ELG4125

Transmission, Distribution, and Utilization Systems

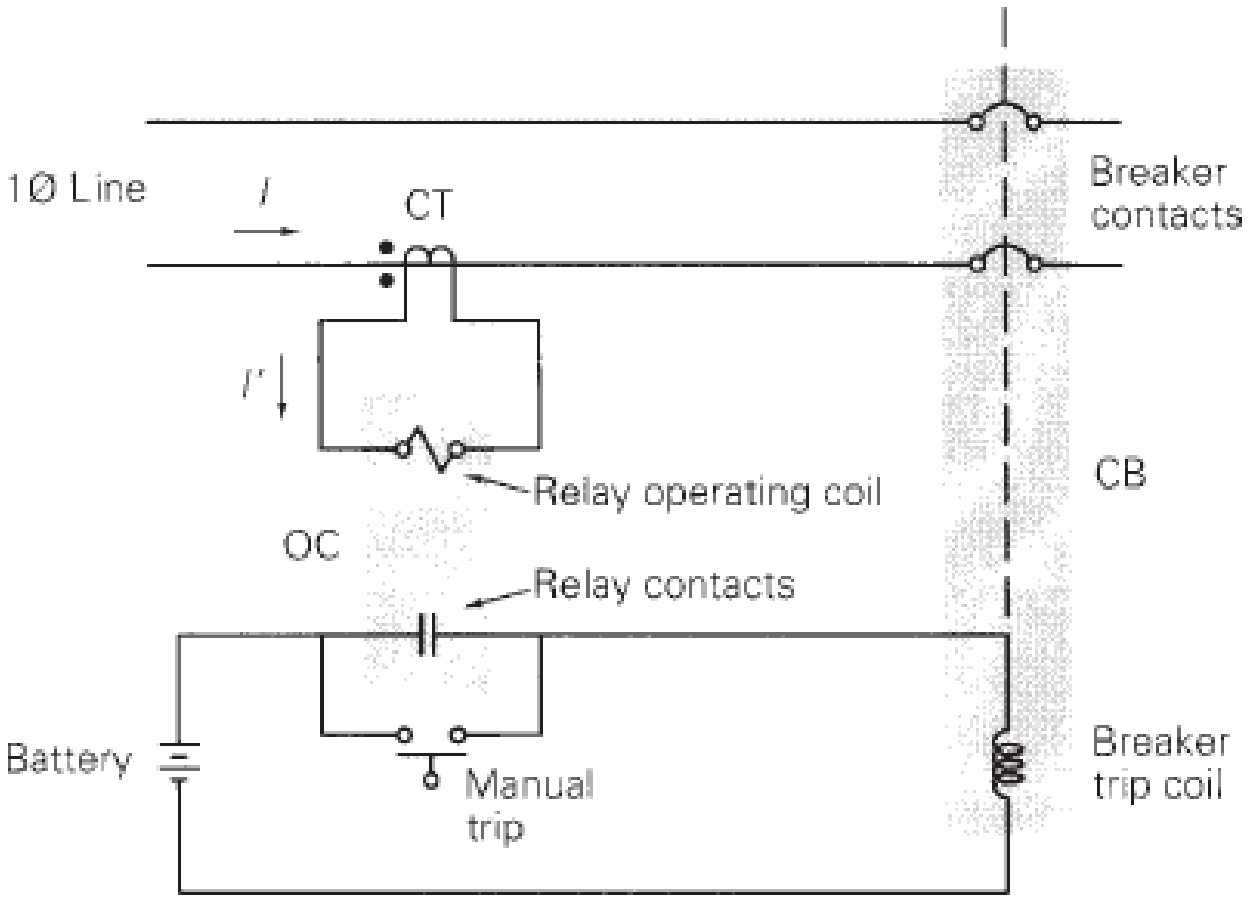
Three Basic Components

Instrument Transformer

Relays

Circuit Breakers

Overcurrent Protection



Instrument Transformer

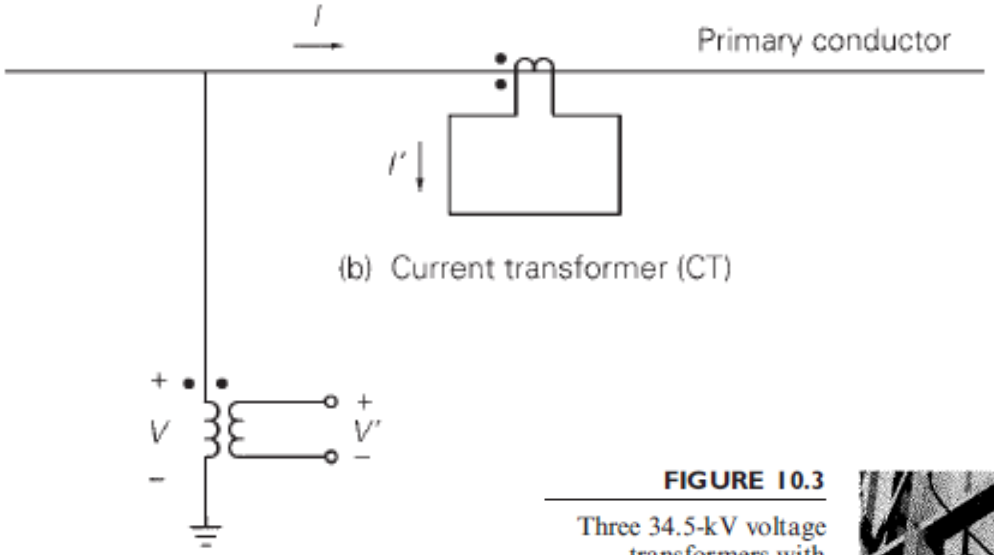


FIGURE 10.3

Three 34.5-kV voltage transformers with 34.5 kV : 115/67 volt VT ratios, at Lisle substation, Lisle, Illinois (Courtesy of Commonwealth Edison, an Exelon Company)

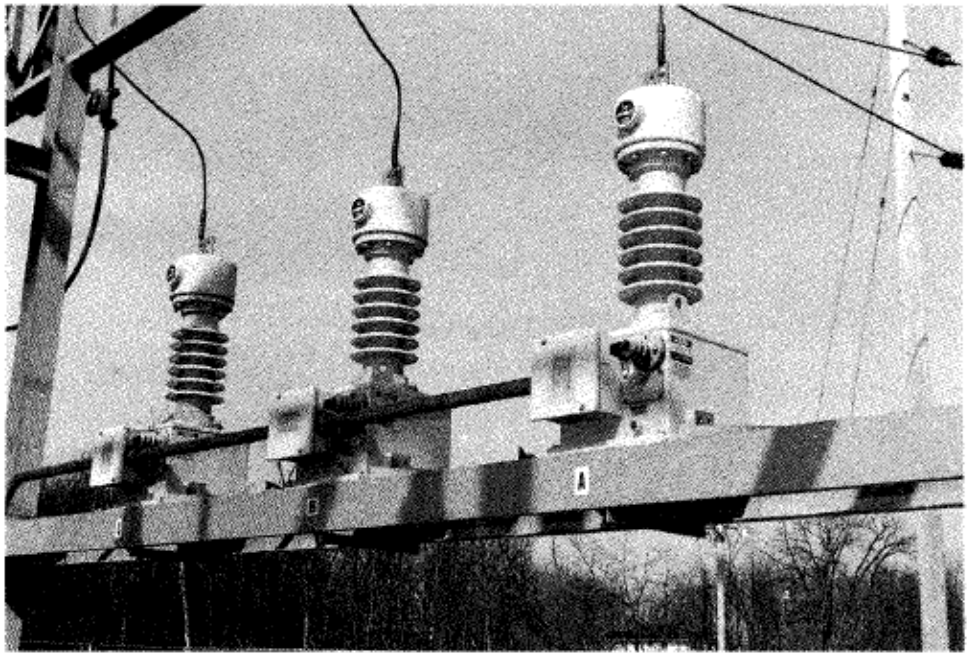


FIGURE 10.5

Three 25 kV class current transformers–window design (Courtesy of Kuhlman Electric Corporation)

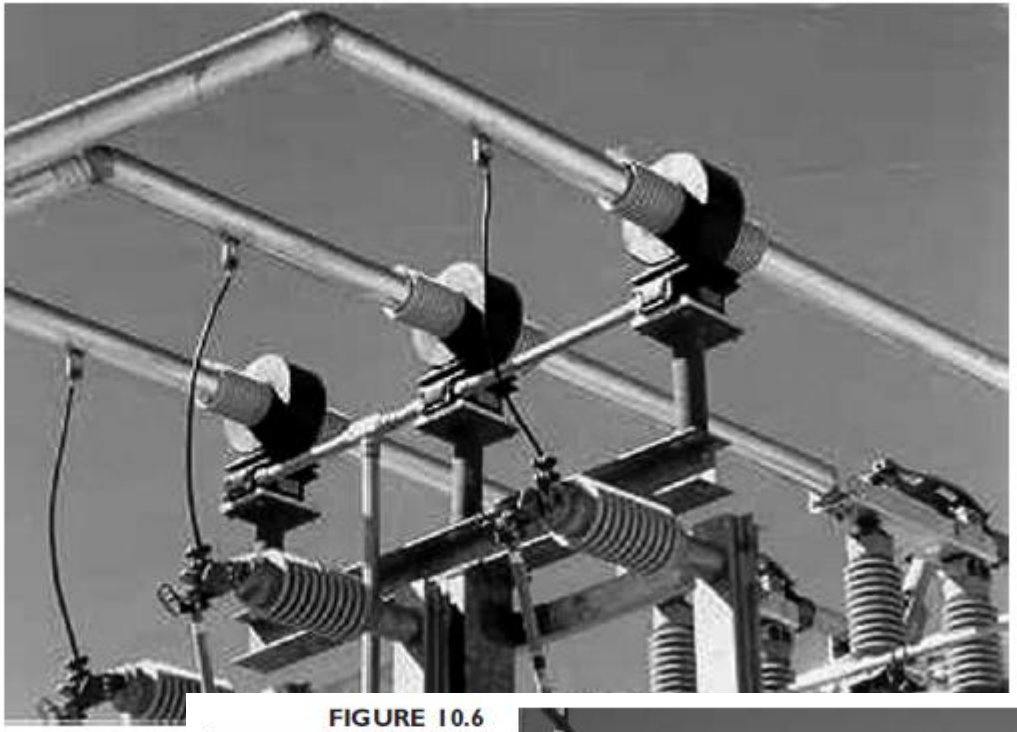


FIGURE 10.6

500-kV class current transformers with 2000:5 CT ratios in front of 500-kV SF6 circuit breakers, Westwing 500-kV Switching Substation (Courtesy of Arizona Public Service)

TABLE 10.1

Standard VT ratios

Voltage Ratios						
1:1	2:1	2.5:1	4:1	5:1	20:1	40:1
60:1	100:1	200:1	300:1	400:1	600:1	800:1
1000:1	2000:1	3000:1	4500:1			

TABLE 10.2

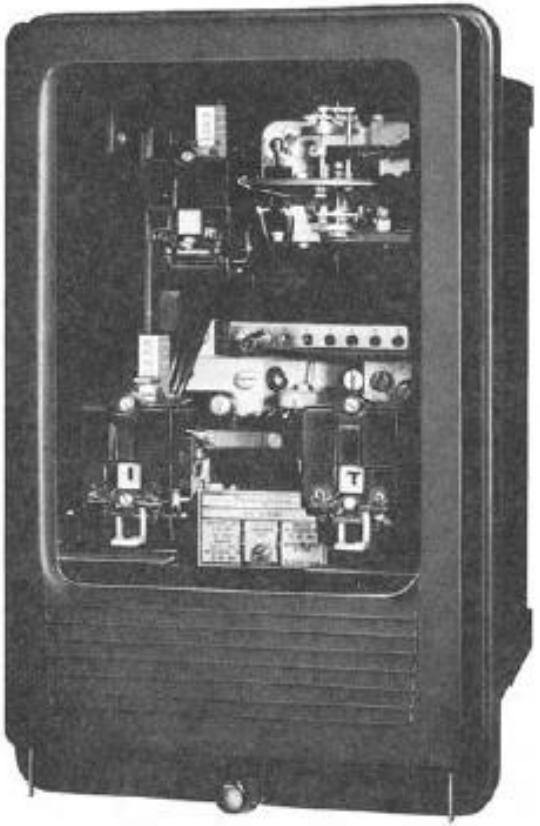
Standard CT ratios

Current Ratios						
50:5	100:5	150:5	200:5	250:5	300:5	400:5
450:5	500:5	600:5	800:5	900:5	1000:5	1200:5
1500:5	1600:5	2000:5	2400:5	2500:5	3000:5	3200:5
4000:5	5000:5	6000:5				

Overcurrent Relays

FIGURE 10.11

Time-delay overcurrent relays: (a) Westinghouse Electromechanical (Courtesy of ABB-Westinghouse) (b) Basler Electric Digital (Courtesy Danvers Electric)



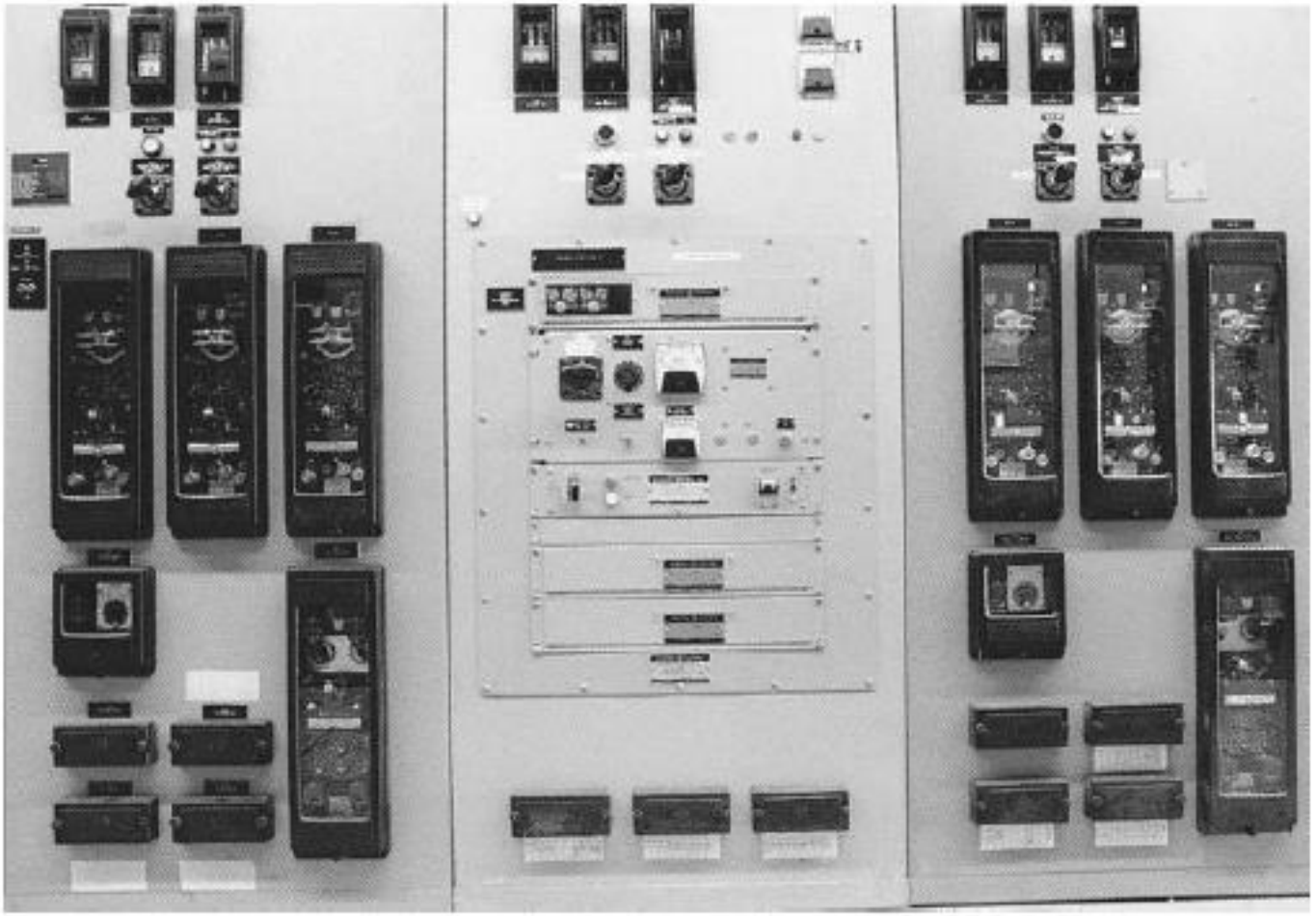
(a)

(b)

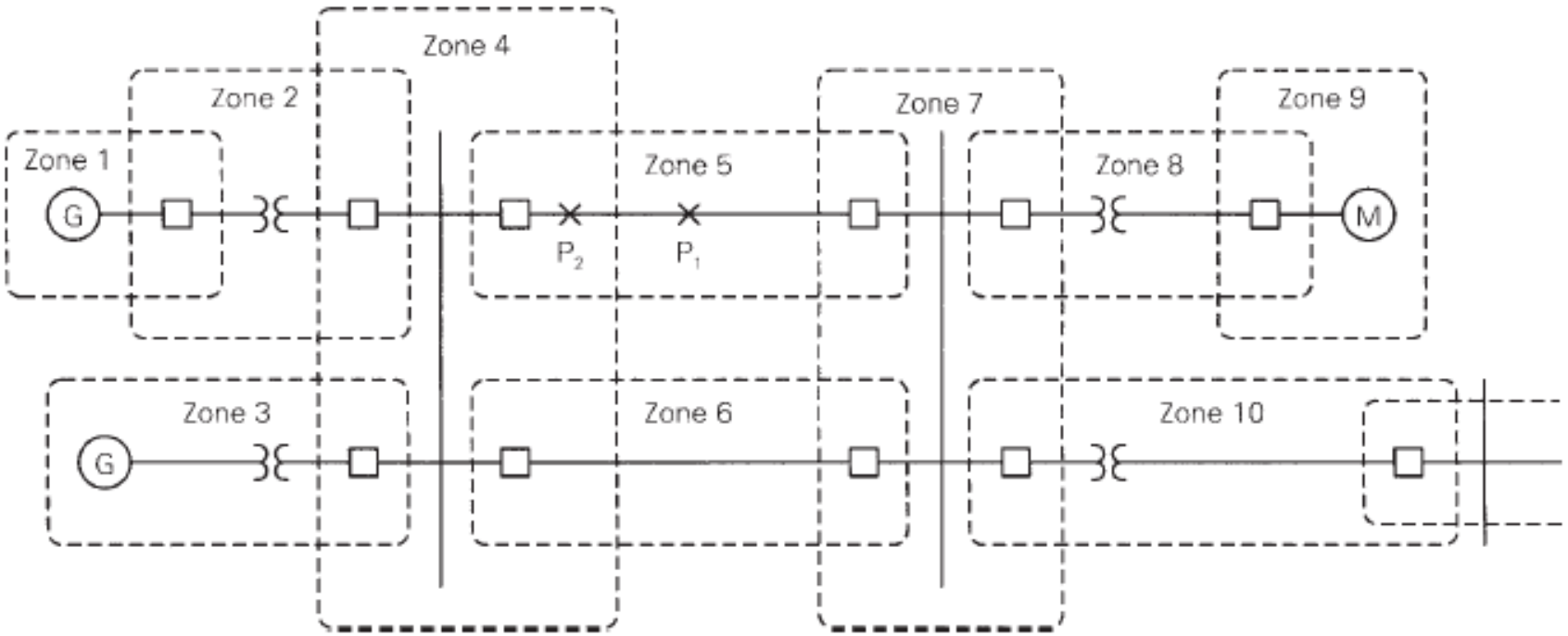
Solid State Relays

FIGURE 10.15

Solid-state relay panel (center) for a 345-kV transmission line, with electromechanical relays on each side, at Electric Junction Substation, Naperville, Illinois (Courtesy of Commonwealth Edison, an Exelon Company)



Zones of Protection



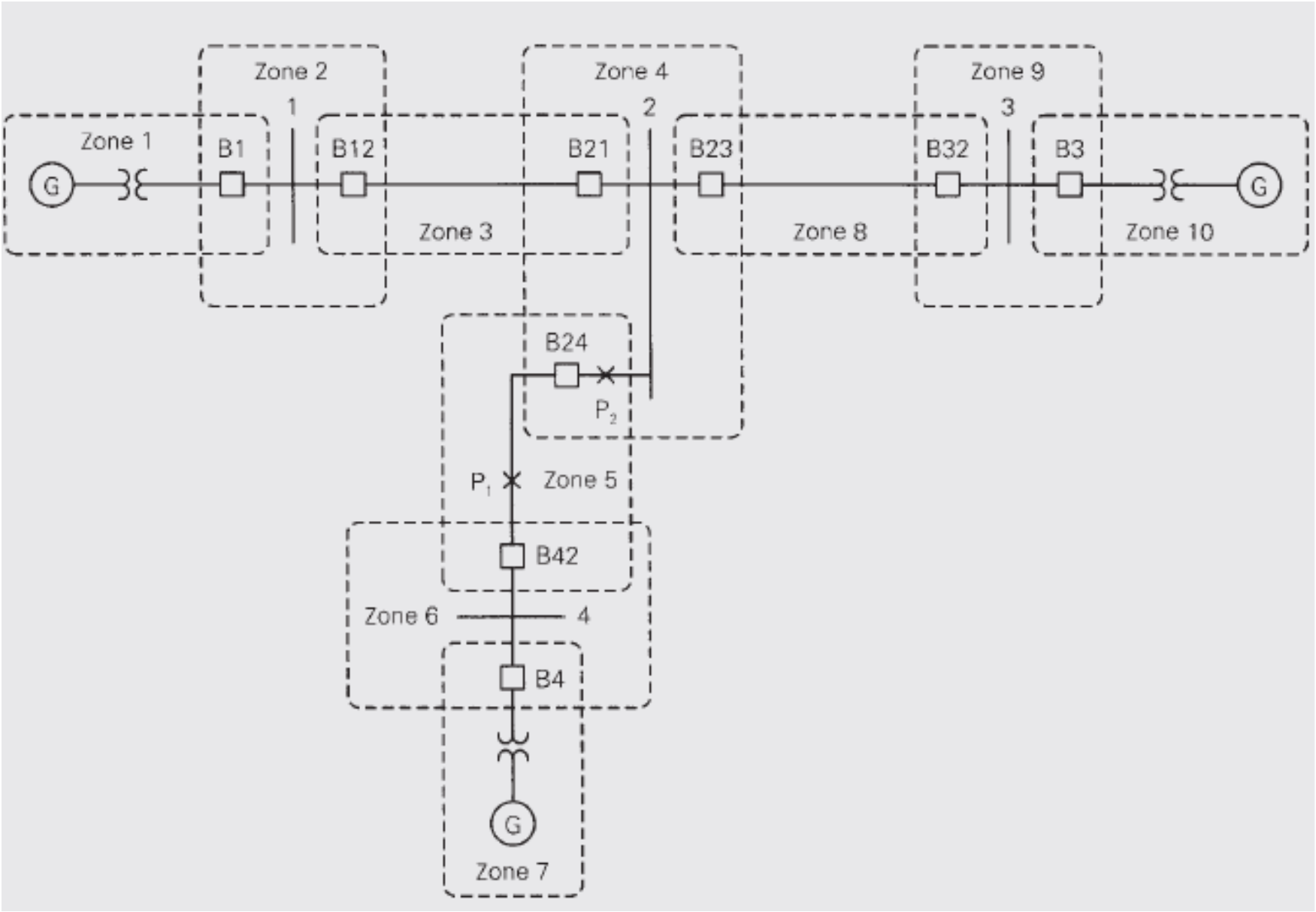
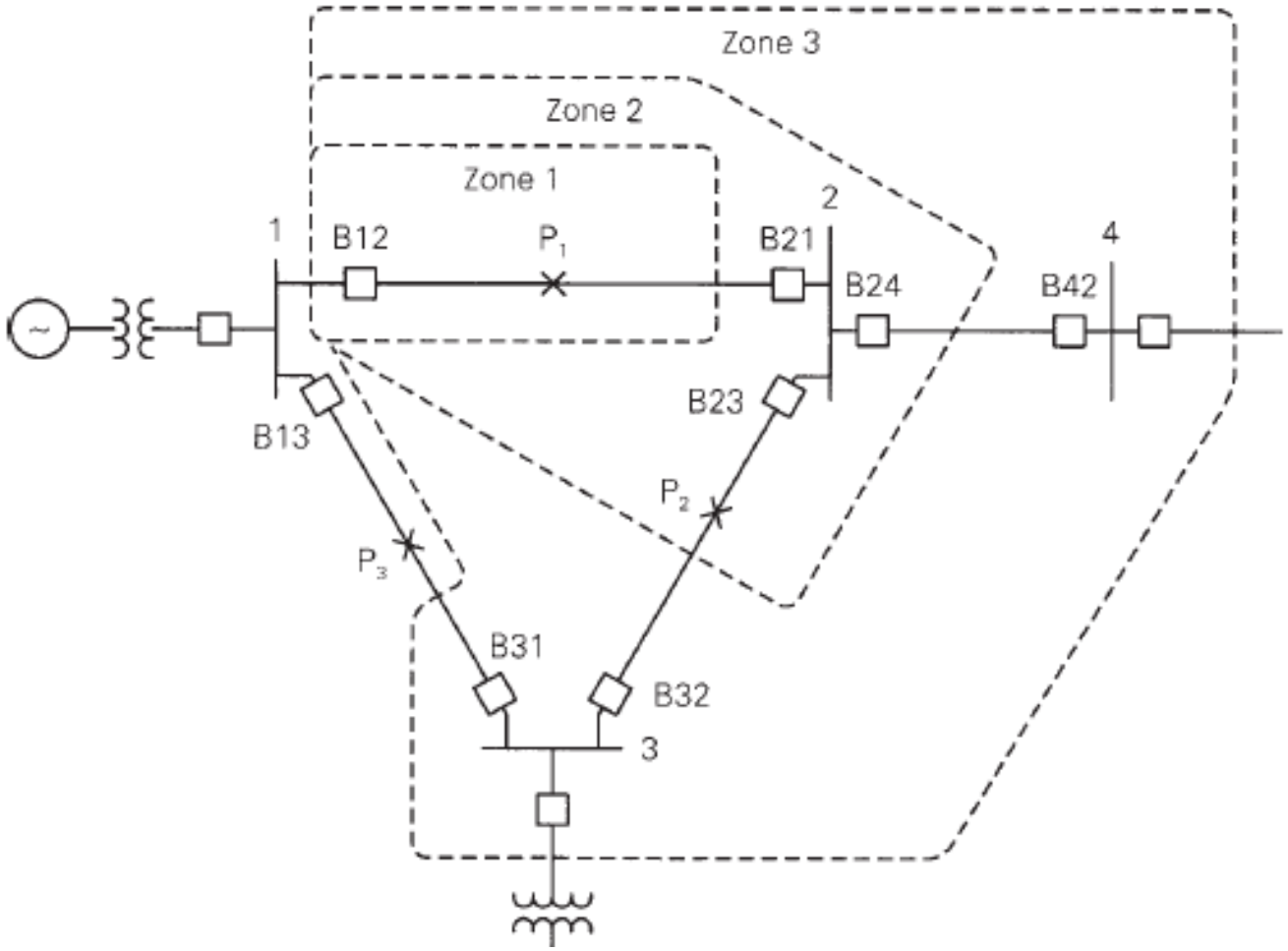

Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
Zone 8
Zone 9
Zone 10
B1
B12
B21
B23
B32
B3
B24
B42
B4
1
2
3
4
P_1
P_2
G
G
G

FIGURE 10.27

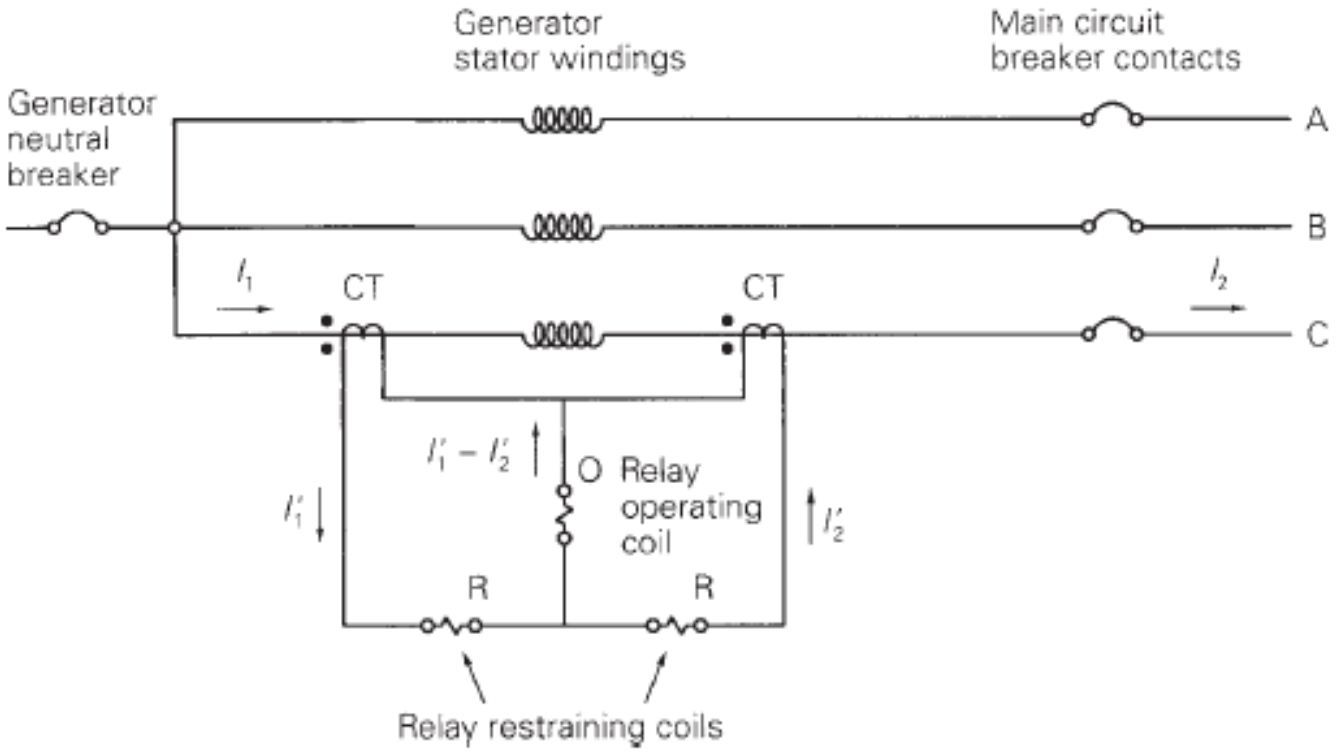
345-kV transmission loop



Differential Relays

FIGURE 10.32

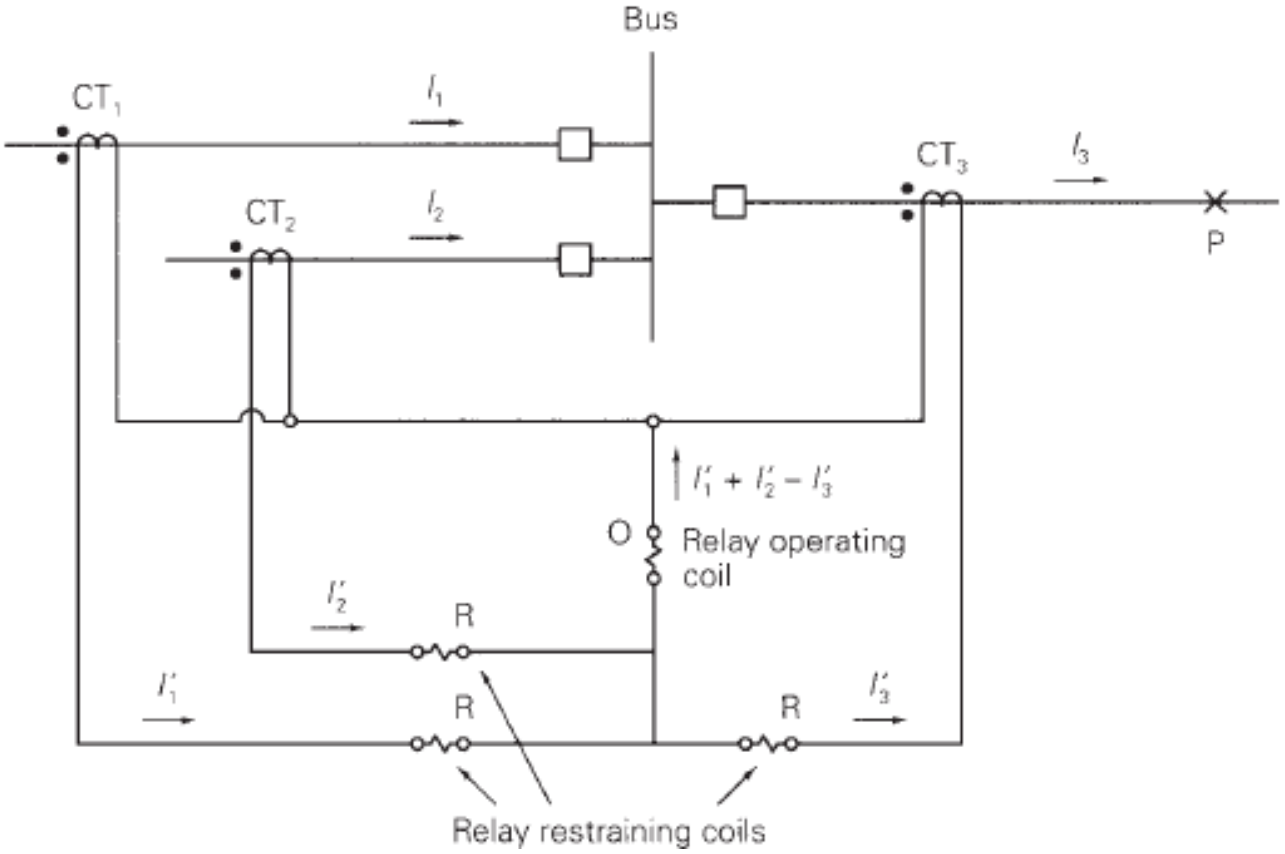
Differential relaying for generator protection (protection for one phase shown)



Bus Protection with Differential Relays

FIGURE 10.35

Single-line diagram of differential bus protection



Transformer Protection with Differential Relays

FIGURE 10.36

Differential protection of a single-phase, two-winding transformer

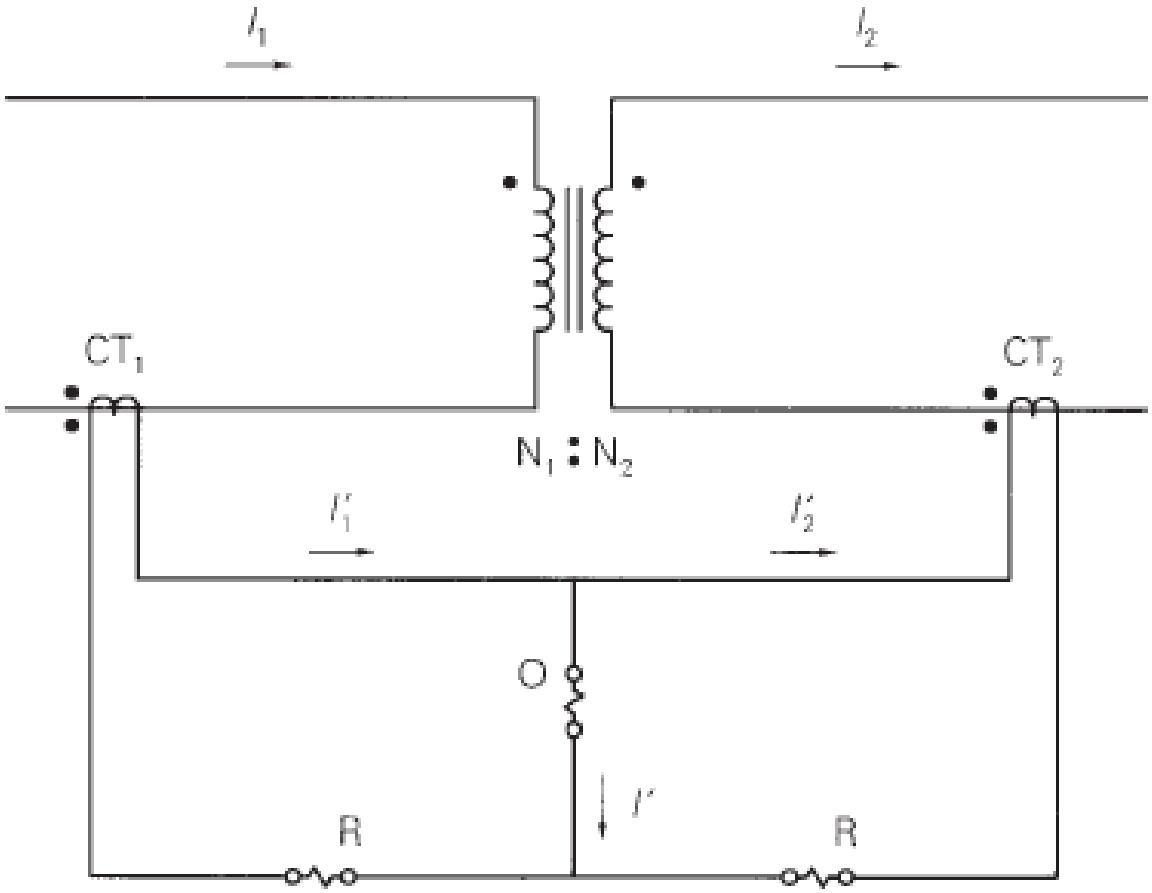


FIGURE 10.37

Differential protection of a three-phase, Y–Δ, two-winding transformer