Chapter 5

Electromechanical Systems

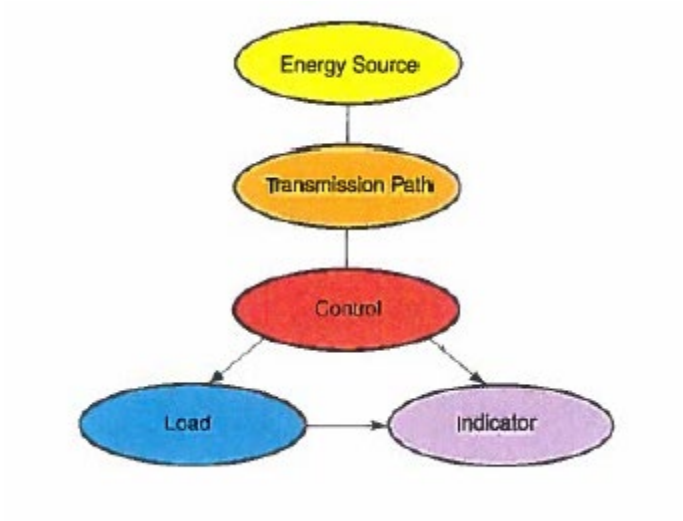
Objectives

By the end of this lesson the learner should be able to:

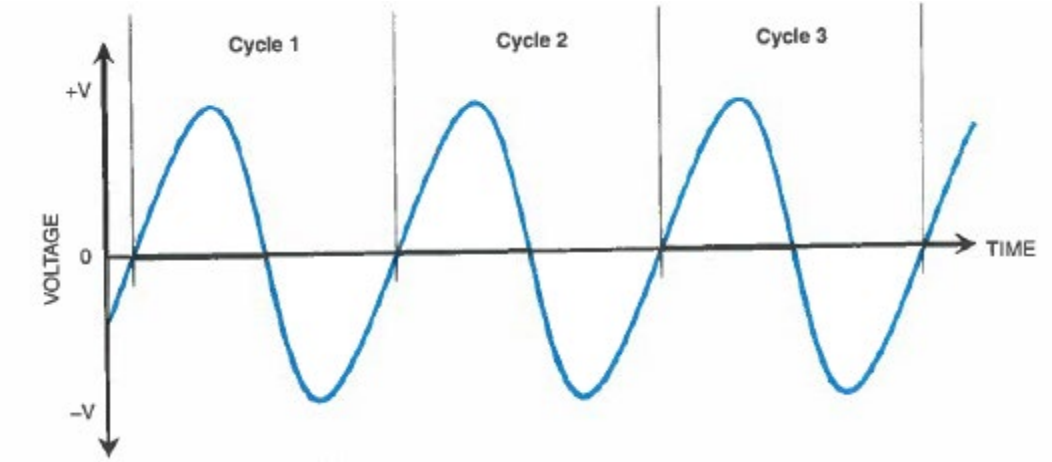
- Identify and discuss the basic sub-systems of an automated system
- List and discuss the use of electromechanical systems with robotics
- Identify and explain the function of control systems used with robotics
- Summarize and explain the differences in characteristics between direct current (DC), single phase alternating current (AC), and three phase AC motors
- Describe the type of motion that rotary actuators produce

Automated Systems and Sub-Systems

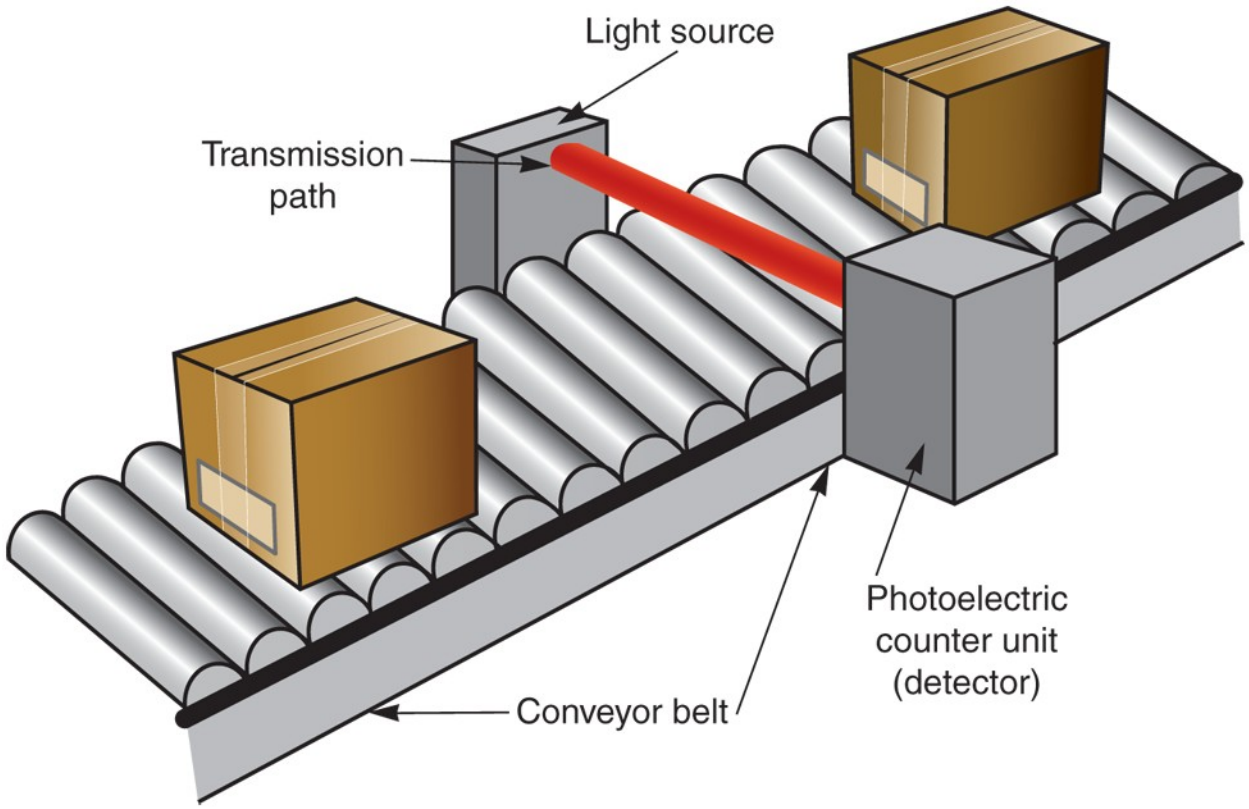
Basic parts of an automated system



Voltage Cycles in AC Power

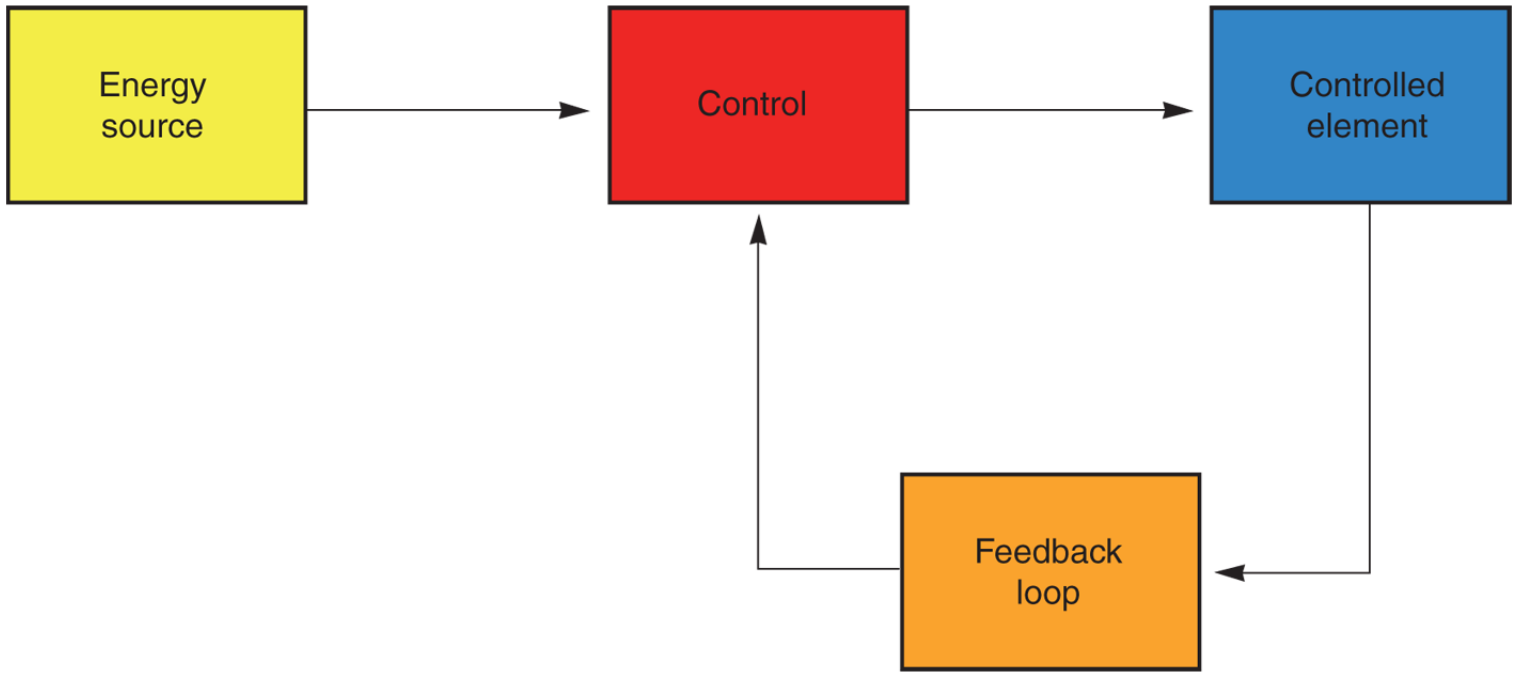


Conveyor Sensing System



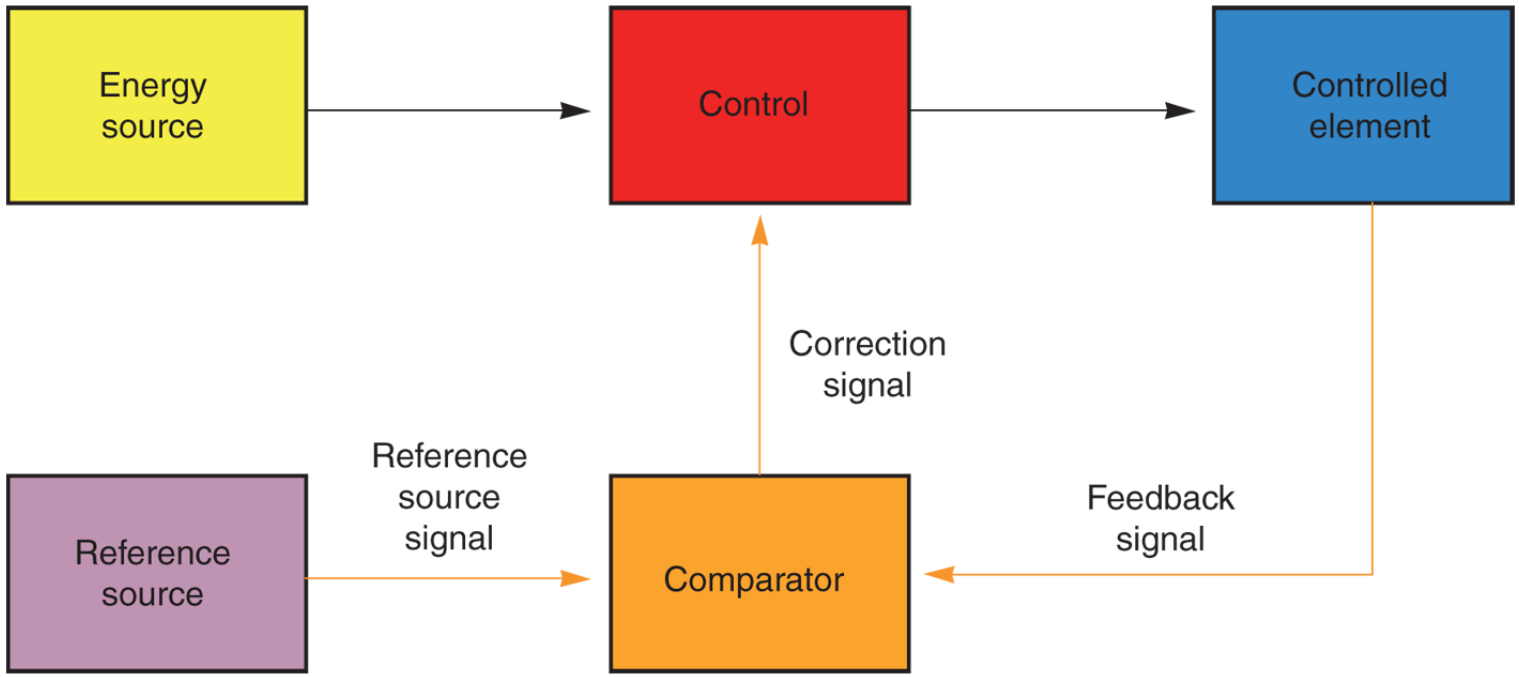
LS 5-1

Closed-loop System



LS 5-2

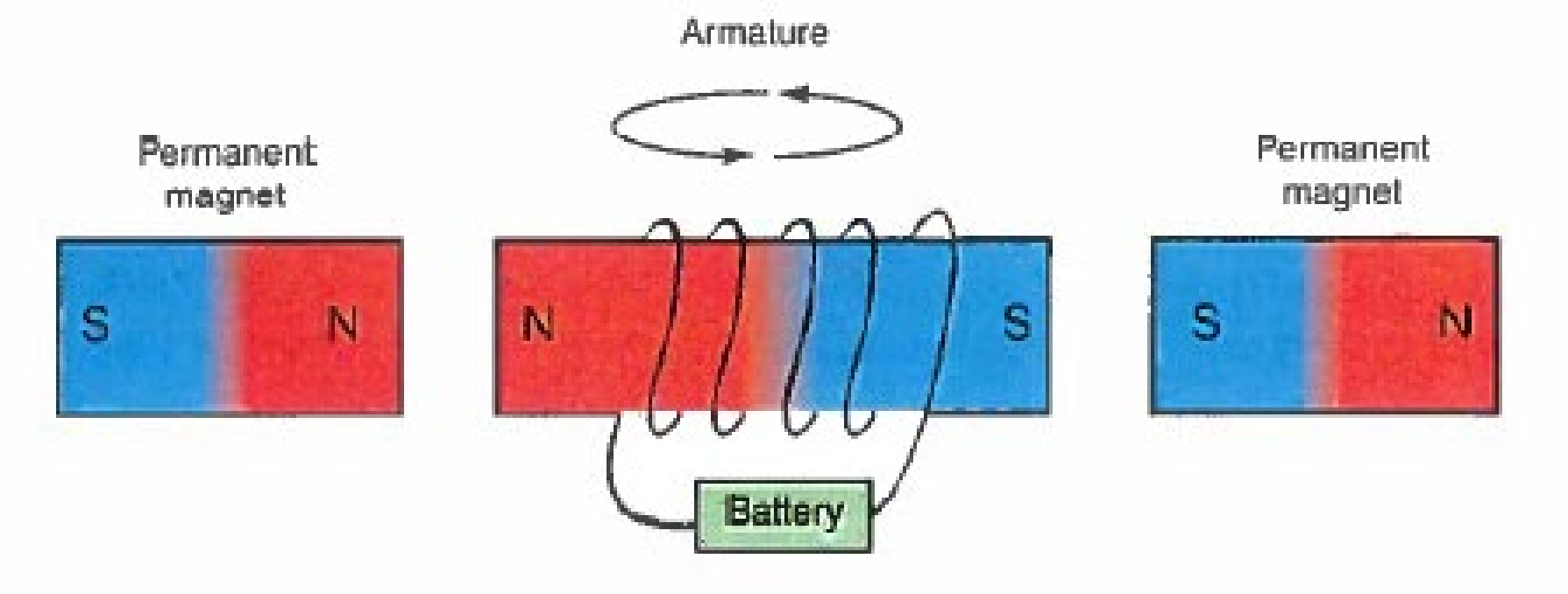
Closed-loop System with Automatic Adjustment



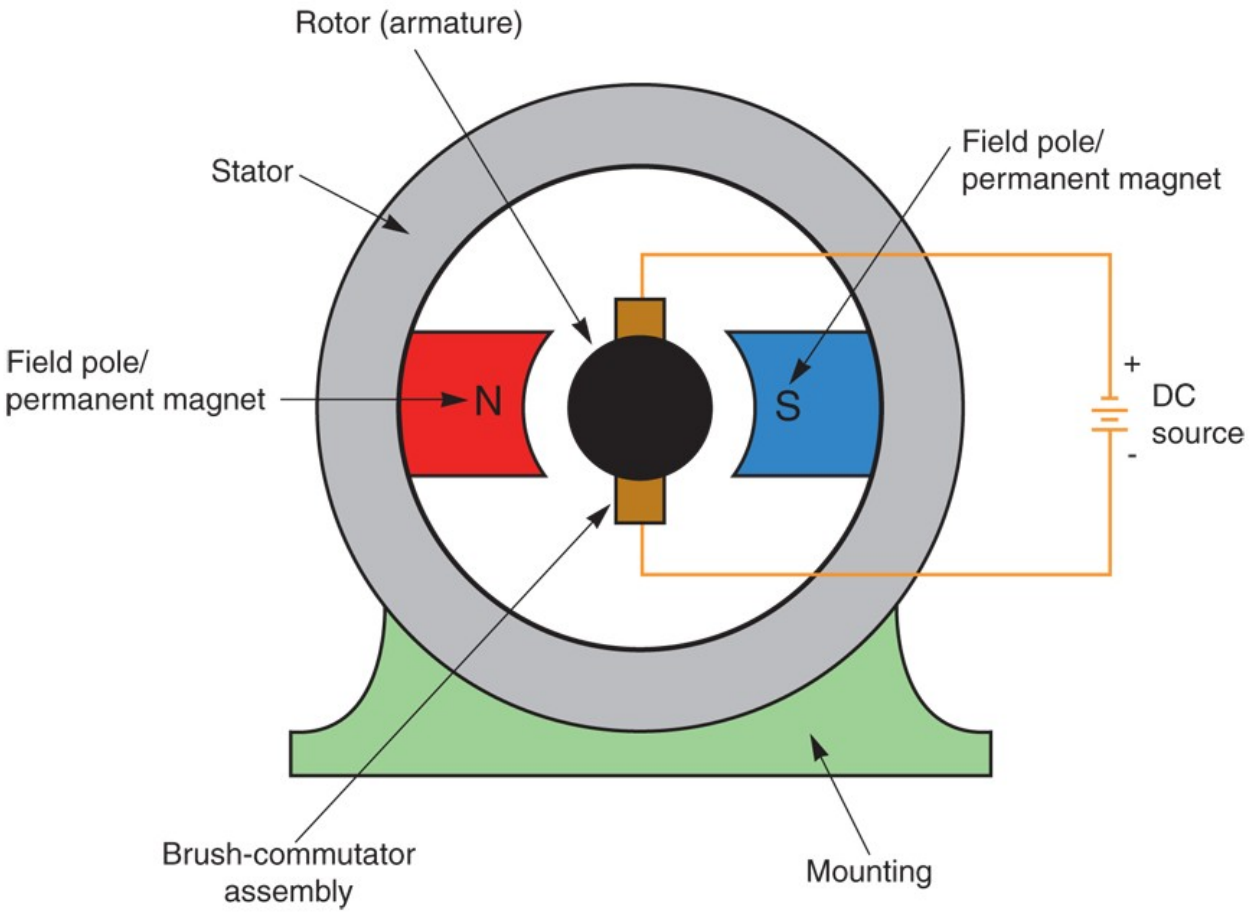
Magnetic Laws & Motor Rotation

Laws of magnetism

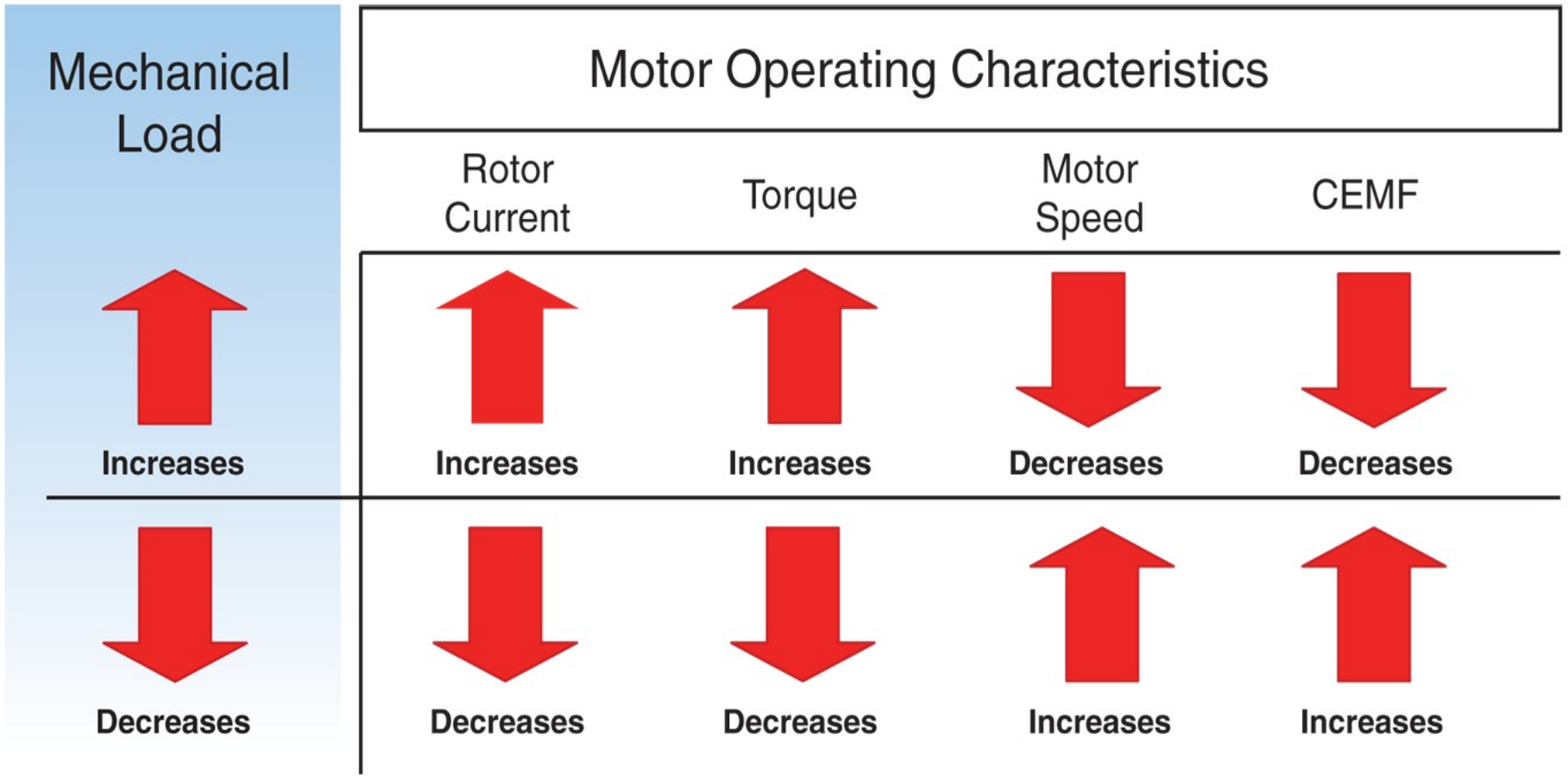
- Like poles repel
- Opposite poles attract



DC Motor Parts



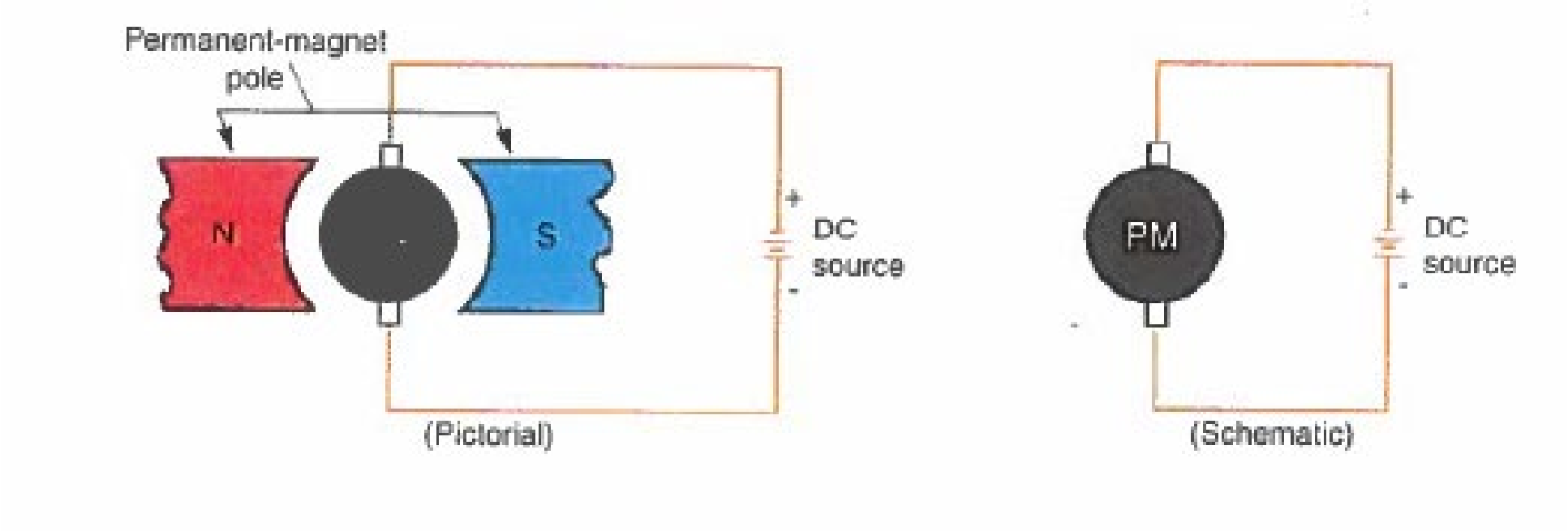
DC Motor Operating Characteristics



Permanent Magnet DC Motor

Characteristics

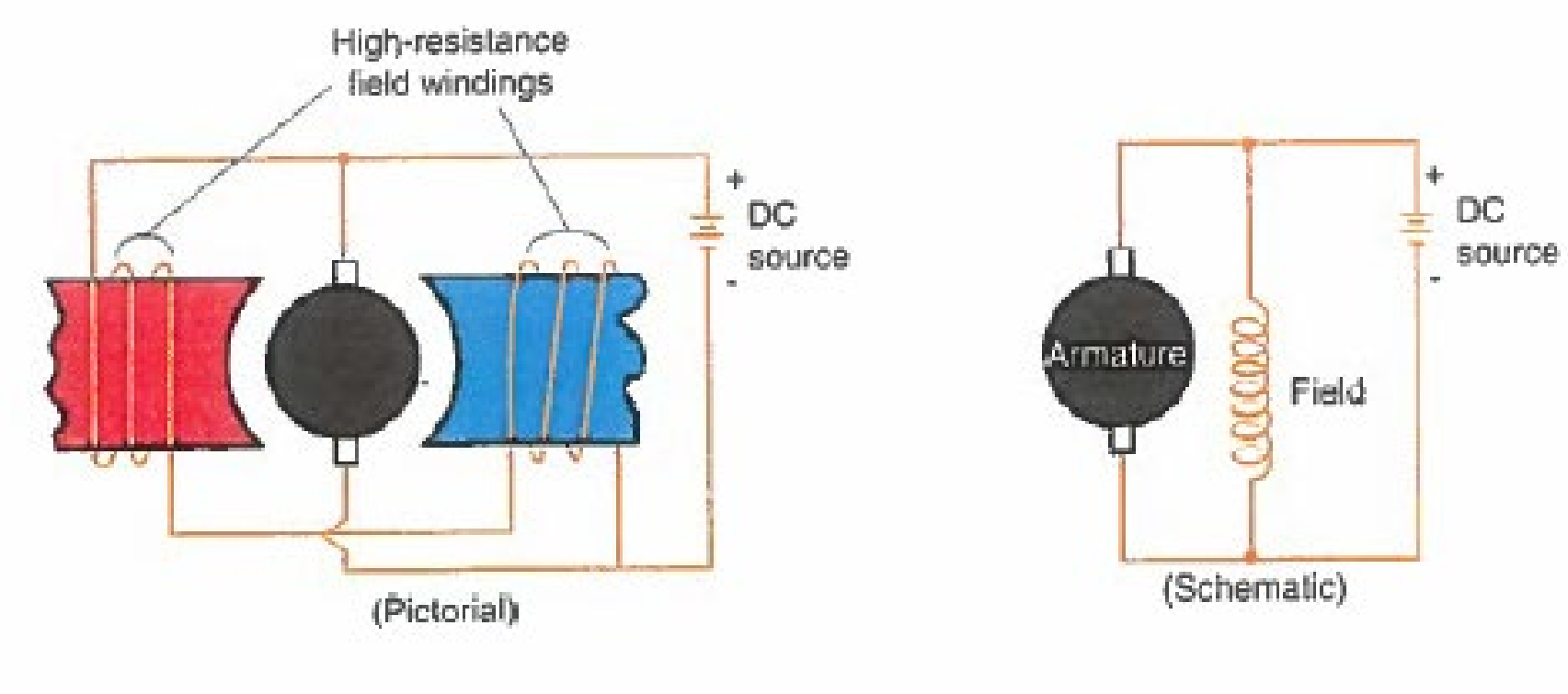
- Low torque applications – timer motors



Shunt-Wound DC Motors

Characteristics

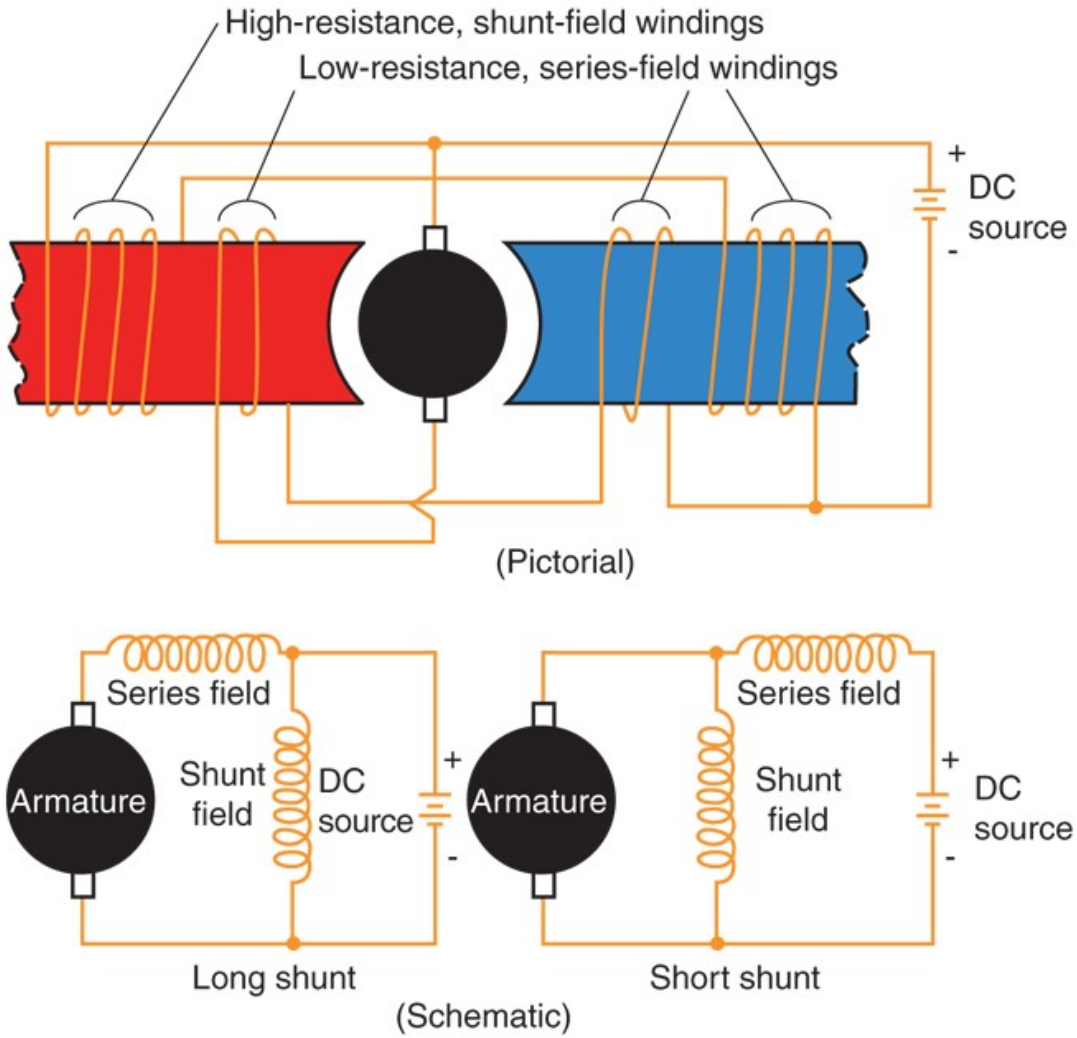
- Most commonly used type of DC motor
- Commonly used in industrial applications because of effective speed control



Compound-wound DC Motor

Characteristics

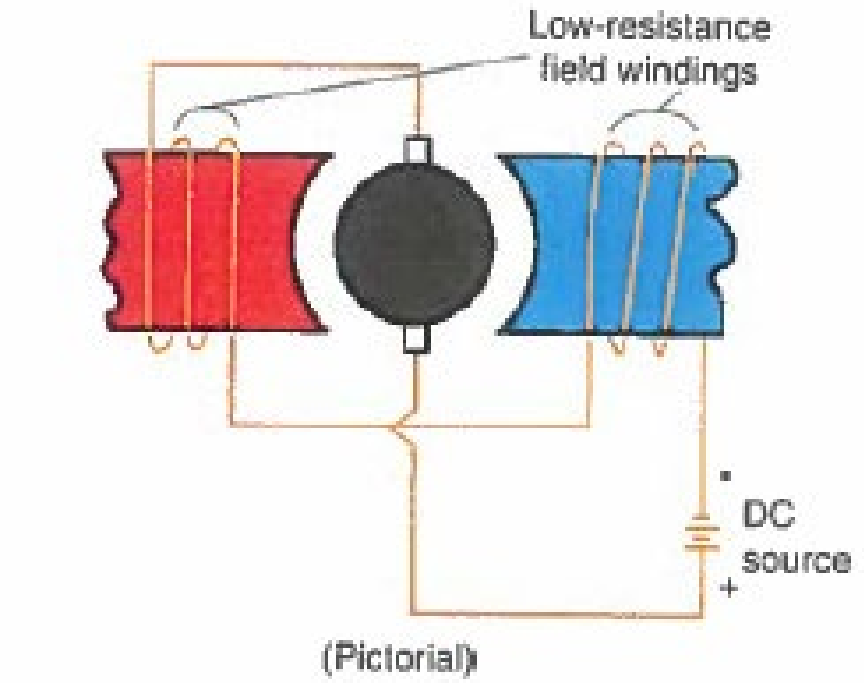
- Applies characteristics of both series-wound and shunt-wound DC motors
- High torque capability
- Good speed control
- Disadvantage – higher cost

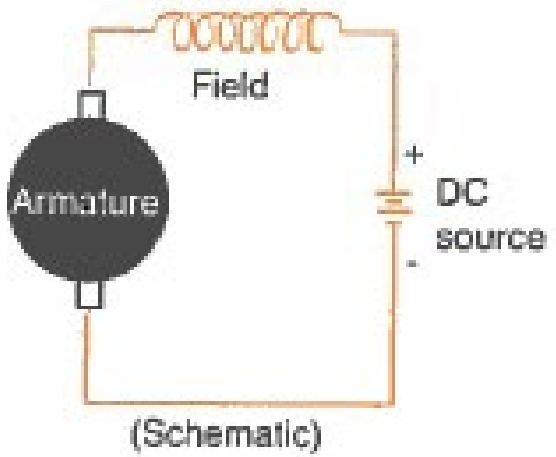


Series-Wound DC Motors

Characteristics

- Produces high torque
- Poor speed regulation
  - Fast under light load
  - Slow under heavy load
- Also called universal motors

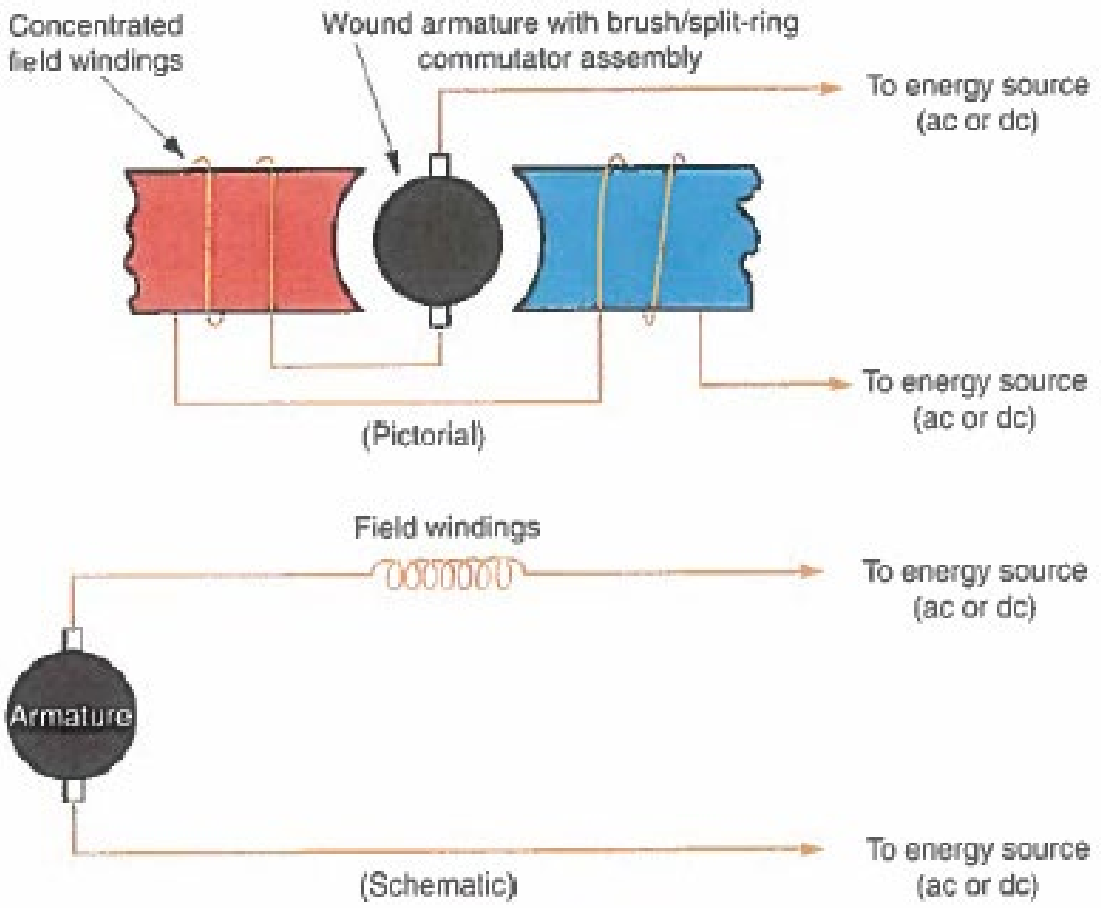




Universal Motor

Characteristics

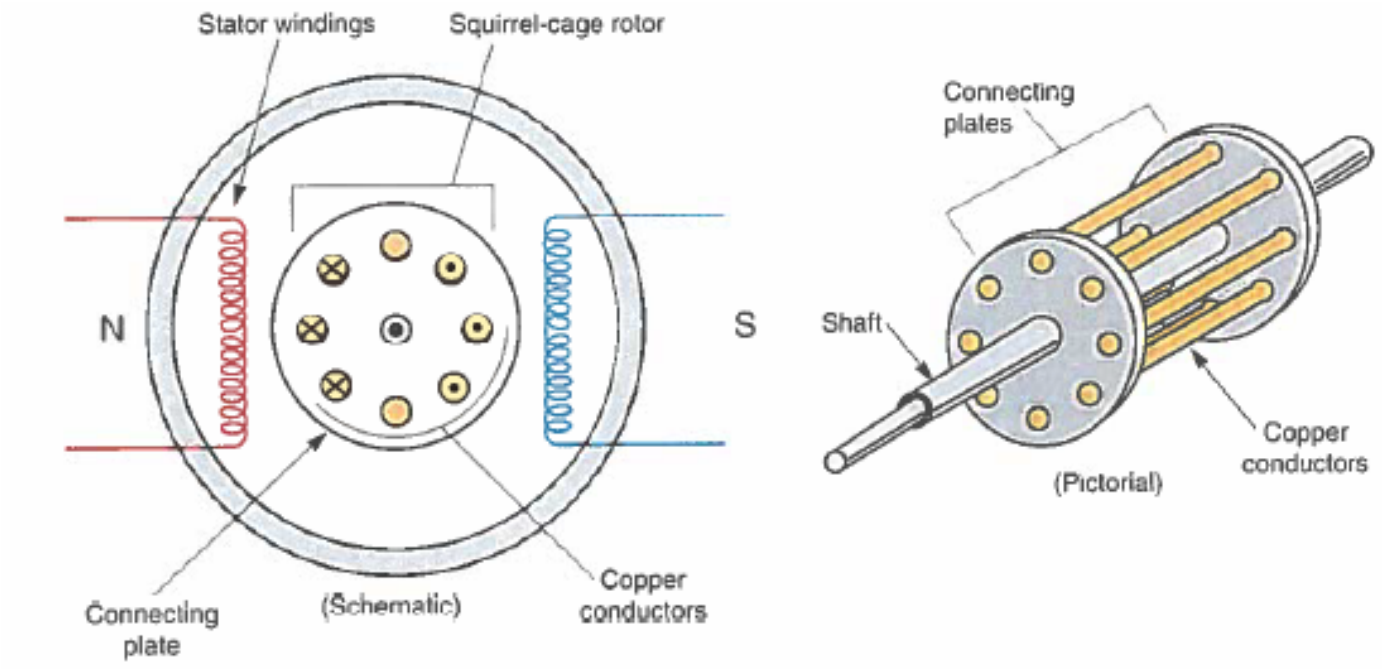
- Can be operated on DC or AC
- Used primarily for portable tools and small equipment



Single-Phase Induction Motor

Characteristics

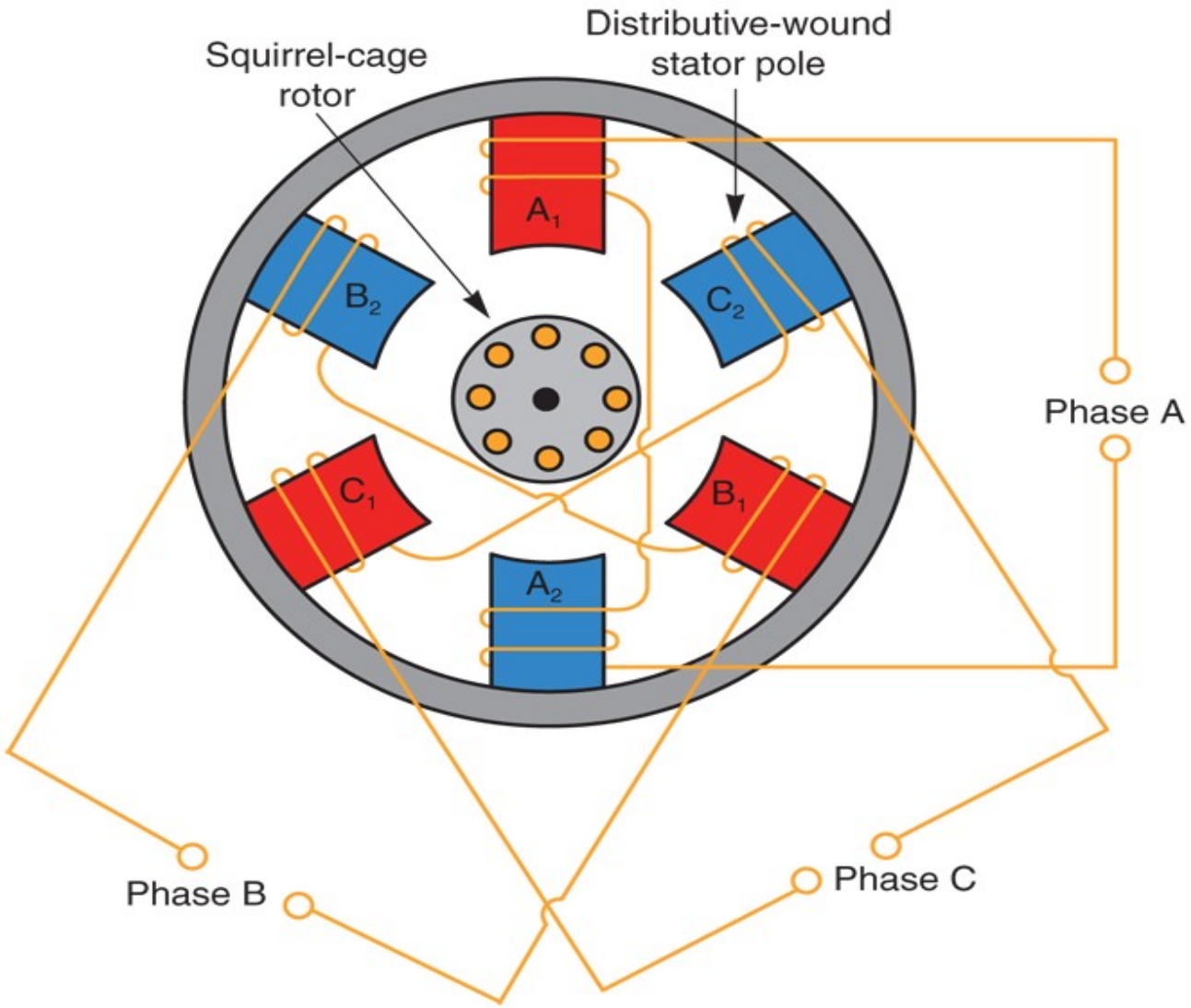
- Also know as the squirrel-cage motor because of the design
- Must be set in motion through external means (excitation)
- Creates a rotating magnetic field
- Speed (RPM) based on speed of the rotating magnetic field
- Rotor speed somewhat different than synchronous speed to develop torque
  - Rotor to synchronous speed difference is called “slip”
  - Greater slip = increased torque
  - As difference becomes smaller, torque decreases



Three-phase AC Induction Motor

Characteristics

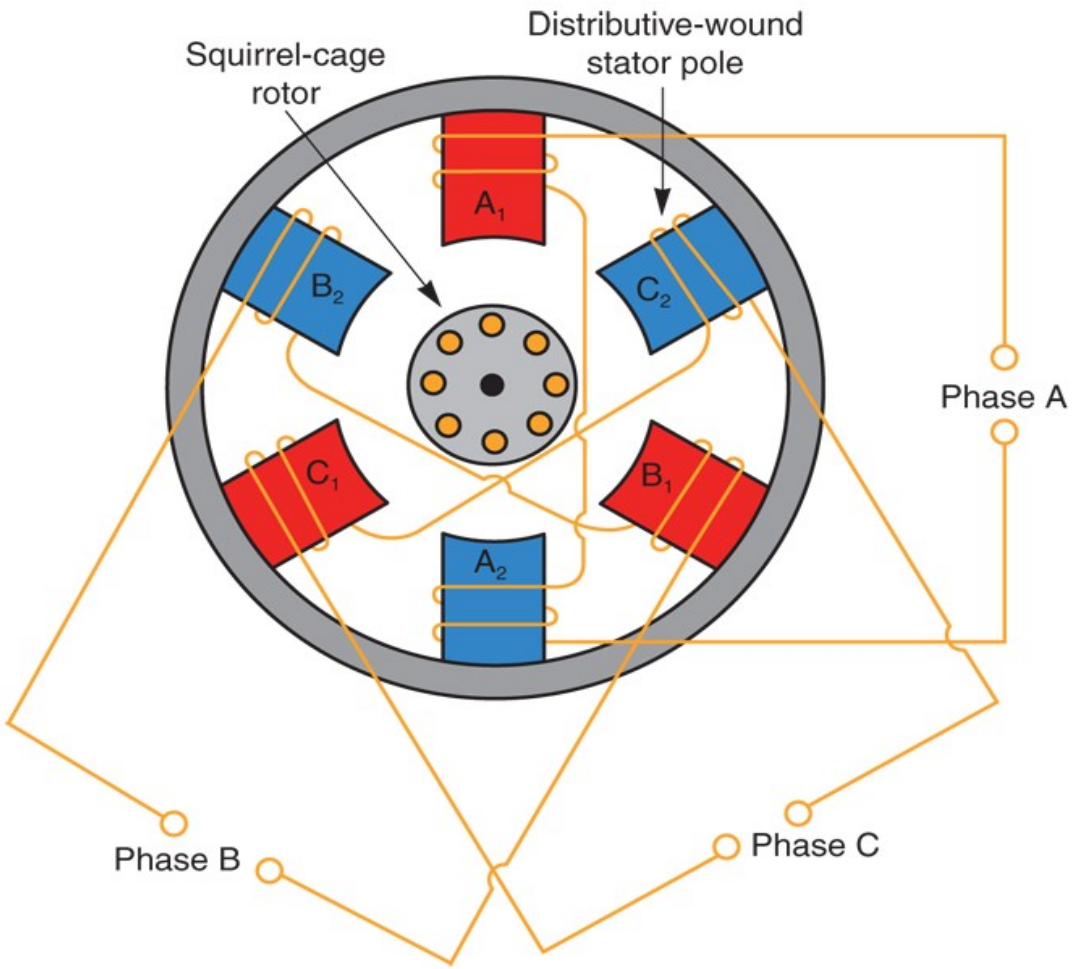
- Also know as the workhorses of industry – most widely used motor in industry
- Two basic types
  - Induction
  - Synchronous



Three-phase AC Induction Motor

Characteristics

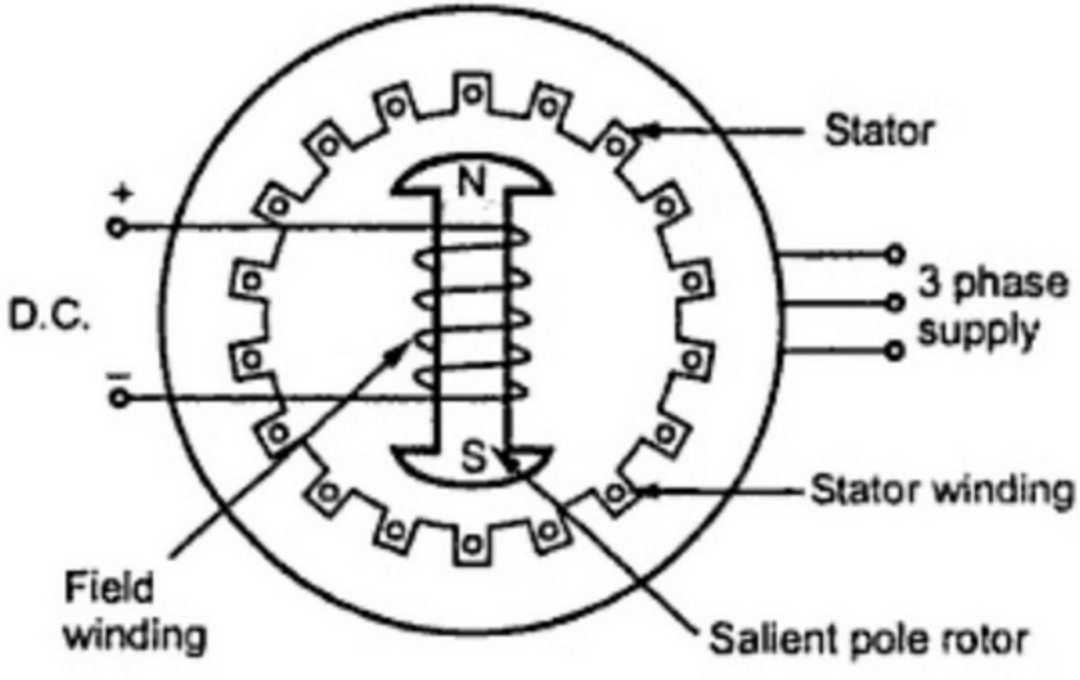
- Induction
  - Have a squirrel-cage rotor
  - Many different sizes
  - Good starting and running characteristics
  - Applications in industry
    - Machine tools
    - Pumps
    - Elevators
    - Hoists
    - Conveyors



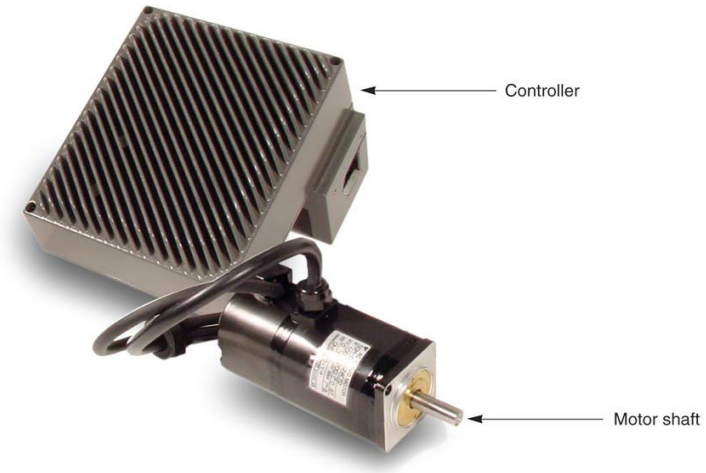
Three-phase AC Induction Motor

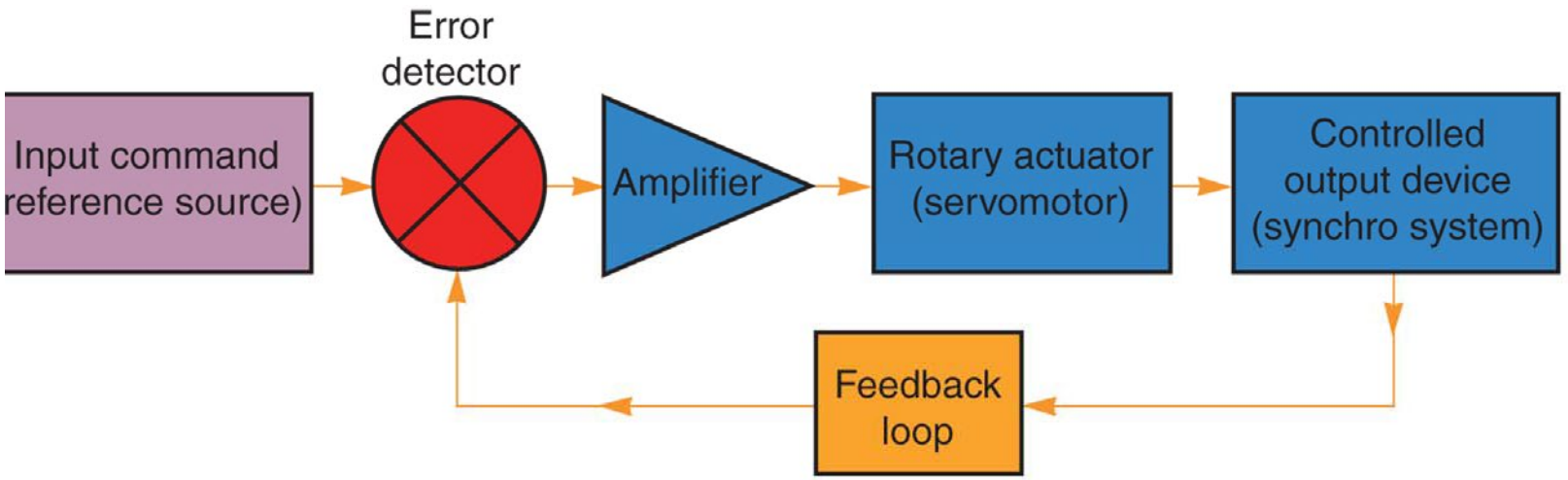
Characteristics

- Synchronous
  - Unique / Specialized Motor
  - DC supplied to wound rotor to produce electro-magnetic field
  - 3-Phase applied to stator windings
  - No starting torque
  - Some external means must be used to initially start this type motor
  - At synchronous speed
    - Rotor speed = synchronous speed
    - No slip – the name synchrounous

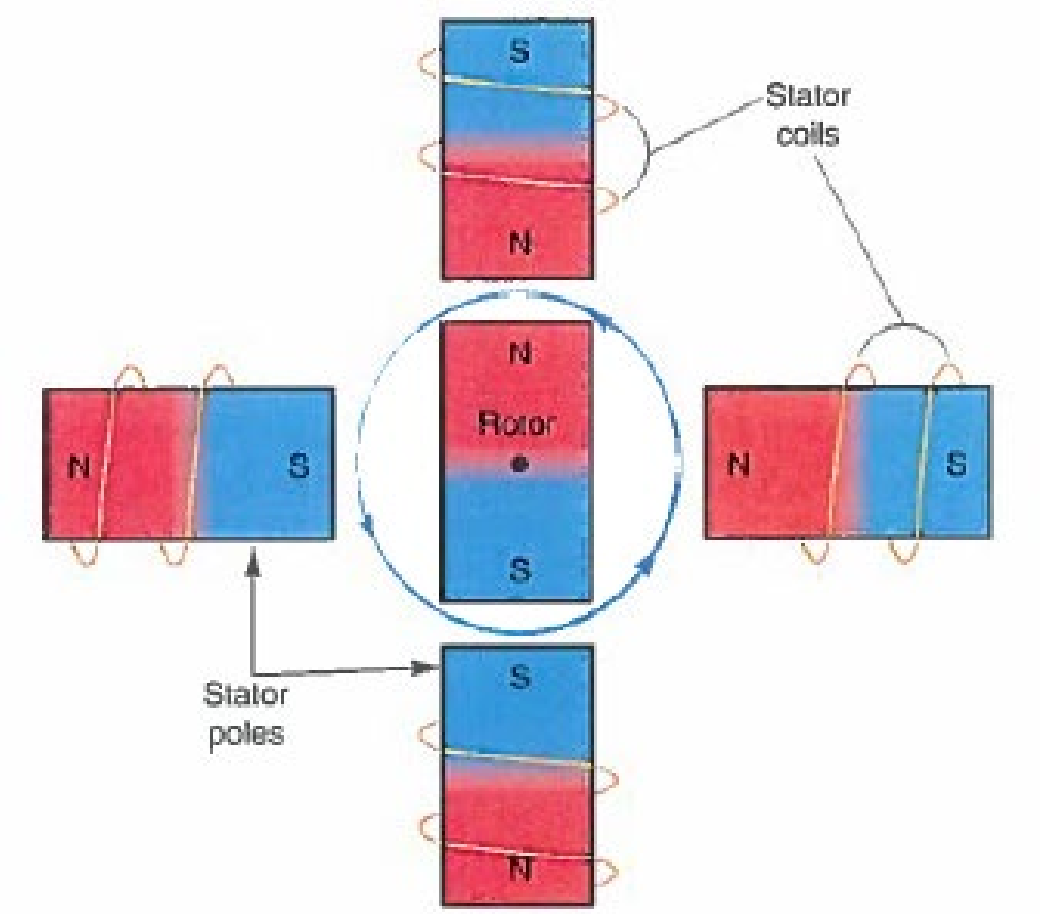


Servo System

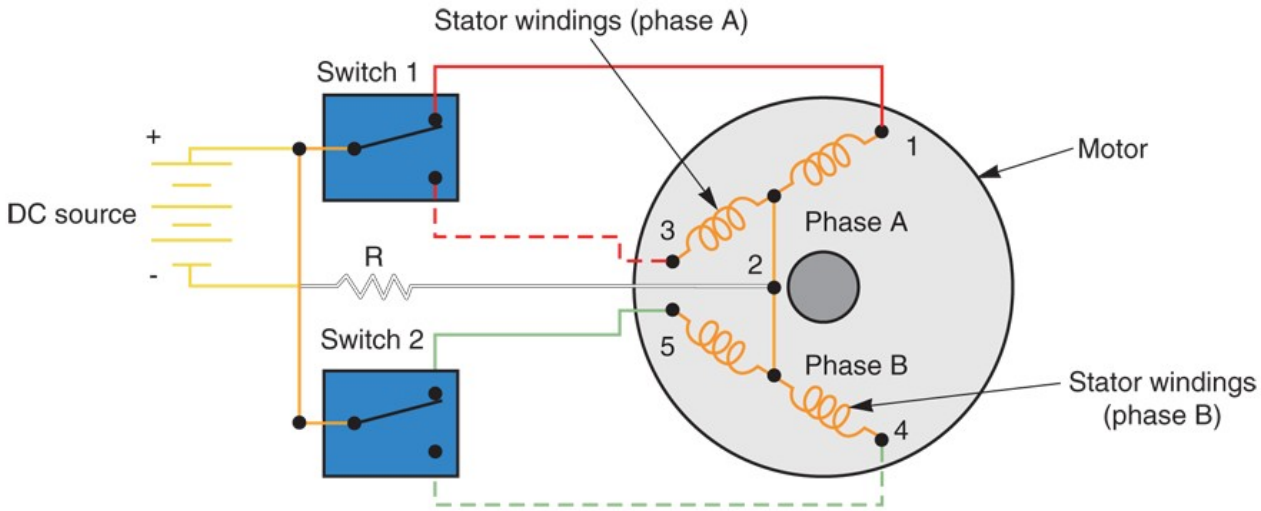




Single-Phase Synchronous Motor



DC Stepping Motor



Switching Sequence*

Step	Switch #1	Switch #2
1	1	5
2	1	4
3	3	4
4	3	5
1	1	5

*To reverse direction, read chart from bottom to top.