(2) Multigrounded Neutral System Connection. The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.

Maximum protection is achieved where the SPD protecting a transformer supplying a secondary system has the grounded conductor of the secondary system connected to at least four grounding locations for every one mile of primary neutral conductor.

(B) Through Spark Gap or Device. Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54(B)(1) or (B)(2).

A spark gap device has two conductors separated by a gap often filled with a gas such as air. This permits an arc to pass between the conductors when the voltage difference between them exceeds the breakdown voltage of the gas within the gap. The arc forms, ionizing the gas, and reduces its electrical resistance, allowing the high voltage surge to pass to ground.

(1) Ungrounded or Unigrounded Primary System. For ungrounded or unigrounded primary systems, the spark gap or a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(2) Multigrounded Neutral Primary System. For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(C) By Special Permission. An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54(A) or (B), shall be permitted to be made only by special permission.

242.56 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

N ARTICLE 245

Overcurrent Protection for Systems Rated Over 1000 Volts ac, 1500 Volts dc

N 245.1 Scope. This article covers overcurrent protection requirements for systems over 1000 volts ac, 1500 volts dc, nominal.

New Article 245 has been created to cover overcurrent protection for systems rated over 1000 volts ac, 1500 volts dc. Former Article 240 Part IX has been relocated here as the basis for new Article 245, which was created to aid in the usability of the *NEC*® when locating medium-voltage overcurrent protection requirements.

N 245.2 Reconditioned Equipment.

N (A) Reconditioned Equipment Permitted. The following reconditioned equipment shall be permitted:

(1) Medium- and high-voltage circuit breakers
(2) Electromechanical protective relays and current transformers

N (B) Reconditioned Equipment Not Permitted. Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted.

N 245.21 Circuit-Interrupting Devices.

N (A) Circuit Breakers.

N (1) Location.

(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.
(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.
(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner.

N (2) Operating Characteristics. Circuit breakers shall have the following equipment or operating characteristics:

(1) An accessible mechanical or other identified means for manual tripping, independent of control power
(2) Be release free (trip free)
(3) If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation
(4) A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts
(5) A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated

N (3) Nameplate. A circuit breaker shall have a permanent and legible nameplate showing the manufacturer's name or

trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.

N **(4) Rating.** Circuit breakers shall have the following ratings:

(1) The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.
(2) The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.
(3) The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.
(4) The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.
(5) The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.

N **(5) Retrofit Trip Units.** Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed.

N **(B) Power Fuses and Fuseholders.**

N **(1) Use.** Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.

N **(2) Interrupting Rating.** The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.

N **(3) Voltage Rating.** The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.

N **(4) Identification of Fuse Mountings and Fuse Units.** Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.

N **(5) Fuses.** Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.

N **(6) Fuseholders.** Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:

DANGER — DISCONNECT CIRCUIT
BEFORE REPLACING FUSES.

Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.

N **(7) High-Voltage Fuses.** Switchgear and substations that use high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.

Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.

N **(C) Distribution Cutouts and Fuse Links — Expulsion Type.**

N **(1) Installation.** Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.

N **(2) Operation.** Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.

N **(3) Interrupting Rating.** The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.

N **(4) Voltage Rating.** The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.

N **(5) Identification.** Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.

N **(6) Fuse Links.** Fuse links shall have a permanent and legible identification showing continuous current rating and type.

N **(7) Structure Mounted Outdoors.** The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).

N **(D) Oil-Filled Cutouts.**

N **(1) Continuous Current Rating.** The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.

N **(2) Interrupting Rating.** The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.

N **(3) Voltage Rating.** The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.

N **(4) Fault Closing Rating.** Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.

N **(5) Identification.** Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.

N **(6) Fuse Links.** Fuse links shall have a permanent and legible identification showing the rated continuous current.

N **(7) Location.** Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.

N **(8) Enclosure.** Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.

N **(E) Load Interrupters.** Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.

Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.

N **(1) Continuous Current Rating.** The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.

N **(2) Voltage Rating.** The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.

N **(3) Identification.** Interrupter switches shall have a permanent and legible nameplate, including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.

N **(4) Switching of Conductors.** The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.

N **(5) Stored Energy for Opening.** The stored-energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.

N **(6) Supply Terminals.** The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure, or, if the terminals are located elsewhere, the equipment shall have barriers installed to prevent persons from accidentally contacting energized parts or dropping tools or fuses into energized parts.

Exhibits 245.1 and 245.2 are examples of a fused interrupter switch and the fuseholder components. The components shown include the spring and cable assembly, refill unit, holder, and snuffler.

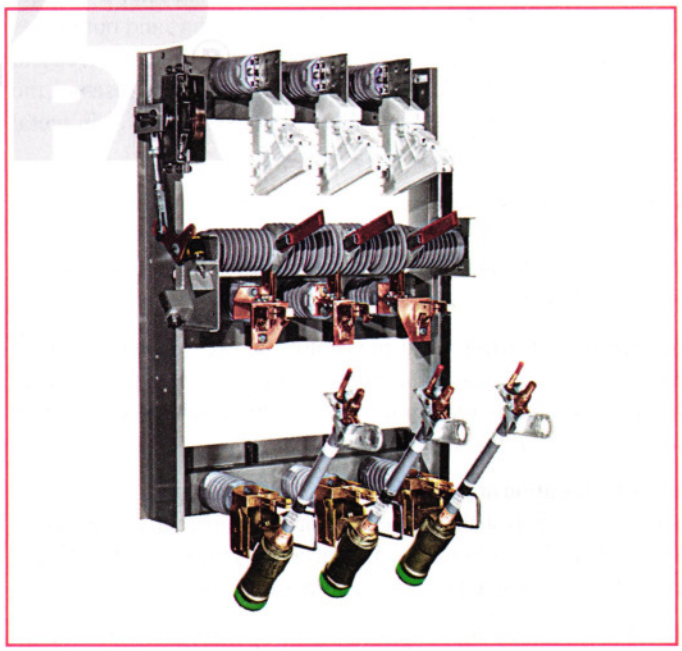

EXHIBIT 245.1 Group-operated interrupter switch and power fuse combination rated at 13.8 kilovolts, 600 amperes continuous and interrupting, 40,000 amperes momentary, 40,000 amperes fault closing. *(Courtesy of S&C Electric Co.)*