SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIT-5 OTHER MOTORS

AC SERIES MOTOR

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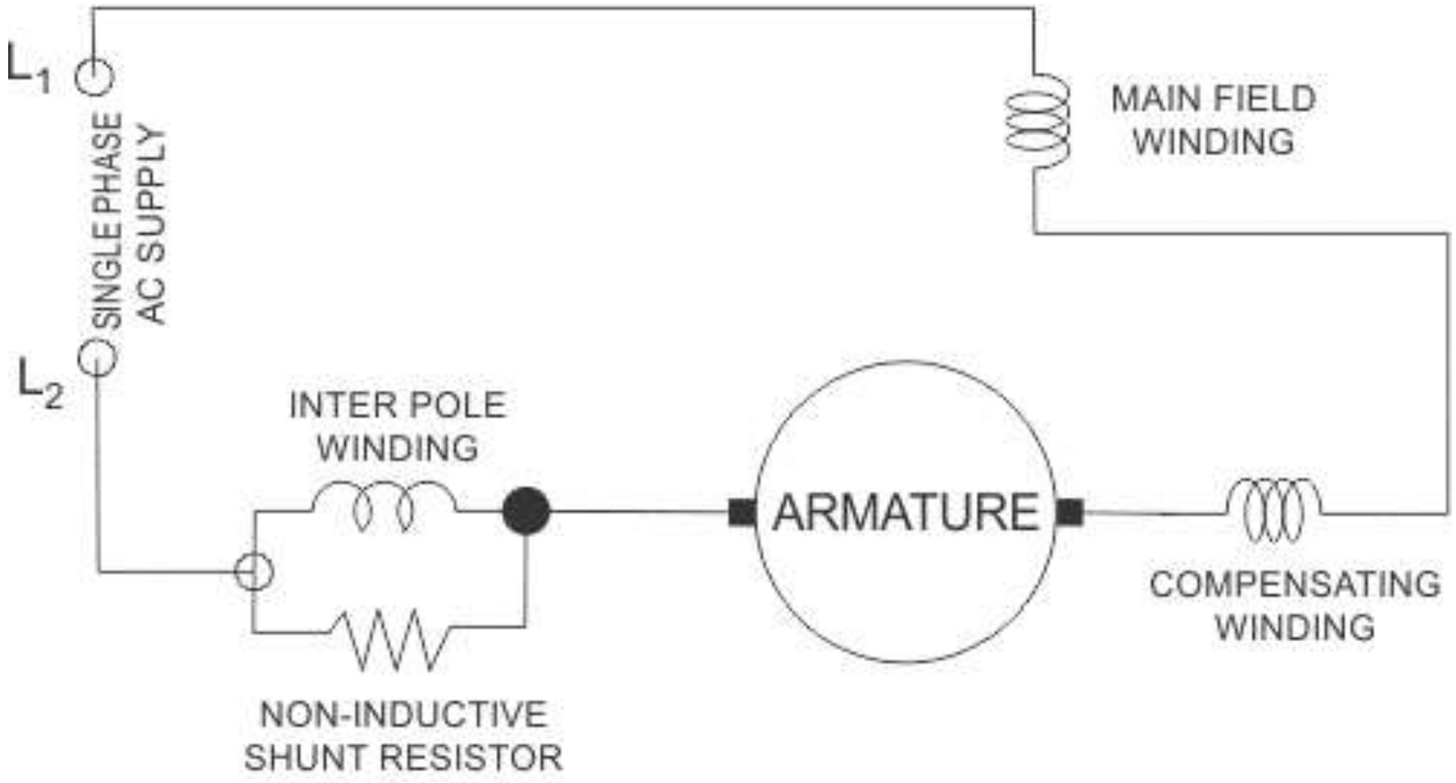
INTRODUCTION

The AC series motor, also known as a universal motor, is a versatile electric motor that operates on both alternating current (AC) and direct current (DC) power sources. It is constructed similarly to a DC series motor, where the field winding and armature winding are connected in series. This design allows the motor to produce high starting torque, which is ideal for applications with heavy or sudden load demands. To ensure stable operation on AC power, AC series motors are equipped with compensating windings that counteract the effects of armature reaction, maintaining smooth torque output. The motor also includes a brush and commutator mechanism, which helps to reverse current direction within the armature for continuous rotation. With these features, the AC series motor is widely used in high-speed, compact applications, such as in power tools, vacuum cleaners, and other household appliances, where high torque and small size are advantageous.

AC Series Motor



CONSTRUCTION

- Stator (Field Windings): The stator consists of laminated steel cores and field windings. The laminations help reduce eddy currents, which would otherwise cause energy losses when the motor operates on AC. The field windings, typically connected in series with the armature, generate the magnetic field required for motor operation.

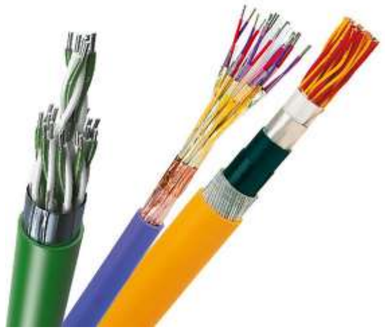
- Rotor (Armature): The rotor is composed of a laminated iron core and has windings similar to those in a DC motor. The lamination reduces energy losses due to eddy currents when AC is applied. The rotor windings are connected to the commutator, allowing current to pass through and produce torque.

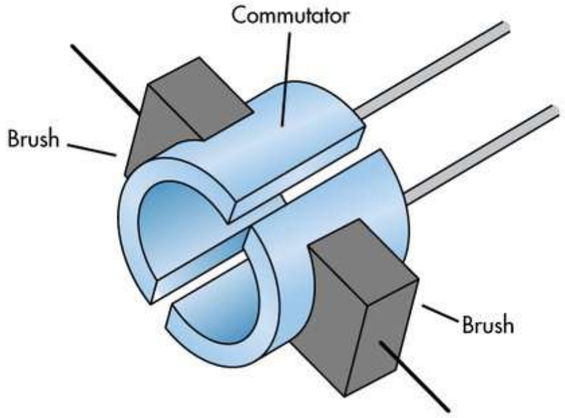
- Commutator and Brushes: The commutator, along with carbon brushes, provides the connection between the rotor windings and the power source. This arrangement ensures that the current direction in the rotor reverses with each half-cycle of AC, producing a unidirectional torque that enables continuous rotation.

CONSTRUCTION

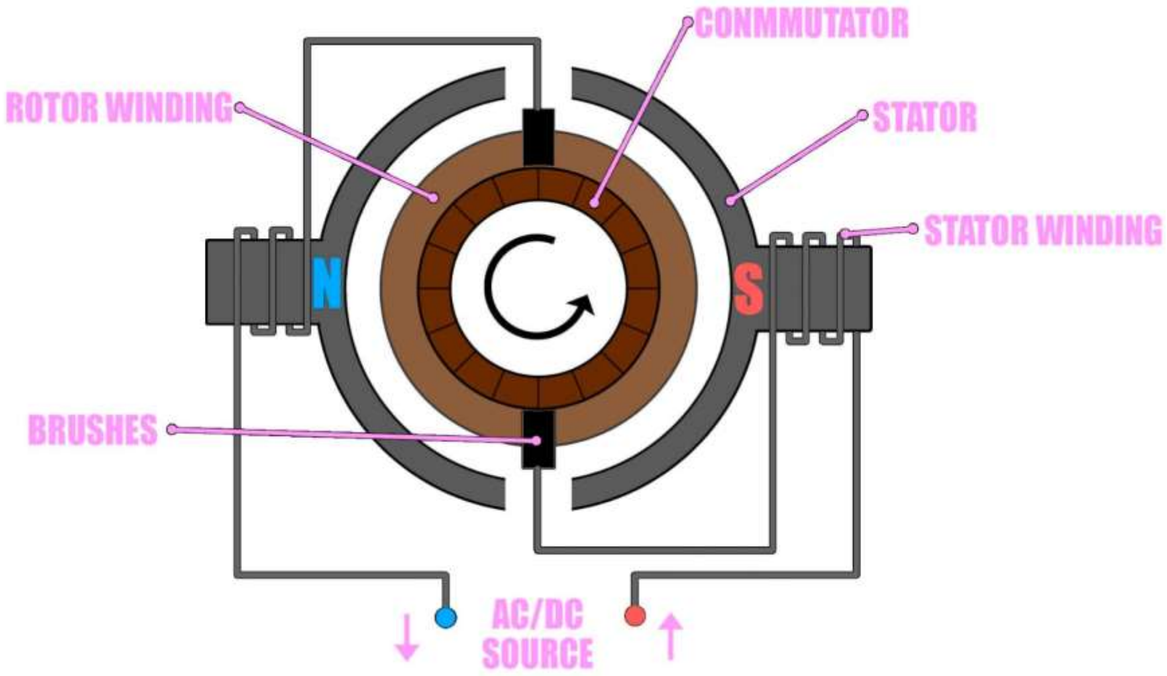
- Compensating Windings: To counteract the effects of armature reaction, which can disrupt torque consistency when using AC, some AC series motors include compensating windings. These are placed on the stator and wired in series with the armature to maintain stable operation.

- Casing and Bearings: The motor's outer casing provides structural support and protection for the internal components. Bearings at each end of the rotor allow smooth rotation and help maintain motor alignment, minimizing friction and wear.





AC Series Motor



OPERATION

- **Power Supply and Current Flow**: When AC power is supplied, the current flows through the series-connected field winding and armature winding. Because the windings are in series, the same alternating current flows through both.
- **Simultaneous Magnetic Field Change**: The alternating current causes both the field and armature windings to reverse polarity at each half-cycle of the AC waveform. Since they are in series, the direction of current and magnetic field change simultaneously, keeping the torque in a consistent direction, which is essential for continuous rotation.
- **Commutation**: The commutator and brushes play a crucial role in maintaining unidirectional torque. The commutator reverses the current within the armature windings with each half-cycle, aligning with the field winding's polarity. This design ensures that the motor maintains steady torque regardless of the current's direction.

OPERATION

- **Production of Torque**: Due to the synchronous reversal of current in both the armature and field, the motor generates a consistent, unidirectional torque, allowing smooth and stable operation even with AC power. The high starting torque makes it ideal for load-heavy applications.
- **Speed Control**: In AC series motors, speed is controlled by varying the voltage or by adding external resistance. The motor speed varies inversely with the load, so under low load conditions, it can achieve high speeds. To prevent overspeeding under no-load conditions, they are often equipped with speed control mechanisms.

ADVANTAGES

- **High Starting Torque**: AC series motors deliver high starting torque, making them ideal for applications that require sudden or heavy load starting, such as power tools and kitchen appliances.
- **Compact Size and Lightweight**: These motors are compact and lightweight, allowing them to be easily integrated into portable devices. Their small size makes them well-suited for appliances with limited space.
- **Operates on AC and DC**: The ability to operate on both AC and DC power sources adds flexibility and broadens their application range.
- **High Speed**: AC series motors can reach high speeds, often up to 20,000 RPM or more, making them ideal for devices like blenders and drills that benefit from rapid rotation.

ADVANTAGES

- **Cost-Effective**: With simple construction and fewer components, AC series motors are generally less expensive to manufacture, making them a cost-effective option for many small appliances.
- **Efficient for Intermittent Duty**: These motors perform efficiently in applications that require intermittent operation, as they can deliver bursts of power when needed without requiring continuous operation.

DISADVANTAGES

- **High Noise and Vibration**: Due to the commutator and brushes, AC series motors tend to produce more noise and vibration compared to other motor types, which can affect user comfort and require additional insulation.
- **High Maintenance**: The brush and commutator mechanism requires regular maintenance, as brushes wear out over time and need to be replaced. This can increase downtime and maintenance costs.
- **Limited Lifespan**: The mechanical wear of brushes and the heating effects from high speeds shorten the motor's lifespan, making it less suitable for continuous or long-term operation.
- **Poor Speed Regulation**: The speed of an AC series motor varies widely with the load, leading to instability under different operating conditions. They can also reach excessively high speeds under no-load conditions, which may damage the motor or connected equipment.

DISADVANTAGES

- **Lower Efficiency on AC**: AC series motors tend to have lower efficiency on AC power due to eddy current and hysteresis losses in the iron core, which can lead to additional heat generation and reduced performance.
- **Electromagnetic Interference (EMI)**: The commutator and brushes produce sparks, which can generate electromagnetic interference. This interference can affect nearby sensitive electronic equipment and may require shielding.
- **Not Suitable for Constant-Torque Applications**: Due to their high-speed nature and lack of speed regulation, AC series motors are unsuitable for applications requiring constant torque, such as conveyors or elevators.

APPLICATIONS

- **Household Appliances**: They are widely used in appliances like vacuum cleaners, blenders, mixers, and food processors, where compact size and high speed are beneficial.
- **Power Tools**: Due to their high starting torque and speed capabilities, AC series motors are popular in portable power tools such as drills, saws, grinders, and sanders.
- **Hair Dryers and Fans**: Universal motors are used in hair dryers and small fans, where the high speed helps produce a strong airflow in a compact device.
- **Sewing Machines**: Many sewing machines use universal motors for their compact design and speed control, allowing for smooth operation in limited spaces.
- **Portable Vacuum Cleaners**: Handheld and portable vacuum cleaners utilize AC series motors for high-speed operation, delivering the suction power required for effective cleaning.
- **Small Kitchen Appliances**: Universal motors power many compact kitchen gadgets, like coffee grinders, juicers, and electric shavers, where efficient, high-speed operation is needed.


Thank you