PRESENTATION
ON
Materials for Automobile Applications

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SUPERSTRUCTURE

STEEL

STEEL

- Most common material used in building cars
- Strong, easy to work with, cheap and readily available
- Doesn't take extremely specialised tools or knowledge to produce, manufacture and repair steel
- Cheapest metal used in car building.

ALUMINIUM

ALUMINIUM

- Much lighter and stronger than steel
- Unlike its ferrous friend, isn't susceptible to rust
- It is, however, much more expensive and far harder to work with than steel so isn't commonly used on cheaper cars
- Jaguar and Audi are the two main manufacturers associated with aluminium-constructed cars.

COMPOSITE MATERIAL

ABS

- **Application:** automotive body parts, dashboards, wheel covers.
- Acrylonitrile Butadiene Styrene is a copolymer made by polymerizing styrene and acrylonitrile in the presence of polybutadiene. The styrene gives the plastic a shiny, impervious surface. The butadiene, a rubbery substance, provides resilience even at low temperatures. A variety of modifications can be made to improve impact resistance, toughness, and heat resistance.

POLY-VINYL-CHLORIDE

- **Application:** automobile instruments panels, sheathing of electrical cables, pipes, doors.
- PVC has good flexibility, is flame retardant, and has good thermal stability, a high gloss, and low (to no) lead content.
- Polyvinyl chloride molding compounds can be extruded, injection molded, compression molded, calendered, and blow molded to form a huge variety of products, either rigid or flexible depending on the amount and type of plasticizers used.

POLYETHYLENE

- **Application:** car bodies (glass reinforced), electrical insulation.
- Polyethylene has high impact resistant, low density, and exhibits good toughness.
- It can be used in a wide variety of thermoplastics processing methods and is particularly useful where moisture resistance and low cost are required.

ACRYLIC

- **Application:** windows, displays, screens.
- A transparent thermoplastic, PMMA is often used as a lightweight or shatter-resistant alternative to glass.
- It's cheaper than PC[polycarbonate] but is also more prone to scratching and shattering.

PBT (polybutylene terephthalate)

- **Application:** door handles, bumpers, carburetor components.
- The thermoplastic PBT is used as an insulator in the electrical and electronics industries.
- It is highly chemical and heat resistant. Flame-retardant grades are available.

ASA (acrylonitrile styrene acrylate)

- **Application:** housings, profiles, interior parts and outdoor applications.
- Similar to ABS, ASA has great toughness and rigidity, good chemical resistance and thermal stability, outstanding resistance to weather, aging and yellowing, and high gloss. Be careful not to burn this material. It will cause a toxic smoke.

AUTOMOTIVE DISC BRAKE

Factors considered when selecting a brake disc material

- The ability of the brake disc material to withstand high friction and less abrasive wear
- Another requirement is to withstand the high temperature that evolved due to friction.
- Weight, manufacturing process ability and cost are also important factors
- Brakes should have posses some combination of properties such as good compressive strength, higher friction coefficient, wear resistant, light weight, good thermal capacity and economically viable

POTENTIAL CANDIDATE MATERIALS

- CAST IRON
- TITANIUM ALLOYS
- ALUMINIUM METAL MATRIX COMPOSITES (AMC)

CAST IRON

- Metallic iron containing more than 2% dissolved carbon within its matrix (as opposed to steel which contains less than 2%) but less than 4.5% is referred to as gray cast iron because of its characteristic color. Considering its cost, relative ease of manufacture and thermal stability, this cast iron (particularly, gray cast iron), is actually a more specialized material for brake applications particularly the material of choice for almost all automotive brake discs. To work correctly, the parts must be produced at the foundry with tightly monitored chemistry and cooling cycles to control the shape, distribution and form of the precipitation of the excess carbon. This is done to minimize distortion in machining, provide good wear characteristics, dampen vibration and resist cracking in subsequent use

TITANIUM ALLOYS

- Titanium alloys and their composites have the potential to reduce weight of the brake rotor disc component which is about 37% less than a conventional cast iron with the same dimensions
- Offering good high temperature strength
- Better resistance to corrosion

AMC

- 20% SiC reinforced Al-composite (AMC 1)
- 20% SiC reinforced Al-Cu alloy (AMC 2)

- These materials having a lower density and higher thermal conductivity as compared to the conventionally used gray cast irons are expected to result in weight reduction of up to 50-60% in brake systems.

THREE MAJOR PROBLEMS WITH AMCs

- First, because of the density difference between aluminum and SiC, segregation or inhomogeneous distribution of SiC particles during solidification cannot be avoided.
- adding SiC particles in an aluminum matrix dramatically reduces the ductility of the material, resulting in low product liability
- The third problem is a lack of a solid lubricant, such as graphite. The lack of graphite in the system results in low braking efficiency, adhesive wear, and galling

STEERING SYSTEM

EPS COMPONENTS

1. Steering wheel
2. Steering Angle Sensor G85
3. Steering column
4. Steering Torque Sensor G269
5. Steering gear
6. Electro-mechanical Power Steering
7. Motor V187
8. Power Steering Control Module J500

TIE RODS

- **Tie Rods** are extensively used in the steering linkage for connecting the rods to the steering knuckles. These rods have apt dimensions which aid in right installation and are perfect for versatile couplings in routing linkages. The ends of these rods allow in affixing and ensure strong connections.

- Tie rods are made using best quality **Mild Steel(MS). EN8, EN19 and Stainless Steel(SS)** alloys can also be used as alternatives.

TYRES

Different components of tyres

- Ply
- Beads
- Belt
- Sidewall
- Shoulder
- Tread
- Sipe and grove
- Rib

PLY

- The plies are the layers of fabric that make up your tyre's skeleton, and are typically made of fibre cords that are woven together and coated with rubber.
- These allow your tyre to be flexible but not elastic.
- A layer called the carcass ply placed directly above the inner liner gives your tyre its strength

BEAD

- Beads are made from high-strength braided steel coated in rubber, and create an airtight seal between tyre and the rim of the wheel.
- The bead is the part of the tire that contacts the rim on the wheel. The bead is typically reinforced with steel wire and compounded of high strength, low flexibility rubber.

BELT

- Steel belts are placed around the tyre to reinforce strength and provide rigidity. These are made of woven sheets of steel wires that are coated in rubber.
- Sometimes Kevlar cord is also added for extra strength, puncture resistance, and durability

Sidewall

- The sidewall is that part of the tire that bridges between the tread and bead.
- The sidewall is largely rubber but reinforced with fabric or steel cords that provide for tensile strength and flexibility. The sidewall contains air pressure and transmits the torque applied by the drive axle to the tread to create traction but supports little of the weight of the vehicle

Shoulder

- The shoulder is that part of the tire at the edge of the tread as it makes transition to the sidewall.

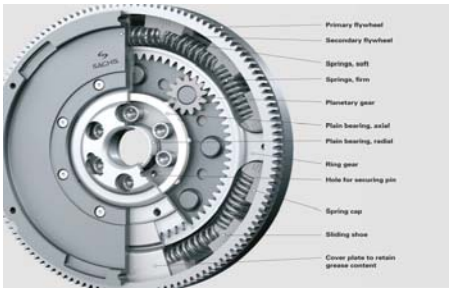
Transmission

It consist of following parts:

- Flywheel
- Clutch plate
- Pressure plate
- Gear box
- Transfer box
- Propellor shaft
- Differential gear

Following parts will be discussed in detail

FLYWHEEL



- A **flywheel** is a rotating mechanical device that is used to store rotational energy
- Material generally used for making flywheel are:

1. cast iron
2. Maraging steel
3. E-glass fiber composite
4. carbon fiber materials

Contd.

- Reasons for above material used

1. High density
2. Less strength

Material	Specific tensile strength $\left(\frac{kJ}{kg}\right)$	Comments
Ceramics	200-2000 (compression only)	Brittle and weak in tension, therefore eliminate
Composites: CFRP	200-500	The best performance—a good choice
Composites: GFRP	100-400	Almost as good as CFRP and cheaper
Beryllium	300	The best metal, but expensive, difficult to work with, and toxic to machine
High strength steel	100-200	Cheaper than Mg and Ti alloys
High strength Al alloys	100-200	Cheaper than Mg and Ti alloys
High strength Mg alloys	100-200	About equal performance to steel and Al-alloys
Ti alloys	100-200	About equal performance to steel and Al-alloys
Lead alloys	3	Very low
Cast iron	8-10	Very low

Clutch

There's the clutch "plate" and pressure plate assembly - which is usually made from steel - and then there's the clutch disc, which is usually steel with a friction material applied
There are five different materials utilized in modern clutch design:
"Organic" clutch material, which is a mix of fiberglass and other materials (including brass in some cases) molded or woven into a friction pad
Kevlar (and it's cousin Twaron), which are synthetic fibers that make for extremely long-lasting (and very forgiving) clutch friction pads
Ceramic clutch material, which is mostly a mix of silicon dioxide and various metals and additives, sintered or brazed onto the clutch disc
Feramic clutch material, which is fairly similar to ceramic material, except containing a much larger percentage of metal

- **Static friction coefficient**, which describes how well a clutch disc will hold onto a flywheel under acceleration. If the coefficient is low, the clutch disc will slip against the flywheel, get hot, and wear away.

Dynamic friction coefficient, which describes how smoothly (or abruptly) a clutch disc will 'grab' a flywheel during engagement. If the coefficient is too high, the clutch will grab immediately, leading to uncomfortable shifts that make low-speed manuevering very difficult (a key concern for truck clutch discs).

Clamping force, which is the amount of force or "weight" that must be applied to a given clutch disc to make sure it doesn't slip against the flywheel. The more force applied, the more pedal effort for the driver, the greater the load on the hydraulic system, etc.

Fade temperature, which is the temperature at which the clutch material begins to lose cohesion. If the temperature is too low, an afternoon spent towing the family boat (or at the local drag strip) can ruin the clutch disc.

Type	μ Range	Fade Temp. (°F)	Best Use
Woven Organic	0.25-0.3	600	Daily Driver
HD Organic	0.25-0.3	700	Most Street Performance, Towing, and Hauling Applications
Kevlar®	0.35-0.37	500	Longevity; Off-roading
Carbotic	0.45-0.48	750	Heavy-Duty Hauling and Towing; Commercial Trucking
Ceramic	0.4-0.6	1000	Racing
Feramic	0.5-.055	1000	Racing/Agricultural
FeramAlloy	0.4-0.6	1000	Heavy Duty Hauling and Towing; Commercial Trucking

The large gearbox casings are generally castings from cast iron or steel. Cast iron is a rigid material with excellent vibration damping properties.

Fabricated steel gearbox are used for small batch quantities.

Gearboxes used for the transmissions in vehicles are often made from cast aluminium this is primarily to save weight.

The tiny gearbox units are made from a variety of materials including cast zinc alloys.

The important criteria in the gearbox casing design are listed below..

- Inclusion of safe lifting points to allow installation

Support of the shaft bearings and hence the gear loadings;

The transfer of the developed gear forces to supporting structure or further drive element;

Containment of lubricant and exclusion of foreign matter;

Providing a safety and noise barrier;

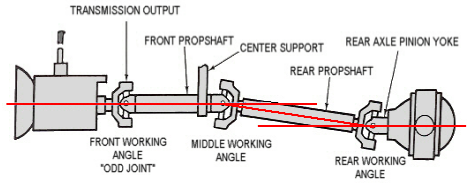
Dissipation of the heat generated by gear friction

Aiding testing, installation, and maintenance by containing all element in one unit;

- Aesthetic benefits

Enable accessible location of nameplate with all of the gear unit details

Providing convenient access to internals for inspection & maintainance



A shaft transmitting power from an engine to a propeller or to the wheels of a motor vehicle.

Materials with :

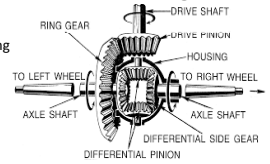
High torsional rigidity

Material that can take a lot of fatigue .

For this we can use alloy 303 or any low carbon steel with 10-18 % chromium and 5-8 % nickel.

Differential gears

A gear allowing erent speeds in



- Convenient to transport and handle;

High strength & Corrosion resistance;

Easy to install & long lifespan;

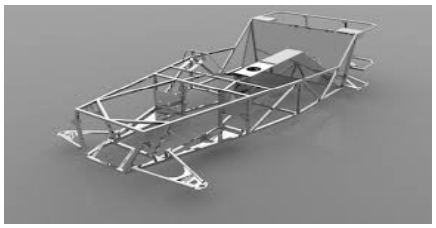
Heat Treatment: Hardening and Tempering, High Frequency Quenching, Carburizing Quenching are used while manufacturing.

If the choice is case carburized gears ,for cars and smaller SUVs we can use SAE 8620 ,16MnCr5 ,20MnCr5 SAE 4115 ,

For trucks and transportation vehicles one can choose case carburizing chrome nickel steels containing
nickel con tent 1 , 2 , and 3% like Erstwhile En 353 En365 and En36 or equivalent grades from other international standards.

If the choice is induction hardening steels use SAE4140 or SAE4340 0r En19 and En24 or equivalents.

If cheaper steel is the choice for low duty service ,one can use plain carbon steel like C40 ,C55 or equivalents



Frame

Typically the material used to construct vehicle chassis and frames is carbon steel; or aluminum alloys to achieve a more light-weight construction.

In the case of a separate chassis, the frame is made up of structural elements called the *rails* or *beams*. These are ordinarily made of steel *channel* sections, made by folding, rolling or pressing steel plate. There are three main designs for these. If the material is folded twice, an open-ended cross-section, either C-shaped or hat-shaped (U-shaped) results. "Boxed" frames contain chassis rails that are closed, either by somehow welding them up, or by using premanufactured metal tubing.

The major components of an automobile engine or an IC engine are listed below.

Engine of an Automobile

- The cylinder block
- Cylinder head or cylinder cover
- Piston and Piston rings
- Crank shaft
- Poppet Valves
- Manifold
- Gudgeon pin or piston pin
- Spark plug
- Engine bearing
- Carburetor
- Fuel atomizer or injector
- Rocker arm
- Radiator

Cylinder block

1. Functional Requirements of a Cylinder Block

Cylinder block is one of the most important part of an engine. It must be lasting the life of the vehicle , be able to withstand the pressure created by the combustion process, have ease for service and maintenance and is housing for internal moving parts and fluids.

2. Properties materials should possess

The materials used to manufacture cylinder block must possess high strength, corrosion resistance, abrasion resistance and high modulus of elasticity. The compression ratios for convention engines and diesel engines are approximately 10:1 and 17:1 respectively. So the high strength of material is a particular concern for diesel engine.

Other properties the materials should possess are :-

- Have low density , thermal expansion (to resist expanding under high operating temperatures), and thermal conductivity (to prevent failure under high temperatures).
- Good machinability and castability of the metal alloy are also important factors as the harder it is to machine the product, the higher are the costs of manufacturing.
- the alloys must possess good vibration damping to absorb the shuddering of the moving parts.
- cylinder blocks are subjected to thermal strains, aggressive wear conditions, and high fatigue stresses that an alloy must be able to endure.

Materials being used currently for cylinder blocks

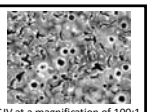
Gray cast iron –

BMW's S54 inline-6 engine, which uses a gray cast iron engine block

- Gray cast iron alloy have been the dominant metal that was used to manufacture conventional gas-powered engine blocks. Though extensive use of aluminum alloys has diminished the popularity of this material, it still finds wide use in diesel-fueled blocks, where the internal stresses are much higher.
- Gray cast iron alloys typically contains 2.5-4 wt.% carbon and 1-3 wt.% silicon, 0.2-1.0 wt.% manganese, 0.02-0.25 wt.% sulfur, and 0.02-1.0 wt.% phosphorus [8].
- It has excellent damping capacity, good wear and temperature resistance, is easily machinable, and is inexpensive to produce.
- However, gray cast irons are relatively weak and are prone to fracture and deformation. Due to these problems, **compacted graphite iron (CGI)** has recently begun to compete with gray cast iron as the choice material to produce diesel engine blocks.

Compacted graphite cast iron

Compacted graphite cast iron (CGI), which was accidentally discovered while trying to produce ductile cast iron.



GJV at a magnification of 100:1

- It possesses higher tensile strength and elastic modulus than gray castiron due to the compacted graphite found on the microstructure of CGI. Gray cast iron has a lower tensile strength than CGI, despite its higher weight.
- It has proven to be useful in the manufacture of V topology diesel engines where the loading on the block is very high between the cylinder banks, and for heavy goods vehicles which use diesel engines with high combustion pressures.
- Like gray cast iron, compacted graphite cast iron has good damping capacity and thermal conductivity, but its difficulty to machine has limited the wide-scale use of CGI. A new manufacturing process, however, has opened the way for larger applications of CGI. The development of rotary insert tools has increased the life of the tools used to machine the metal, thus allowing manufacturers to use CGI without worrying about purchasing new tools
- It is also used for turbo housings and exhaust manifolds. In the latter case to reduce corrosion.

Aluminum Alloys

- Aluminum alloy use has gained popularity as a way to reduce the overall weight of the vehicle.
- There are two practical implications: improved performance-to-weight ratio and increased fuel efficiency.
- The drawbacks of using aluminum in engine blocks are that they are more expensive to manufacture than cast iron alloys.
- However, the strength-to-weight ratio of aluminum alloys is hard to ignore, and manufacturing processes developed throughout the years have minimized the cost disparity between aluminum and cast iron.
- There are two aluminum alloys that are mainly used in the manufacture of cylinder blocks: 319 and A356.
- **Aluminum alloy 319** has a composition of 85.8-91.5 wt.% aluminum, 5.5-6.5 wt.% silicon, 3-4 wt.% copper, 0.35 maximum wt.% nickel, maximum 0.25 wt.% titanium, maximum 0.5 wt.% manganese, maximum 1% iron, maximum 0.1 wt.% magnesium, and maximum 1 wt.% zinc. The alloy has good casting characteristics, corrosion resistance, and thermal conductivity.
- When heat treated with the T5 process, it possesses high strength and rigidity for engine block use.
- Aluminum alloy A356 has a composition of 91.1-93.3 wt.% aluminum, 6.5-7.5 wt.% silicon, 0.25-0.45 wt.% magnesium, and maxima of 0.2 wt.% copper, 0.2 wt.% titanium, 0.2 wt.% iron, and 0.1 wt.% zinc . Mechanical properties are similar to that of aluminum alloy319.
- However, when heat treated with a T6 treatment, it possesses higher strength than 319.
- A356-T6 has lower elastic modulus compared to that of 319-T5.

The Chevrolet Corvette LS1 V8 engine which utilizes an aluminum alloy 319-T5 cylinder block

General Motor's inline-5 engine which uses aluminum alloy A356-T6 as its engine block

AMC-SC1 Magnesium alloy

- This grade of magnesium alloy contains two rare earth elements, lanthanum and cerium, and was heat-treated with T6. This stabilizes the strength of the alloy at high engine operating temperatures, which is a necessary requirement for a cylinder block material.
- The most significant point is that the yield strength of AMC-SC1 essentially stays the same at 177ºC as it does at room temperature. This means that the material is able to tolerate a wide range of operating temperatures without a loss in strength.
- Other properties of the magnesium alloy include good thermal conductivity, excellent machining and casting qualities, and excellent damping characteristics.

BMW's 6-cylinder R6 powerplant uses a magnesium alloy AMC-SC1-fabricatedcylinder block

- To demonstrate the significant weight savings of magnesium alloy over cast iron and aluminum alloy, consider BMW's inline-6 R6 , which replaced the company's M54 aluminum engine. Its cylinder block is made of AMC-SC1 and is said to have decreased the weight of a comparably-built gray cast iron and aluminum alloy block by 57% and 24% respectively.
- So far, BMW is the only company to have used magnesium alloy cylinder blocks in production vehicles.

- Low carbon steel

Steel is an alloy of iron and other elements, primarily carbon, that is widely used in construction and other applications because of its high tensile strength and low cost. Steel's base metal is iron, which is able to take on two crystalline forms (allotropic forms), body centered cubic (BCC) and face centered cubic (FCC), depending on its temperature. It is the interaction of those allotropes with the alloying elements, primarily carbon, that gives steel its range of unique properties.

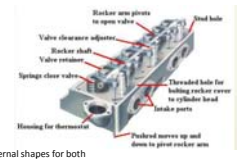
Steel is basically of three types :

1. Low carbon steel (% weight of carbon is less than 0.3)
2. Medium carbon steel (% weight of carbon is in between 0.3 to 0.6 (excluding 0.6))
3. High carbon steel (% weight of carbon equal to or more than 0.6)

Low carbon Steel : - The carbon in these alloys is limited , and is not enough to strengthen these materials by heat treatment, hence these alloys are strengthened by cold work. Their microstructure consists of ferrite and pearlite and these alloys are relatively soft ,ductile combined with high toughness. Hence these materials are easily machined and welded .

Cylinder head or cylinder cover

- One end of the cylinder block is closed by means of cylinder head.This consist of inlet valve for admitting air fuel mixture and exhaust valve for removing the products of combustion.
- The inlet valve, exhaust valve , spark plug, injector etc. are bolted on the cylinder head.The main function of cylinder head is to seal the cylinder block and not to permit entry and exit of gases on cover head valve engine.



Cylinder-head Materials

- The cylinder head material should be readily cast with complicated internal shapes for both the coolant passages and for the inlet and exhaust ports.
- The material should be strong enough in compression and able to operate continuously under fluctuating gas pressures and temperatures when fixed rigidly to the cylinder block by bolts or studs.
- Although the gas-pressure loads are not excessive for the available materials, but prevailing temperature gradients produce non-uniform expansion and contraction of the metal in these regions. As a result, thermal stresses are developed across the cylinder head eventually causing distortion or even cracks in the critical areas exposed to the heat of combustion.

- The ideal cylinder-head material should limit the temperature of the surface so that lubrication remains effective, combustible petrol-and-air mixtures do not overheat to cause detonation, hot spots that promote pre-ignition are not formed, and high cyclic thermal stresses are not developed.
- In particular, under various operating conditions like continuous full-load running on motorways or under part load operations with weak mixtures and late ignition, surface temperatures rise causing local thermal stresses, which can easily reach dangerously high values unless the heat is adequately dissipated.

The materials generally used are grey cast iron and aluminium alloys. The common cylinder-head cast iron meets most of the requirements, such as cheapness, good castability, good machinability, good corrosion resistance, adequate rigidity, strength, and hardness, and low thermal expansion. But it has the disadvantages of high weight and low thermal conductivity.

The aluminium alloy head, on the other hand, has half the weight of equivalent cast-iron heads. It also has a thermal conductivity three times better than that of cast iron due to which the possibility of thermal distortion is reduced and the head cooling system permits the use of higher compression ratios. The disadvantages of aluminium alloy are that it is more expensive, it's corrosion resistance is inferior to cast iron, it is much softer than cast iron, and it has a high thermal expansion which causes fretting between an aluminium-alloy head and a cast-iron cylinder block during starting and stopping of engines, so that separate wear-resisting valve seats and guide inserts become necessary.

- The composition of the cast iron used in cylinder heads is similar to that used in cylinder blocks .
- In the case of aluminium alloys, however, slightly different compositions are preferred. **Two commonly recommended aluminium-alloys are:-**
  (i) 3.0% copper. 5% silicon, 0.5% manganese in a matrix of aluminium; and
  (ii) 4.5% silicon, 0.5% manganese, 0.5% magnesium in matrix of aluminium.
- The copper and silicon in the alloys reduces thermal expansion and contraction and improves the fluidity and castability properties of aluminium.
- Copper promotes age-hardening and silicon improves the abrasion resistance. Addition of manganese and magnesium improves the strength of the alloy. The corrosion resistance of the slightly superior alloy containing copper is inferior to that of the copper-free silicon-aluminium alloy.
- **Magnesium alloys have also been used in engines for cylinder head covers.**

- Piston is used to reciprocate inside the cylinder.
- It transmits the energy to crank shaft through connecting rod.
- In the case of four-stroke engine the piston is pulled or pushed with the help of crankshaft while in the case of compression stroke, piston is pushed with the powerful explosion of mixture of air and fuel.

- ❑ Pistons are commonly made of a cast aluminum alloy for excellent and lightweight thermal conductivity.
- ❑ *Thermal conductivity* is the ability of a material to conduct and transfer heat. Aluminum expands when heated, and proper clearance must be provided to maintain free piston movement in the cylinder bore. Insufficient clearance can cause the piston to seize in the cylinder.
  - o Excessive clearance can cause a loss of compression and an increase in piston noise.

Piston rings

These are used to maintain pressure tight seal between the piston and cylinder walls and also it transfer the heat from the piston head to cylinder walls.

Materials used

Cast iron of fine grain and high elastic material.

Reason

The piston ring has to go through very high stress both mechanical and thermal.Thus the material used must have a high strength, corrosion resistance, abrasion resistance and high modulus of elasticity.

Crank

Function

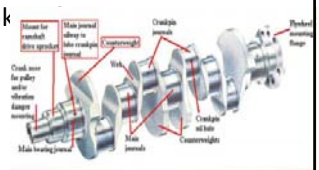
A crankshaft is a mechanical part able to perform a conversion between reciprocating motion and rotational motion.

Material used

37C15 Alloy Steel

Reason

Rust proof , hard , high strength , Can be able to bear high pressure.



Counterweights used in some crankshafts

Some expensive, high performance crankshafts also use heavy-metal counterweights to make the crankshaft more compact. The heavy-metal used is most often a tungsten alloy but depleted uranium has also been used. A cheaper option is to use lead, but compared with tungsten its density is much lower.

Poppet valves

- A valve is a device that regulates directs or controls the flow of the fluid by opening or closing or partially obstructing various passageways.
- The intake and exhaust valves open at the proper time to let in air and fuel to let out exhaust.

Materials used

Phosphorous , Bronze and monel metal

Reason

The resistance to corrosion, low fiction with the fuel ,ductile and machinable, resists metal fatigue and is a good conductor of heat (helps in controlling the temperature of fuel).

Carburettor

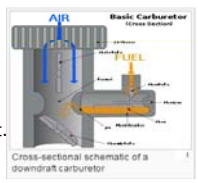
- The function of carburetor is to atomize and meter the liquid fuel and mix it with the air as it enters the induction system of the engine.

Materials used

The thermoplastic PBT is used

Reason

- It is highly chemical and heat resistant. Flame-retardant grades are available.



Fuel atomizer or fuel injector

- Fuel injection is a system for mixing fuel with air in an internal combustion engine. It has become the primary fuel delivery system used in automotive petrol engines and have almost completely replaced carburetors.

Radiator

Function

To circulate the coolant ,temperature contr

Material used

Up to the 1980s, radiator cores were often made of**copper** (for fins) and **brass** (for tubes, headers, and side-plates, while tanks could also be made of **brass** or of plastic, often a polyamide).

Modern radiators have **aluminum** cores, and often save money and weight by using plastic headers.

The engine temperature on modern cars is primarily controlled by a wax-pellet type of thermostat, a valve which opens once the

Manifold

Function

To supply the air fuel mixture and collect exhaust gases equally from all the cylinders.Two manifold are used in one engine one for intake and other for exhaust.

Material used

Aluminium alloy-Alloy 4600

Rocker arm

- These are typically in between the pushrod and the intake and exhaust valves. They allow th push rods to push up on the rocker arms and therefore push down on the valves.
- **Material used**

  Medium carbon steel

Engine bearing

Function

Everywhere there is a rotary motion in the engine, bearings are used to support the moving parts. It has the purpose to reduce the friction and allow the parts to move freely.

Materials used

The most common arrangement is a hybrid bearing, usually with**stainless steel rings** and ceramic balls. The most common ceramic material used is **silicon nitride**.

Spark plug

Function

- To conduct high potential from the ignition system into the combustion chamber.
- It provides the proper gap across which the spark is produced by applying high voltage , to ignite the mixture in ignition chamber.

Material properties required:-

- Spark plug passes through the wall of the combustion chamber and therefore must also seal the combustion chamber against high pressures and temperatures without deteriorating over long periods of time and extended use.

Structure : consists of two electrodes ,the insulator and the shell.

Materials used

The main part of the insulator is typically made from sintered alumina a very hard ceramic material with high dielectric strength.

Central electrode :The tip can be made of a combination of copper, nickel-iron, chromium, or noble metals.

The side electrode is made from high nickel steel.

Gudgeon pin or Piston pin

- These are hardened steel parallel spindles fitted through the piston bosses and the small end bushes or eyes to allow the conneting rods to swivel.

It connects piston to connecting rod.

- **Material used**

  Plain carbon steel

Automotive batte

- An **automotive battery** is a rechargeable ba
that supplies electric energy to an automobile
- Traditionally, this is called an SLI, for starting
lighting, ignition, and its main purpose is to sta
the engine.
- Once the engine is running, power for the car is supplied by the alternator Typically, starting discharges less than three per cent of the battery capacity.
- SLI batteries are designed to release a high burst of current, measured in amperes, and then be quickly recharged. They are

Different types of batteries

Lead –acid batteries

- Flooded lead-acid batteries are the cheapest and in past most common traction batteries available. There are two main types of lead-acid batteries: automobile engine starter batteries, and deep cycle batteries.
- Traditionally, most electric vehicles have used lead-acid batteries due to their mature technology, high availability, and low cost .
- Flooded batteries require inspection of electrolyte level and occasional replacement of water which gases away during the normal charging cycle.

Nickel Metal hybrid

- Nickel-metal hydride batteries are now considered a relatively mature technology. While less efficient (60–70%) in charging and discharging than even lead-acid, they boast an energy density of 30–80 Wh/kg, far higher than lead-acid.
- When used properly, nickel-metal hydride batteries can have exceptionally long lives, as has been demonstrated in their use in hybrid cars and surviving NiMH RAV4EVs that still operate well after 100,000 miles (160,000 km) and over a decade of service.
- Downsides include the poor efficiency, high self-discharge, very finicky charge cycles, and poor performance in cold weather.

Headlamp

The first electric headlamp light source was the **tungsten filament**, operating in a **vacuum or inert-gas** atmosphere inside the headlamp bulb or sealed beam.

Drawbacks:Compared to newer-technology light sources, tungsten filaments give off small amounts of light relative to the power they consume.

Halogen infrared reflective (HIR)

- A further development of the tungsten-halogen bulb has a dichroic coating that passes visible light and reflects infrared radiation.
- The glass in such a bulb may be spherical or tubular. The reflected

High-intensity discharge (HID)

High-intensity discharge lamps (HID) produce light with an **electric arc** rather than a glowing filament.

- The high intensity of the arc comes from metallic salts that are vapourised within the arc chamber. These lamps are formally known as gas-discharge burners.
- Automotive HID may be called "xenon headlamps", though they are actually metal-halide lamps that contain xenon gas. The xenon gas allows the lamps to produce minimally adequate light immediately upon start, and shortens the run-up time.
- The usage of argon, as is commonly done in street lights and other stationary metal-halide lamp applications, causes

HID projector low beam headlamp illuminated on a Lincoln MKS

THANK YOU