**ENGINEERING-ELECTRICAL ENGINEERING.**

***CAPACITORS.***

Capacitors are electronic components that store and release electrical energy in a circuit. They are passive two-terminal devices that consist of two conductive plates separated by an insulating material called a dielectric. The primary function of a capacitor is to store and release electrical charge.

Components and Characteristics of Capacitors

1. **Two Plates:** Capacitors have two metal plates, usually made of materials like aluminum or tantalum, which are conductive and can hold an electric charge.
2. **Dielectric:** The space between the two plates is filled with a dielectric material. The dielectric is an insulator that prevents the direct flow of electrical current between the plates. Common dielectric materials include ceramic, electrolytic fluids, or plastic films.
3. **Capacitance:** The capacitance (measured in farads, symbolized by F) is a crucial parameter of a capacitor. It represents the ability of the capacitor to store charge. A higher capacitance means the capacitor can store more charge.
4. **Voltage Rating:** Capacitors are designed to operate within a specified voltage range. Exceeding this voltage can lead to the breakdown of the dielectric and cause the capacitor to fail.
5. **Polarity (for Polarized Capacitors):** Some capacitors, like electrolytic capacitors, are polarized and must be connected with the correct polarity in a circuit. Connecting them incorrectly can lead to damage.

Applications and functions of Capacitors.

* **Filtering and Smoothing:** Capacitors are used to filter out AC components from a signal or smooth variations in voltage.
* **Energy Storage:** Capacitors can store energy and release it rapidly when needed, making them useful in applications like flash photography and electronic flashes.
* **Timing Circuits:** Capacitors, in combination with resistors, are used in timing circuits to control the rate of charge and discharge, influencing the timing of events in a circuit.
* **Coupling and Decoupling:** Capacitors can couple AC signals between different parts of a circuit while blocking DC, or they can decouple one part of a circuit from another.
* **Power Factor Correction:** In some applications, capacitors are used to improve the power factor in electrical systems

*NB; that capacitors come in various types, each with its own characteristics and suitable applications, such as electrolytic capacitors, ceramic capacitors, tantalum capacitors, and more.*

*Three types of Capacitors.*

A.START CAPACITOR.

*Definition:*

A start capacitor is a type of capacitor commonly used in single-phase induction motors to provide an additional phase angle to the motor's starting winding. Its purpose is to help initiate the rotation of the motor by creating a phase shift between the start and run windings. This additional phase angle generates a rotating magnetic field, which is crucial for starting the motor.

 **Features of a Start Capacitor**

1. **Application in Single-Phase Motors:** Single-phase induction motors typically require a phase shift to start rotating. A start capacitor is connected in series with the motor's start winding to introduce a phase difference between the current in the start winding and the current in the run winding.
2. **Temporary Operation:** Start capacitors are designed for temporary use during the motor's startup process. Once the motor reaches a certain speed, a centrifugal switch disconnects the start capacitor from the circuit to prevent continuous operation, as these capacitors are not suitable for continuous duty.
3. **Capacitance Value:** The capacitance value of start capacitors is relatively high compared to run capacitors, typically ranging from a few microfarads to tens of microfarads. This higher capacitance is necessary for providing the required phase shift during motor starting.
4. **Non-Polarized Design:** Start capacitors are usually non-polarized, meaning they do not have a strict orientation for connection in the circuit. This design allows for flexibility in installation.

**Centrifugal Switch:** In many applications, a centrifugal switch is used in conjunction with a start capacitor. The switch is connected to the motor shaft

1. and is designed to open the circuit and disconnect the start capacitor once the motor reaches a predetermined speed.

It's important to note that start capacitors are distinct from run capacitors, which are used to improve the efficiency and power factor of the motor during its normal operation. The use of start capacitors is common in appliances like air conditioners, refrigerators, and compressors, where single-phase induction motors are prevalent.

 B. RUN CAPACITOR

*Definition:*

A run capacitor is an electrical component used in conjunction with alternating current (AC) motors, particularly in induction motors. Unlike start capacitors, run capacitors are designed for continuous duty and remain connected to the motor circuit throughout its operation. They play a crucial role in improving the efficiency, power factor, and performance of motors.

**Features and functions of a Run capacitor**

1. **Continuous Operation:** Run capacitors are designed to be connected to the motor circuit continuously during the entire operation of the motor. Unlike start capacitors, they do not have a centrifugal switch to disconnect them once the motor is up to speed.
2. **Capacitance Value:** The capacitance value of run capacitors is generally lower than that of start capacitors. It typically ranges from a few microfarads to dozens of microfarads, depending on the motor's design and requirements.
3. **Improving Power Factor:** Run capacitors are used to improve the power factor of the motor. Power factor is a measure of how effectively electrical power is converted into useful mechanical work. By adding a run capacitor, the motor can be more efficient, leading to energy savings and improved performance.
4. **Phase Shift Correction:** Run capacitors create a phase shift between the current and voltage in the motor windings, helping to optimize the motor's performance. This phase shift assists in maintaining a relatively constant torque across the motor's operating range.
5. **Polarized Design:** Run capacitors are often polarized, meaning they have a specific orientation for connection in the circuit. It's crucial to observe the correct polarity to ensure proper operation and prevent damage to the capacitor.

**Common Applications:** Run capacitors are commonly used in various applications, including air conditioners, refrigerators, pumps, fans, and other devices with AC induction motors.

**NB:**

Run capacitors contribute to the efficiency and performance of AC induction motors by addressing power factor issues and providing the necessary phase shift. They are a crucial component in many electrical appliances and systems, helping to ensure smooth and optimized motor operation.

C. DUAL CAPACITOR

*Definition*:

A dual capacitor is a type of capacitor that combines two capacitors into a single unit, usually housed in a common casing. Each capacitor within the dual capacitor has its own capacitance value and is designed for specific functions in an electrical system, often found in applications such as air conditioning units, heat pumps, and other HVAC systems.

**Features and Components of a Dual Capacitor**

1. **Two Capacitors:** As the name suggests, a dual capacitor has two distinct capacitors within a single unit. These capacitors are often labeled as "C1" and "C2," each with its own capacitance value measured in microfarads (µF).
2. **Common Terminal (COM):** The dual capacitor typically has a common terminal shared by both capacitors. This common terminal is used as a connection point for one lead of the fan motor and one lead of the compressor motor.
3. **Individual Terminals (C1 and C2):** The dual capacitor has two additional terminals, one for each capacitor. The terminals labeled "C1" and "C2" are connected to the respective leads of the fan and compressor motors.
4. **Wiring Configuration:** Dual capacitors are used to simplify wiring in HVAC systems. Instead of having separate capacitors for the fan motor and compressor motor, a dual capacitor allows for a more compact and organized setup.
5. **Capacitance Values:** The capacitance values of C1 and C2 can vary depending on the specific requirements of the HVAC system. Common values might range from a few microfarads to several dozen microfarads, and the values are usually marked on the capacitor.
6. **Polarity:** Dual capacitors may be non-polarized or polarized. In the case of polarized capacitors, it's essential to observe the correct polarity during installation to ensure proper functioning.
7. **HVAC Applications:** Dual capacitors are commonly used in air conditioning and heating systems to support the operation of both the fan motor and the compressor motor. The capacitors provide the necessary phase shifts and electrical energy for the motors to start and run efficiently.

**NB:**

Dual capacitors are critical components in HVAC systems, and if they fail, it can result in issues such as motor failure, reduced efficiency, or even system malfunction. Regular inspection and maintenance are recommended to ensure the capacitors are in good working condition. If a dual capacitor needs replacement, it's advisable to consult a qualified HVAC technician for proper diagnosis and installation.

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