Elektrische Aandrijvingen

WTB

Lokatie / evenement

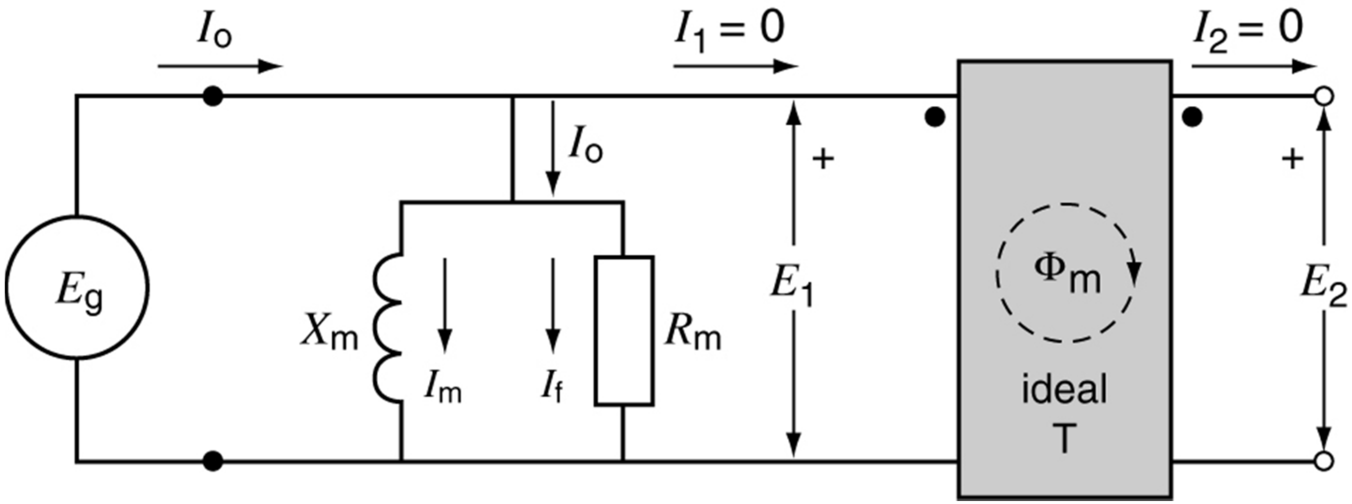
P.BAUER

February 17, 2012

Delft University of Technology

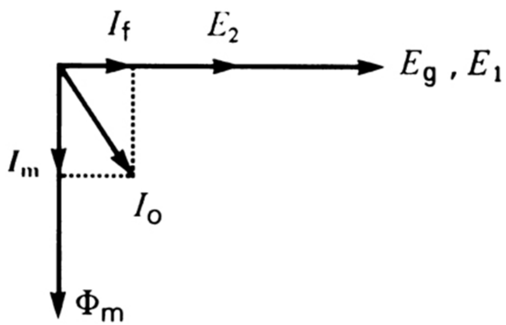
Practical transformer

FIGURE 10-1a **An imperfect core represented by a reactance X_m and a resistance R_m.**



- $R_m = E_1^2 / P_m$
- $X_m = E_1^2 / Q_m$
- $\Phi_m = E_1 / (4{,}44\ f\ N_1)$

FIGURE 10-1b **Phasor diagram of a practical transformer at no-load.**



- no load I_0=5A, 120 V, 60 Hz. 180 W
- Sm= $E_1 I_0$
- Pm= 180 W
- Qm= $E_1 I_0$
- $R_m = E_1^2 / P_m$
- $X_m = E_1^2 / Q_m$

FIGURE 10-2a **See Example 10-1.**

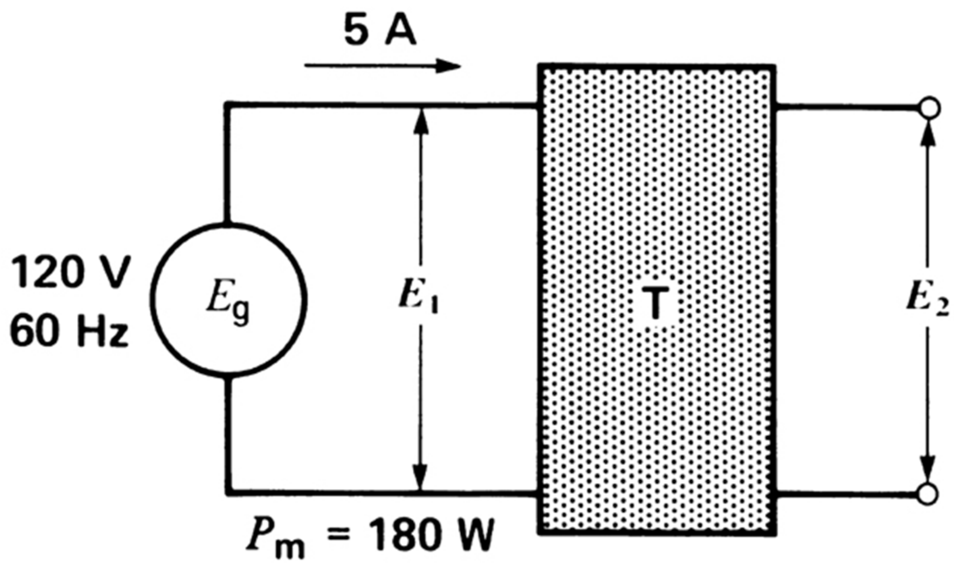


FIGURE 10-2b **Phasor diagram.**

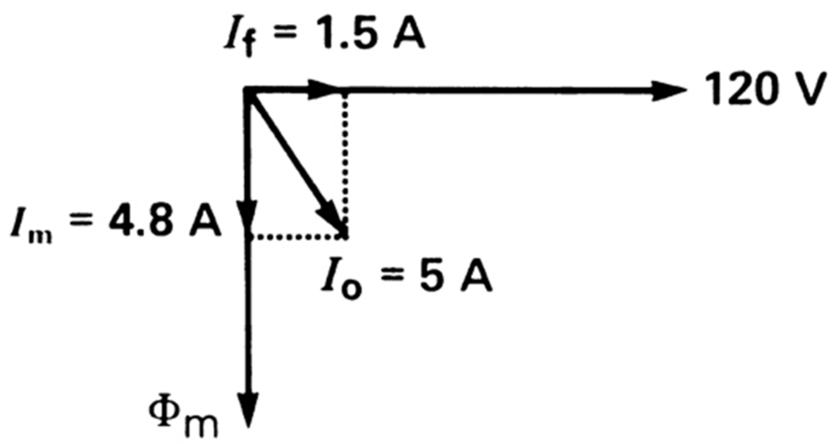


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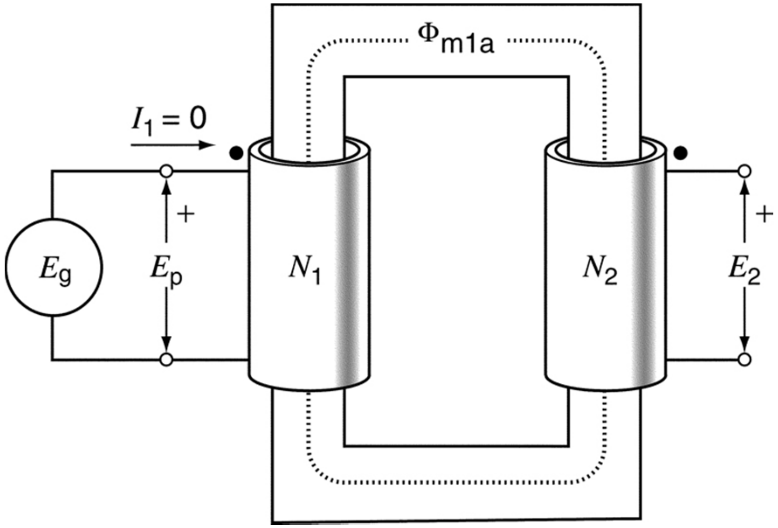
FIGURE 10-3 Transformer with infinitely permeable core at no-load.

Ideal Transformer with loose coupling



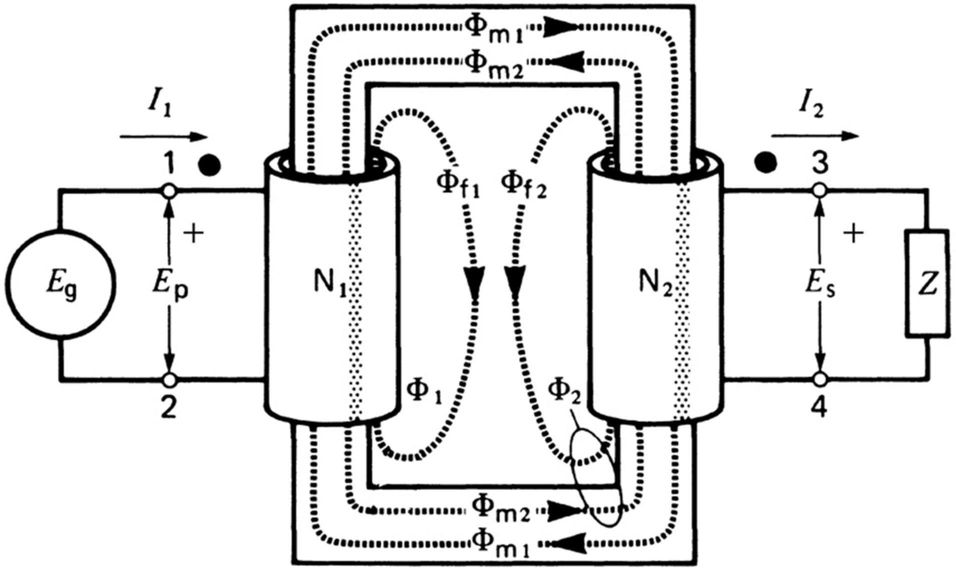


FIGURE 10-5 **A transformer possesses two leakage fluxes and a mutual flux.**

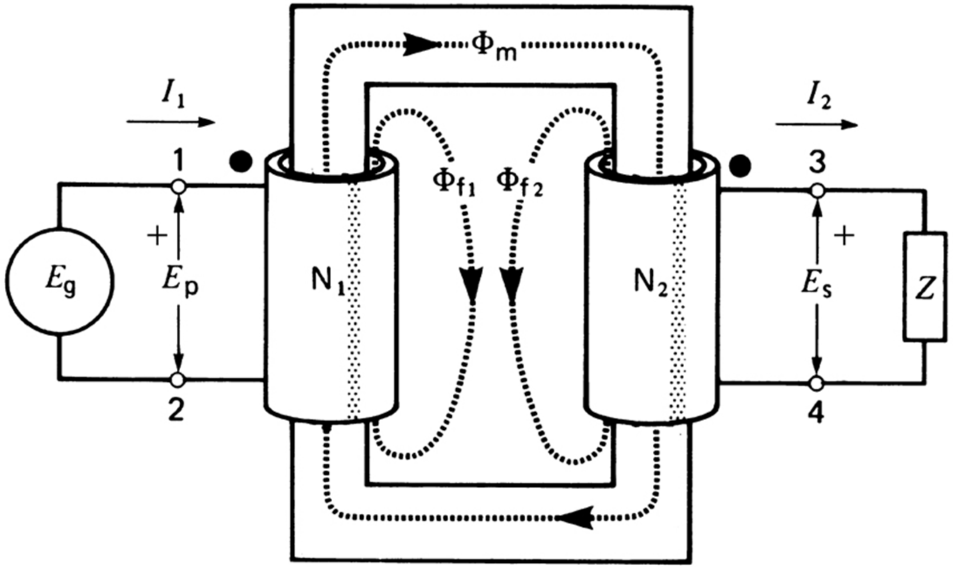


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FIGURE 10-6 **Separating the various induced voltages due to the mutual flux and the leakage fluxes.**

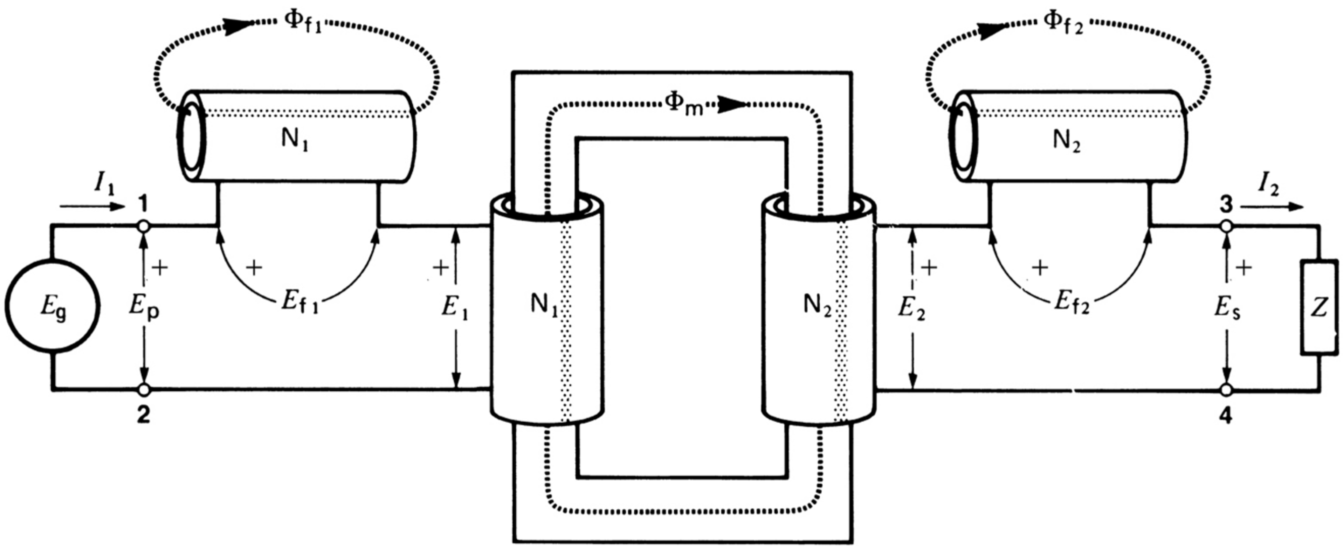

FIGURE 10-7 **Resistance and leakage reactance of the primary and secondary windings.**

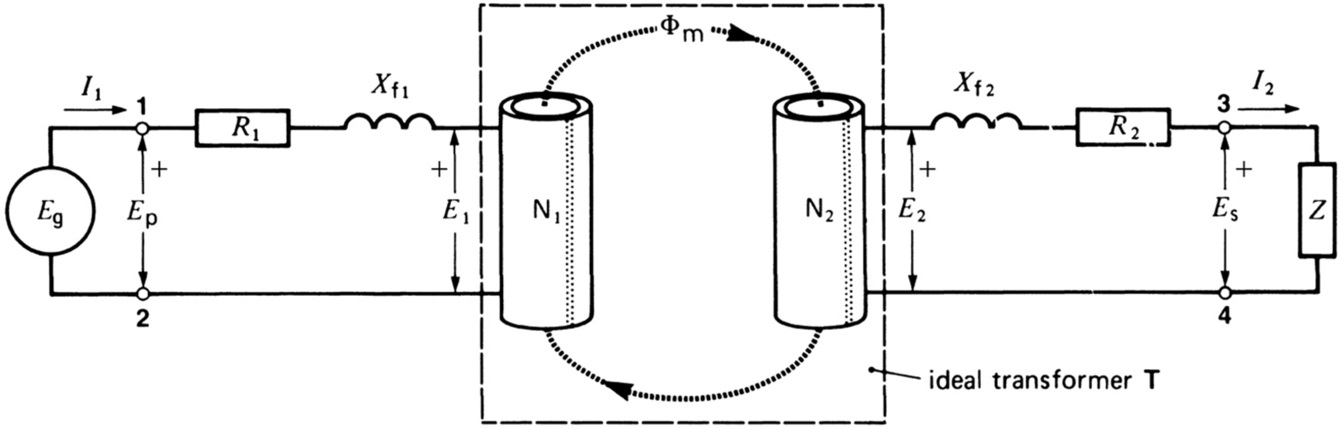

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FIGURE 10-8 **Complete equivalent circuit of a practical transformer. The shaded box T is an ideal transformer.**

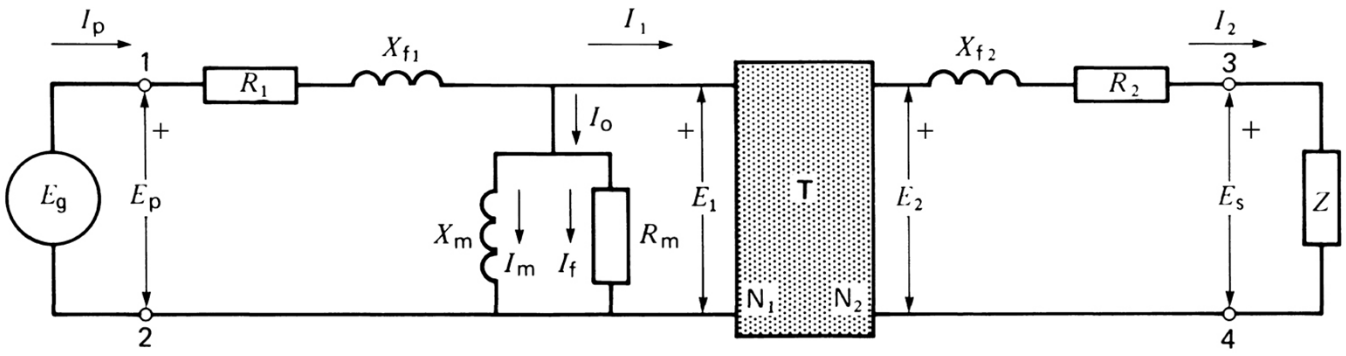

FIGURE 10-10 **Additive and subtractive polarity depend upon the location of the H_1-X_1 terminals.**

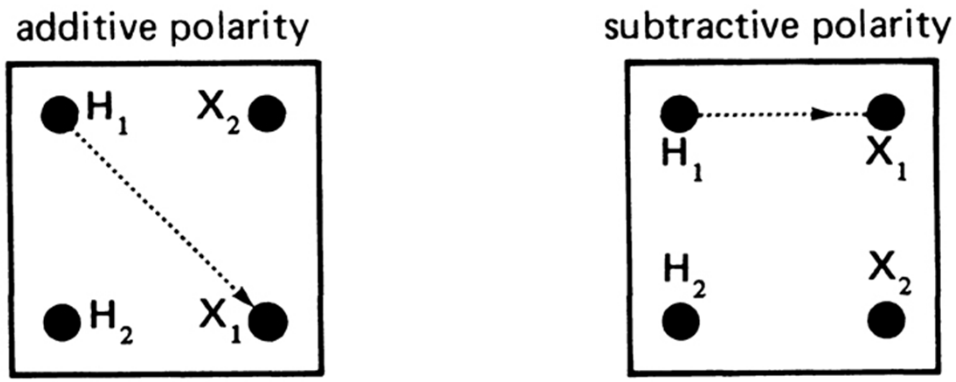

FIGURE 10-11 **Determining the polarity of a transformer using an ac source.**

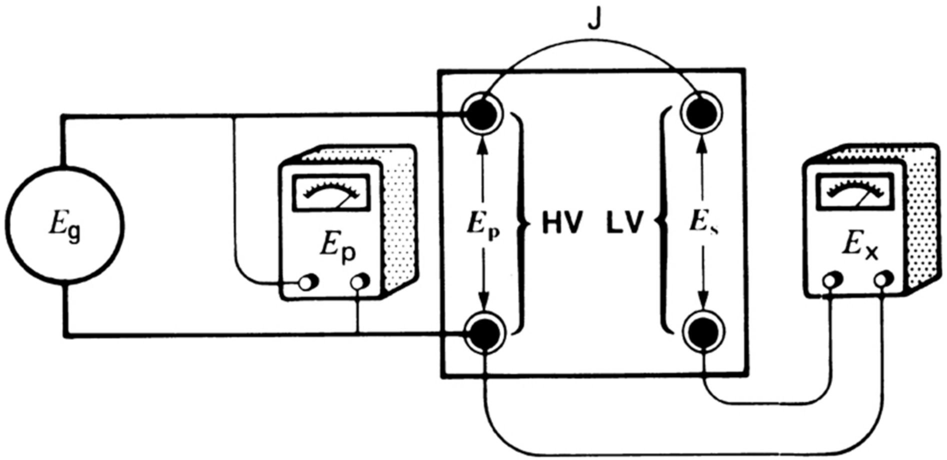

FIGURE 10-12 **Determing the polarity of a transformer using a dc source.**

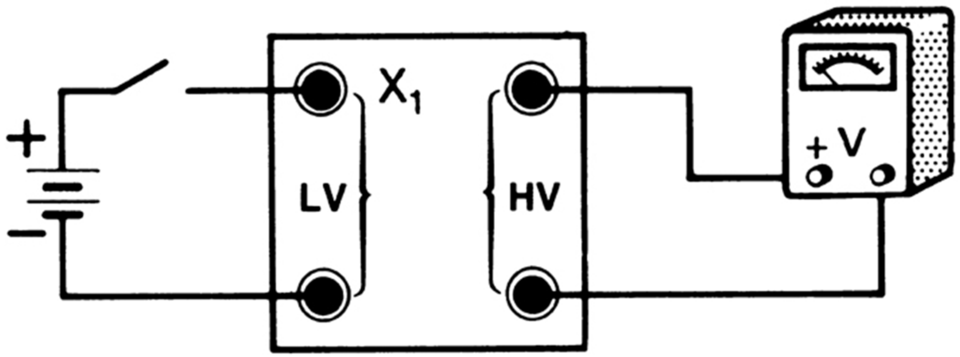

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FIGURE 10-13 **Distribution transformer with taps at 2400 V, 2292 V, 2184 V, and 2076 V.**

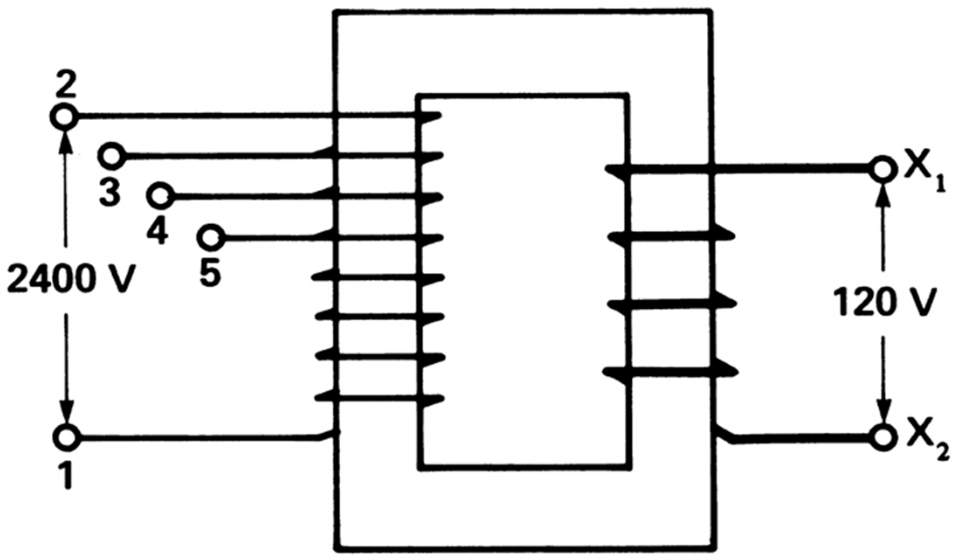

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FIGURE 10-14 **No-load saturation curve of a 167 kVA, 14.4 kV/480 V, 60 Hz transformer.**

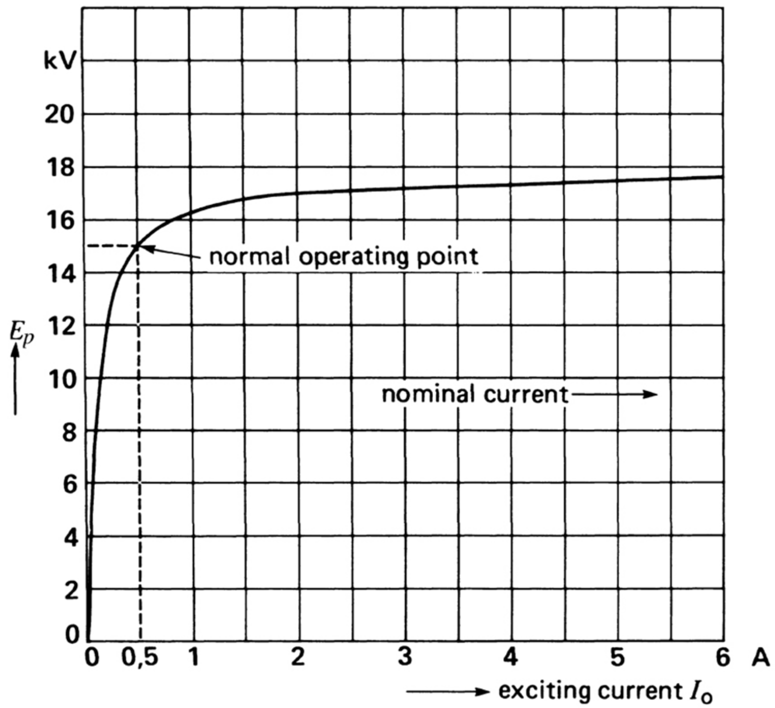

FIGURE 10-15 **Single-phase, dry-type transformer, type AA, rated at 15 kVA, 600 V/240 V, 60 Hz, insulation class 150°C for indoor use. Height: 600 mm; width: 434 mm; depth: 230 mm; weight: 79.5 kg. (*Courtesy of Hammond*)**

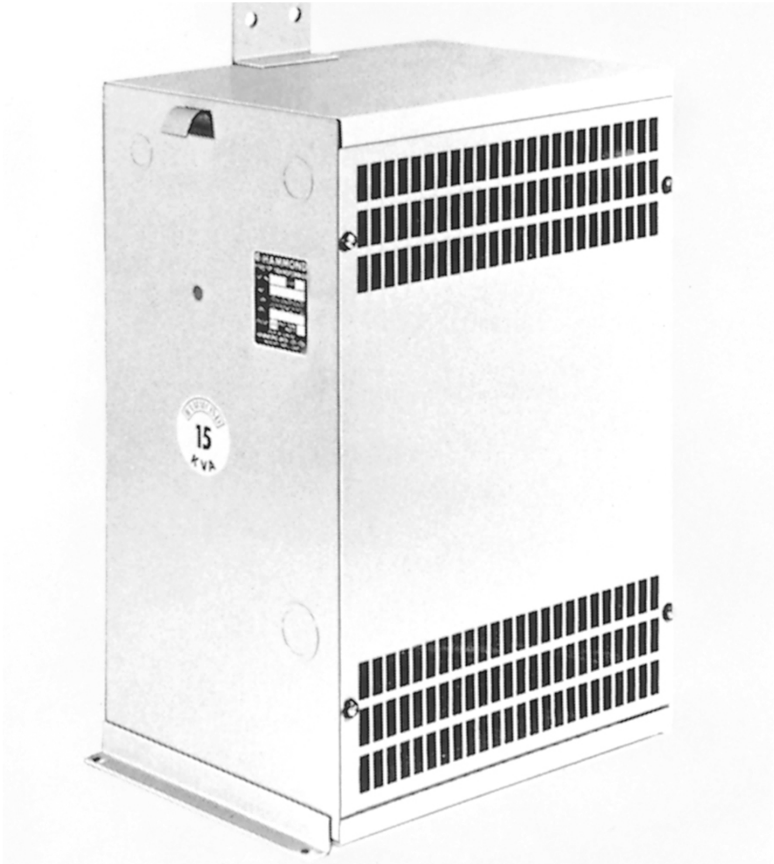

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FIGURE 10-16 **Two single-phase transformers, type OA, rated 75 kVA, 14.4 kV/240 V, 60 Hz, 55°C temperature rise, impedance 4.2%. The small radiators at the side increase the effective cooling area.**

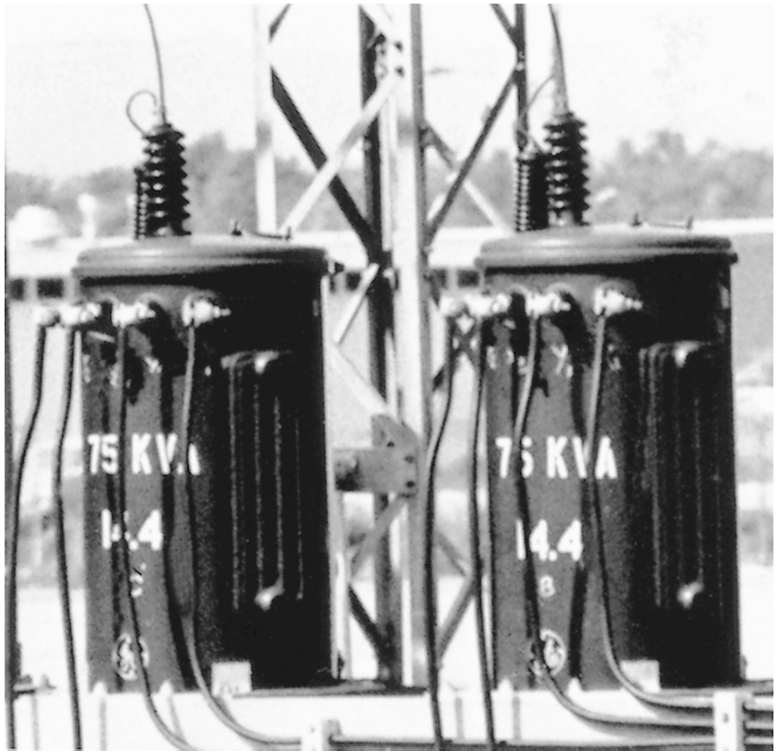

FIGURE 10-17 **Three-phase, type OA grounding transformer, rated 1900 kVA, 26.4 kV, 60 Hz. The power of this transformer is 25 times greater than that of the transformers shown in Fig. 10.16, but it is still self-cooled. Note, however, that the radiators occupy as much room as the transformer itself.**

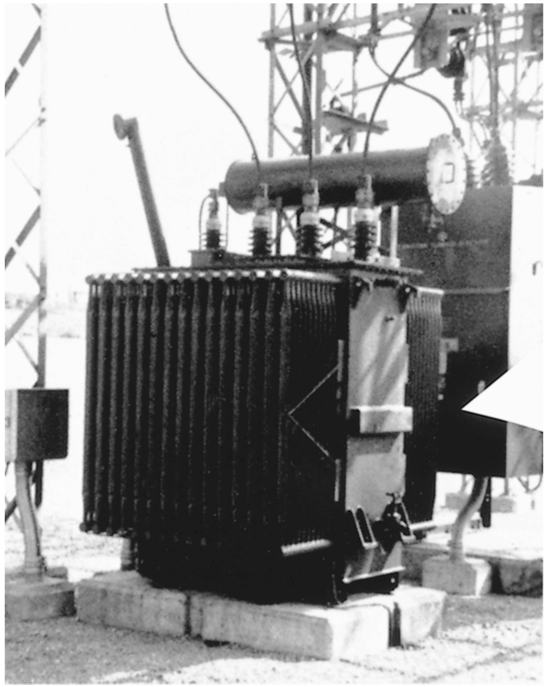

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FIGURE 10-18 **Three-phase, type FOA, transformer rated 1300 MVA, 24.5 kV/345 kV, 60 Hz, 65°C temperature rise, impedance 11.5%. This step-up transformer, installed at a nuclear power generating station, is one of the largest units ever built. The forced-oil circulating pumps can be seen just below the cooling fans. (*Courtesy of Westinghouse*)**

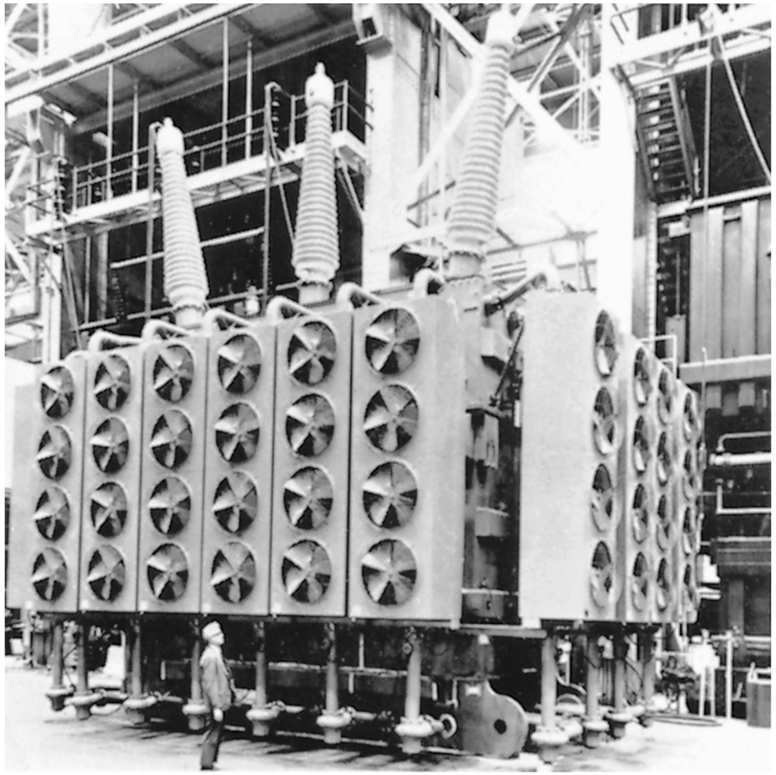

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FIGURE 10-19 **Three-phase, type OA/FA/FOA transformer rated 36/48/60 MVA, 225 kV/26.4 kV, 60 Hz, impedance 7.4%. The circular tank enables the oil to expand as the temperature rises and reduces the surface of the oil in contact with air. Other details:**
weight of core and coils: 37.7 t
weight of tank and accessories; 28.6 t
weight of coil (44.8 m³): 38.2 t
Total weight: 104.5 t

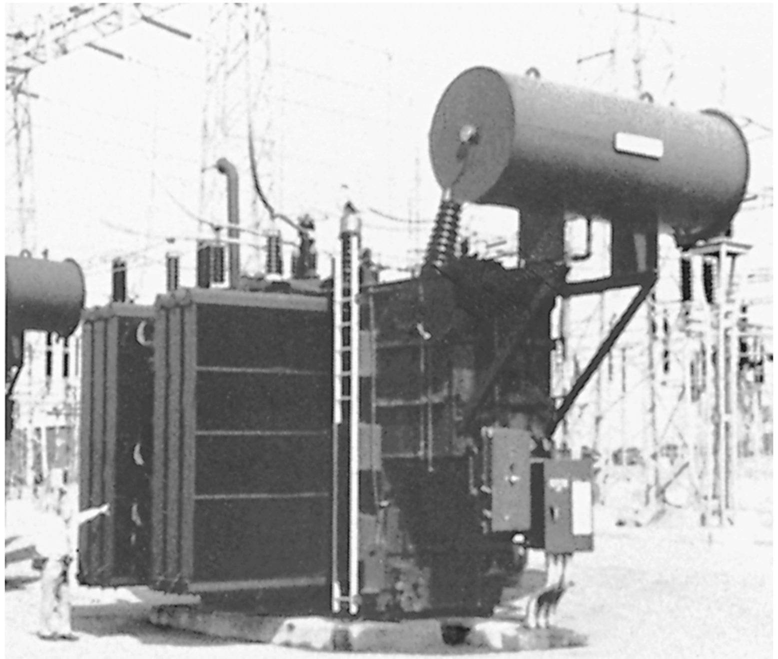

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FIGURE 10-20 **Complete equivalent circuit of a transformer at no-load.**

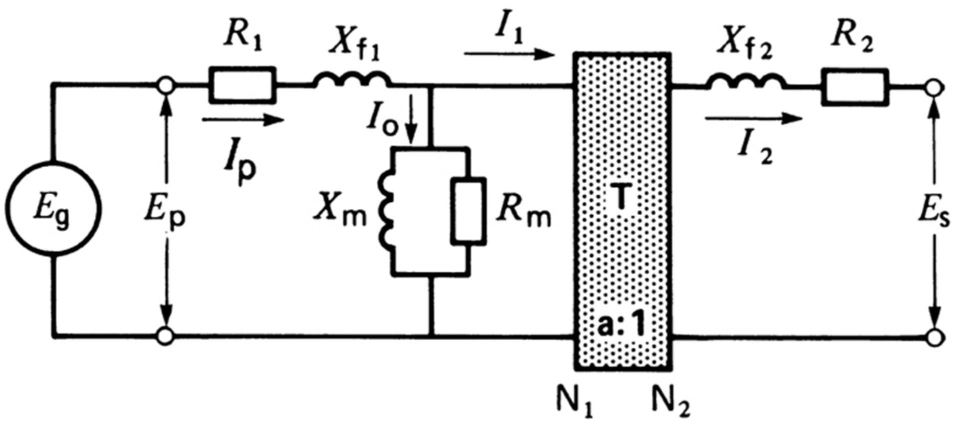

FIGURE 10-21 **Simplified circuit at no-load.**

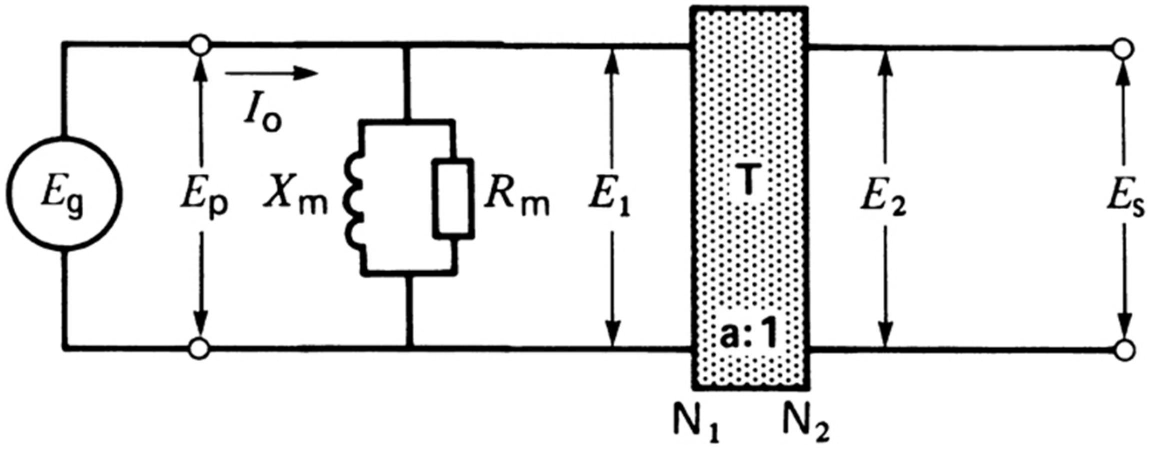

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FIGURE 10-22 **Simplified equivalent circuit of a transformer at full-load.**

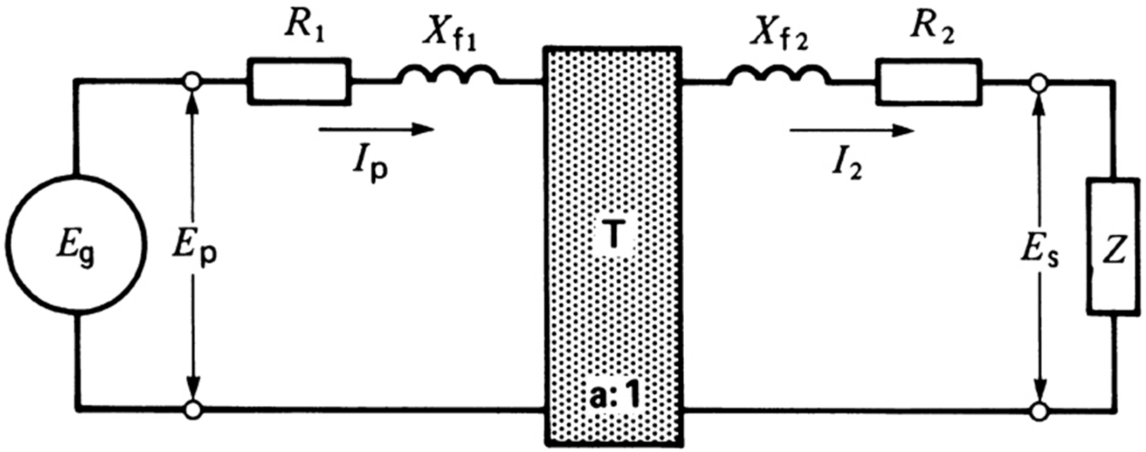

FIGURE 10-23 **Equivalent circuit with impedances shifted to the primary side.**

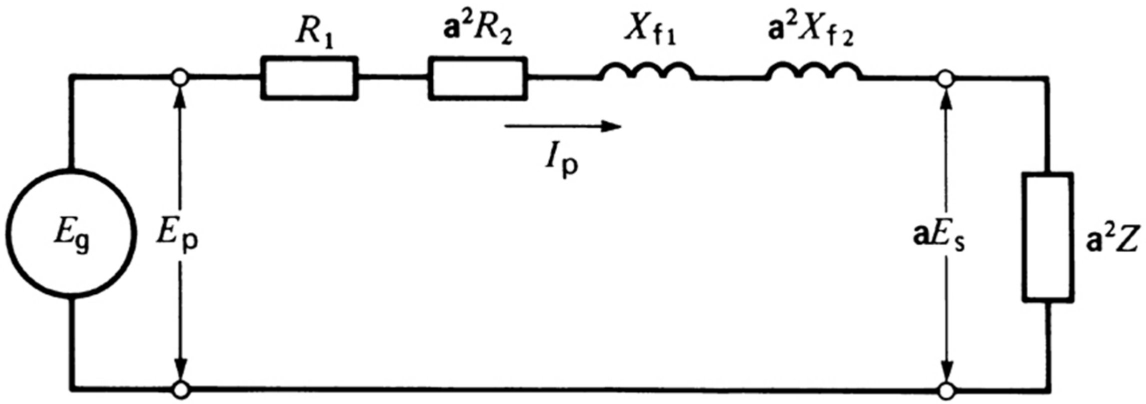

FIGURE 10-24 **The internal impedance of a large transformer is mainly reactive.**

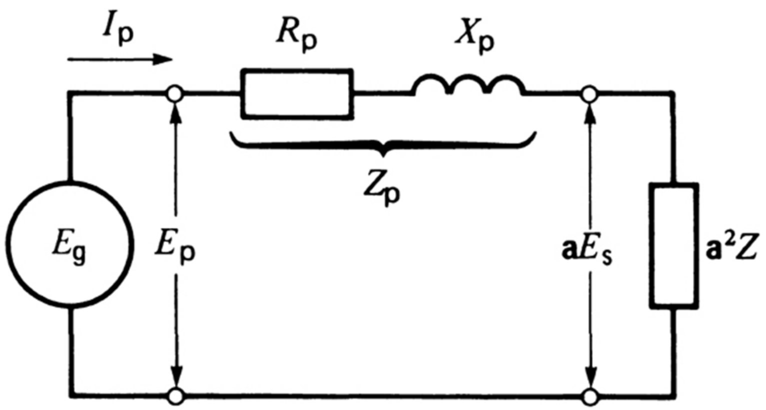

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FIGURE 10-25 **The internal impedance of a large transformer is mainly reactive.**

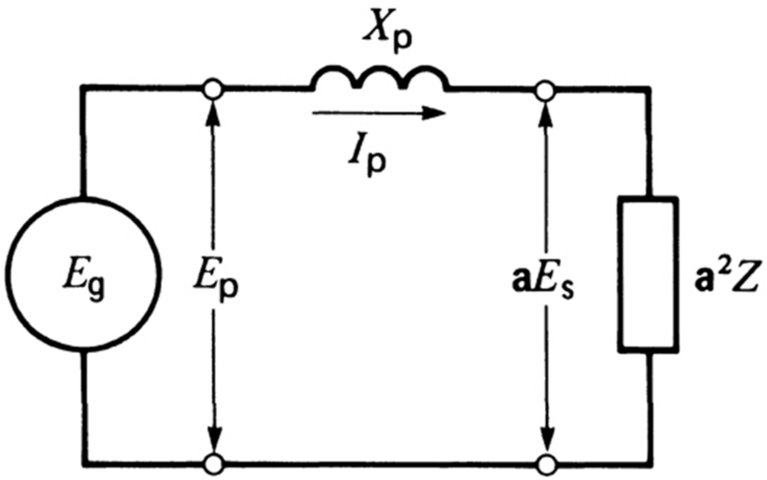

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FIGURE 10-26a **See Example 10-7.**

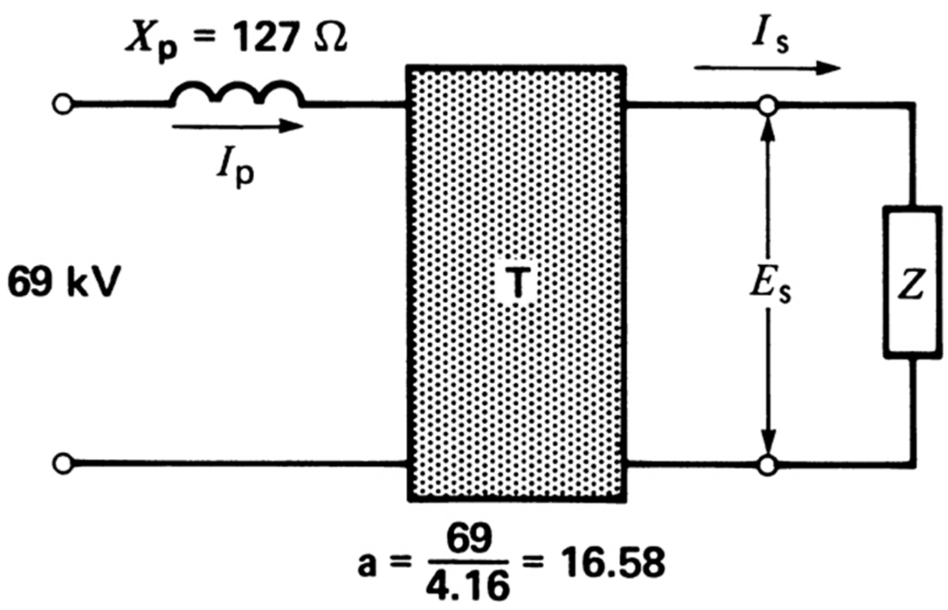

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FIGURE 10-26b **See Example 10-7.**

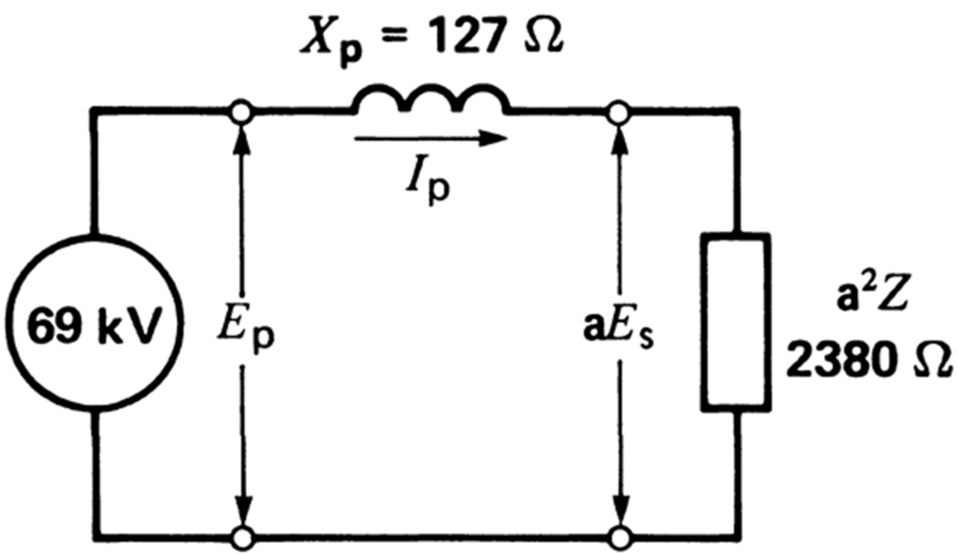

FIGURE 10-27 **Open-circuit test and determination of R_m, X_m, and turns ratio.**

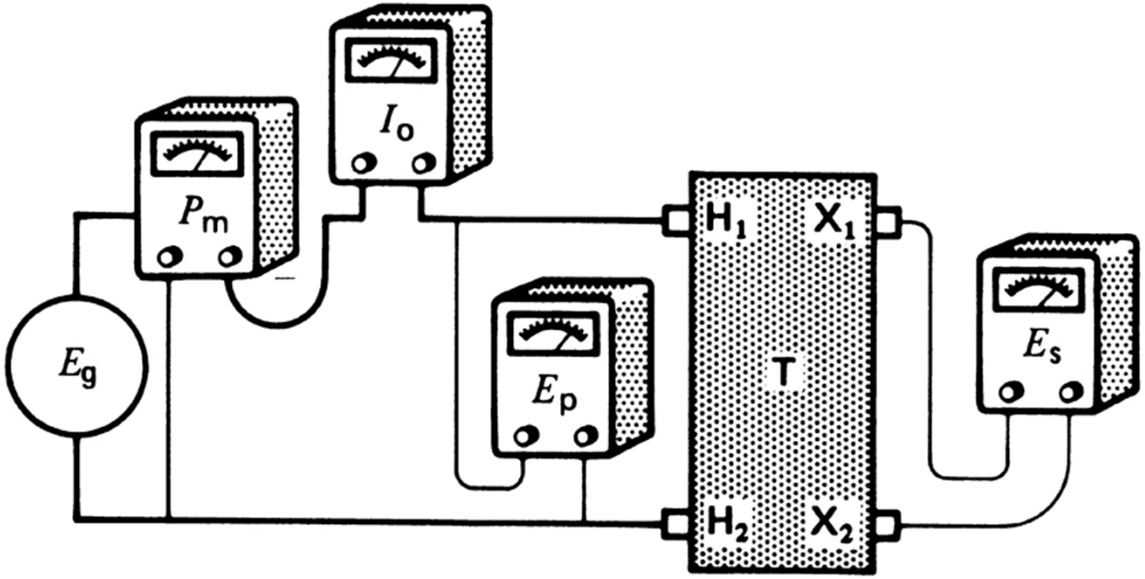

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FIGURE 10-28 **Short-circuit test to determine leakage resistance and winding resistance.**

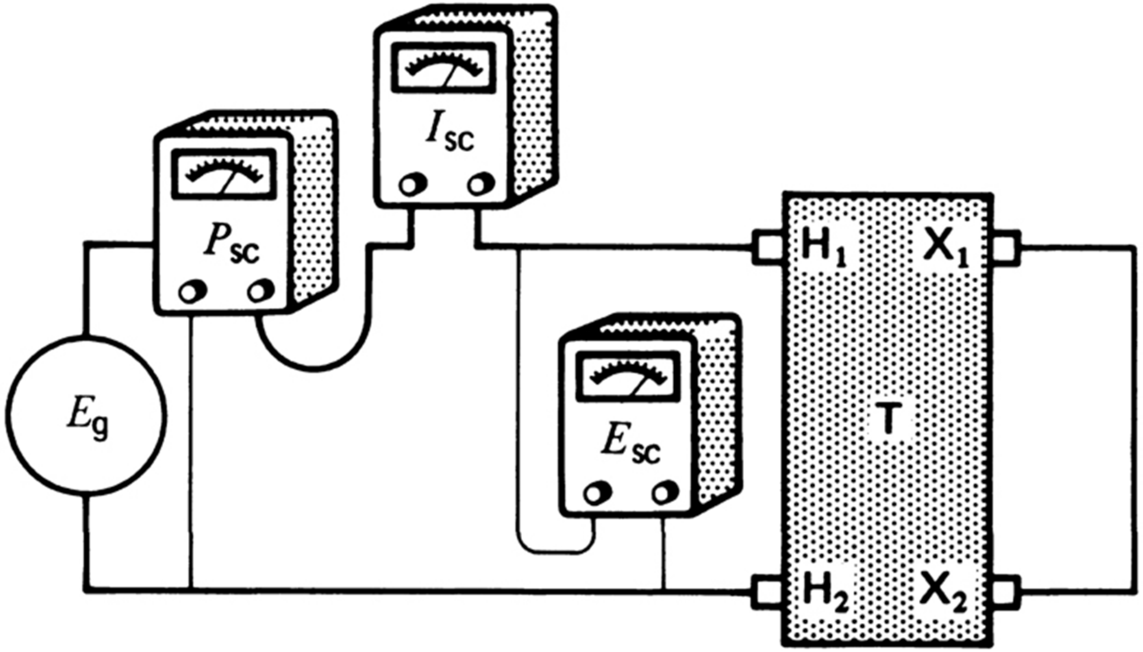

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FIGURE 10-29 **See Example 10-6.**

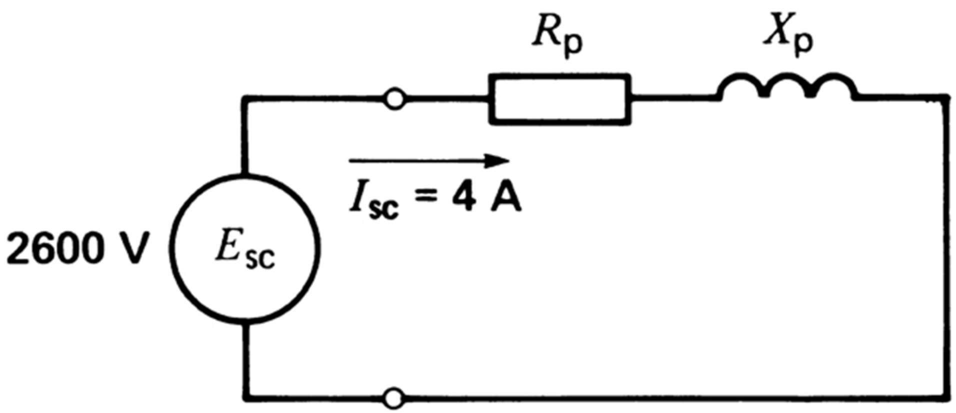

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FIGURE 10-30 **See Example 10-7.**

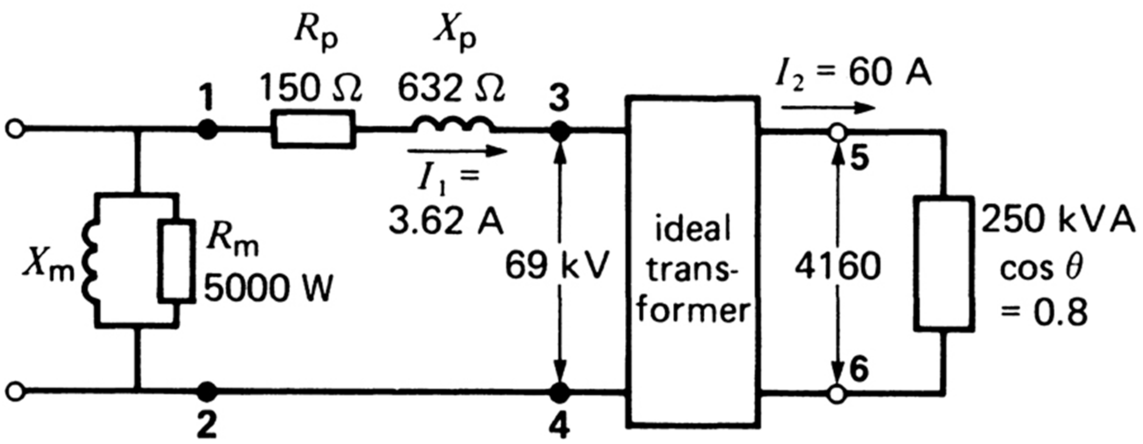

FIGURE 10-31 **Equivalent circuit of a transformer.**

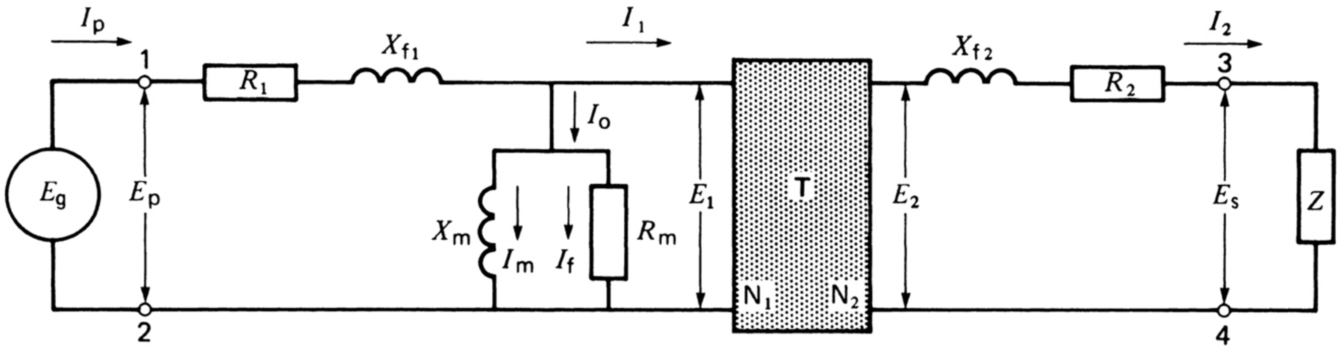

FIGURE 10-32 **See Example 10-9.**

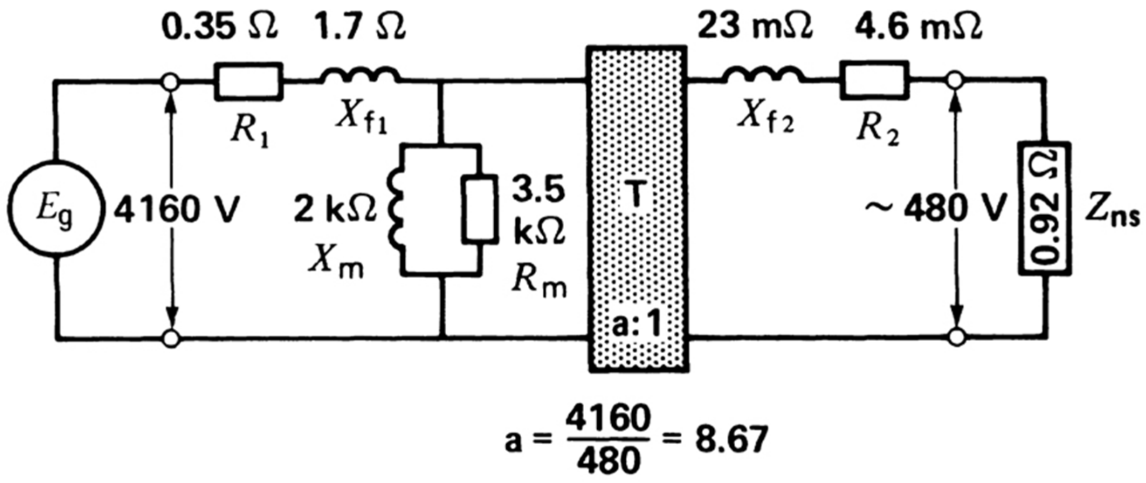

FIGURE 10-33 **Per-unit equivalent circuit of a 500 kVA transformer feeding a 250 kVA load.**

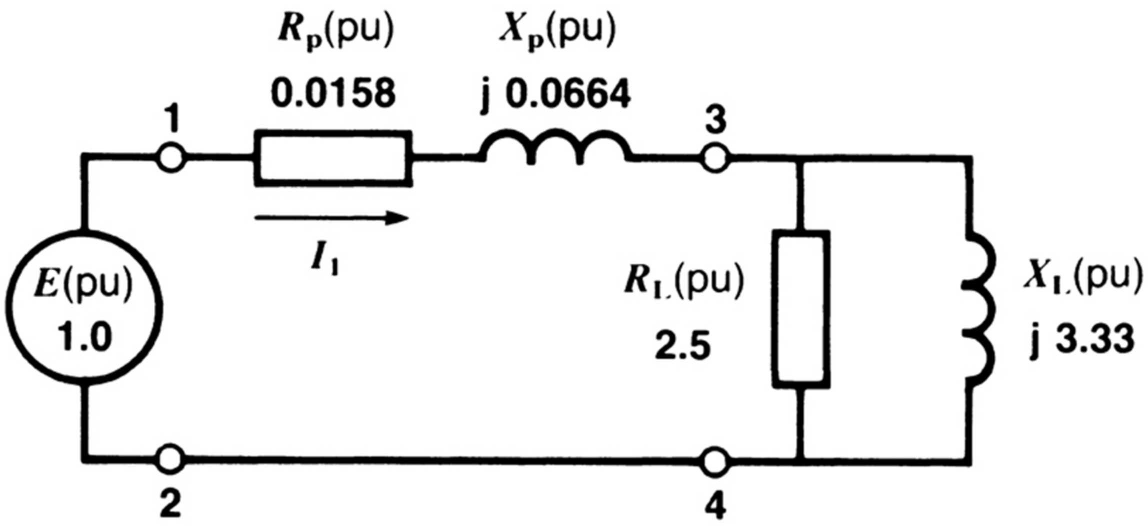

FIGURE 10-34 **Connecting transformers in parallel to share a load.**

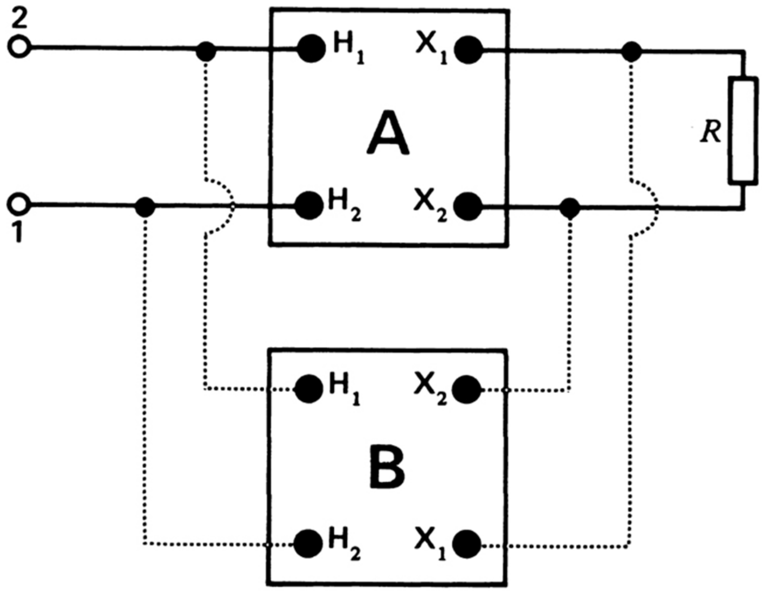

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FIGURE 10-35a **Equivalent circuit of a transformer feeding a load Z_L.**

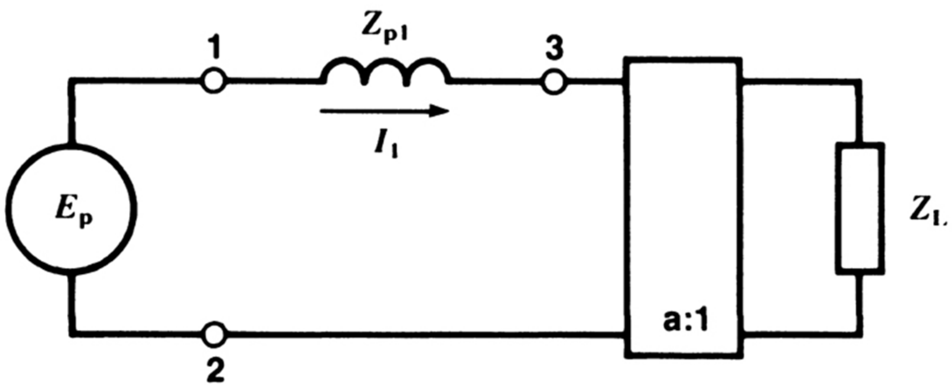

FIGURE 10-35b **Equivalent circuit with all impedances referred to the primary side.**

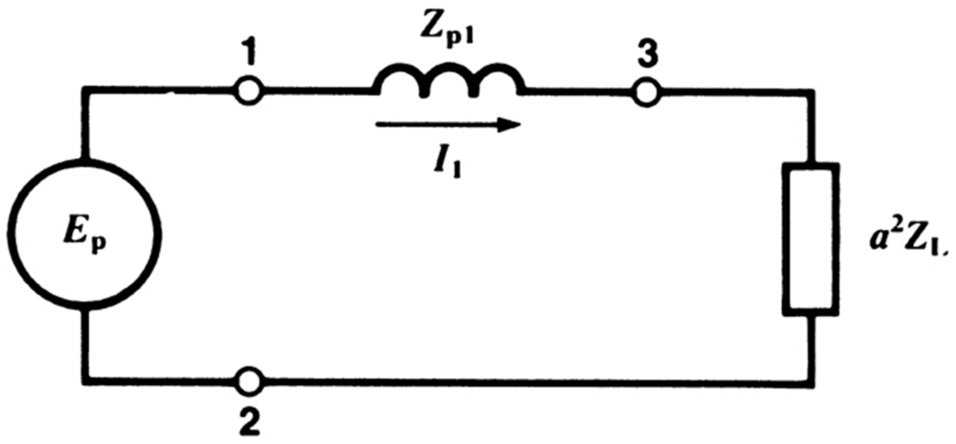

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FIGURE 10-35c **Equivalent circuit of two transformers in parallel feeding a load Z_1. All impedances referred to the primary side.**

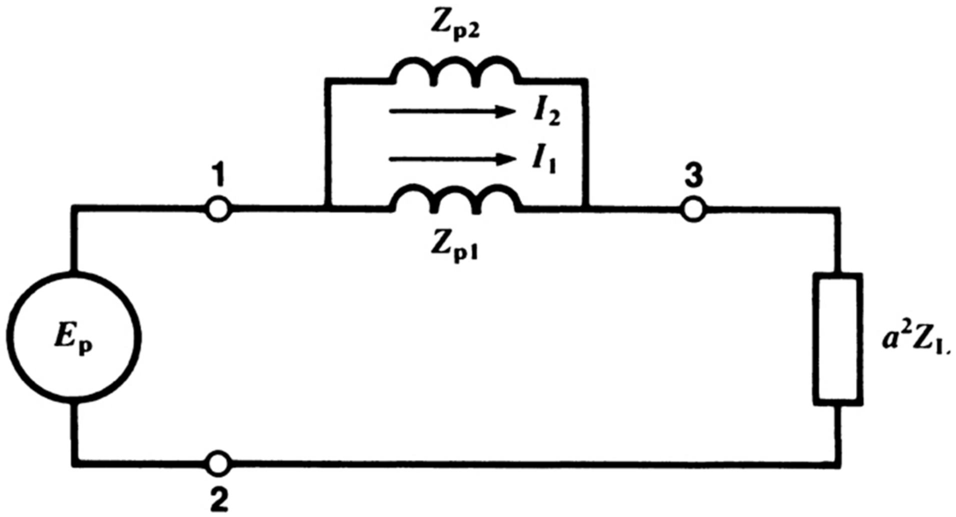

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FIGURE 10-36a **Actual transformer connections.**

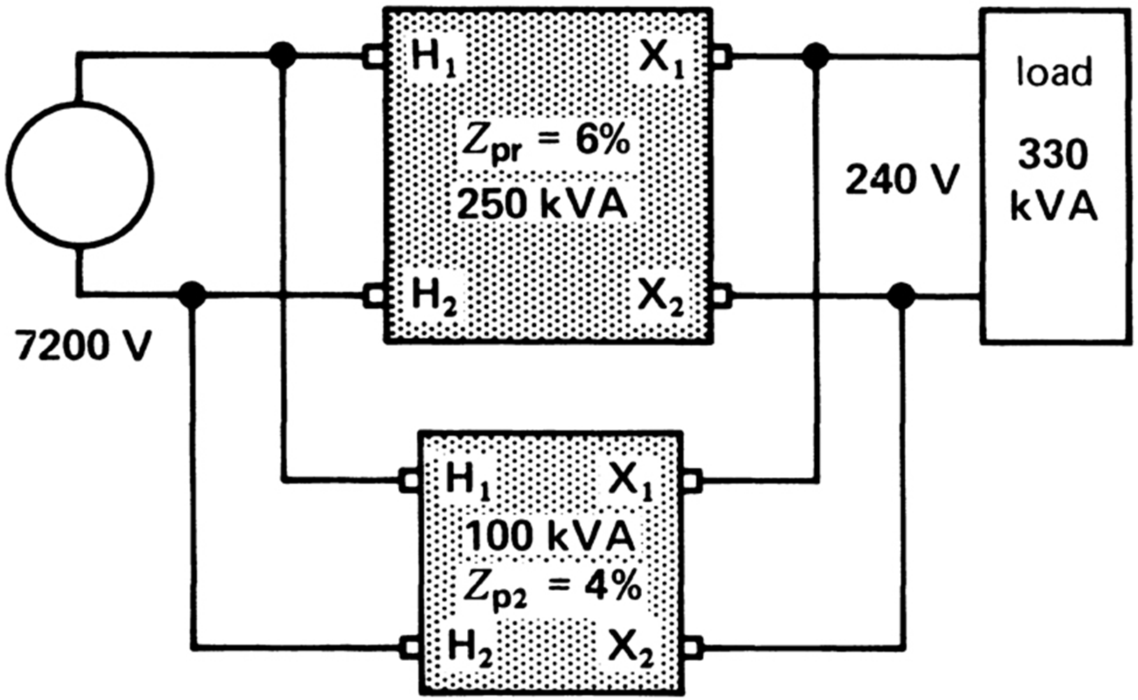

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FIGURE 10-36b **Equivalent circuit. Calculations show that the 100 kVA transformer is seriously overloaded.**

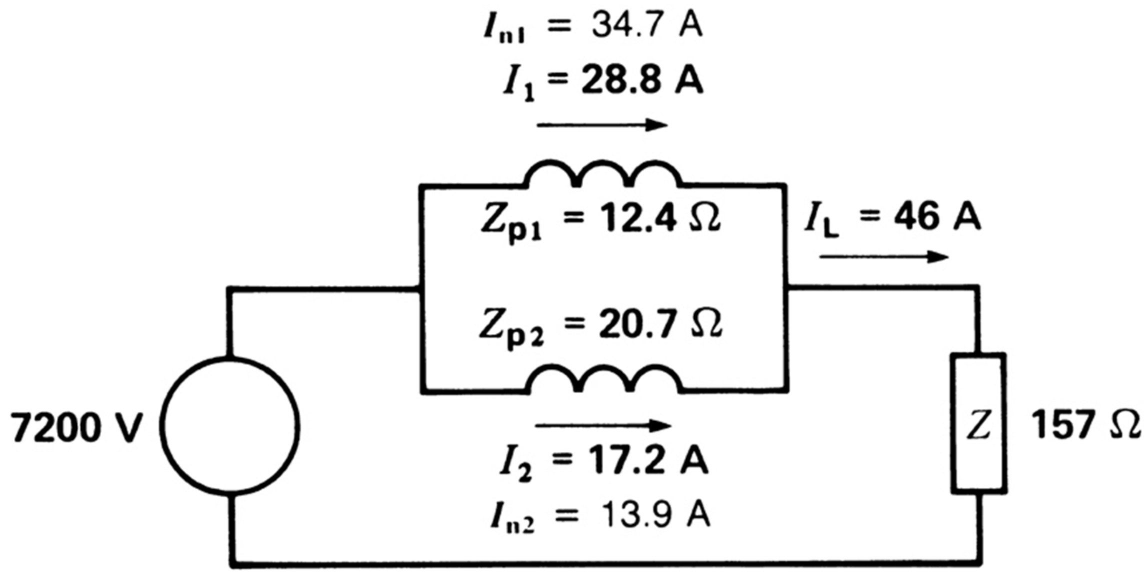

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FIGURE 10-37 **See Problem 10-18.**

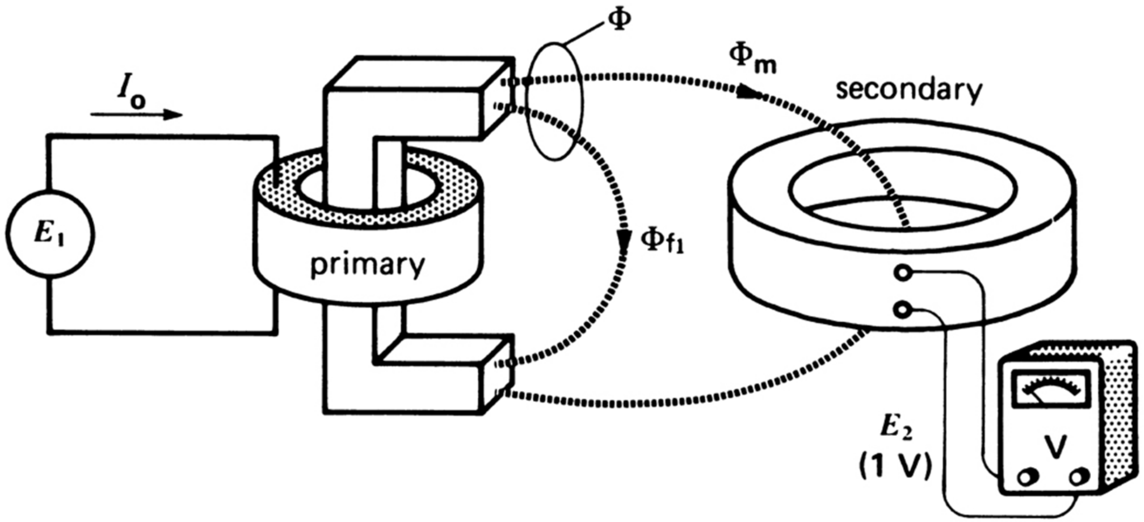


FIGURE 10-38 **See Problem 10-19.**

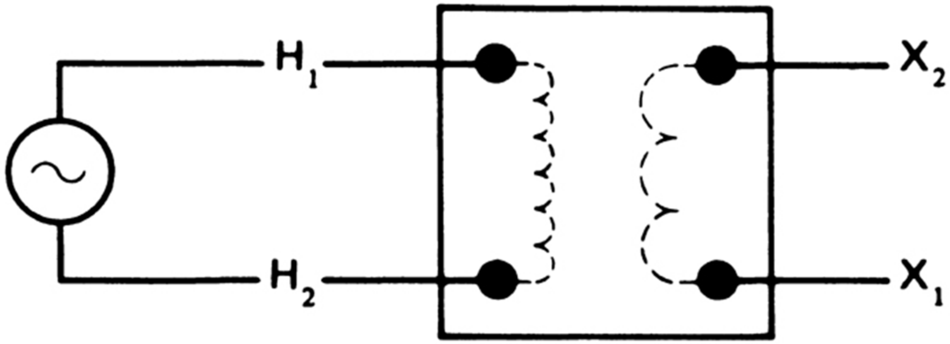
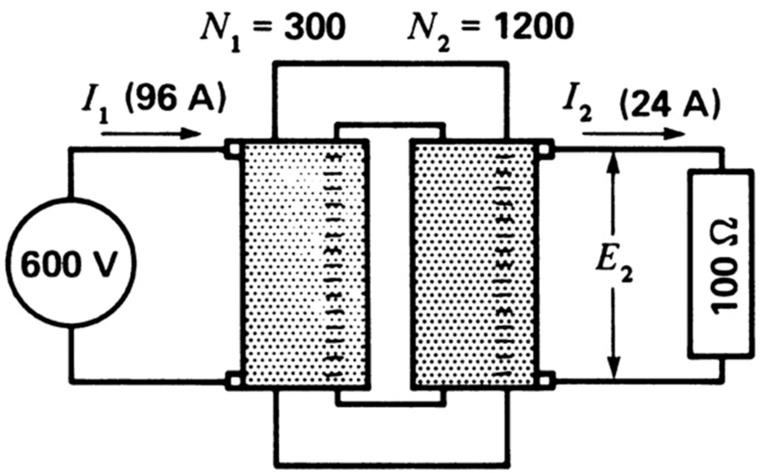


FIGURE 10-39 **See Problem 10-33. The primary is wound on one leg and the secondary on the other.**



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