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Units of Construction

1.1 MAIN UNITS OF AN AUTOMOBILE

- (i) Basic structure.
- (ii) Power plants.
- (iii) Transmission system.
- (iv) Auxiliaries.
- (v) Controls.
- (vi) Superstructure.

1.2 BASIC STRUCTURE

It is the main base of the vehicle on which the other units are mounted to build it as a power-operated vehicle. The main parts of the structure are the frame, the suspension system, axles, wheels and tyres.

(i) **Frame.** Generally the frames are constructed in two distinct forms :

- (a) **Pressed-steel frame.** On this conventional pressed-steel frame body is mounted with the help of bolts and hooks. Other units are also attached to it by mechanical methods.
- (b) **Integral or frameless construction.** In this system, body structure as well frame structure are designed combined to give rigidity to whole of the structure. Other units are also attached to the frame then being attached to the body.

The integral construction is very useful in the case of closed car, roof of buses, since screen pillars, door pillars and other load-taking parts of the vehicle structure needs this construction.

(ii) **Suspension System.** Main objects of suspension are :

- (a) The road shocks are very harmful for the vehicle components which can be prevented to transmit further by suspension system.
- (b) To prevent and safeguard the occupants from road shocks.
- (c) To give stability to vehicle in pitching or rolling, while in motion.

Generally there are two types of suspension systems :

(a) **Conventional System.** When the road springs are attached to a rigid beam axle then this system is known as a “conventional system”.

(b) **Independent System.** When there is no rigid axle beam and each wheel is free to move vertically without any reaction on the other wheel then this system is known as an “independent system”.

(iii) **Axles.** Both front and rear axles are loaded at two intermediate points through the spring centres and consist of the following loads :

(a) Vertical load at the centres of the springs due to the weight of the vehicle.

(b) Side thrust at the radius of the wheel due to centrifugal force when passing a curve.

(c) Fore and aft load at the wheel centre due to driving and braking efforts.

(d) Torque reactions due to drive or brakes.

Generally there are three types of rear axles :

(a) Axle fully floating type.

(b) Axle three-quarter floating type.

(c) Axle semi-floating type.

The front axle is generally simple section of forging ; carrying the king pins at its outer ends. But when the front wheels are power driven then tube type hollow axle is selected.

(iv) **Wheels.** On sports cars wire-spoked wheels are used because they are light in weight and quick and easy in changing. For general purposes, these wheels have been replaced by the pressed steel wheels. Pressed steel wheels consist of central flanged disc pressed into rolled-section rims and those are retained in position by welding the joints. To fasten the tyres on the wheels rings and lock rings are used. These are also of pressed steel.

1.3 POWER PLANTS

Power plant for a vehicle is an engine which provides the motive power to all the units and the parts those need power. All the major units of the vehicle function due to power of plant only.

The internal combustion engine which may be either of compression-ignition or spark-ignition is generally used as power plant in the vehicle. Now these days the gas turbines have also been used in certain cars due to their better performance compared to internal combustion engines but their high cost is a disadvantage.

1.4 TRANSMISSION SYSTEM

The power from an engine is transmitted equally between the driving wheels through clutch system ; a gear box giving three to five different advance ratios and one back ratio of torque output to torque input, a propeller shaft or series of propeller shafts to transmit the torque output from the gear box to the rear axle using differential gear. When the vehicle is used as four wheel drive then the additional arrangement of power transmission is used to transmit the power up to front wheels.

Functions of the transmission system

- (i) To connect the engine to driving wheels so as to rotate on road without shocks.
- (ii) To disconnect the engine from the driving wheels when desired.
- (iii) To vary the leverage between the engine and the driving wheels as per load and speed of the vehicle.
- (iv) To reduce the engine revolutions permanently in a fixed ratio to give particular speed to the vehicle.
- (v) To turn the drive through a desired angle without slip.
- (vi) To provide the driving wheels to move in different speeds at the turns.
- (vii) To accommodate the flexing system of the road springs which causes a relative movement between the engine and the axles.

The main units of the transmission system are

- (i) *Clutch*. The main purpose of it is to disconnect the drive from the road wheels and to engage the drive from the engine to the road wheels gradually while the vehicle is moving from rest.
- (ii) *Gear Box*. The gear box provides three to five forward and one backward torque output to torque input, between the engine and road wheels.
- (iii) *Crown Wheel and Bevel Pinion*. They provide a permanent reduction in speed and turn the drive round through 90°.
- (iv) *Universal Joints*. They provide for the relative movement between the non-plane units due to rotary movements of gear shafts and propeller shaft and movement between the engine and the driving wheels due to flexing of road springs.
- (v) *Differential*. While taking turns the inner wheel covers less distance in respect to the outer, therefore, wheels must turn at different speeds. This is done with the help of differential unit.

Instead of power supply to the rear axle the same can be supplied to the front axle which is nearer the engine by eliminating the

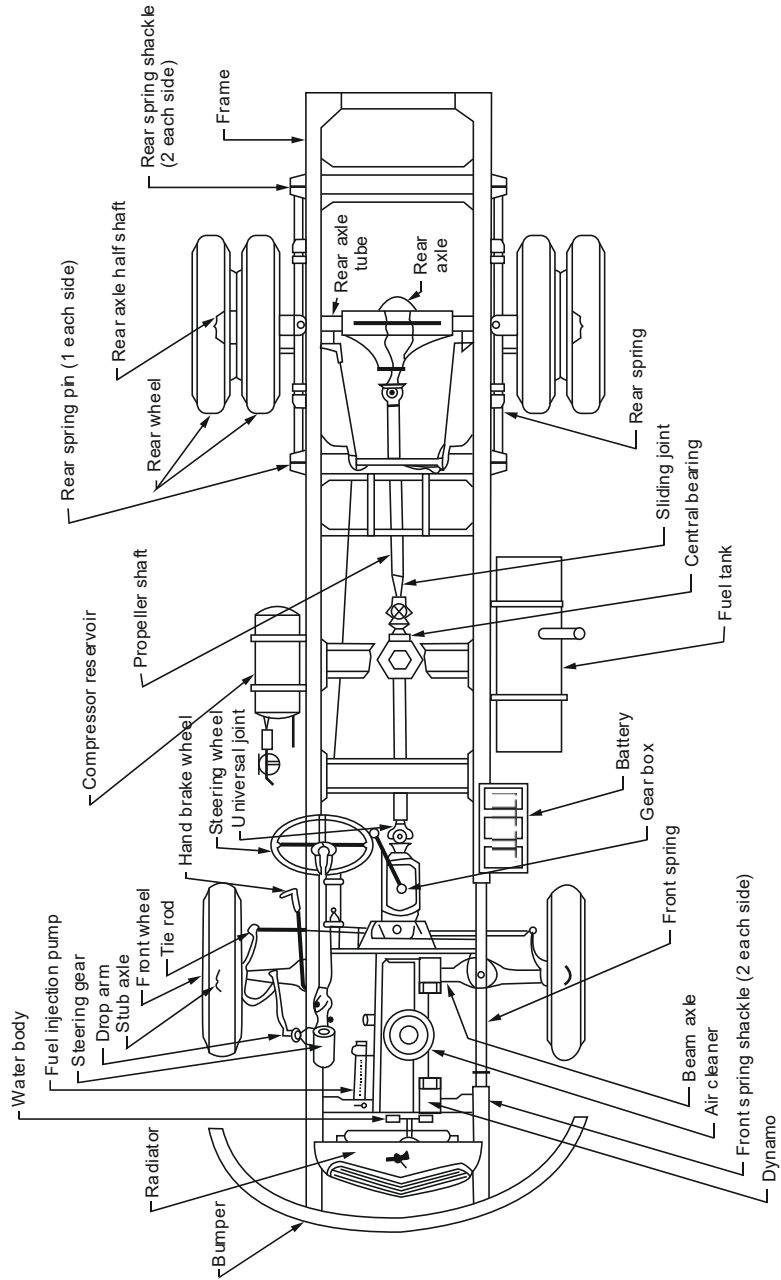


Fig. 1.1

length of the propeller shafts. The advantages of front wheel drive are to lower the chassis height and in this case the engine pulls the vehicle rather than pushing it. The disadvantage in the case of front wheel drive system is that it has to function the steering movement also which is a complicated arrangement. Complete shaft and joint system needs change with this alteration.

1.5 AUXILIARIES

The main auxiliaries those are common to absolutely all types of vehicles are the electrical equipments and few other miscellaneous equipments. These can be divided into the following systems :

- (i) The supply systems—Battery and dynamo.
- (ii) The starter.
- (iii) The ignition systems—Magneto and coil ignition.
- (iv) Ancillary devices :
 - (a) *Driving Lights*—Head, tail, side and number plate lights.
 - (b) *Signalling*—Horn, brake light and direction indicators.
 - (c) *Other Lights*—Roof light, panel light and reverse gear light, etc.
 - (d) *Miscellaneous*—Fuel pump, wind screen wipers, fans heater, radio etc.

1.6 CONTROLS

The controls consist of as given under :

- (i) Steering system.
- (ii) Gear shift lever, transmission : forward gears and reverse gear.
- (iii) Hand Brake lever.
- (iv) Clutch pedal.
- (v) Brake pedal.
- (vi) Accelerator pedal.
- (vii) Dimmer switch.
- (viii) Horn Button.

Control panel consists of as given under :

- (i) Oil pressure gauge.
- (ii) Temperature gauge for cooling water.
- (iii) Air pressure gauge.
- (iv) Speedometer and Odometer.
- (v) Fuel gauge.
- (vi) Glow plug and starter switch.

- (vii) Spare opening.
- (viii) Switch, instrument panel lights.
- (ix) Wiper motor switch.
- (x) Blue lamp : Light up only when head light upper beam is switched on.
- (xi) Red charging control lamp. Lights up when switch key is pressed in and must go out when driving.
- (xii) Main switch.

1.7 SUPER STRUCTURE

When frameless construction is not done in the vehicle then separate body is used on the frame which is known as “superstructure”.

1.8 CLASSIFICATION OF AUTOVEHICLES

Wide range, say about 400 million autovehicles run on the world roads and serve some specific purposes are classified on the basis of their specialities. Mopeds, scooters, motorcycles are meant for individual uses. Cars, jeeps etc. are supposed to be family vehicles. Motorcycles and jeeps are suitable for rough purposes but scooters and cars are used on roads. A minibus serves the purpose of society by transporting people. The buses are meant for long distance movement. The trucks are used for carrying goods. The tractor is a field vehicle, while the bulldozer is involved in construction works, and gun-carriage works in military operations. The main basics on which vehicles are classified are as given below :

1. On the basis of number of wheels,
2. On the basis of prime mover used,
3. On the basis of weight of the vehicle and its pay load capacity,
4. On the basis of purpose served,
5. On the basis of type of wheel drive system,
6. On the basis of engine capacity,
7. Sports, luxury and high altitude vehicles,
8. On the basis of fuel used,
9. On the basis of placement of steering wheel,
10. Special purposes vehicles.

(i) On the basis of Number of Wheels

1. Two-wheelers : Such as mopeds, scooties, scooters, motorcycles etc.
2. Three-wheelers : Such as tempos, tractors, road rollers etc.
3. Four-wheelers : Such as cars, jeeps, minibuses, buses, racing cars, trucks, tractors etc.

4. Five-wheelers : Such as road rollers.
5. Six-wheelers : Such as trucks, tankers, gun carriage vehicles etc.
6. Eight or more-wheelers : Such as car and two-wheeler transporting vehicles, rocket transporting vehicles.

(ii) On the basis of Prime Mover Used

1. I.C. engine driven autovehicles : Such as petrol vehicles, diesel vehicles, and gas vehicles.
2. Gas turbine driven auto vehicles
3. Wankel engine driven auto vehicles
4. Electric power driven auto vehicles
5. Battery (chemical power) driven auto vehicles
6. Solar energy driven auto vehicles
7. Hybrid powered auto vehicles
8. Hydrogen (as fuel) propelled auto vehicles
9. Steam engine driven auto vehicles

(iii) On the basis of weight of the vehicle and its payload capacity

- (a) *Kerb weight or unladen weight.* It is the weight of chassis without any load on it.
- (b) *Gross Vehicle Weight (GVW) or laden weight.* It is the maximum load capacity of the vehicle.
- (c) *Payload.* The difference between laden weight and unladen weight is called the payload.

Based on the GVS of vehicles, they are grouped as under :

1. Light weight or light duty vehicles : 1 tonne GVW.
2. Medium weight or medium duty vehicles : 1 to 3.5 tonne GVW.
3. Heavy weight or heavy duty vehicles : 3.5 to 7.5 tonne GVW.
4. Extra heavy duty vehicles : 7.5 to 15 tonne GVW.
5. Special purpose (load) vehicles : Above 15 tonne GVW.

(iv) On the basis of purpose served. Since a car cannot run on the agricultural land comfortably, and a moped is not supposed to run across the country, therefore the vehicles can be classified as given under.

1. On-the-road vehicles : Such as cars, scooters, trucks etc.
2. Off-the-road vehicles : Such as tractors, construction equipments etc.
3. On-the-road and off-the-road vehicles : Such as military tanks, gun carriages, bulldozers etc.

(v) **On the basis of type of wheel drive system.** The power from engine may be given to a single or more wheels. The power receiving wheels may be rear wheels, or front wheels or all the wheels. Thus on this basis the vehicles are classified as under :

1. Single wheel drive : Such as scooter having two wheels whose rear wheel gets driving power. Similarly a tempo having 3 wheels and its front wheel gets power.
2. Two wheel drive : Such as cars trucks and tractors. They generally have rear-wheel drives. But in some cars driving power is provided in front wheels only.
3. Four wheel drive : Such as jeeps, racing cars, trucks, buses etc. have four wheels and all four wheels are power driven.
4. All wheel drive : Such vehicles may be six wheelers or more than six wheelers. They may be $6w \times 6d$, $10w \times 4$ drive. Similarly an endless chain driven vehicle may be 8 wheels \times 8 driven. Military tanks, earthmovers and bulldozers are chain driven vehicles.

(vi) **On the basis of engine capacity.** The engine capacity means its swept volume (V_s) which is calculated as under :

$$V_s = \frac{\pi}{4} D^2 L \text{ cc}$$

where D is bore of the cylinder in cms and L is the stroke in cms.

In case of 6 cylinder engine the swept volume will be as.

$$V_s = 6 \times \frac{\pi}{4} D^2 L.$$

Therefore vehicles are accordingly classified as 50 cc, 100 cc, 150 cc, 250 cc, 350 cc, 800 cc, 3500 cc or 5000 cc and so on.

(vii) **Sports, Luxury and High Altitude Vehicles.**

1. *Sports (racing) cars.* To attain the maximum possible speed, these vehicles are propelled by engines of higher powers. Generally jet propelled autovehicles are more popular in this field.

2. *Luxury cars.* These vehicles are superior as well costlier than ordinary vehicles, and are also provided with additional facilities such as : Air conditioner, Power steering, collapsible steering, Power windows Multi-point fuel injection system, Automatic fuel-flap and trunklid, Automatic transmission gear box, Rear-window defroster, Front and rear fog lamps, Central locking system, Side impact beam, Multi-directional adjustment of driver's seat, Seat belt, Stereo system, Power antenna etc.

3. *High altitude driving cars.* The roads at high altitude locations are generally sloppy, steeper, curved zigzag and of non-bituminous top layer. Cause due to varying climatic condition at different

heights, the temperature, pressure and density of air also lower than those at ground level. Therefore vehicles have some specialities in their designs to serve properly at these conditions, which include :

- (a) Powerful vehicle engine,
- (b) Gear box with large starting torque,
- (c) Supercharger for providing sufficient air,
- (d) Improved carburettor etc.

(viii) **On the basis of fuel used.** They are classified as :

- 1. Petrol vehicles,
- 2. Diesel vehicles,
- 3. Dual fuel (petrol and diesel) vehicles,
- 4. Gas vehicles such as C.N.G. (Compressed Natural Gas used),
- 5. Hydrogen vehicles.

(ix) **On the basis of placement of steering wheel.** They are classified as :

- 1. *Left hand driven vehicles.* Having steering wheel located on the left side.
- 2. *Right hand driven vehicles.* Having steering wheel located on the right side.

Their movement on the road are also defined and ruled accordingly.

(x) **Special purpose vehicles.** Depending upon their utility in various fields they are classified such as :

- 1. Military applications
- 2. Aircraft service
- 3. Industries and power stations
- 4. Underground boring
- 5. Car carriers
- 6. Construction of dams, bridges, roads etc.
- 7. Mine works
- 8. Material handling
- 9. Earth moving equipments
- 10. Petroleum and L.P.G. carriers.

QUESTIONS

- 1. What are the main units of an automobile ? Describe them in brief.
- 2. What is the function of the transmission system in automobiles ?

3. What are the functions of the various electrical devices in a vehicle ?
4. What are the advantages of a front wheel drive over the rear wheel drive system ?
5. What is the function of universal joints ? Where are they used ?
6. What are the different controls of the vehicle ? Describe their functions.
7. Describe the function of the gear-box and clear the working of the back gear.
8. What are different types of rear axles ? Describe the transmission of power system at 90°.
9. What are the auxiliaries ? Describe the classification of the auxiliaries.
10. What are the different positions of the power plant in the vehicle and give their merits and demerits ?
11. “The integral construction, in which the body structure is so designed as to combine the functions of body and frame”. True, or false ?
12. The frameless construction is generally opted in the case of a closed car/Truck/Bus.
13. The conventional system, in which the road springs are attached to a rigid beam axle/stub axle.
14. The independent system in which there is no rigid axle. True or false.
15. The purpose of the clutch is to connect or disconnect the drive from the engine to the road wheels gradually/suddenly.
16. The universal joints provide for the relative movement for the leverage variation between the engine and the driving wheels. True or false.
17. While taking turns, the driving wheels must turn at same/different speeds. This is done with the help of gear-box/differential.
18. The advantage of the front wheel drive is that in this case the engine pulls/pushes the vehicle.