

UNIT – II

Cooling System Ignition System Electrical System

Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions.

Ignition System

Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser, and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

Electrical System

Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

1. Cooling System

An IC engine passes only about 25–30% of heat energy into useful work. The rest must be dissipated to prevent component failure, thermal distortion, and lubricating oil breakdown.

Types of Cooling Systems

- **Air Cooling:**

Uses extended surfaces (**fins**) to increase the surface area for heat transfer via radiation and convection. Commonly used in motorcycles and small engines due to its simplicity and lightweight nature.

- **Liquid Cooling:**

Uses a coolant (water + antifreeze) circulated through engine jackets to absorb heat, which is then dissipated via a radiator.

Circulation Methods

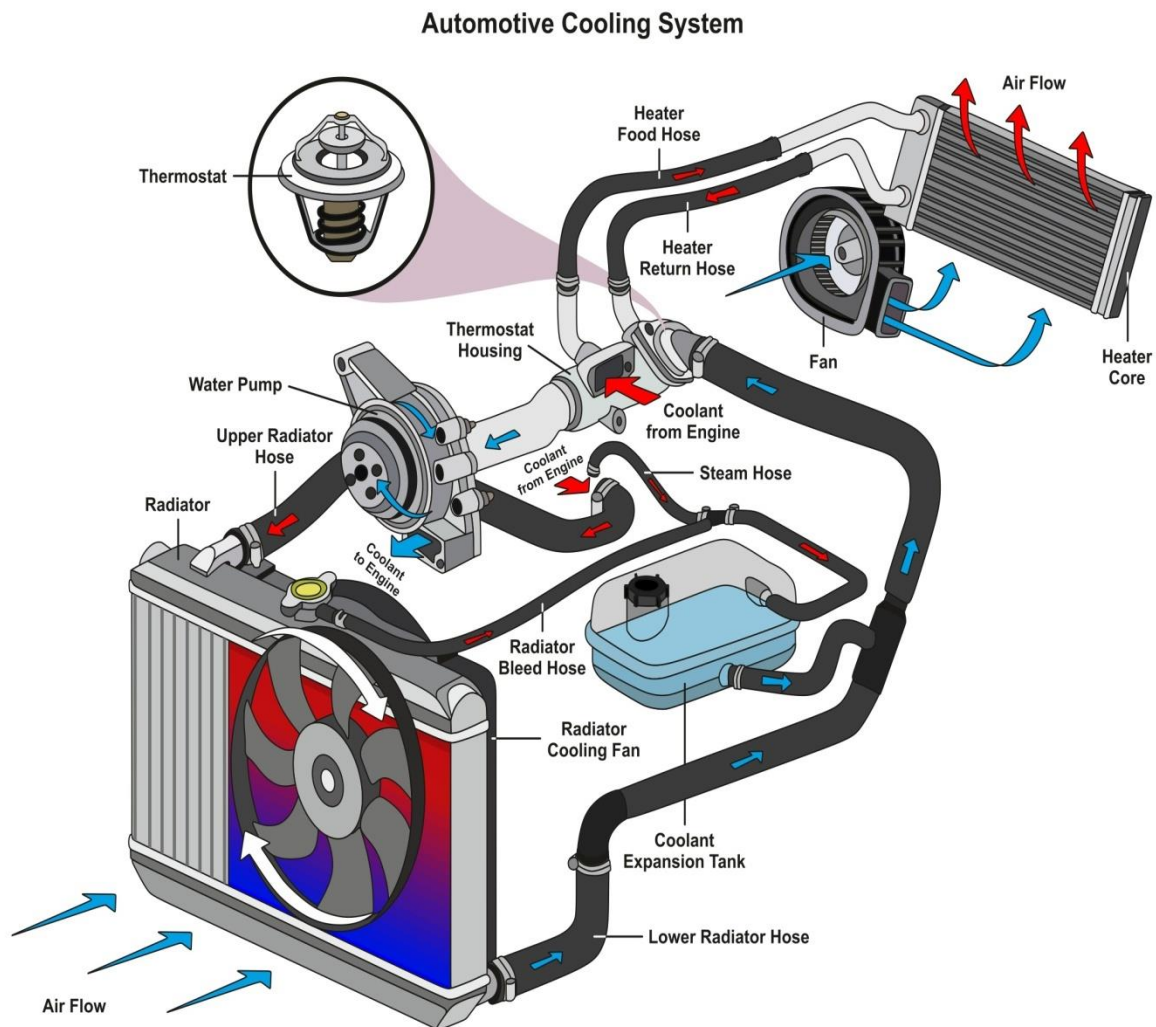
- **Thermosyphon System:**

Relies on natural convection. Hot water (lower density) rises to the top of the radiator, and cool water (higher density) sinks to the engine block. **No water pump is used.** It requires a large volume of water and precise radiator placement.

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- **Forced/Pump Circulation:**

Uses a centrifugal **water pump** driven by the engine belt to positively force coolant through the system, ensuring efficient heat transfer even at high speeds and loads.



Key Components

- **Radiator:**

A heat exchanger that transfers heat from the coolant to the ambient air.

Types:

Tubular core (water flows through tubes, air passes around them) and

Cellular/Honeycomb core (water flows through spaces between air cells).

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- **Cooling Fan:**

Draws air through the radiator core to accelerate heat dissipation, especially when the vehicle is stationary or moving slowly.

- **Thermostat Valve:**

A temperature-controlled valve placed between the engine and the radiator. When the engine is cold, it remains closed, bypassing the radiator to help the engine reach its optimum operating temperature quickly.

- **Pressure Cap (Pressure Sealed Cooling):**

Seals the system and increases operating pressure. Because raising pressure raises the boiling point of water, it prevents boiling at high loads and reduces coolant loss.

- **Evaporative Cooling:**

Utilizes the latent heat of vaporization of the coolant to carry away heat. Primarily used in stationary engines or specialized high-performance setups.

- **Antifreeze Solutions:**

Chemical additives (like **Ethylene Glycol**) mixed with water to lower its freezing point (preventing winter cracking of the engine block) and raise its boiling point.

2. Ignition System

The primary function of the ignition system is to produce a high-voltage spark at the correct instant (near the end of the compression stroke) to ignite the air-fuel mixture in a petrol (SI) engine.

Types of Ignition Systems

- **Battery Ignition System:**

Uses a storage battery to supply low-voltage (6V or 12V) current to the primary winding of an **ignition coil (auto-transformer)**.

- **Magneto Ignition System:**

Generates its own electricity using a permanent magnet generator driven by the engine. It does not require a battery, making it ideal for racing cars, motorcycles, and aviation.

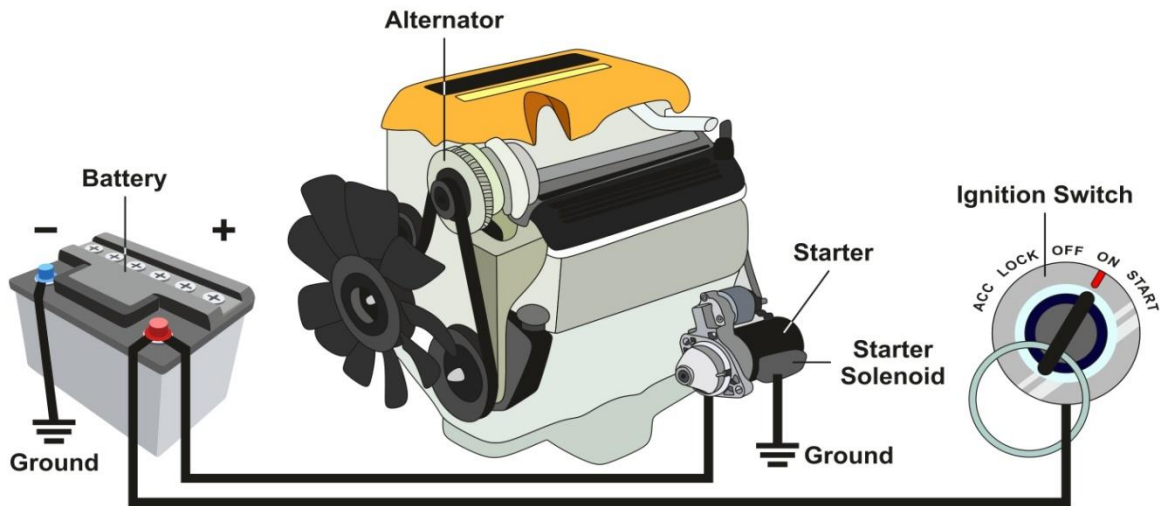
- **Electronic Ignition System:**

Replaces mechanical contact breaker points with electronic switching.

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- *With contact breakers:* Uses mechanical points only to trigger a transistor, reducing current across the points to eliminate pitting.
- *With contact triggers (Pickups):* Uses optical, Hall-effect, or inductive pulse sensors to trigger the spark completely electronically, eliminating mechanical wear entirely.
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Starting System



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Key Components

- **Storage Battery:**

Chemically stores electrical energy to provide low-voltage DC power.

- **Ignition Coil:**

Functions as a step-up transformer. It converts low voltage (12 V) into the high voltage ($15,000\text{ V} - 30,000\text{ V}$) required to jump the spark plug gap.

- **Contact Breaker Points:**

Mechanically opens and closes the primary circuit to break the magnetic field in the coil, inducing high voltage in the secondary winding.

- **Condenser (Capacitor):**

Connected in parallel with the contact breaker points. It prevents arcing across the points when they open and accelerates the collapse of the primary magnetic field.

- **Spark Plug:**

Conducts the high-voltage current into the combustion chamber, where it forces the current to jump an insulated gap, creating the ignition spark.

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Spark Advance and Retard Mechanism

To maximize thermal efficiency, the spark must occur slightly before the piston reaches Top Dead Center (TDC).

- **Centrifugal Advance:**

Adjusts timing based on **engine speed**. As RPM increases, weights fly outward due to centrifugal force, advancing the spark.

- **Vacuum Advance:**

Adjusts timing based on **engine load** (manifold vacuum). At part-throttle (high vacuum), the mixture burns slower, requiring an advanced spark.

3. Electrical System

The electrical network manages power generation, engine starting, and auxiliary operations.

Charging & Regulating Circuit

- **Generator / Alternator:**

Converts mechanical energy from the engine into electrical energy to charge the battery and run accessories. Modern vehicles use alternators because they generate higher current at low engine idling speeds.

- **Current & Voltage Regulator:**

Protects the electrical system and battery. The **voltage regulator** prevents overcharging by limiting maximum voltage, while the **current regulator** prevents generator burnout under heavy electrical loads.

Starting System

- **Solenoid Switch:**

A heavy-duty electromagnetic switch. When the ignition key is turned, it connects the battery directly to the starter motor and simultaneously shifts the starter pinion gear into mesh with the engine flywheel.

- **Bendix Drive Mechanism:**

An inertia-based automatic engagement drive. When the starter motor spins rapidly, the inertia of the pinion gear forces it to slide along a helical splined shaft to engage the engine flywheel. Once the engine starts and spins faster than the starter, it automatically kicks the pinion back out of mesh to prevent damage.

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Instrumentation & Accessories

- **Lighting Systems:**

Includes headlamps, tail lamps, indicators, and brake lights, controlled via relays and switches.

- **Horn & Wipers:**

Safety accessories operating via electromagnetic diaphragms (horn) and PMDC motors with linkage mechanisms (wipers).

- **Gauges & Indicators:**

- *Fuel Gauge:* Uses a float-operated variable resistor (rheostat) in the tank to alter current sent to a dashboard display.
- *Oil Pressure Gauge:* Monitors engine lubrication health using a pressure transducer or bimetallic strip.
- *Engine Temperature Indicator:* Employs a thermistor (negative temperature coefficient resistor) in the cooling jacket to register engine operating temperatures.