Engine

The diesel engine is much more efficient and preferable as compared with gasoline engine due to the following reasons:

- Modern diesel engines have overcome disadvantages of earlier models of higher noise and maintenance costs. They are now quiet and require less maintenance as compared with gas engines of similar size.
- They are more rugged and reliable.
- There is no sparking as the fuel auto-ignites. The absence of spark plugs or spark wires lowers maintenance costs.
- Fuel cost per KiloWatt produced is thirty to fifty percent lower than that of gas engines.
- An 1800 rpm water cooled diesel unit operates for 12,000 to 30,000 hours before any major maintenance is necessary. An 1800 rpm water cooled gas unit usually operates for 6000-10,000 hours before it needs servicing.
- Gas units burn hotter than diesel units, and hence they have a significantly shorter life compared with diesel units.

2.1.5 **Applications & Uses for Diesel Engines**

Diesel engines are commonly used as mechanical engines, power generators and in mobile drives. They find wide spread use in locomotives, construction equipment, automobiles, and countless industrial applications. Their realm extends to almost all industries and can be observed on a daily basis if you were to look under the hood of everything you pass by. Industrial diesel engines and diesel powered generators have construction, marine, mining, hospital, forestry, telecommunications, underground, and agricultural applications, just to name a few. Power generation for prime or standby backup power is the major application of today's diesel generators. Check out our article on the various types of engines and generators and their common applications for more examples.

2.2.1 Petrol Engine

In most petrol engines, the fuel and air are usually pre-mixed before compression (although some modern petrol engines now use cylinder-direct petrol injection). The pre-mixing was formerly done in a carburetor, but now it is done by electronically controlled fuel injection, except in small engines where the cost/complication of electronics does not justify the added engine efficiency. The process differs from a diesel engine in the method of mixing the fuel and air, and in using spark plugs to initiate the combustion process. In a diesel engine, only air is compressed (and therefore heated), and the fuel is injected into very hot air at the end of the compression stroke, and self-ignites.

With both air and fuel in a closed cylinder, compressing the mixture too much poses the danger of auto-ignition — or behaving like a diesel engine. Because of the difference in burn rates between the two different fuels, petrol engines are mechanically designed with different timing than diesels, so to auto-ignite a petrol engine causes the expansion of gas inside the cylinder to reach its greatest point before the cylinder has reached the "top dead center" (TDC) position. A typical spark ignition occurs just a few degrees of crankshaft rotation before the piston reaches TDC, which allows time for the gas to begin to expand. Then the bulk of the expansion occurs just after the piston has rotated beyond TDC. Higher octane petrol burns slower, therefore it has a lower propensity to auto-ignite and its rate of expansion is lower. Thus, engines designed to run high-octane fuel exclusively can achieve higher compression ratios.

Petrol engines run at higher speeds than diesels, partially due to their lighter pistons, connecting rods and crankshaft (a design efficiency made possible by lower compression ratios) and due to petrol burning faster than diesel. However the lower compression ratios of a petrol engine give a lower efficiency than a diesel engine. To give an example, a petrol engine is like operating a bicycle in its lowest gear where each push from your feet adds little energy to the system, but you still expend energy to move your legs back to the TDC position. A diesel engine is like operating that same bicycle in its highest gear, where each push imparts substantially more energy to the system than in the lower gear, but with the same effort being used to move your legs back to TDC.

Petrol, or gasoline, is a liquid mixture created form crude oil. It is made up of hydrocarbons and iso-octane. It is a fuel most commonly used in internal combustion engines.

2.2.2 Advantages

- Relatively concentrated and you can travel many hundred km with one full tank of petrol
- It is highly available
- It is fairly cheap
- It is not difficult to make - it just has to be distilled and no waste is produced
- It is easy to carry around
- It is fairly safe to store

2.2.3

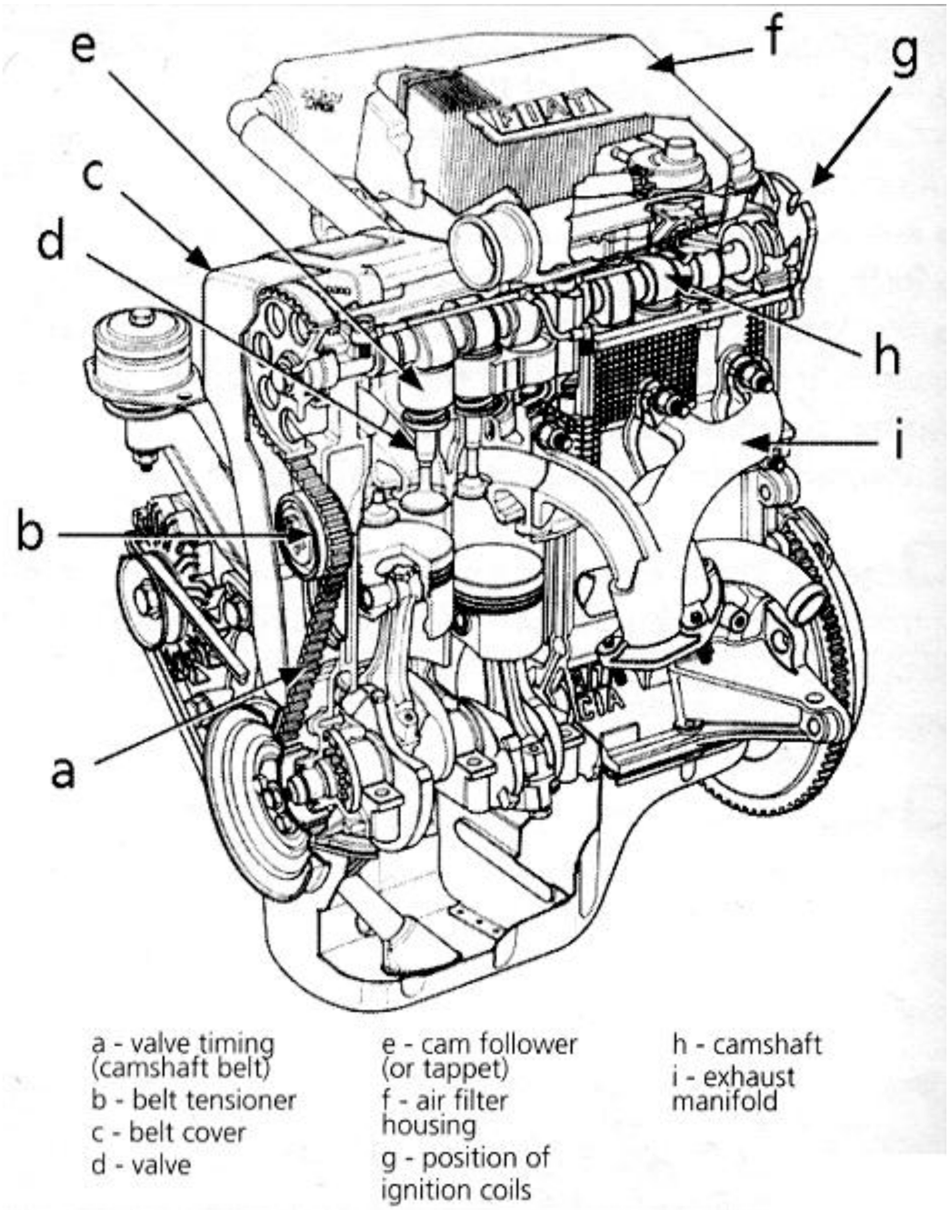


Fig 2.2 Petrol Engine

2.2.4 Fuel System:

The purpose of the fuel system is to supply the right amount of fuel for the engine to burn, and control the speed of the engine.

Two types of fuel systems have been used in gasoline engines in modern times:

1. ***Carburetors***
2. ***Fuel Injection***

Parts of the fuel supply system:

1. ***Gas Tank - The gas tank is usually made of two pieces of stamped steel, spot welded together to form a container, or it can be made of plastic. It may have baffles inside to keep gas from sloshing around. It will have a fuel pickup located at the deepest part, a filler neck, a vent to allow air back in when the fuel is removed, and it will have a gauge to give the driver information on fuel level. Many cars have the fuel pump located in the gas tank. This keeps a normally noisy electric fuel pump quiet.***
   The gas tank can be located in many different locations. Safety should enter into the design of the location of the gas tank, but safety often takes a back seat to profit. All manufacturers have been guilty of poor gas tank locations at one time or another. Examples are the Ford Pinto, and the Chevrolet & GMC C/K Pickup truck from 1973 - 1988. Both were notorious for having their gas tanks explode in a relatively minor accident. The safest place for a gas tank is somewhere within the perimeter of the four wheels. Gas tanks could be made crash proof (fuel cells used in race cars are designed not to explode) but again , profits often win over safety.
2. ***Fuel Lines and vent lines - Galvanized steel fuel lines carry the fuel from the tank to the engine. Manufacturers try to minimize the amount of rubber line used, because rubber deteriorates over time, but some rubber lines must be used to allow the engine to flex on its' mounts. From 1972 model year on, the gas tank and carburetor float bowl have been vented into a charcoal canister under the hood, so a vent line runs forward from the tank, to the canister. Most fuel injection systems vent the excess fuel supplied by the pump, but not used by the engine, back into the tank by a fuel return line.***
3. ***Fuel Pump - Two types of fuel pumps are used in modern cars:***
   Mechanical Pump - driven by the engine itself. Usually by an eccentric (cam) on the camshaft. The cam pushes down on a rocker arm which pulls up on a pull rod compressing a spring, pulling up the diaphragm, and filling the pump chamber with fuel. When the cam turns, and releases the rocker, the spring is able to push down on the diaphragm, pumping the fuel to the carburetor. Pump pressure is regulated by the tension of the spring.
   Electric Pump - can be mounted anywhere in the fuel line, but in modern cars is usually submerged in the gas tank. This keeps them cool, and quiet.

Be aware that an electric fuel pump will supply a certain amount of pressure, and are different between an engine using a carburetor, and one using fuel injection.
Pumps for fuel injection run fuel pressures of from 30 to 75 PSI, whereas on for a carburetor will only supply from 3 to 7 PSI. They are not interchangeable.
Electric pumps can be solenoid types which work similar to a mechanical pump, but instead of a cam moving the diaphragm, an electric solenoid does the work; or they can be an impeller type which uses an electric motor to drive a little impeller wheel. Fuel pressure is regulated by a pressure regulator located on the end of the fuel supply rail on the engine.

♦Carburetors

A carburetor does the following;

- *Mixes air and fuel together in the correct proportion under all conditions.*
- *Regulates the speed of the engine.*

The carburetor must mix the air and fuel together in the correct proportions under all conditions, and those conditions change depending upon whether the engine is cold or hot, idling or at high RPM, accelerating, decelerating, or staying the same speed.

Fig 2.3 Carburetor

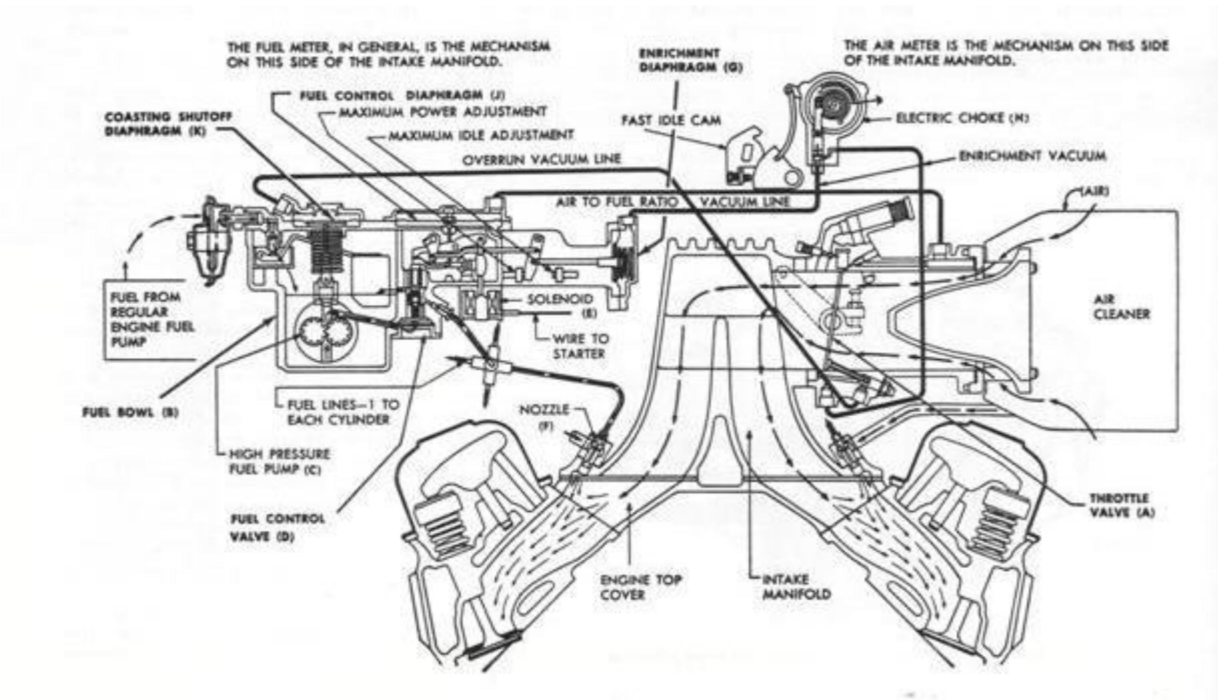
2.2.6 Fuel injection

This is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in automotivepetrol engines, having almost completely replaced carburetors in the late 1980s.

A fuel injection system is designed and calibrated specifically for the type(s) of fuel it will handle. Most fuel injection systems are for gasoline or diesel applications. With the advent of electronic fuel injection (EFI), the diesel and gasoline hardware has become similar. EFI's programmable firmware has permitted common hardware to be used with different fuels.

♦ Objectives

The functional objectives for fuel injection systems can vary. All share the central task of supplying fuel to the combustion process, but it is a design decision how a particular system will be optimized. An engine's air/fuel ratio must be precisely controlled under all operating conditions to achieve the desired engine performance, emissions, driveability, and fuel economy. Modern electronic fuel-injection systems meter fuel very accurately, and use closed loop fuel-injection quantity-control based on a variety of feedback signals from an oxygen sensor, a mass airflow (MAF) or manifold absolute pressure (MAP) sensor, a throttle position (TPS), and at least one sensor on the crankshaft and/or camshaft(s) to monitor the engine's rotational position. Fuel injection systems can react rapidly to changing inputs such as sudden throttle movements, and control the amount of fuel injected to match the engine's dynamic needs across a wide range of operating conditions such as engine load, ambient air temperature, engine temperature, fuel octane level, and atmospheric pressure. A multipoint fuel injection system generally delivers a more accurate and equal mass of fuel to each cylinder than can a carburetor, thus improving the cylinder-to-cylinder distribution. Exhaust emissions are cleaner because the more precise and accurate fuel metering reduces the concentration of toxic combustion byproducts leaving the engine, and because exhaust cleanup devices such as the catalytic converter can be optimized to operate more efficiently since the exhaust is of consistent and predictable composition. Fuel injection generally increases engine fuel efficiency. A fuel-injected engine often produces more power than an equivalent carbureted engine. Fuel injection has contributed to modern automobiles typical longevity, reducing the need for carburetor cleaning and overhaul expense. With the introduction of direct ignition, replacing the distributor, many modern automobiles are now typically kept beyond 100,000 miles (160,934.4 km) or more, providing the same fuel economy, and reduced emissions, as newer cars.



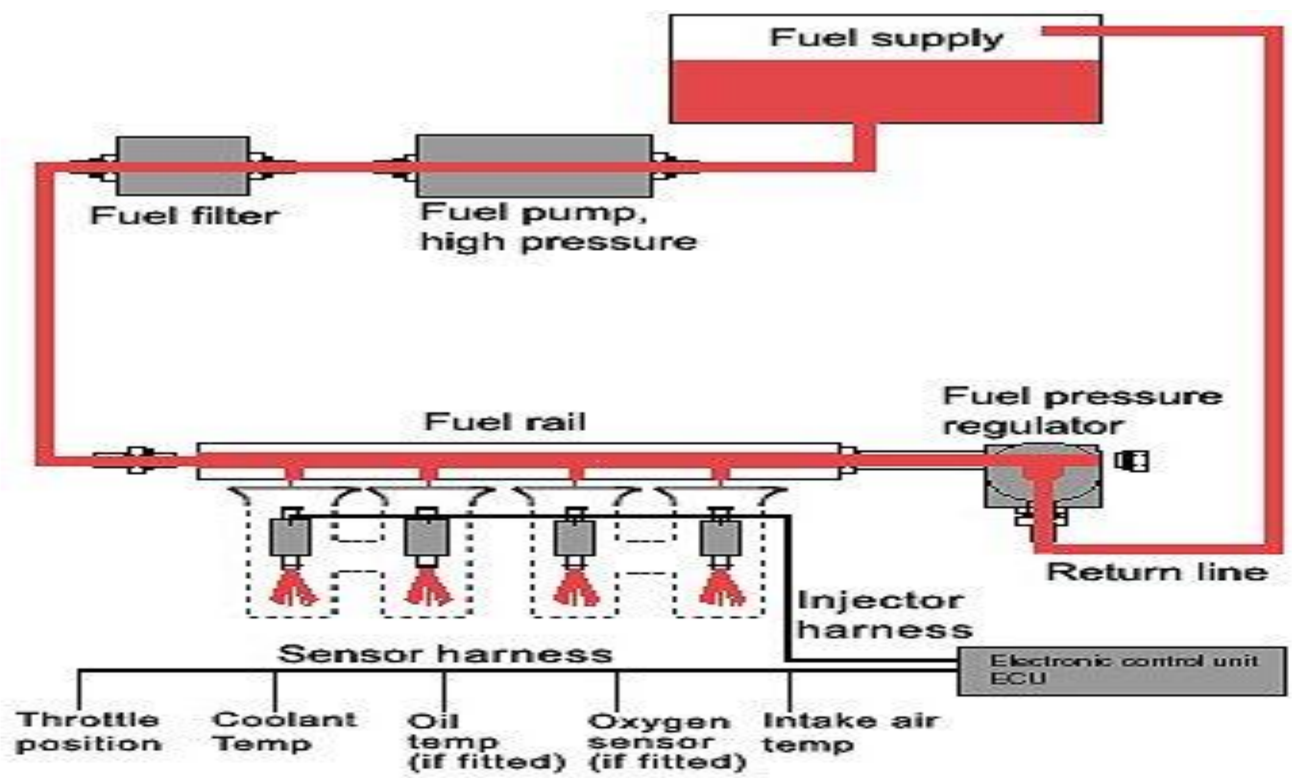


Fig 2.4 Fuel injection System Diagram

2.2.7 Intake system

Early automobile intake systems were simple air inlets connected directly to carburetors. A modern automobile air intake system has three main parts, an air filter, mass flow sensor, and throttle body. Some modern intake systems can be highly complex, and often include specially-designed intake manifolds to optimally distribute air and air/fuel mixture to each cylinder. Many cars today now include a silencer to minimize the noise entering the cabin. Silencers impede air flow and create turbulence which reduce total power, so many performance enthusiasts often remove them.

Production cars have specific-length air intakes to cause the air to vibrate and buffetat a specific frequency to assist air flow into the combustion chamber. Aftermarket companies for cars have introduced larger throttle bodies and air filters to decrease restriction of flow at the cost of changing the harmonics of the air intake for a small net increase in power or torque.

Porsche in the 1980s designed an intake system for their cars that changed the length of the intake system by alternating between a longer and shorter set of tubing using a butterfly valve, creating a small amount of positive pressure which increased overall performance of the engine. Audi began to use a similar system in some cars in the 1990s.[Alfa Romeo used variable-length intakes in their 2.0 Twin Spark engines powering the model 156.

♦Airfilter

A particulate airfilter is a device composed of fibrous materials which removes solid particulate s such as dust , pollen , mold ,

Fig 2.5 Airfilter

♦Massflowsensor

A mass air flowsensor is used to find out the massflowrate of air entering a fuel-injected internal combustion engine .

Fig 2.6 Massflowsensor

♦Throttle body

A throttle **is the mechanism by which the flow of a fluid is managed by constriction or obstruction. An engine's power can be increased or decreased by the restriction of inlet gases (*i.e.,* by the use of a throttle).**

Fig 2.7 <u>throttle body</u>

2.2.8 Exhaust System

An exhaust system is usually piping used to guide reaction exhaust gases away from a controlled combustion inside an engine or stove. The entire system conveys burnt gases from the engine and includes one or more exhaust pipes. Depending on the overall system design, the exhaust gas may flow through one or more of:

- **Cylinder head and exhaust manifold**
- **A turbocharger to increase engine power.**
- **A catalytic converter to reduce air pollution.**
- **A muffler (North America) / silencer (Europe), to reduce noise.**

1. Cylinder Head

In an internal combustion engine, the **cylinder head** (often informally abbreviated to just **head**) sits above the cylinders on top of the cylinder block. It closes in the top of the cylinder, forming the combustion chamber. This joint is sealed by a head gasket. In most engines, the head also provides space for the passages that feed air and fuel to the cylinder, and that allow the exhaust to escape. The head can also be a place to mount the valves, spark plugs, and fuel injectors.

Fig 2.8 **Cylinder Head**

2. Turbocharger

A **turbocharger**, (mixing/spinning) is a forced induction device used to allow more power to be produced for an engine of a given size. Turbos are commonly used on truck, car, trains and construction equipment engines. The key difference between a turbocharger and a supercharger is that the turbocharger is driven by an engine's exhaust gases (a supercharger is mechanically driven from the engine, often from a belt connected to the crankshaft).

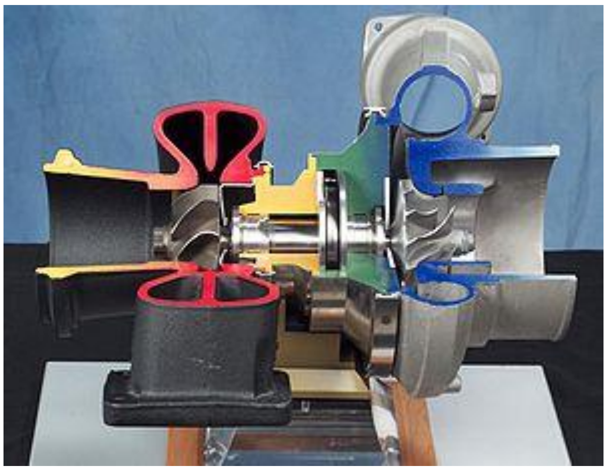


Fig 2.9 Turbocharger

3. Catalytic Converter

A **catalytic converter** (colloquially, "cat" or "catcon") is an exhaust emission control device which converts toxic chemicals in the exhaust of an internal combustion engine into less noxious substances. Inside a catalytic converter, a catalyst stimulates a chemical reaction in which noxious byproducts of combustion are converted to less toxic substances by way of catalysed chemical reactions. The specific reactions vary with the type of catalyst installed. Most present-day vehicles that run on gasoline are fitted with a "three way" converter, so named because it converts the three main pollutants in automobile exhaust: an oxidising reaction converts carbon monoxide (CO) and unburned hydrocarbons (HC), and a reduction reaction converts oxides of nitrogen (NO_x) to produce carbon dioxide (CO_2), nitrogen (N_2), and water (H_2O).

Fig 2.10 **Catalytic Converter**

4. Muffler

A **muffler** (or **silencer** in British English) is a device for reducing the amount of noise emitted by the exhaust of an internal combustion engine.

Fig 2.11 Muffler/ Silencer

2.2.9 Cooling system

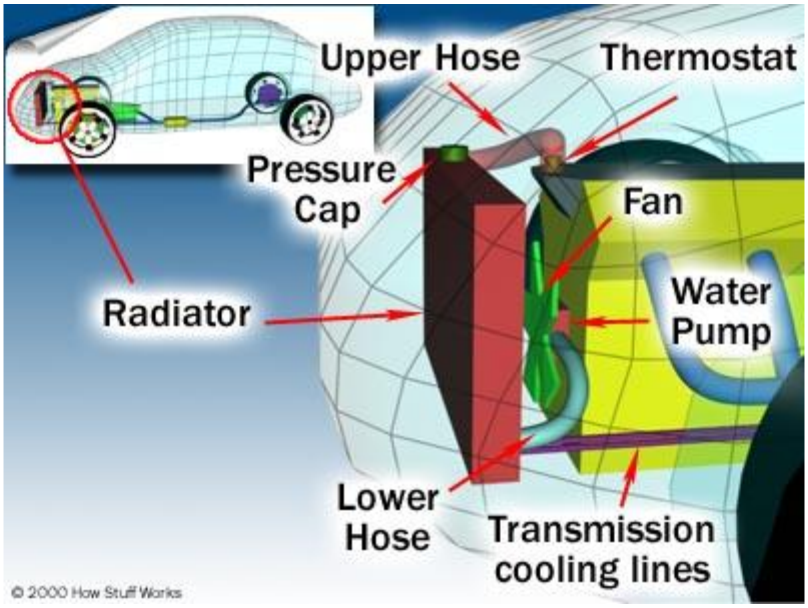
Internal combustion engine cooling refers to the cooling of an internal combustion engine, typically using either air or a liquid. Water cooling is commonly used for cooling automobileinternal combustion engines. Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling.

Engines with higher efficiency have more energy leave as mechanical motion and less as waste heat. Some waste heat is essential: it guides heat through the engine, much as a water wheel works only if there is some exit velocity (energy) in the waste water to carry it away and make room for more water. Thus, all heat engines need cooling to operate.

Cooling is also needed because high temperatures damage engine materials and lubricants. Internal-combustion engines burn fuel hotter than the melting temperature of engine materials, and hot enough to set fire to lubricants. Engine cooling removes energy fast enough to keep temperatures low so the engine can survive.

Some high-efficiency engines run without explicit cooling and with only accidental heat loss, a design called adiabatic. For example, 10,000 mile-per-gallon "cars" for the Shell economy challenge are insulated, both to transfer as much energy as possible from hot gases to mechanical motion, and to reduce reheat losses when restarting. Such engines can achieve high efficiency but compromise power output, duty cycle, engine weight, durability, and emissions. Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water.

Most liquid-cooled engines use a mixture of water and chemicals such as antifreeze and rust inhibitors.



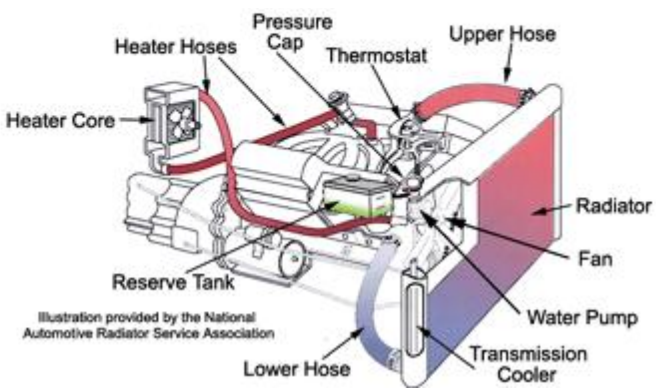


Fig 2.12 Cooling System

3

Transmission System

3.1 Introduction

An **automatic transmission** (also called **automatic gearbox**) is one type of motor vehicletransmission that can automatically change gear ratios as the vehicle moves, freeing the driver from having to shift gears manually. Most automatic transmissions have a defined set of gear ranges, often with a parking pawl feature that locks the output shaft of the transmission.

Similar but larger devices are also used for heavy-duty commercial and industrial vehicles and equipment. Some machines with limited speed ranges or fixed engine speeds, such as some forklifts and lawn mowers, only use a torque converter to provide a variable gearing of the engine to the wheels.

Fig 2 .13 Automatic Gearbox

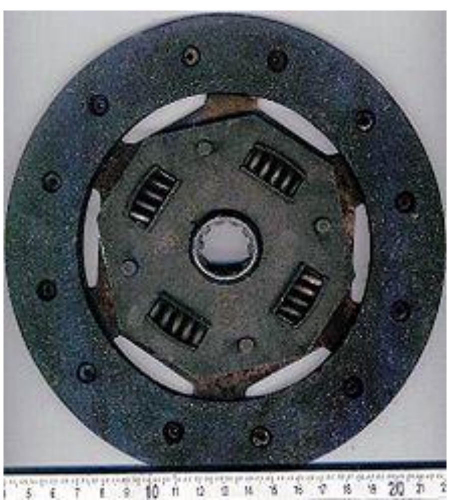
3.1.2 Clutch

A **clutch** is a mechanical device that provides for the transmission of power (and therefore usually motion) from one component (the driving member) to another (the driven member). The opposite component of the clutch is the brake.

Clutches are used whenever the ability to limit the transmission of power or motion needs to be controlled either in amount or over time (e.g., electric screwdrivers limit how much torque is transmitted through use of a clutch; clutches control whether automobiles transmit engine power to the wheels).

In the simplest application, clutches are employed in devices which have two rotating shafts (drive shaft or line shaft). In these devices, one shaft is typically attached to a motor or other power unit (the driving member) while the other shaft (the driven member) provides output power for work to be done.

In a drill for instance, one shaft is driven by a motor and the other drives a drill chuck. The clutch connects the two shafts so that they may be locked together and spin at the same speed (engaged), locked together but spinning at different speeds (slipping), or unlocked and spinning at different speeds (disengaged).



3.1.3 Transfer Case

A **transfer case** is a part of a four-wheel-drive system found in four-wheel-drive and all-wheel-drive vehicles. The transfer case is connected to the transmission and also to the front and rear axles by means of drive shafts. It is also referred to as a "transfer gearcase"

Fig 2.14 Transfer Case

3.1.4 Differential

A differential is a device, usually, but not necessarily, employing gears, which is connected to the outside world by three shafts, through which it transmits torque and rotation.

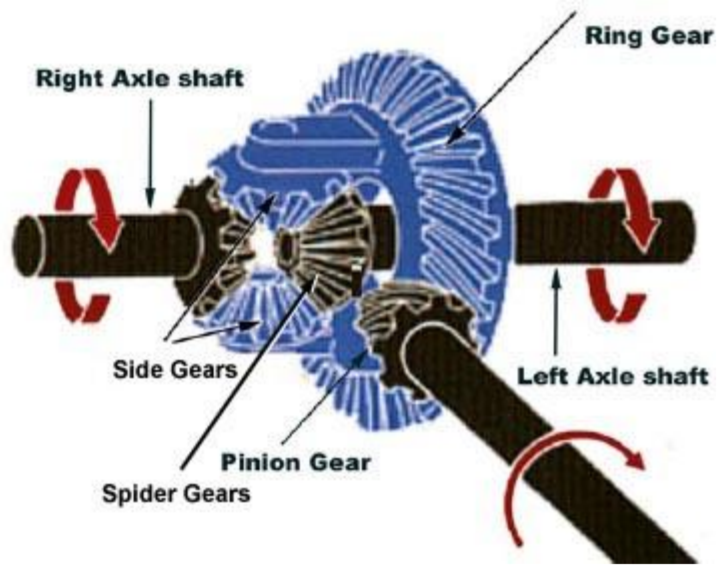


Fig 2.15 Differential

3.1.5 Wheels/ Tyres

A **tire** (in American English and Canadian English) or **tyre** (in Commonwealth Nations such as UK, Australia, and others excluding Canada) is a ring-shaped covering that fits around a wheel rim to protect it and enable better vehicle performance by providing a flexible cushion that absorbs shock while keeping the wheel in close contact with the ground. The word itself may be derived from the word "tie," which refers to the outer steel ring part of a wooden cart wheel that ties the wood segments together (see Etymology below). The fundamental materials of modern tires are synthetic rubber, natural rubber, fabric and wire, along with other compound chemicals. They consist of a tread and a body. The tread provides traction while the body ensures support. Before rubber was invented, the first versions of tires were simply bands of metal that fitted around wooden wheels in order to prevent wear and tear. Today, the vast majority of tires are pneumaticinflatable structures, comprising a doughnut-shaped body of cords and wires encased in rubber and generally filled with compressed air to form an inflatable cushion. Pneumatic tires are used on many types of vehicles, such as bicycles, motorcycles, cars, trucks, earthmovers, and aircraft.

3.1.6 Drive wheels

A **wheel** is a circular component that is intended to rotate on an axle. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel and flywheel.Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines.In vehicle acrobatics, a **wheelie** is a vehicle maneuver in which the front wheel or wheels come off the ground due to extreme torque being applied to the rear wheel or wheels.[1] Wheelies are usually associated with bicycles and motorcycles, but can be done with other vehicles such as cars, especially in drag racing and tractor pulling.

Fig 2.16Drive wheels

4

Running System

Suspension

4.1 Introduction:

Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels. Suspension systems serve a dual purpose — contributing to the vehicle's roadholding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations,etc. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the forces acting on the vehicle do so through the contact patches of the tires. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The design of front and rear suspension of a car may be different.

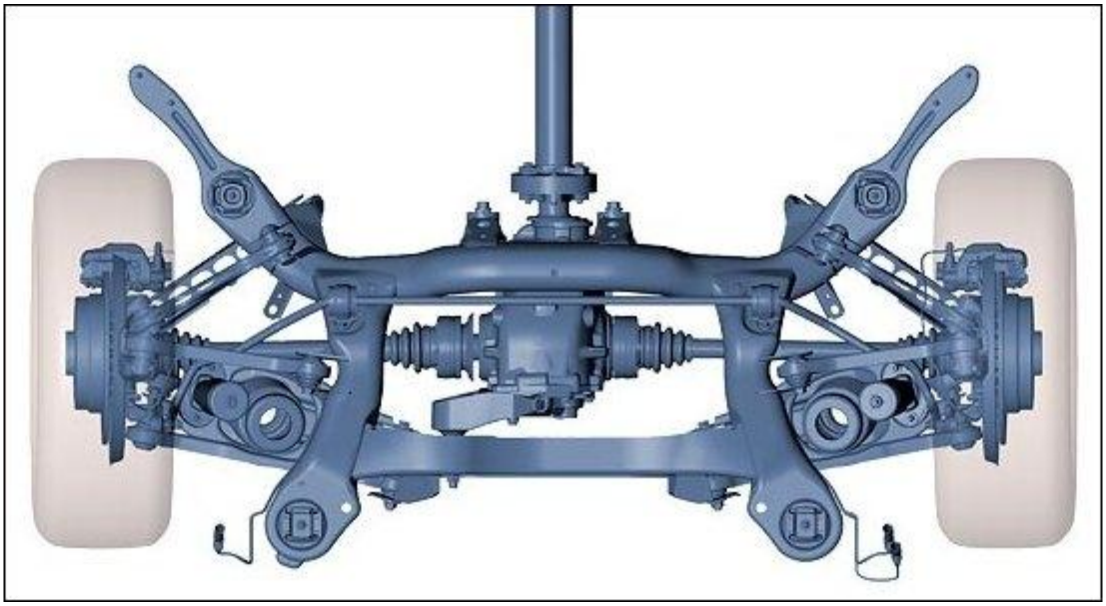


Fig 2.17 Suspension

4.1.1 Steering

99% of the world's car steering systems are made up of the same three or four components. The steering wheel, which connects to the steering system, which connects to the track rod, which connects to the tie rods, which connect to the steering arms. The steering system can be one of several designs, which we'll go into further down the page, but all the designs essentially move the track rod left-to-right across the car. The tie rods connect to the ends of the track rod with ball and socket joints, and then to the ends of the steering arms, also with ball and socket joints. The purpose of the tie rods is to allow suspension movement as well as an element of adjustability in the steering geometry.

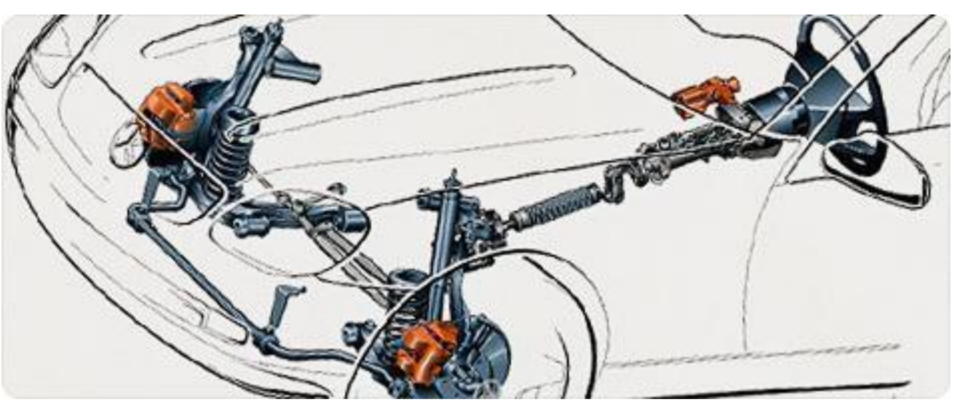
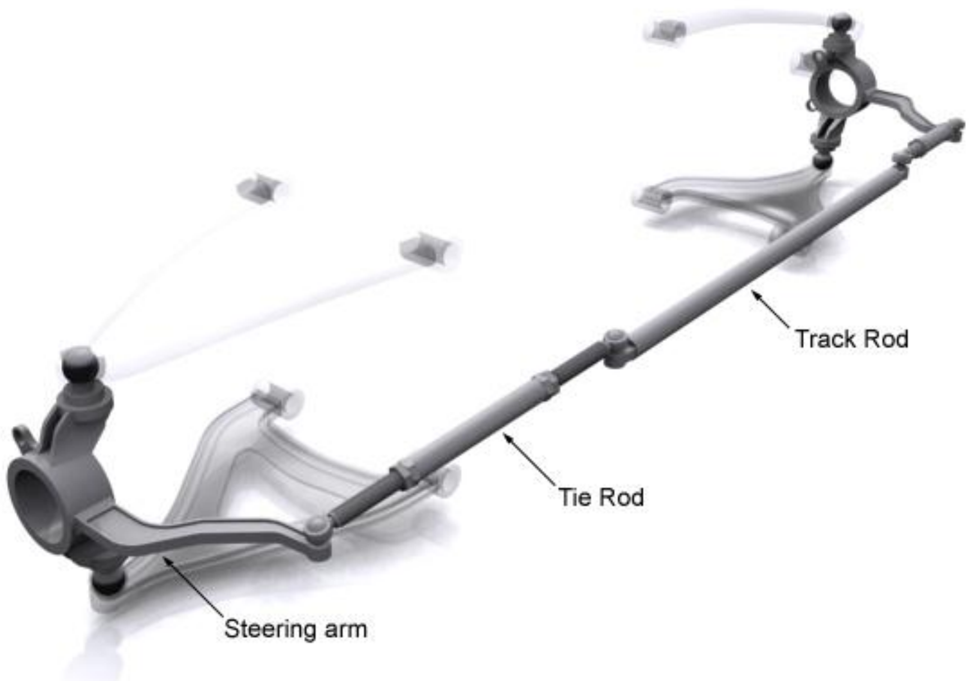


Fig 2.18 Vehicle Steering

♦Basic steering components



4.12 Brake

A **vehicle brake** is a brake used to slow down a vehicle by converting its kinetic energy into heat. The basic hydraulic system, most commonly used, usually has six main stages. The brake pedal, the brake boost (vacuum servo), the master cylinder, the apportioning valves and finally the road wheel brakes themselves.

The automotive brake system or automobile brake system is mainly used for helping the driver control the deceleration of the vehicle. It is one of the crucial systems, which is especially designed for decreasing the speed of the fast moving vehicle. A typical automotive brake system comprises of a brake device having different components, which are used for slowing or stopping down a vehicle. More precisely, these devices decrease or stop the speed of a moving or rotating body by absorbing kinetic energy mechanically or electrically. These automotive brake systems automatically control wheel slips and prevent the wheels from spinning. They are widely used in motor vehicles, buses, trucks, trains, airplanes, passenger coaches, trailers, and other types of automobiles.

Automotive brake system or automobile brake system used in automobiles has come a long way in recent years. The adoption of anti-lock brake systems along with the introduction of different brake parts made of carbon fiber, steel, aluminum etc have really provided better stopping performance in comparison with traditional ones. An **anti-lock braking system** (**ABS**, from German: Antiblockiersystem) is a safety system that allows the wheels on a motor vehicle to continue interacting tractively with the road surface as directed by driver steering inputs while braking, preventing the wheels from locking up (that is, ceasing rotation) and therefore avoiding skidding.

♦ An ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces for many drivers; however, on loose surfaces like gravel or snow-covered pavement, an ABS can significantly increase braking distance, although still improving vehicle control.

♦ Friction brake

A friction brake is a type of automotive brake that slows or stops a vehicle by converting kinetic energy into heat energy, via friction. The heat energy is then dissipated into the atmosphere. Inmost systems, the brake acts on the vehicle's roadwheel hubs, but some vehicles use brakes which act on the axles or transmission. Friction brakes may be of either drum or disc type.

♦ Drum brake

A drum brake is a brake in which the friction is caused by a set of brake shoes that press against the inner surface of a rotating drum. The drum is connected to the rotating roadwheel hub.

♦ Disc brake

The disc brake is a device for slowing or stopping the rotation of a road wheel. A brake disc (or rotor in U.S. English), usually made of cast iron or ceramic, is connected to the wheel or the axle. To stop the wheel, friction material in the form of brake pads (mounted in a device called a brake caliper) is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

4.13 Lubrication system

Lubrication Systems

With energy prices rising and both markets and legislation demanding more efficient engines, optimising the lubrication systems of your powertrain systems is essential to ensuring as efficient and economical vehicle operation as possible.

A **lubricant** is a substance introduced to reduce friction between moving surfaces. It may also have the function of transporting foreign particles. The property of reducing friction is known as lubricity.

A good lubricant possesses the following characteristics:

- High boiling point.
- Low freezing point.
- High viscosity index.
- Thermal stability.
- Corrosion prevention.
- High resistance to oxidation.

One of the single largest applications for lubricants, in the form of motor oil, is protecting the internal combustion engines in motor vehicles and powered equipment.

Typically lubricants contain 90% base oil (most often petroleum fractions, called mineral oils) and less than 10% additives. Vegetable oils or synthetic liquids such as hydrogenated polyolefins, esters, silicones, fluorocarbons and many others are sometimes used as base oils. Additives deliver reduced friction and wear, increased viscosity, improved viscosity index, resistance to corrosion and oxidation, aging or contamination,

♦ Purpose

Lubricants perform the following key functions.

- Keep moving parts apart
- Reduce friction
- Transfer heat
- Carry away contaminants & debris
- Transmit power
- Protect against wear
- Prevent corrosion
- Seal for gases
- Stop the risk of smoke and fire of objects

♦ Benefits of an Automatic Lubrication System

Auto lube systems have many advantages over traditional methods of manual lubrication:

1. All critical components are lubricated, regardless of location or ease of access
2. Lubrication occurs while the machinery is in operation causing the lubricant to be equally distributed within the bearing and increasing the machine's availability.
3. Proper lubrication of critical components ensures safe operation of the machinery.
4. Less wear on the components means extended component life, fewer breakdowns, reduced downtime, reduced replacement costs and reduced maintenance costs
5. Measured lubrication amounts means no wasted lubricant
6. Safety - no climbing around machinery or inaccessible areas (gases, exhaust, confined spaces, etc.)
7. Lower energy consumption due to less friction
8. Increased overall productivity resulting from increase in machine availability and reduction in downtime due to breakdowns or general maintenance

♦ Lubricating **Oil Properties**

- Precipitation Number
- The precipitation number recommended by the ASTM is the number of milliliters of precipitate formed when 10 mL of lubricating oil is mixed with 90 mL of petroleum naphtha under specific conditions and then centrifuged
-
- Corrosion and Neutralization Number
- Oiliness
- Extreme-Pressure (Hypoid) Lubricants
- Chemical and Physical Stability
- Gravity
- The gravity of petroleum oil is a numerical value which serves as an index of the weight of a measured volume of this product
- There are two scales generally used by petroleum engineers:
- Specific-gravity scale
- American Petroleum Institute gravity scale
-
- Flash Point
- The flash point of an oil is the temperature to which the oil must be heated in order to give off enough vapor to form a combustible mixture above the surface that will momentarily flash or burn when the vapor is brought into contact with a very small flame
-
- Viscosity

- Viscosity is technically defined as the fluid friction of an oil
-
- Cloud Point
- Pour Point
- Carbon-Residue Test
- Ash Test
- The ash test is an extension of the carbon-residue test

♦Classification of Lubricants

1. Animal Lubricants

Lubricants with animal origin:

Tallow

Tallow oil

Lard oil

Neat's foot oil

Sperm oil

Porpoise oil

These are highly stable at normal temperatures. Animal lubricants may not be used for internal combustion because they produce fatty acids

3. Vegetable Lubricants

- Examples of vegetable lubricants are:
  - Castor oil
  - Olive oil

- Cottonseed oil

- Animal and vegetable oils have a lower coefficient of friction than most mineral oils but they rapidly wear away steel

3. Mineral Lubricants

- These lubricants are used to a large extent in the lubrication of aircraft internal combustion engines
- There are three classifications of mineral lubricants:
  - Solid
  - Semisolid
  - Fluid

4. Synthetic Lubricants

- Because of the high operating temperatures of gas-turbine engines, it became necessary to develop lubricants which would retain their characteristics at temperatures that cause petroleum lubricants to evaporate and break down
- Synthetic lubricants do not break down easily and do not produce coke or other deposits

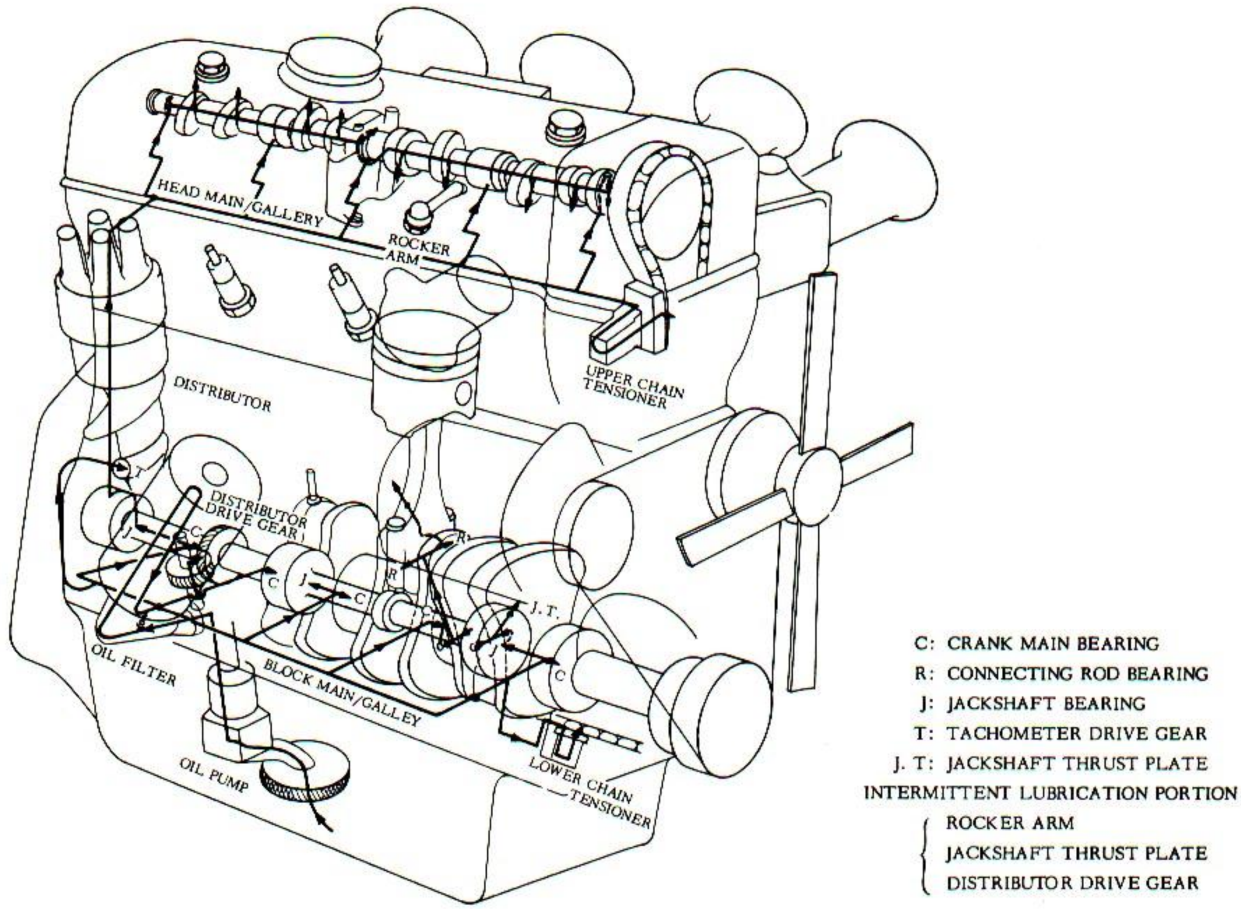


Fig 2.19 An Engine Lubrication system

5

Comfort System

5.1 HVAC/AC/Heater System

5.1.1 Introduction:

The concept of air conditioning is known to have been applied in Ancient Rome, where aqueduct water was circulated through the walls of certain houses to cool them down. Other techniques in medievalPersia involved the use of cisterns and wind towers to cool buildings during the hot season. Modern air conditioning emerged from advances in chemistry during the 19th century, and the first large-scale electrical air conditioning was invented and used in 1902 by Willis Haviland Carrier.

p to: navigation, search

Air conditioning is the removal of heat from indoor air for thermal comfort.

In another sense, the term can refer to any form of cooling, heating, ventilation, or disinfection that modifies the condition of air.[1] An air conditioner (often referred to as AC or air con.) is an appliance, system, or machine designed to change the air temperature and humidity within an area (used for cooling as well as heating depending on the air properties at a given time), typically using a refrigeration cycle but sometimes using evaporation, commonly for comfort cooling in buildings and motor vehicles.

Automobile air conditioning systems cool the occupants of a vehicle in hot weather, and have come into wide use from the late twentieth century. Air conditioners use significant power; on the other hand the drag of a car with closed windows is less than if the windows are open to cool the occupants evaporatively. There has been much debate on the effect of air conditioning on the fuel efficiency of a vehicle. Factors such as wind resistance, aerodynamics and engine power and weight have to be factored into finding the true variance between using the air conditioning system and not using it when estimating the in actual fuel mileage. Other factors on the impact on the engine and an overall engine heat increase can have an impact on the cooling system of the vehicle.

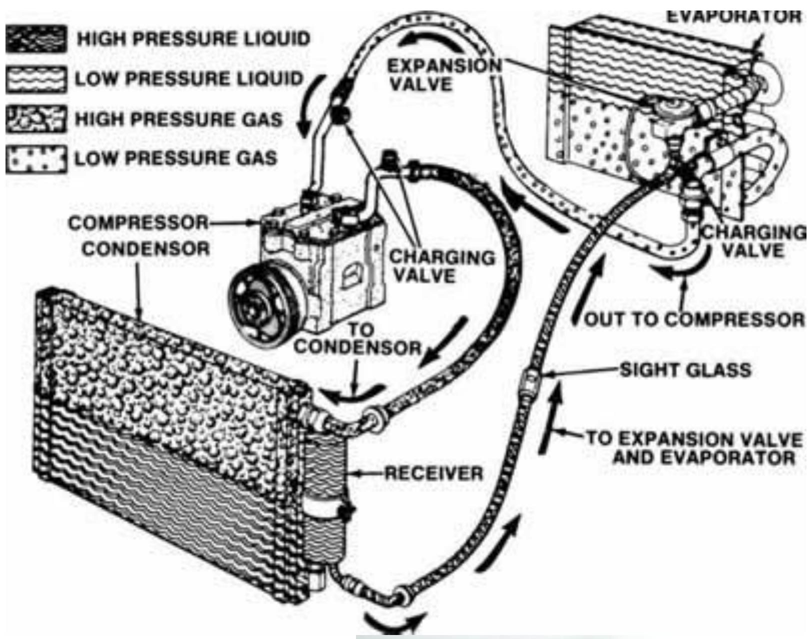


Fig 2.30 Automotive Air Conditioning Systems

5.1.2 Seating

A **car seat** is the chair used in automobiles. Most car seats are made from inexpensive but durable material in order to withstand as much use as possible.

♦ Safety

A Child Restraint system, also commonly referred to as a child safety seat or a car seat, is a restraint which is secured to the seat of an automobile equipped with safety harnesses or seat belts, to hold a child in the event of a crash.

A **car seat** is the chair used in automobiles. Most car seats are made from inexpensive but durable material in order to withstand as much use as possible.

Safety

A Child Restraint system, also commonly referred to as a child safety seat or a car seat, is a restraint which is secured to the seat of an automobile equipped with safety harnesses or seat belts, to hold a child in the event of a crash.

Fig 2.31 vehicle seat

5.1.3 Audio

In modern cars, the primary control device for an audio system is commonly referred to as a head unit, and is installed in the center of the dash panel between the driver and the passenger. In older vehicles that had audio components as an option, such devices were mounted externally to the top of or underneath the dash. Car speakers often use space-saving designs such as mounting a tweeter directly over a woofer or using non-circular cone shapes. Subwoofers are a specific type of loudspeaker for low frequency reproduction.

Fig Car Audio/Video System

5.1.4 GPS

An **automotive navigation system** is a satellite navigation system designed for use in automobiles. It typically uses a GPS navigation device to acquire position data to locate the user on a road in the unit's map database. Using the road database, the unit can give directions to other locations along roads also in its database. Dead reckoning using distance data from sensors attached to the drivetrain, a gyroscope and an accelerometer can be used for greater reliability, as GPS signal loss and/or multipath can occur due to urban canyons or tunnels.

The **Global Positioning System** (**GPS**) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver.

The GPS program provides critical capabilities to military, civil and commercial users around the world. In addition, GPS is the backbone for modernizing the global air traffic system.

Advanced Navigation Systems- Advanced vehicle navigation systems are units that have additional features to the standard pre-loaded maps and voice directions. These units generally have detailed maps of North America and an extensive amount of POIs. Other features that you will find in some of these models will be Text-to-speech routing which verbally speaks the name of the street that you are turning onto, Bluetooth technology, real-time traffic capability, and MP3 players.\

5

Conclusion and Summary

5.1 Conclusion:

In our work, the premier purport of our project was designing a SPV - Single passenger vehicle. Three-wheeler cars, usually microcars, are often built for economic reasons: in the UK for tax advantages, or in the US to take advantage of lower safety regulations, being classed as motorcycles. As a result of their light construction and often relaxed pollution requirements, leading to higher efficiency, three-wheeled cars are usually very economical to run.For improving our knowledge about SPV - Single passenger vehicle a separate chapter was devoted to it describing its history, construction, operation and other related topics. After completion and testing we found it working effectively.

5.2 The SPV is the future vehicle. It has high mpg and low cost. With three wheels instead of four it is like a hybrid of an automobile and a motorcycle. The aptera is an example of three wheel SPV (single passenger vehicle) and it gets 330mpg.

If we like long enough in the road ahead we will see future children playing with future toys. The limitations of our world are the limitations of our imagination:

Love them or loathe them the 3-wheeler, Cycle-car or even Tri-car, has had an important impact in the development of the present day motor car. From the beginnings of the Industrial Revolution to the Concept cars of the future, these vehicles can hold their headlamps up with pride. They were present at the birth of motoring and possibly may well be the answer to the future with the constant depletion of the Earth's energy resources. http://www.3wheelers.com/

Fig. 5.1 **SPV - Single passenger vehicle**

5.3 Advantages and Disadvantages of SPV - Single passenger vehicle

Advantages

Three-wheeler cars, usually microcars, are often built for economic reasons: in the UK for tax advantages, or in the US to take advantage of lower safety regulations, being classed as motorcycles. As a result of their light construction and often relaxed pollution requirements, leading to higher efficiency, three-wheeled cars are usually very economical to run.

-Ease of transportation

- Fast commute from one place to another

- Advantage to old and sick people

- Decrease Pollution

Disadvantages:

- Decrease in practices such as walking and cycling

-Expensive to buy

-Difficult to park in busy cities.

-Traffic

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