Elektrische Aandrijvingen

WTB

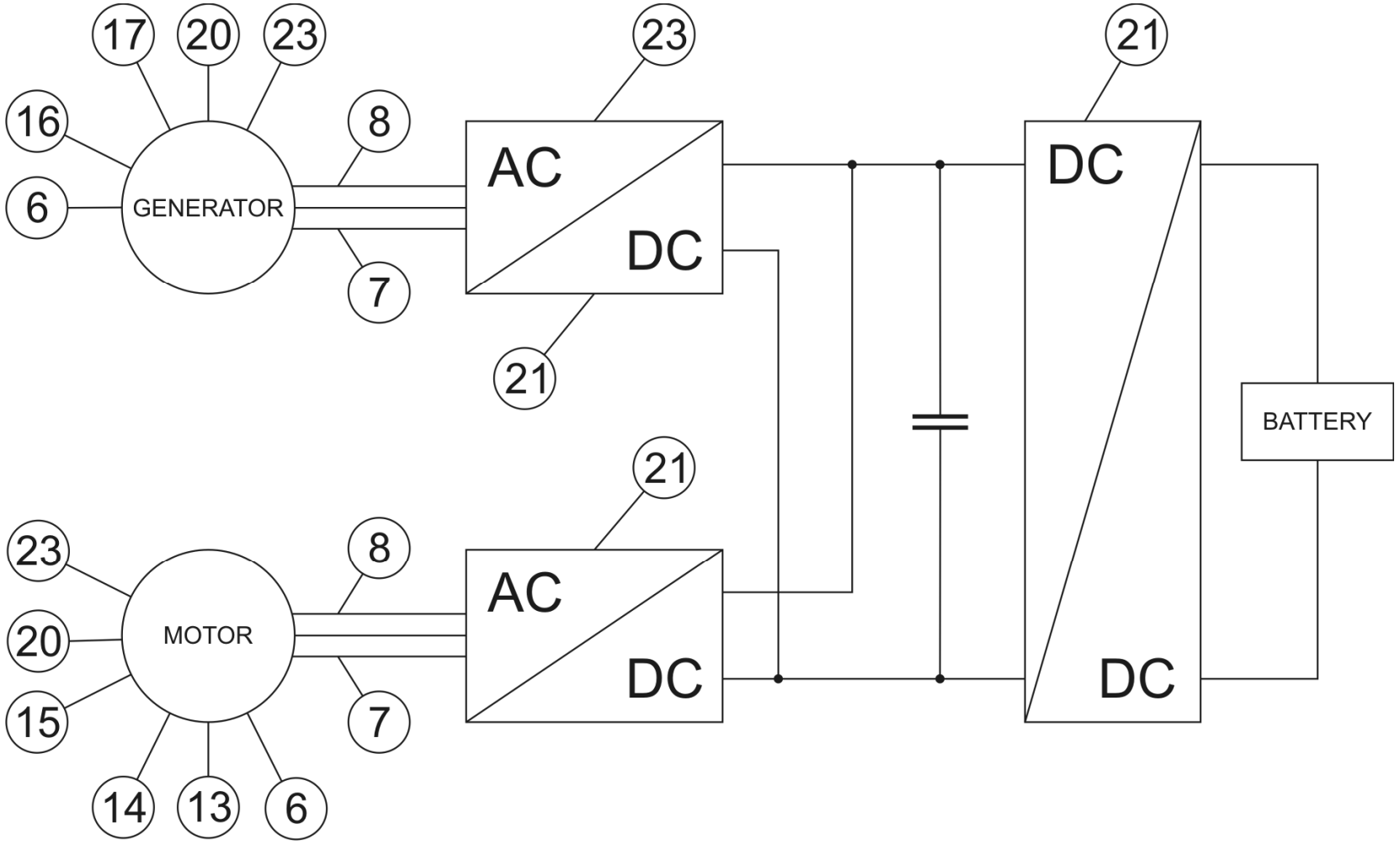
Lokatie / evenement

P.BAUER

February 19, 2009

TU Delft
Delft University of Technology

Three phase induction machines



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Three phase induction machines

- Stator
- Rotor – Squirrel Cage rotor
  - Wound rotor

Three phase induction machines

FIGURE 13-1 **Super-E, premium efficiency induction motor rated 10 hp, 1760 r/min, 460 V, 3-phase, 60 Hz. This totally-enclosed fan-cooled motor has a full-load current of 12.7 A, efficiency of 91.7%, and power factor of 81%. Other characteristics: no-load current: 5 A; locked rotor current: 85 A; locked rotor torque: 2.2 pu; breakdown torque: 3.3 pu; service factor 1.15; total weight: 90 kg; overall length including shaft: 491 mm; overall height: 279 mm. (*Courtesy of Baldor Electric Company*)**

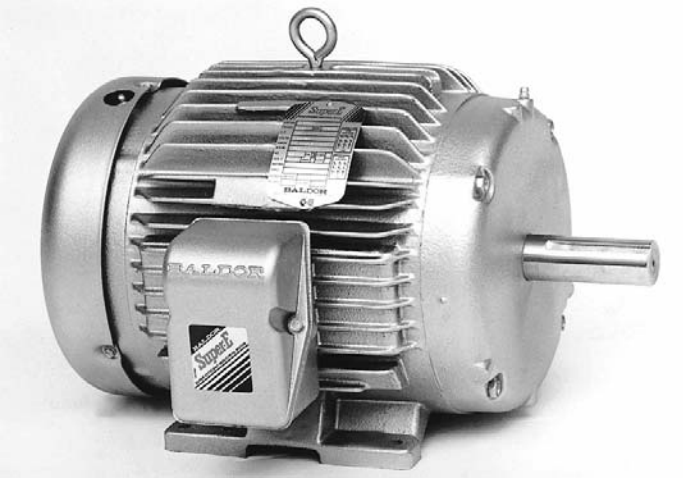


FIGURE 13-2 **Exploded view of the cage motor of Fig. 13.1, showing the stator, rotor, end-bells, cooling fan, ball bearings, and terminal box. The fan blows air over the stator frame, which is ribbed to improve heat transfer. (*Courtesy of Baldor Electric Company*)**

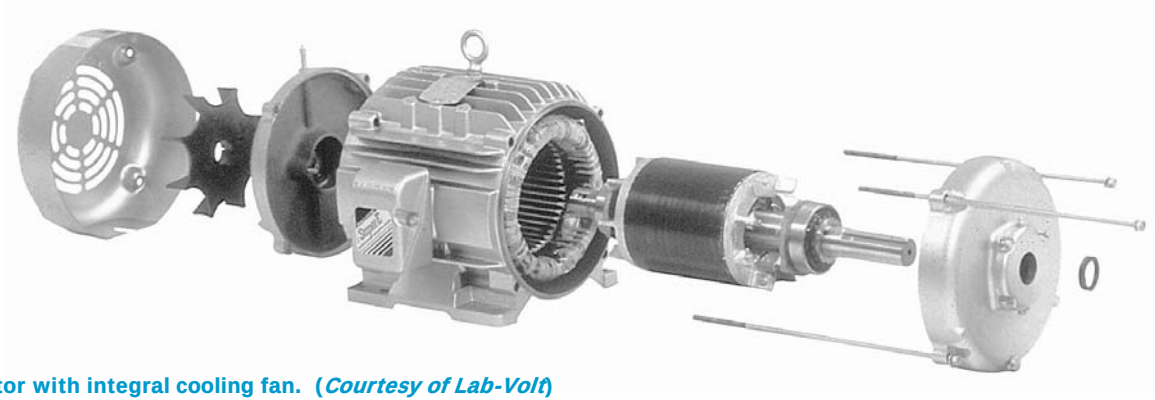
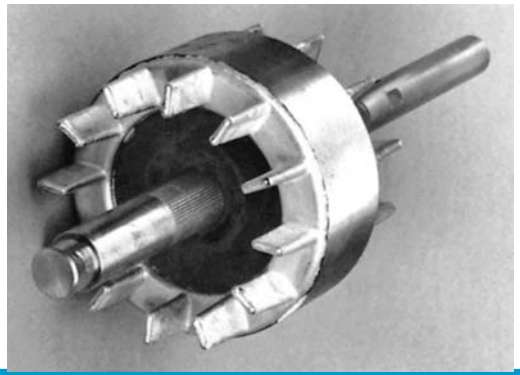


FIGURE 13-3a **Die-cast aluminum squirrel-cage rotor with integral cooling fan. (*Courtesy of Lab-Volt*)**



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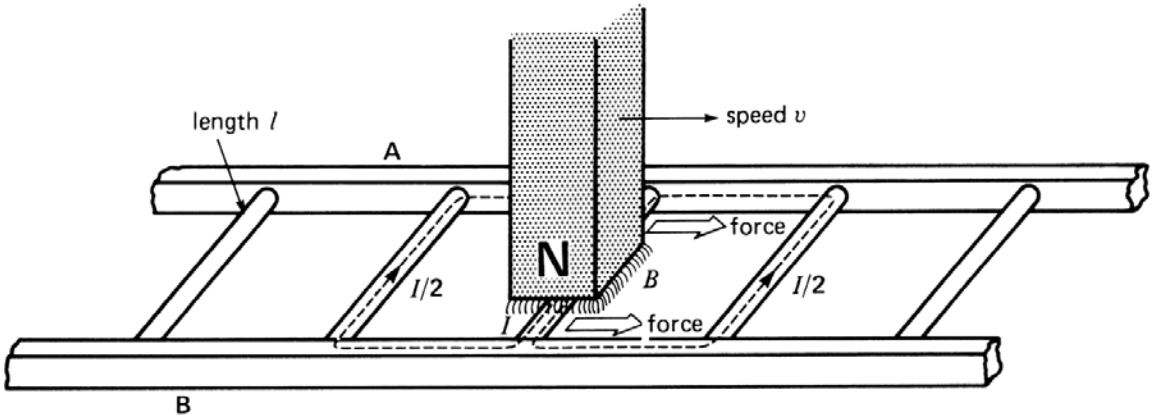
Principle of operation



- Voltage E=B l v
- Induced voltage = current I
- Current + magnetic field = force

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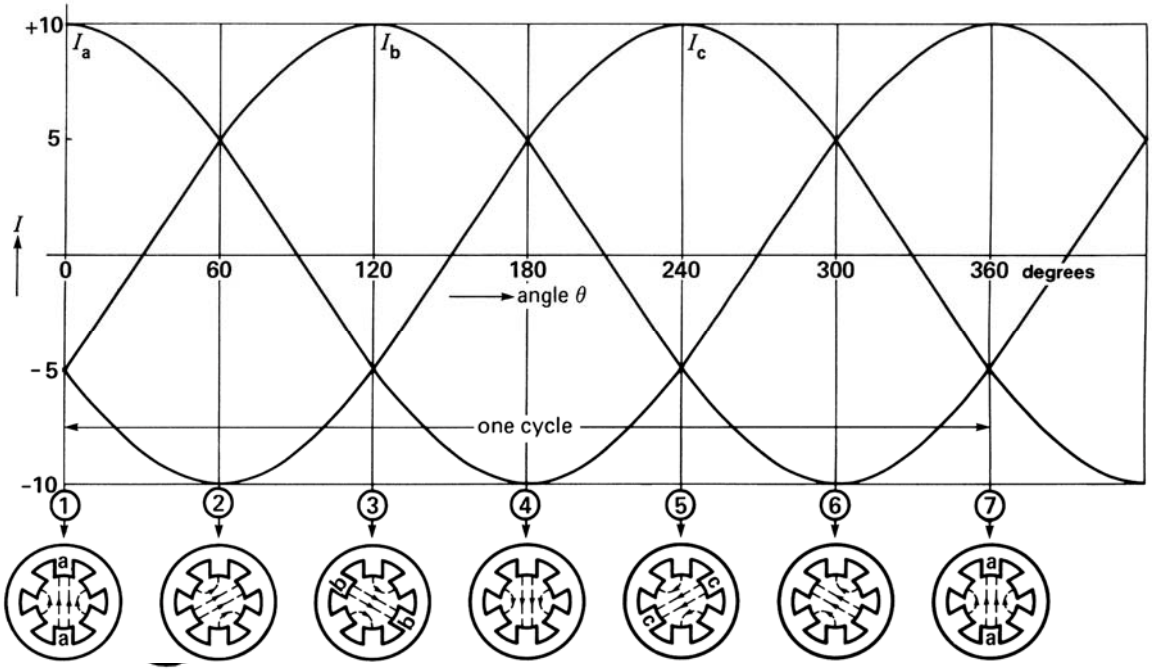
Principle of operation

FIGURE 13-6 **Elementary stator having terminals A, B, C connected to a 3-phase source (not shown). Currents flowing from line to neutral are considered to be positive.**

FIGURE 13-5b **Ladder bent upon itself to form a squirrel cage.**



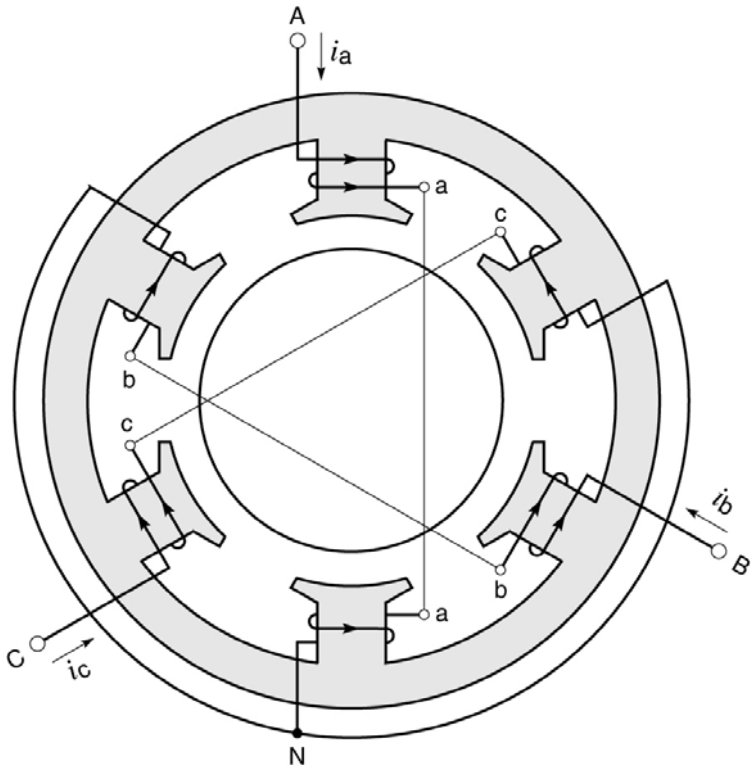


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FIGURE 13-7 **Instantaneous values of currents and position of the flux in Fig. 13.6.**

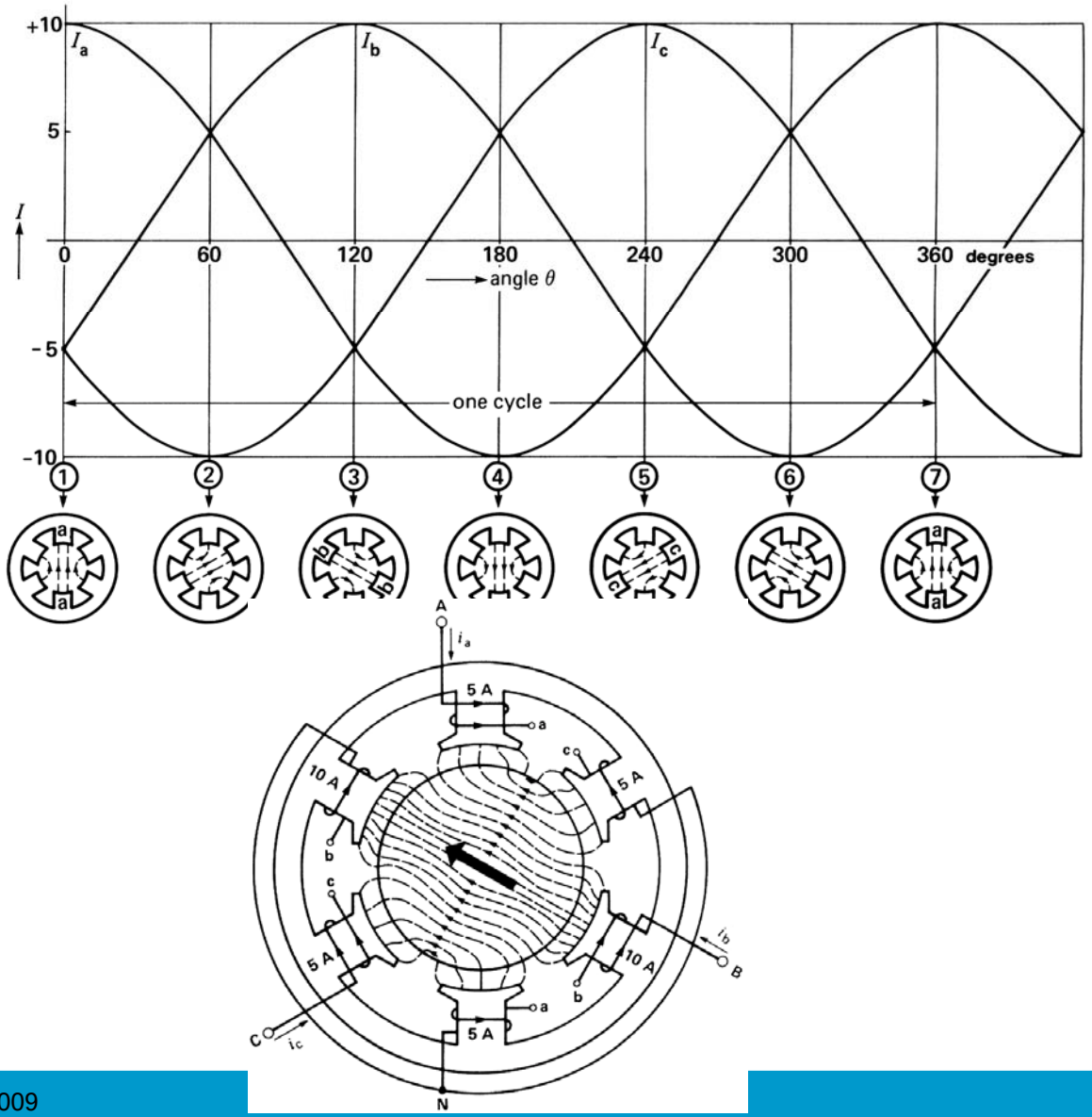
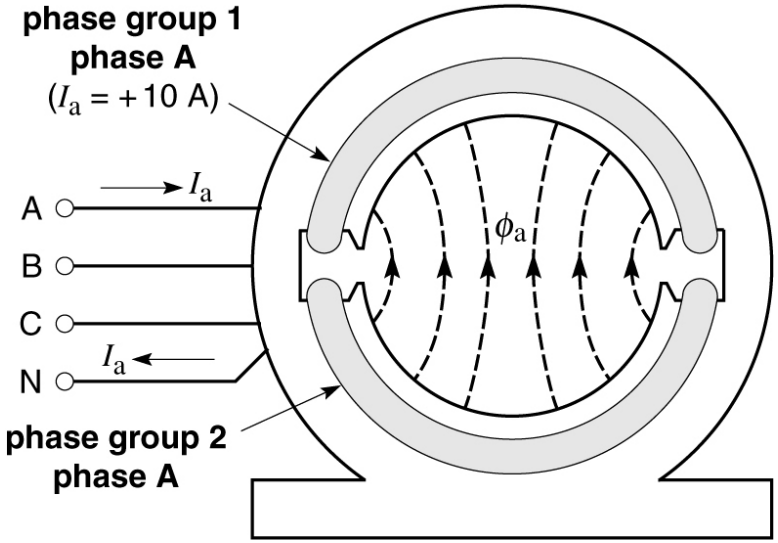


FIGURE 13-9a **Phase group 1 is composed of a single coil lodged in two slots. Phase group 2 is identical to phase group 1. The two coils are connected in series. In practice, a phase group usually consists of two or more staggered coils.**



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Number of poles

FIGURE 13-9b **Two-pole, full-pitch, lap-wound stator and resulting magnetic field when the current in phase A = +10 A and $I_b = I_c = -5$ A.**

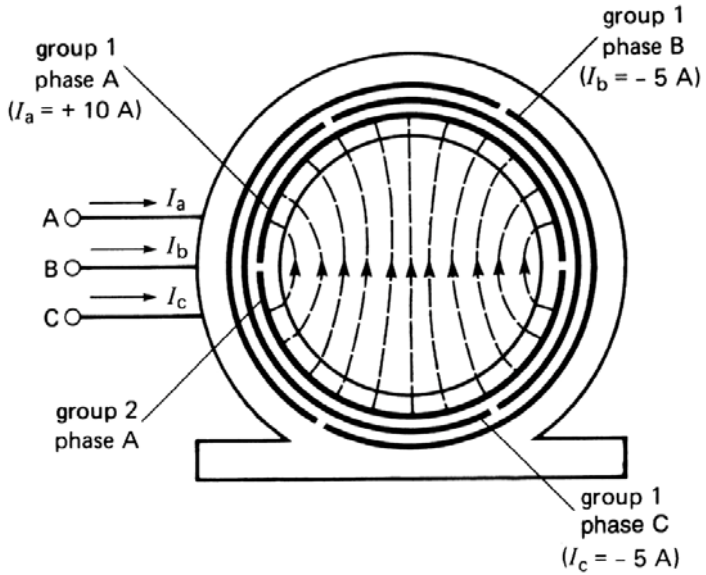

FIGURE 13-10a **The four phase groups of phase A produce a 4-pole magnetic field.**

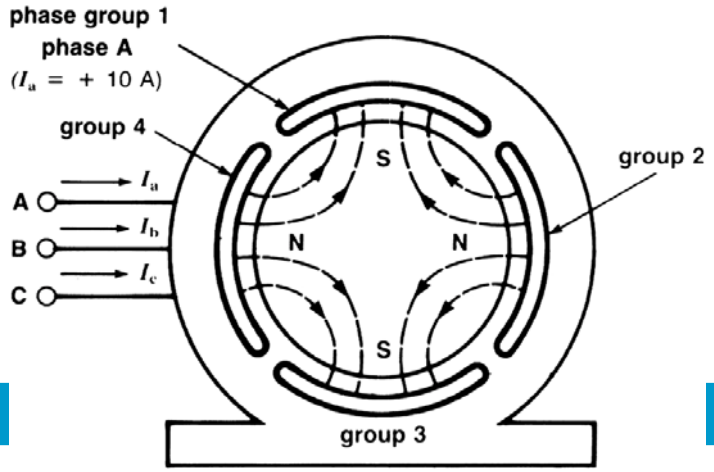

FIGURE 13-10b **Four-pole, full-pitch, lap-wound stator and resulting magnetic field when $I_a = +10$ A and $I_b = I_c = -5$ A.**

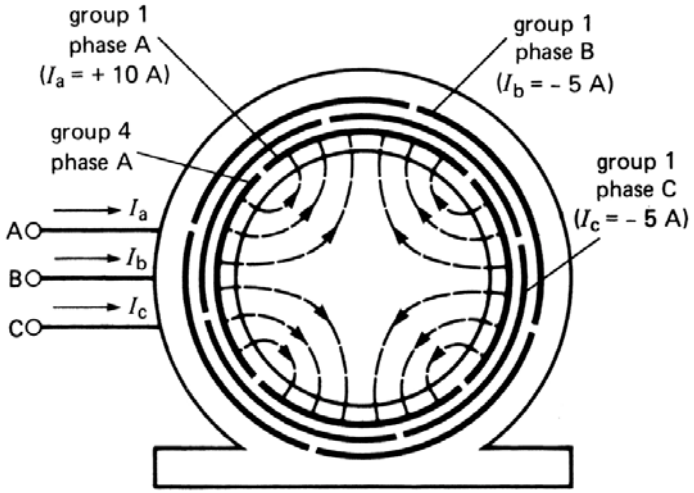

FIGURE 13-11 **Eight-pole, full-pitch, lap-wound stator and resulting magnetic field when $I_a = +10$ A and $I_b = I_c = -5$ A.**

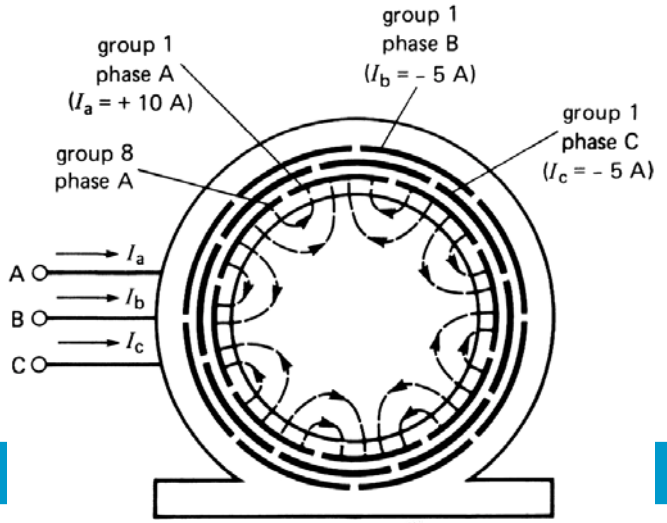

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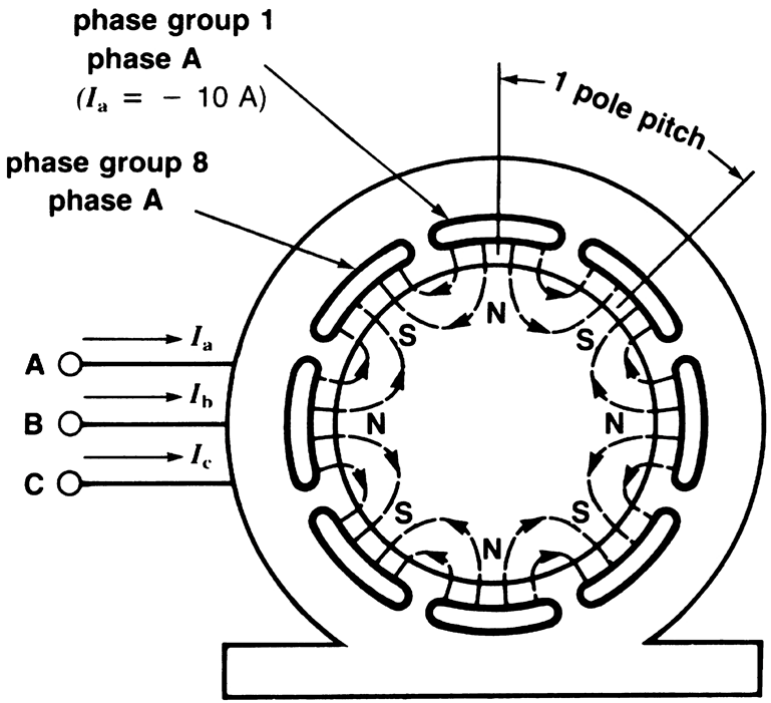
FIGURE 13-12b **Flux pattern when the current in phase A is at its maximum negative value. The pattern is the same as in Fig. 13.12a but it has advanced by one pole pitch.**



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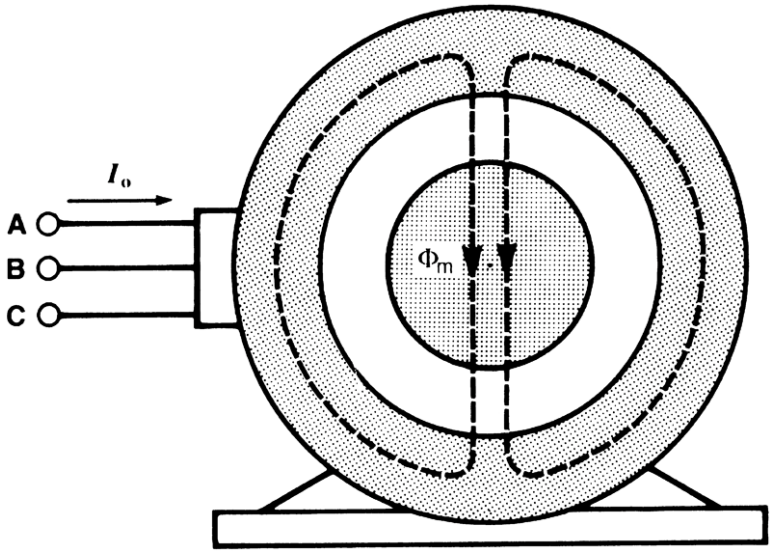
- Starting characteristics of a squirrel cage motor
- Acceleration of the rotor slip
- Motor under load
- Slip and slip speed
- $S = (n_s - n) / n_s$
- Voltage and frequency induced in the rotor
- $f_2 = s\ f$
- $E_2 = s\ E_{oc}$

Characteristics of squirel cage IM

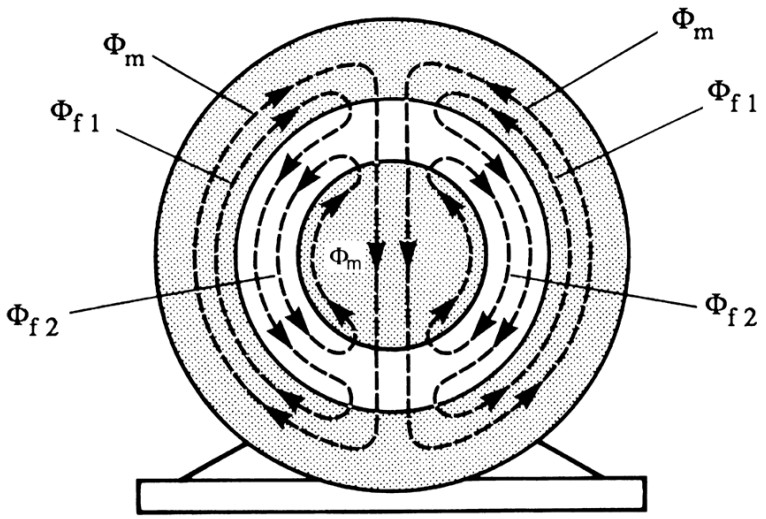
- No load

FIGURE 13-13 **At no-load the flux in the motor is mainly the mutual flux Φ_m . To create this flux, considerable reactive power is needed.**



under load

FIGURE 13-14 **At full-load the mutual flux decreases, but stator and rotor leakage fluxes are crea The reactive power needed is slightly greater than in Fig. 13.13.**



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Active power flow

FIGURE 13-15 **Active power flow in a 3-phase induction motor.**

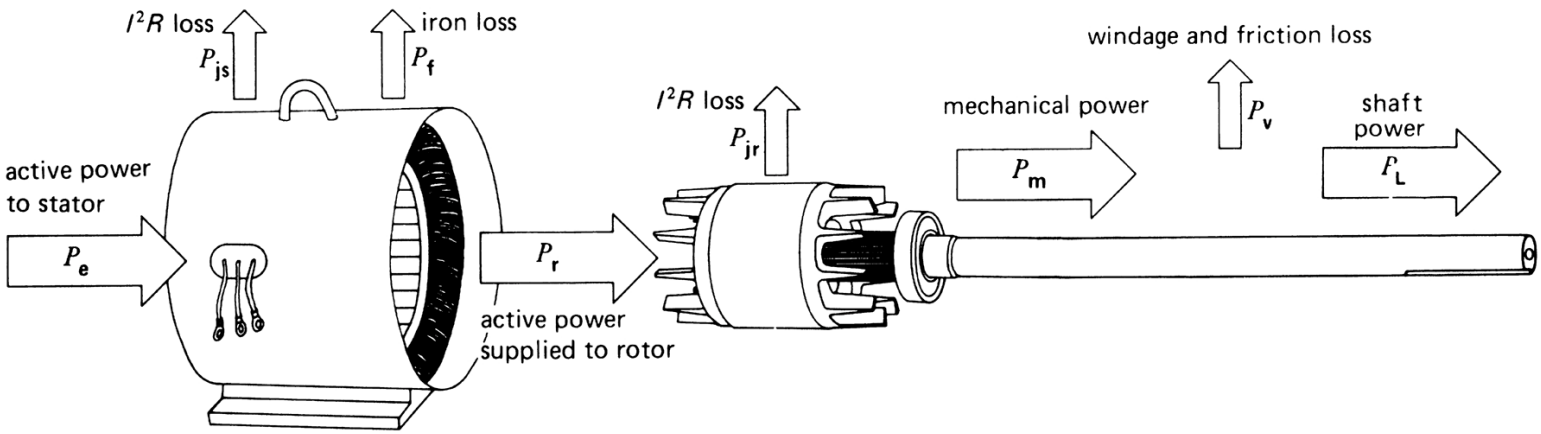

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FIGURE 13-16a **See Example 13-7.**

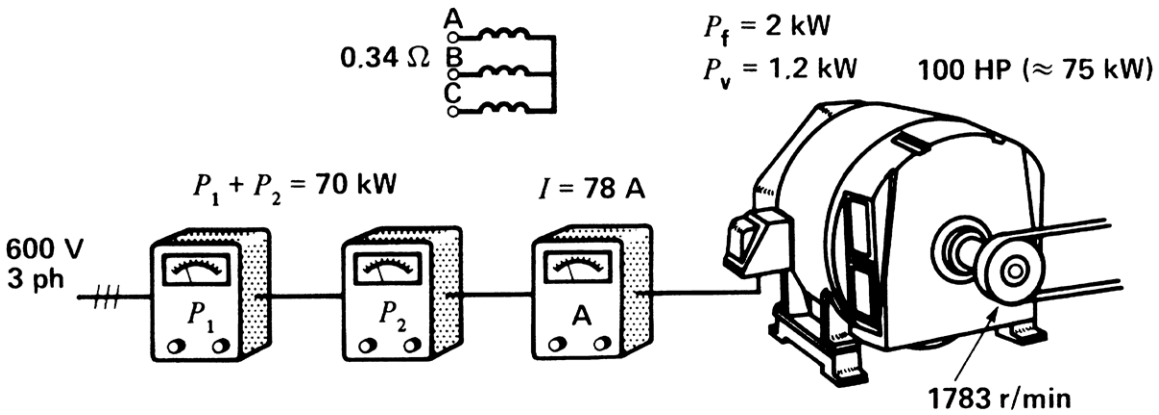

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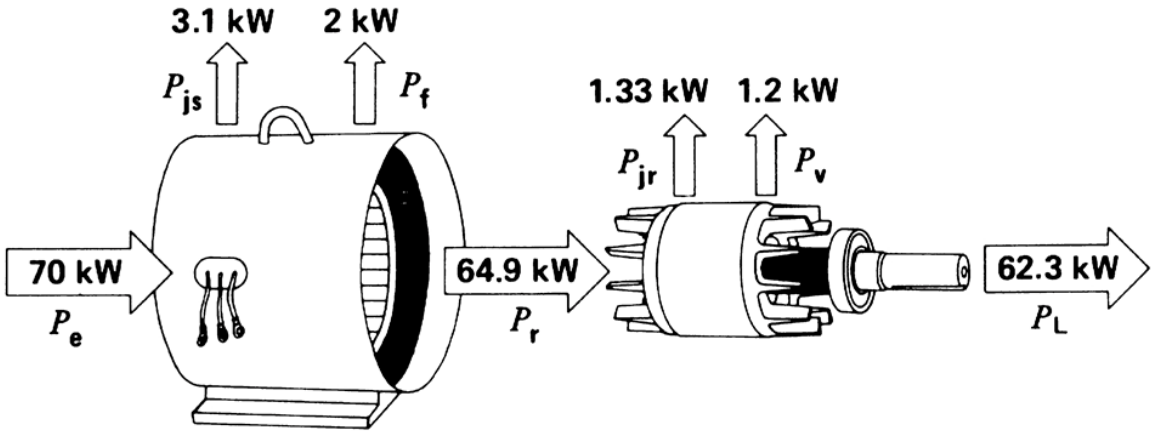
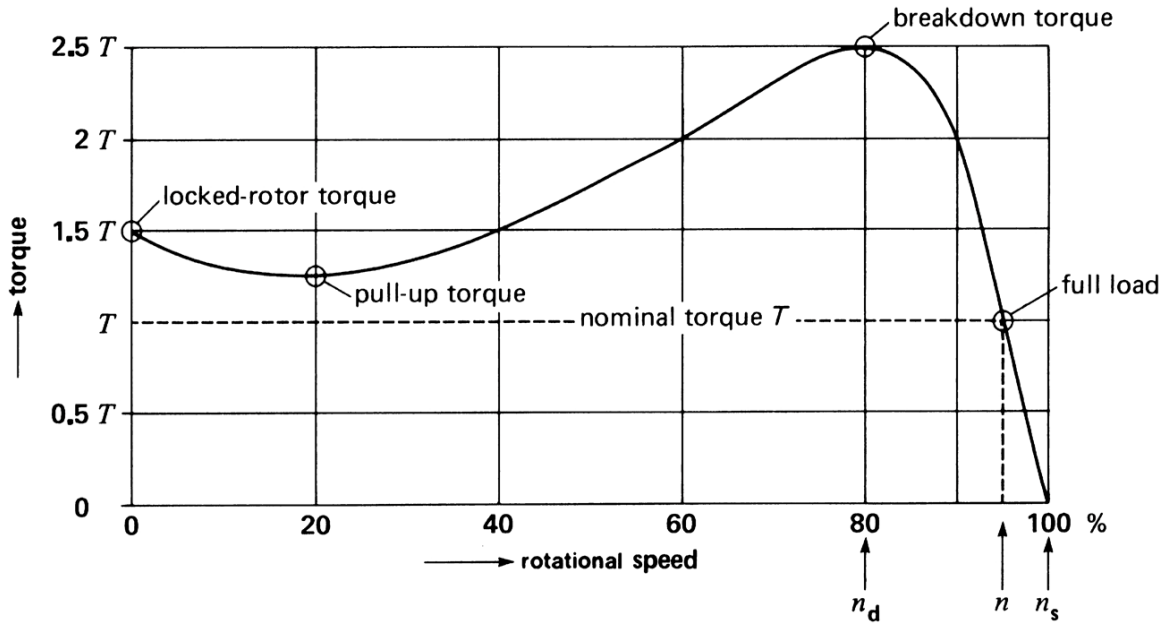
FIGURE 13-16b **Power flow in Example 13-7.**



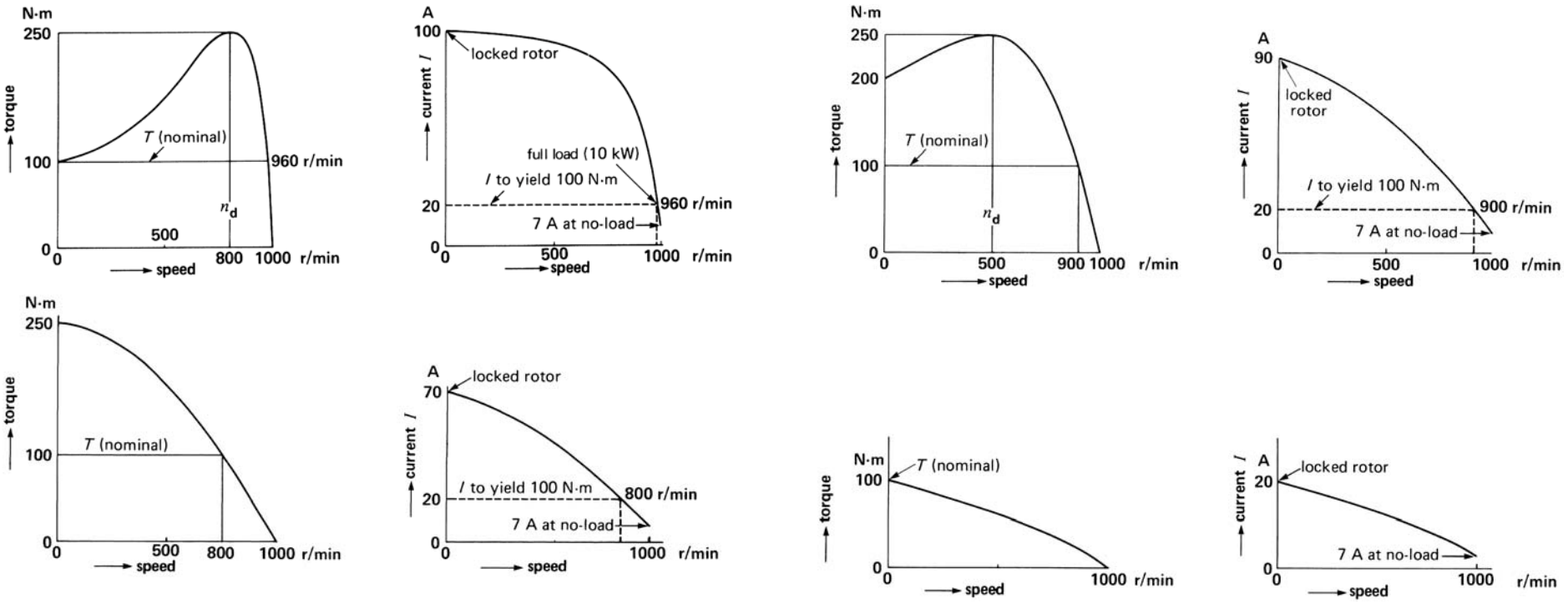
Torque vs speed

FIGURE 13-17 **Typical torque-speed curve of a 3-phase squirrel-cage induction motor.**



Effect of rotor resistance

FIGURE 13-18 **Rotor resistance affects the motor characteristics.**



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Wound rotor

FIGURE 13-19 **External resistors connected to the three slip-rings of a wound-rotor induction motor.**

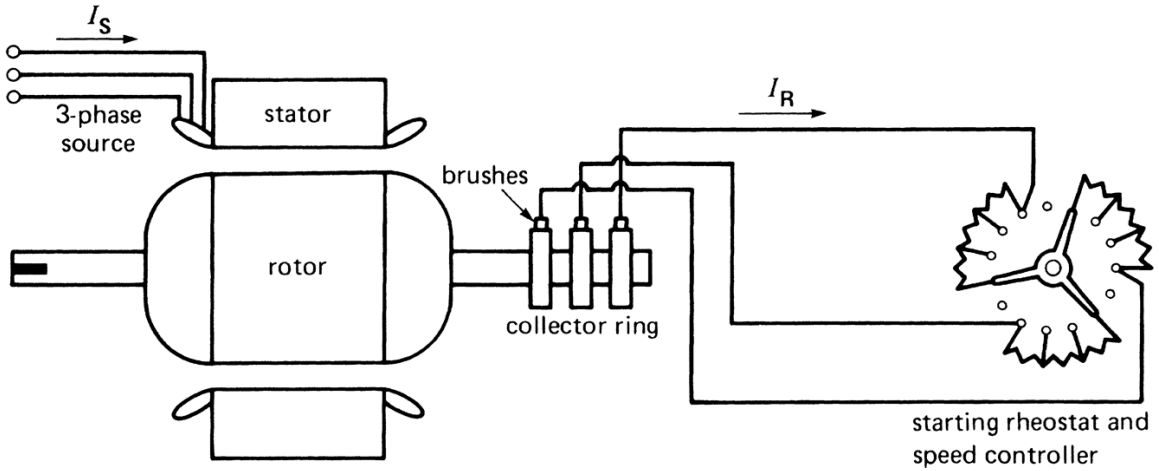

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FIGURE 13-29 **Current and magnetic poles at low speed.**

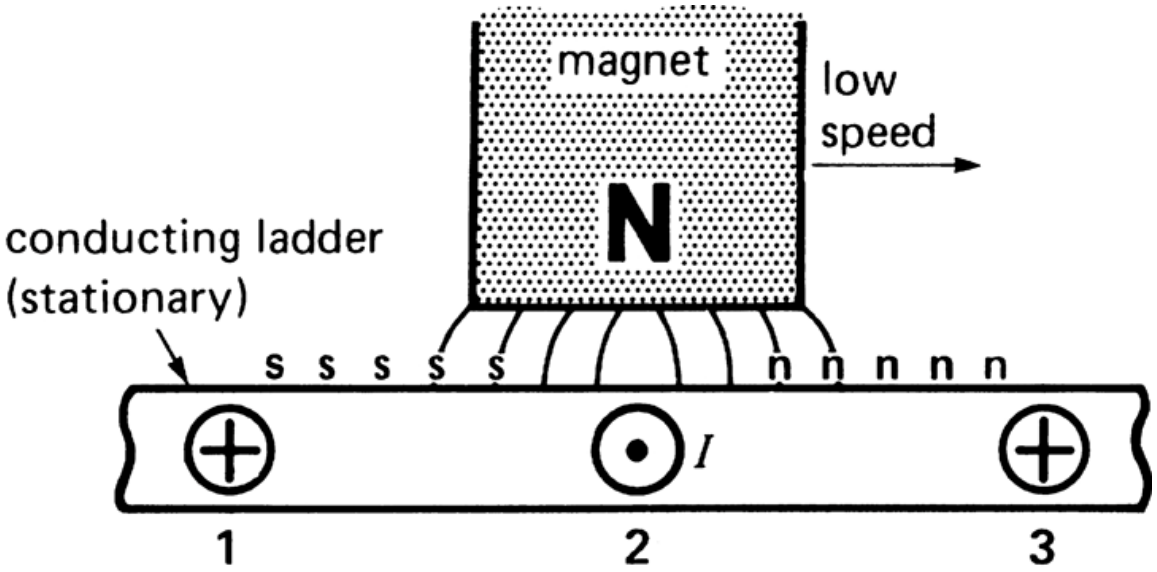

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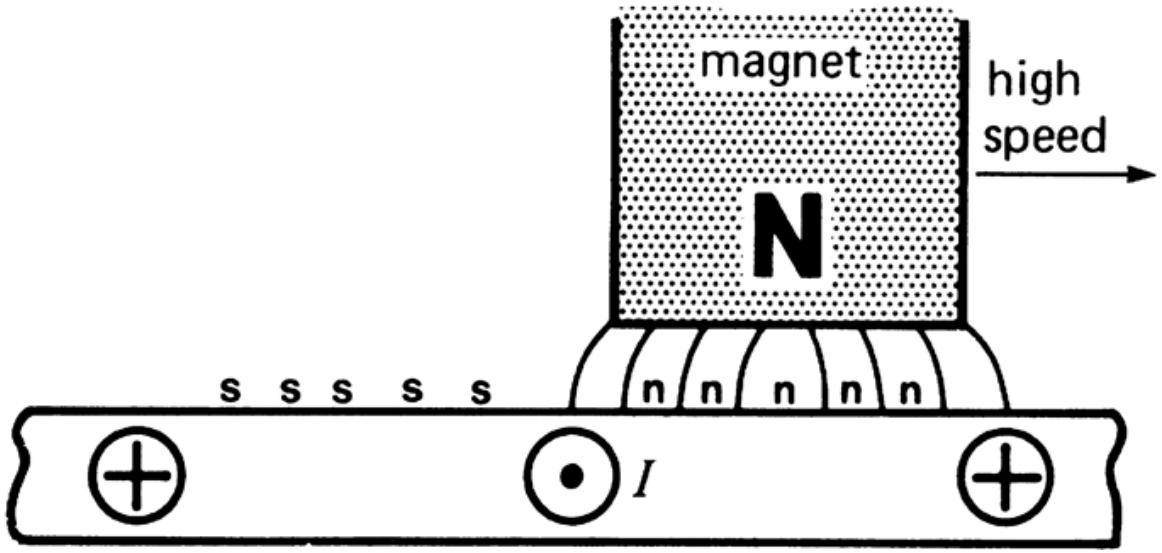
FIGURE 13-30 **Currents and magnetic poles at high speed.**



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