CHAPTER 7

Switches and Fuses

Manual and automatic switches are used to open and close circuits. They must be designed to carry their rated current continuously without overheating and must have clearances and insulation for the normal voltage of the circuit. Fuses and circuit breakers provide a simple, comparatively inexpensive method of automatic overcurrent protection, as well as a means of controlling the location of breakdowns.

DISCONNECTS

Disconnect switches are generally used in a primary circuit where opening the circuit is necessary under voltage with little or no load current. They must interrupt only the charging or exiting current of lines or apparatus connected. These switches are ordinarily used to disconnect branch lines, off-circuit breakers, and transformers where the load current may otherwise be broken.

TYPES

Disconnect switches are available in various types, ratings, and classes. The switch shown in Figure 7-1 is used at switch structures and out on the line. If the mounting height is not too great, the switch can be operated from the ground with a long-handled switch stick. The switches shown in Figure 7-2, page 7-2, are used for line sectionalizing. They are generally installed on the crossarms carrying the primary circuit and are operated by a switch stick that can be fastened to the lineman's belt.

BYPASS SWITCHES

Bypass switches may be used at booster and regulator installations to provide a quick, reliable means of taking such apparatus in and out of service without de-energizing the feeder circuits and to prevent winding burn-outs from open-circuit windings.

Figure 7-1. Open-type disconnect switch and components
GANG-OPERATED DISCONNECTS
Gang-operated disconnects are used where more than one phase of a circuit must be opened simultaneously. The most common gang-operated disconnect switches are the air-brake type manufactured in 200-, 300-, and 400-ampere ratings in all voltage classes from 5,000 volts up. They are used at substations, switching structures, and on the lines for energizing and de-energizing transformer banks and other apparatus. They are also used for sectionalizing. Although they can be motor-operated, they are more commonly provided with a switch handle for hand operation. This type of switch is ideal because it lends itself to operation from the ground, often permitting service to be restored to sections of the network without pole climbing.

MAINTENANCE
Contacts of disconnects must stay smooth and covered with a thin film of nonoxide grease. The bearing must be well lubricated, and the blades should move freely yet be rigid enough for proper alignment with contacts. Locate broken or defective insulators during inspections and replace them immediately. Ensure that all bolts and nuts are tight.

CAUTION
Always ground the switch handle by connecting it to the counterpoise or ground plate, below the topsoil, directly beneath the operating handle.

OIL CIRCUIT BREAKERS
Oil circuit breakers open a circuit automatically under load. They are generally designed and connected for one or more automatic reclosings to restore service quickly when a fault has cleared itself. Their use is generally confined to substations or switching stations where either high interrupting capacity or high-grade service is required.

Pole-mounted oil circuit breakers are also called reclosers, sectionalizing oil circuit breakers, or interrupters. They are adaptable for use on the low side of step-down substations, on branch circuits that are connected to important feeders, and for protecting important loads and isolating line trouble. Reclosers are available with ratings up to 50 amperes and 15,000 volts; the 50-ampere breaker has an interrupting rate of about 1,200 amperes.

The recloser is connected in the line and is normally closed. The trip coil is in series with the contacts and derives energy from fault current, which may lift the armature and the movable contact of the interrupting element by magnetic attraction. When a fault occurs, the circuit promptly opens and then automatically recloses in about three seconds. If the fault is not cleared on the first interruption, the recloser opens the circuit a second and possibly a third time. If the fault is cleared after the second or third interruption, the recloser mechanism automatically resets. If the fault persists after the third interruption, the recloser opens a fourth time and locks open. It must then be reset manually.

The recloser contains one pair of contacts—the lower (stationary) contact is in the bottom of the unit, and the upper (movable) contact is connected to one end of the operating or trip coil. The contacts are normally held in the closed position by positive pressure, but when a short circuit occurs, the movable contact rises rapidly, drawing an arc in the oil. The heat of the arc forms a gas bubble, which sets up pressure in the oil-blast chamber. This pressure in the chamber forces a blast of cool air between the contacts,
preventing the arc from reestablishing itself after an early current zero. The butt-type contacts automatically compensate for burning caused by repeated operation. They can be replaced if renewal eventually becomes necessary. Figure 7-3 shows a single-phase installation, including a bypass switch and a lightning arrester. The use of bypass switches is optional. Some types of breakers include internal lightning protective devices so external lightning arresters are not required.

Figure 7-3. Pole-mounted oil circuit breaker, single-phase, Y-primary

**OIL FUSE CUTOUTS**

Oil fuse cutouts are most commonly used on underground systems. They are also used on overhead systems that have voltage ratings up to 7,500 volts, where intermediate interrupting capacity is required and automatic restoration of service is not essential.

**CIRCUIT-RECLOSEING FUSE CUTOUTS**

Circuit-reclosing fuse cutouts (multiple-shot) are either porcelain-housed or open. Porcelain-housed cutouts are manufactured in 50- and 10-ampere ratings and in 5,000- and 500-volt classes. Open cutouts are available in higher voltage classes and mounted on either standard pin-and-cap insulators or one-piece, post-type insulators. Open types are available in sizes up to 100 amperes in voltage classes up to 46 kilovolts and in sizes up to 200 amperes, limited to 7,500- and 15,000-volt ratings.

Cutouts frequently permit quick restoration of service where frequent temporary faults may be caused by lightning or high winds. Although the open type is more commonly used, both types are applicable for use on feeder or branch circuits. Their use should be confined to remotely located and unattended substations or at remote locations on the distribution circuits.

**OPERATION**

When the fuse link blows, the first holder drops out. The dropping of the holder or cartridge, either by pressure or spring action, closes the circuit through the next cartridge. If the cutout is a three-shot type, this
performance is repeated. Three faults on a three-shot cutout cause all three fuses to blow, and all three barrels should be found in the dropout indicating position. Cartridges can be replaced in any sequence without momentary service interruptions.

**FUSES**

Fuses for distribution systems are manufactured in various styles for similar and varying applications. Some manufacturers place the fuse element in a tube that is filled with powder or granular material to absorb the vaporized fuse metal and to extinguish the arc. In other types, the element is placed in a tube; and the arc is extinguished by a dielectric, using either high or low interrupting capacity. Both initial and replacement costs of these fuses are high, and application is usually limited to circuits having 13,200 volts or more. Figures 7-4 and 7-5, page 7-6, show two types of circuit-reclosing fuse cutouts.

![Figure 7-4. Fused disconnect switches](image-url)
3 1/4" x 4 1/4" to 4" x 5" crossarm

11/16" x 1 1/2" slot

11/16" square hole

Pole-mounting hanger

<table>
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<tr>
<th>Voltage</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>7,500/12,500</td>
<td>17 3/8”</td>
<td>26 7/8”</td>
<td>15”</td>
<td>14 1/4”</td>
<td>11”</td>
</tr>
<tr>
<td>15,000</td>
<td>18 3/8”</td>
<td>31 5/8”</td>
<td>16 1/2”</td>
<td>17 1/2”</td>
<td>16 1/4”</td>
</tr>
</tbody>
</table>

**Figure 7-5. Typical open-type fuse**

7-6 Switches and Fuses