

phases, and the volume of liquid identified as flammable, if such is the case.

**460.27 Grounding.** Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.

*Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.*

#### 460.28 Means for Discharge.

**(A) Means to Reduce the Residual Voltage.** A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.

**(B) Connection to Terminals.** A discharge circuit shall be either permanently connected to the terminals of the capacitor or provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, transformers, or other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of 460.28(A).

Means are required to drain off the stored charge in a capacitor after the supply circuit has been opened. Otherwise, a person servicing the equipment could receive a severe shock, or damage could occur to the equipment.

Exhibit 460.1, diagram (a), shows a method in which capacitors are connected in a motor circuit so that they can be switched with the motor. In that arrangement, the stored charge drains off through the windings when the circuit is opened. Diagram (b) shows another arrangement in which the capacitor is connected

to the line side of the motor starter contacts. An automatic discharge device and a separate disconnecting means are required. As shown in Exhibit 460.2, capacitors often are equipped with built-in resistors to drain off the stored charge; however, that type of capacitor is not needed where the connection is as shown in Exhibit 460.1, diagram (a).

#### ARTICLE

### 470

## Resistors and Reactors

### Part I. General

**Δ 470.1 Scope.** This article covers the installation of separate resistors and reactors on electrical circuits.

*Exception: This article does not cover resistors and reactors that are component parts of other apparatus.*

Resistors are made in many sizes and shapes and for different purposes. They can be wire, ribbon, form or edgewise wound, cast or punched steel grid, or box resistors. They can be mounted in the open or in ventilated metal boxes or cabinets, depending on their use and location. Because they give off heat, resistors must be guarded and located at safe distances from combustible materials. Where mounted on switchboards or installed in control panels, they are not required to have additional guards.

Current-limiting reactors are installed to limit the amount of current in a circuit under short circuit conditions. Reactors can be divided into two classes: those with iron cores and those with no magnetic materials in the windings. Both types can be air cooled or oil immersed.

Mechanical stresses exist between adjacent air-core reactors due to their external fields, and the manufacturer's recommendations should be followed in spacing and bracing units and fastening supporting insulators.

#### N 470.2 Reconditioned Equipment.

**N (A) Resistors.** Reconditioned resistors shall not be permitted.

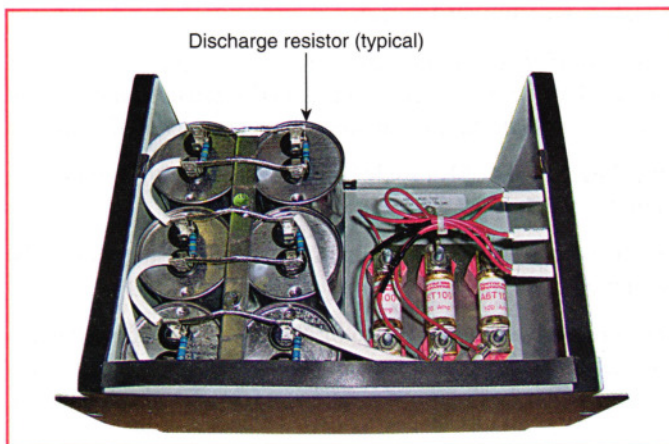
**N (B) Reactors.** Reconditioned reactors shall be permitted.

### N Part II. 1000 Volts, Nominal, or Less

**470.10 Location.** Resistors and reactors shall not be placed where exposed to physical damage.

**470.11 Space Separation.** A thermal barrier shall be required if the space between the resistors or reactors and any combustible material is less than 305 mm (12 in.).

**470.12 Conductor Insulation.** Insulated conductors used for connections between resistance elements and controllers shall be suitable for an operating temperature of not less than 90°C (194°F).



**EXHIBIT 460.2** Power factor correction capacitors with internal discharge resistors (blue) and overcurrent protection. (Courtesy of GE Energy)