The low cost of modern transformer and bus protection relays makes high-speed differential protection applicable in many distribution substations. In addition, modern relays, when used with communication, provide:

- Zone-interlocked protection (Section 6.4.6), an alternative to bus differential protection that uses information from feeder relays to discriminate bus faults from feeder faults.
- Breaker-failure protection (Section 6.5) using transformer and feeder relays for faster back up.
- High-speed distribution and subtransmission line protection using fiber-optic or spread-spectrum radio channels (Section 3.9).

3.3.4 Faster service restoration

Modern relays and recloser controls can speed up restoration of service via throw-over schemes and fast network reconfiguration schemes (Section 3.11). The group settings available in modern relays and recloser controls accommodate configuration changes in the distribution system. You can design protection systems that automatically select the setting group required for each system configuration.

Combining faulted circuit indicators with the fault locating abilities of modern relays reduces the time needed to determine the faulted line section and provide information to line repair crews (Section 3.12).

3.3.5 Higher reliability and lower cost

Replacing many electromechanical relays with one microprocessor-based relay saves panel space and reduces wiring, providing much higher reliability at much lower cost. Figure 3.4 depicts part of a panel for protection, control, and metering of three distribution feeders.

Microprocessor-based relays also self-test. When the relay detects an abnormal hardware or software condition, it disables critical functionality, such as protection, and closes a contact as notification that service is required. Wired to the communications network, this contact improves monitoring of relay status. Relay diagnostic ability increases reliability and reduces cost, because it almost eliminates the need for routine maintenance [1].

New solutions include a dual relay that provides two independent groups of protection functions. One relay provides very low cost overcurrent protection for two feeders, as shown in Figure 3.5(a). This relay can also provide breaker-failure protection. Two relays (Figure 3.5(b)) provide full redundant protection for two feeders. Because the SEL-501 relay also includes dual motor protection functions, it can protect two motors or a feeder and a motor. Another solution, given the low cost of modern relays, is to use two relays per circuit, such as a pair of SEL-351 relays, for excellent reliability. Chapter 12 discusses some possibilities.

Figure 3.4 SEL protection, control and metering panel for three feeders. Three SEL-351 relays replace nine phase relays, three ground relays, three reclosing relays, and many auxiliary relays.

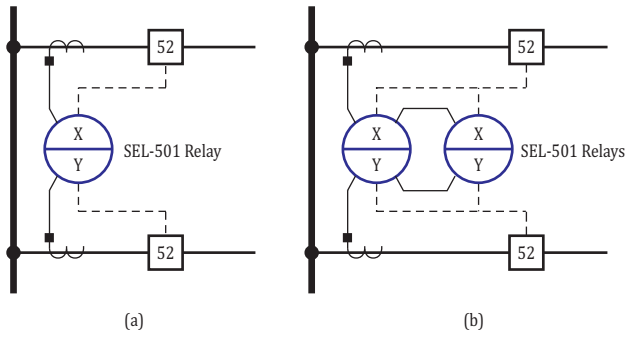

Figure 3.5 SEL-501 dual universal overcurrent relay provides two sets of overcurrent, breaker-failure, and motor protection functions.

3.4 NEGATIVE-SEQUENCE OVERCURRENT PROTECTION

3.4.1 Negative-sequence overcurrent elements

All unbalanced faults produce negative-sequence current. Balanced load does not. Therefore, you can set negative-sequence overcurrent elements, like ground elements, well below load current. The advantages of