Motors and Generators

Part 14b of
"Electronics and Telecommunications"
A Fairfield University E-Course
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Section 14 Schedule

Session 14a	11/19	Intro to Applied Technical Mathematics	Notes: Binary/Octal/Hex, Powers of 10, Basic Algebra
Session 14b	**11/24**	**DC & AC Motors**	**Elect1-7: pp. 7-39: 7-69, pp. 7-89: 7-117**
Session 14c	11/26	Levers/gears, Torque/HP/RPM	
Quiz 14 Review (Quiz 14 due 12/07)	12/01		
Quiz 14 Results	12/08		
MT8 (Sat,Cheshire)	**12/13**		
MT8 Results	12/15		

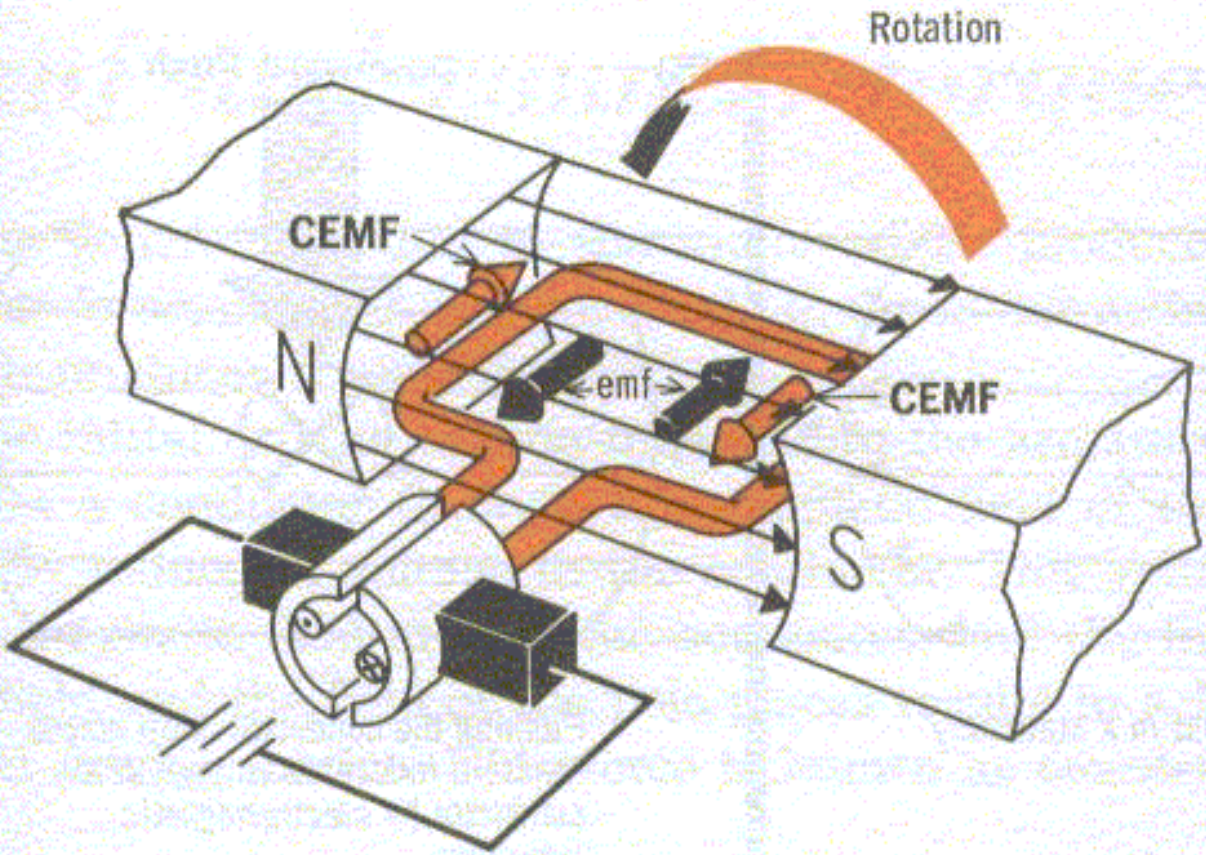
Section 14:
Applied Technical Mathematics

- Math review
  - Binary numbers (Hex and Octal)
  - Powers of ten
  - Working with equations
- DC & AC Motors and Generators
  - Simple relationships and vocabulary
- Levers and Gears
  - Relating linear force and motion to rotational torque and motion
  - F=M*A vs T=J*α
- Torque, RPM and Horsepower
  - Simple relationships and vocabulary

Last Time

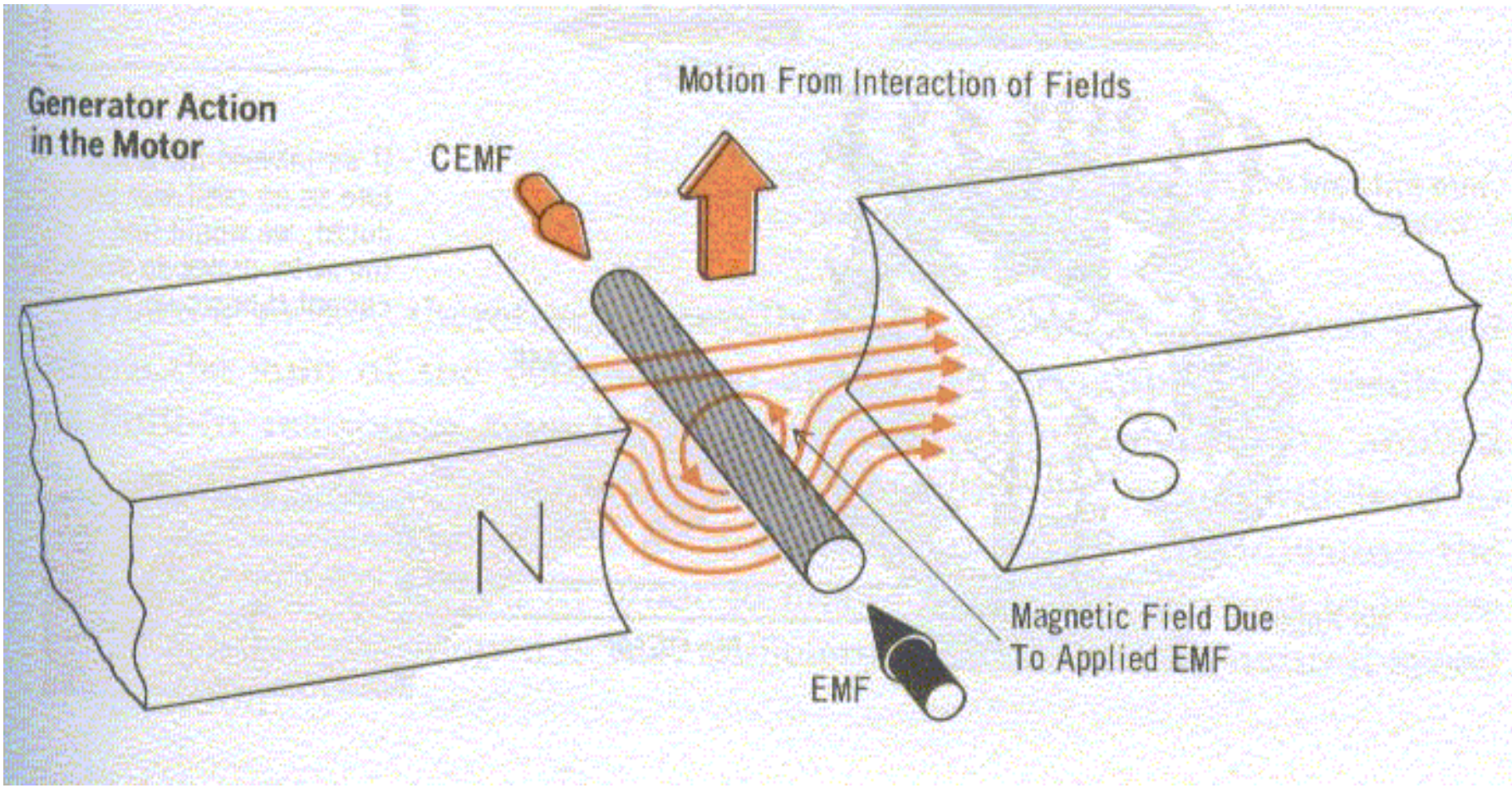
- Number Systems
  - Binary (powers of 2)
  - Octal (3 bits at a time, powers of 8)
  - Decimal (powers of 10)
  - Hexadecimal (4 bits at a time, Powers of 16)
- Scientific Notation ($1.5*10^{3}$, $15*10^{-6}$)
- Solving Equations (Maintain equality)
  - Add (or subtract) the same number to both sides
  - Multiply (or divide) both sides by the same number (except zero)
  - Square (or take the square root of) both sides
  - Use the same function on both side (sine, arccos, log …)
- Multiple Equations (N equations, N unknowns)
- Polynomials
  - Foiling (First, Outer, Inner, Last) $(3x-2)*(2x+1) = 6x^2 - x - 2$
  - UnFoiling (Factoring)

Counter EMF

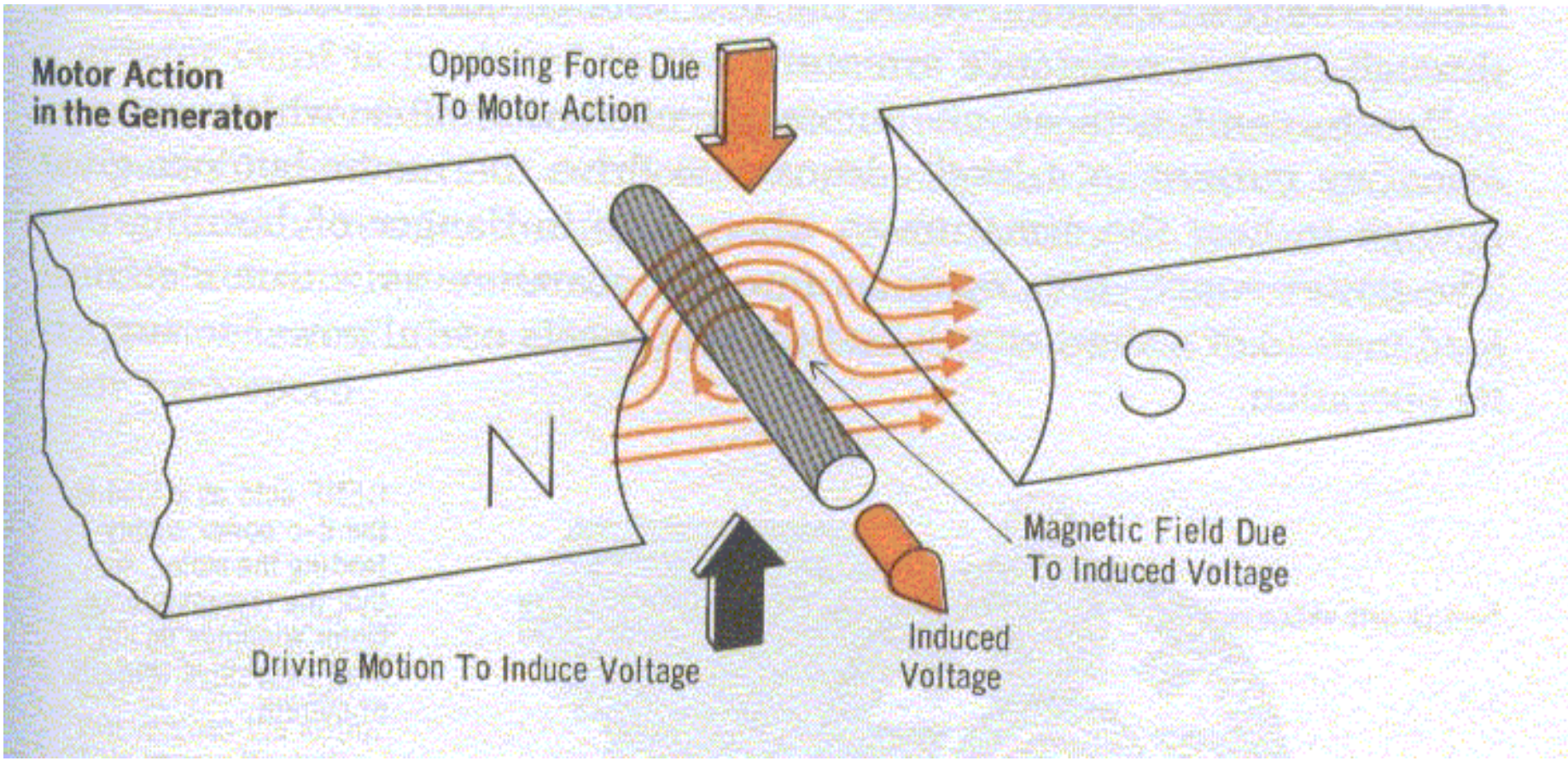


When a motor is used as a generator, the left-hand rule for generators states that the current flow in the armature is the reverse of current flow in the motor for the same direction of rotation. This means that the emf induced in the armature of an operating motor by generator action opposes the emf applied to the motor armature. For this reason, it is called a counterelectromotive force, or cemf

DC Motor

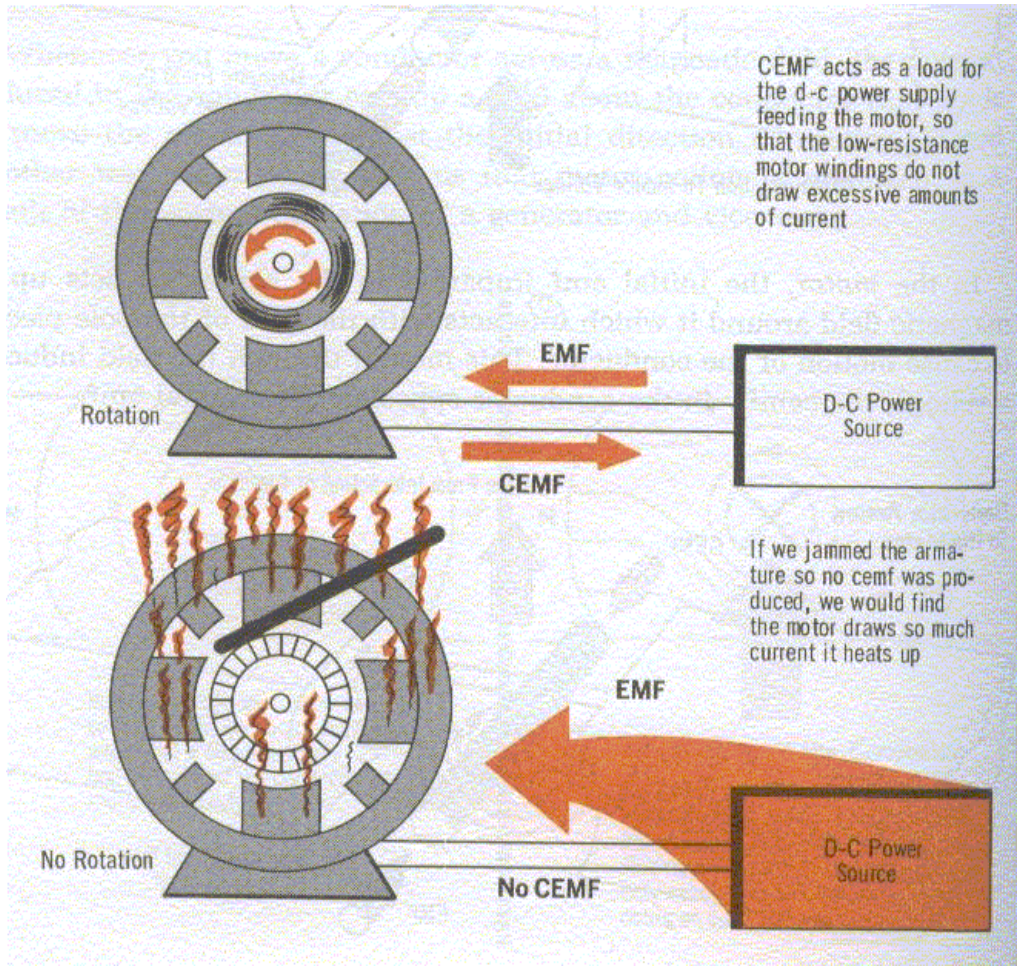

Generator Action
in the Motor
Motion From Interaction of Fields
CEMF
N
S
Magnetic Field Due
To Applied EMF
EMF

DC Generator



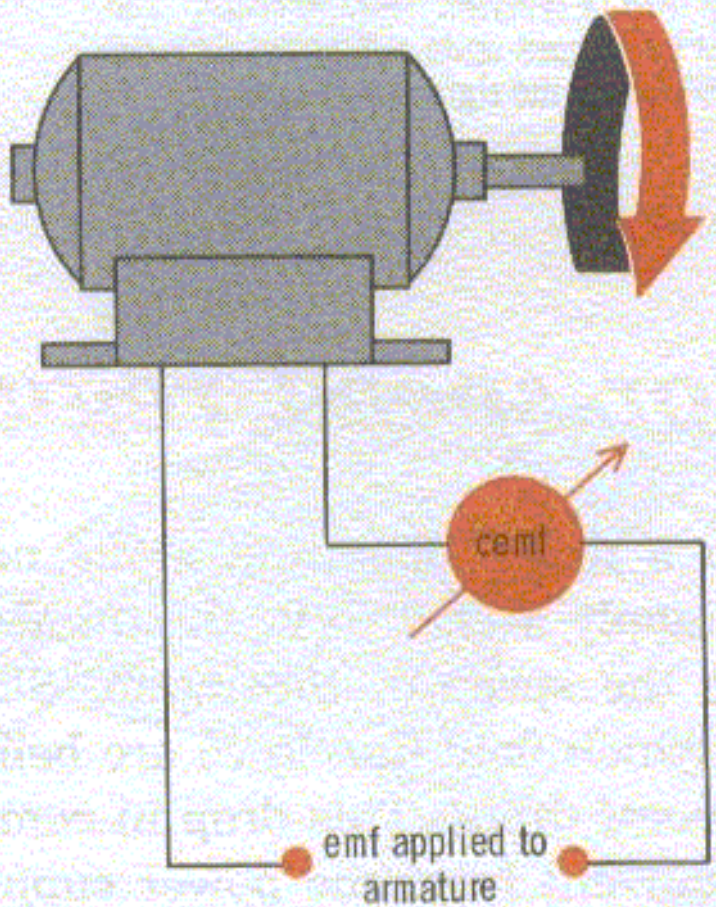
DC Motor Current

- EMF vs CEMF
- Locked rotor current is only limited by armature resistance



Speed is proportional to applied EMF

When the motor turns too fast, more cemf is generated to lower the emf that reaches the motor. This lowers the motor speed to normal. The reverse is also true, so that cemf tends to regulate motor speed

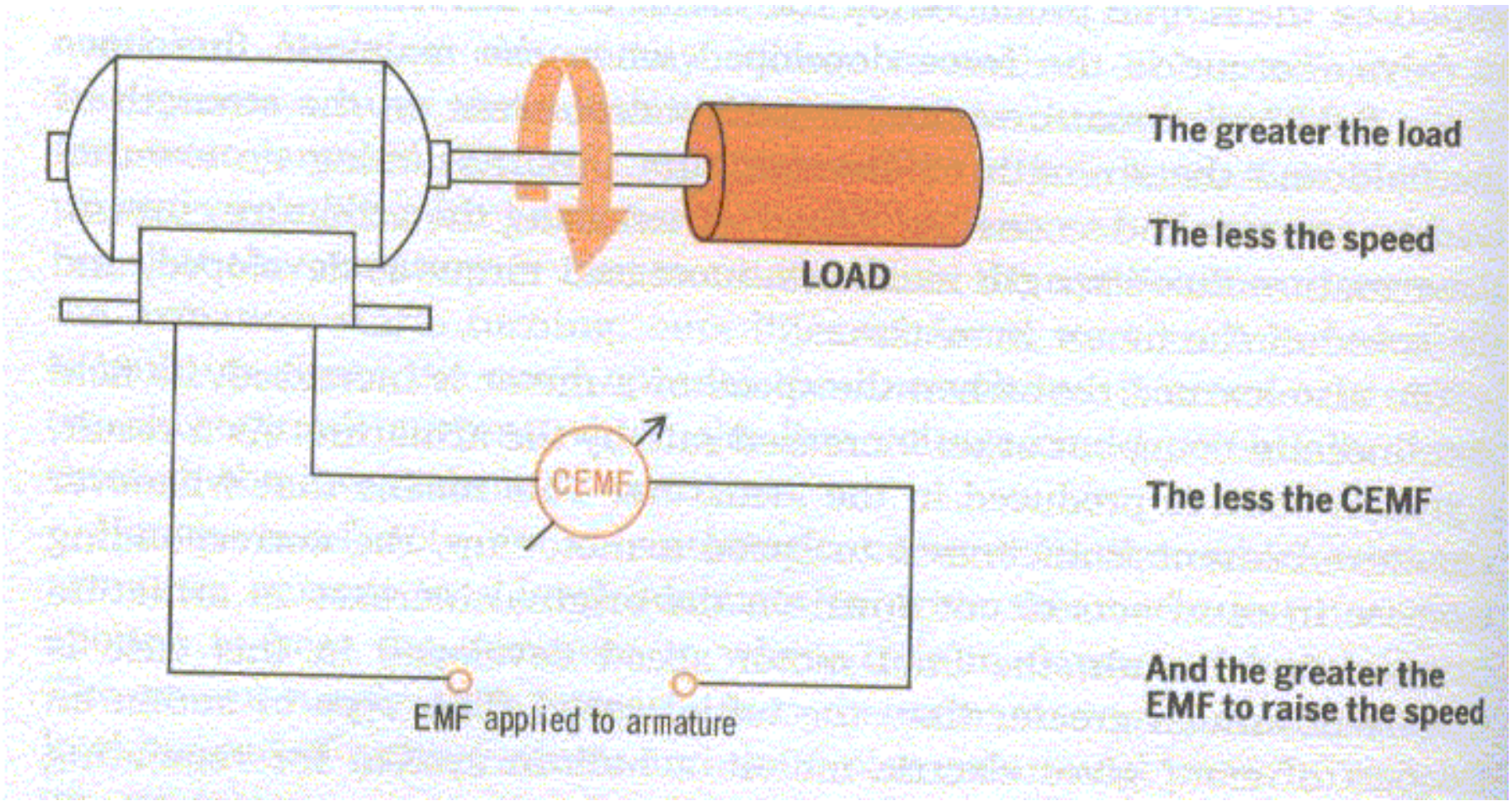


The greater the speed

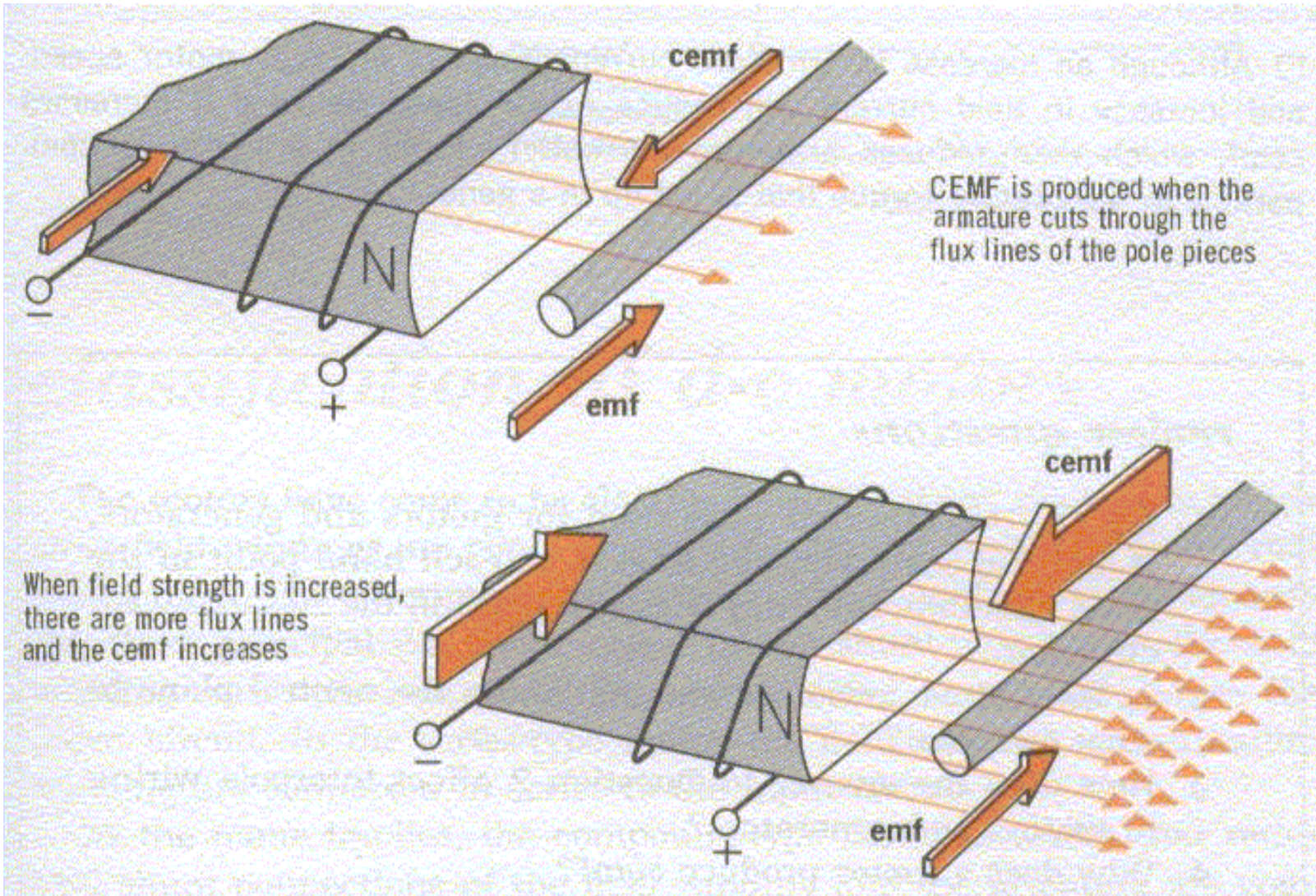
The greater the cemf

And the less the emf, lowering the speed

Higher load = more current



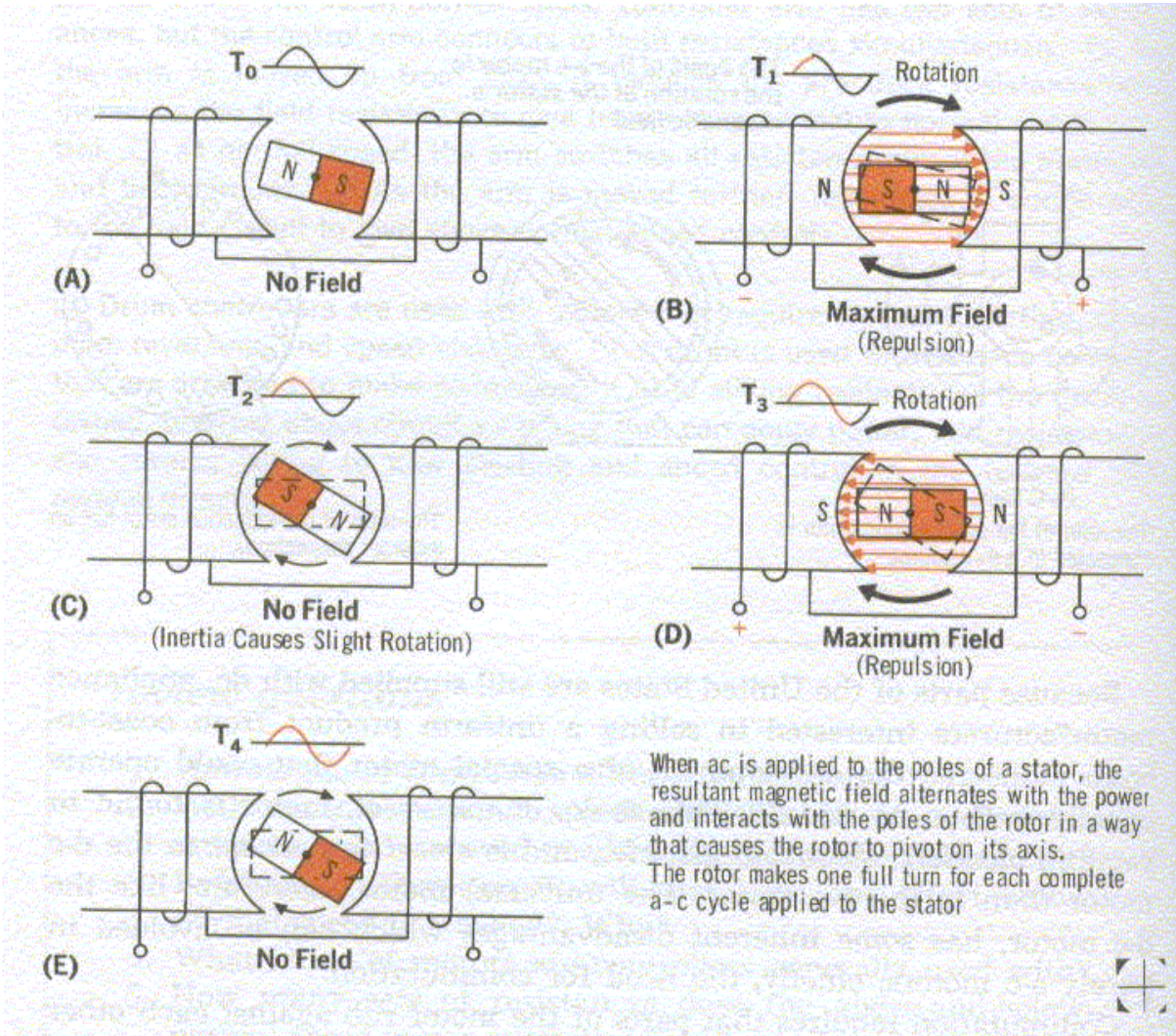
Changing Field Current



DC Motor Facts

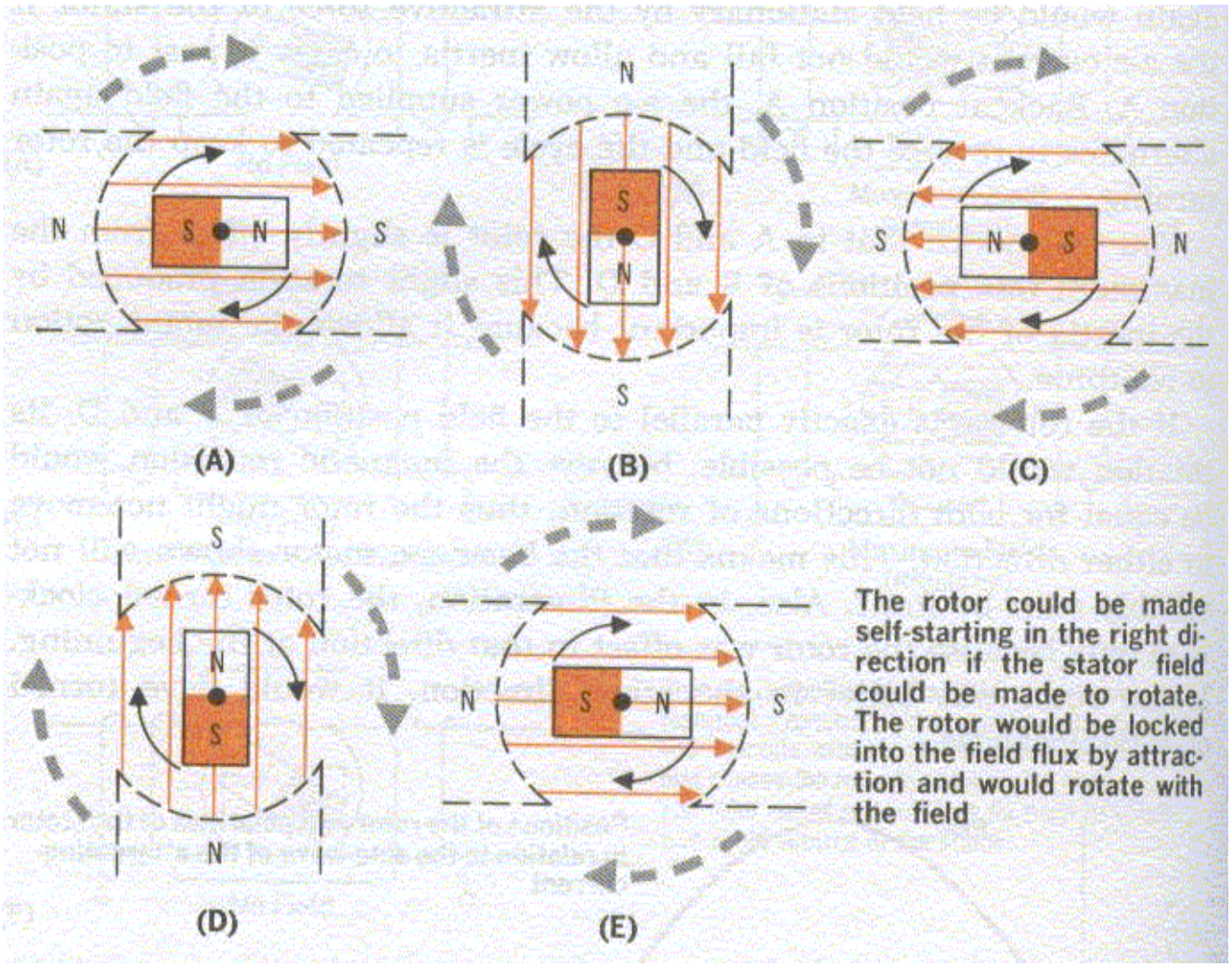
- High starting current
  - No CEMF
  - Motor speeds up to balance EMF with CEMF
- Double EMF $\Rightarrow$ Double Final Speed
- Double Field $\Rightarrow$ Half Final Speed
  - If Field $\Rightarrow$ 0, Motor destroys itself !!!
- Double Load $\Rightarrow$ Double Current

Basic AC Motor



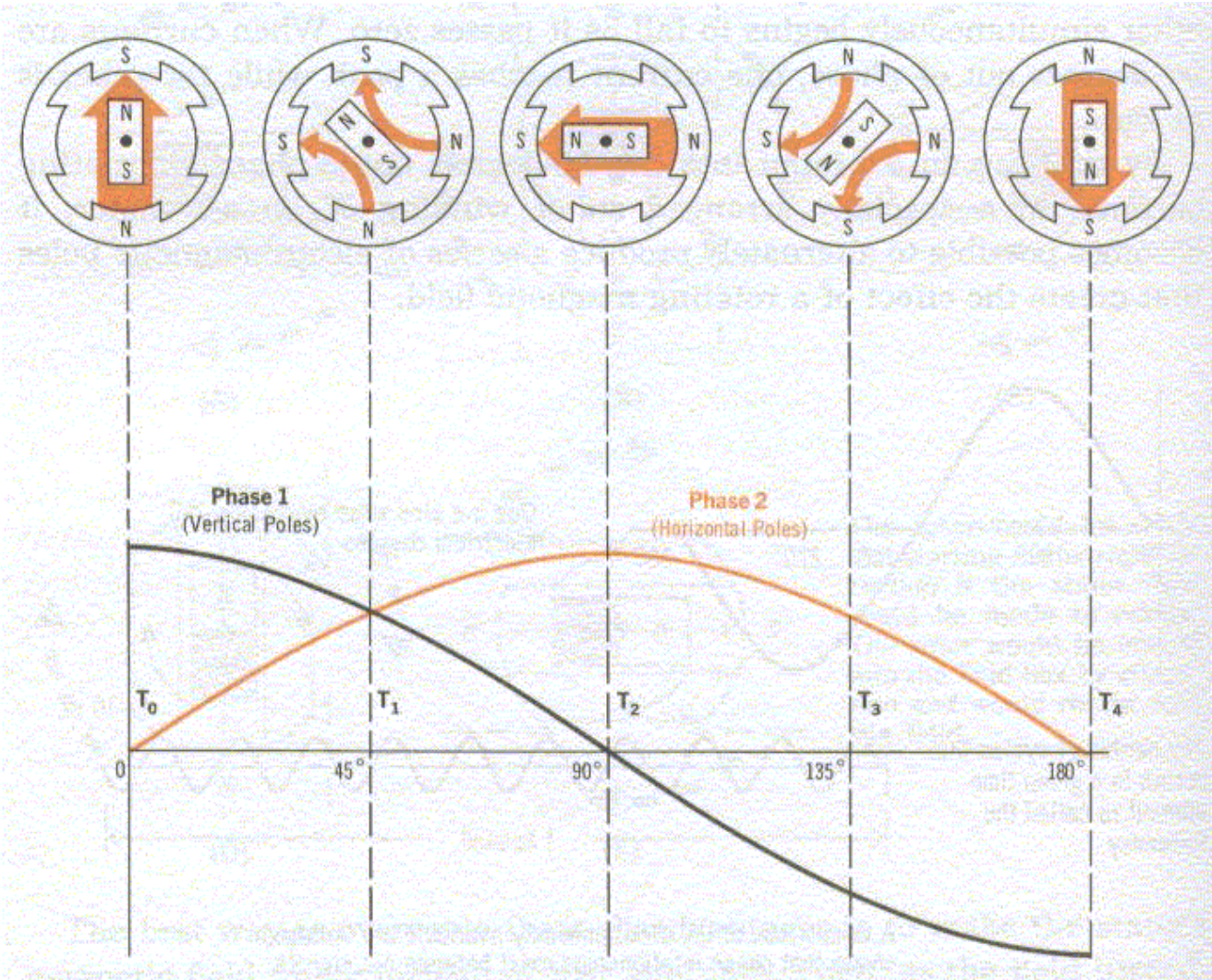
Rotating Field

- Armature tries to stay aligned with the field



Rotating Field continued

- Guarantees rotational direction
- Armature aligns with field
- Speed determined by frequency and the number of poles



Some equations you'll use for motors

- EMF = I * R (Ohms Law)
- $X_L = 2*\pi*L$ (Inductive reactance, remember vectors)
- Power = I * V (in Watts, I & V are RMS values)
  (1 HP = 736 Watts)
- $cemf=V_{total}-(Ia*Ra)-(I_{field}*R_{field})$
  (just Kirchoff, armature winding & field winding in series,
  same current in both windings)
- T=(hp)(5252)/Na (Na=rev/min, T in ft-lbs)
- Nm=(T)*1Nm/0.73756 lb-ft (Nm =Newton-meter)
- Kemf=cemf/(Ifield*Na)
- Hp=(lb-ft)*(rev/min)/5252
- Synchronous speed=120*frequency/no. of poles

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