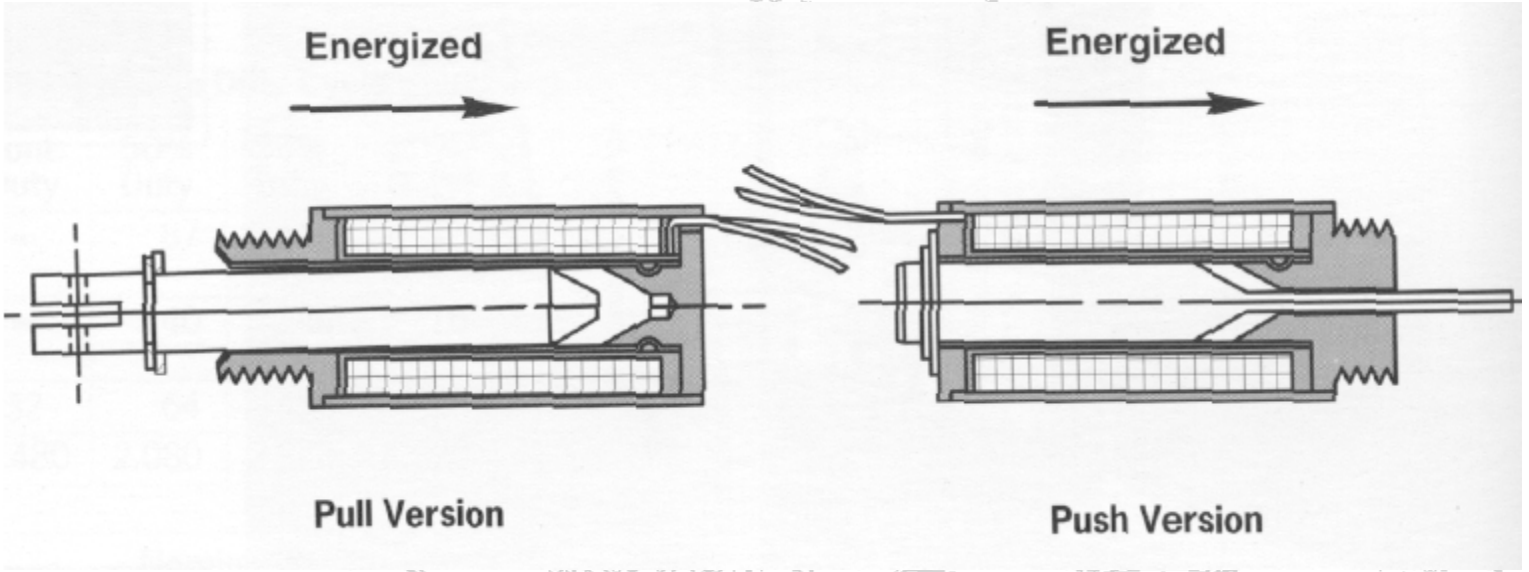
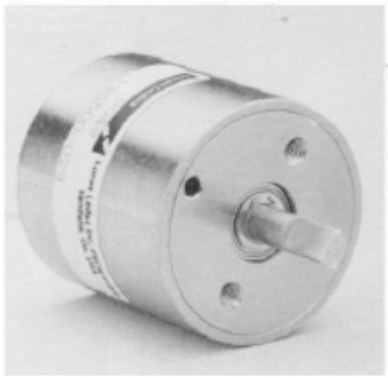
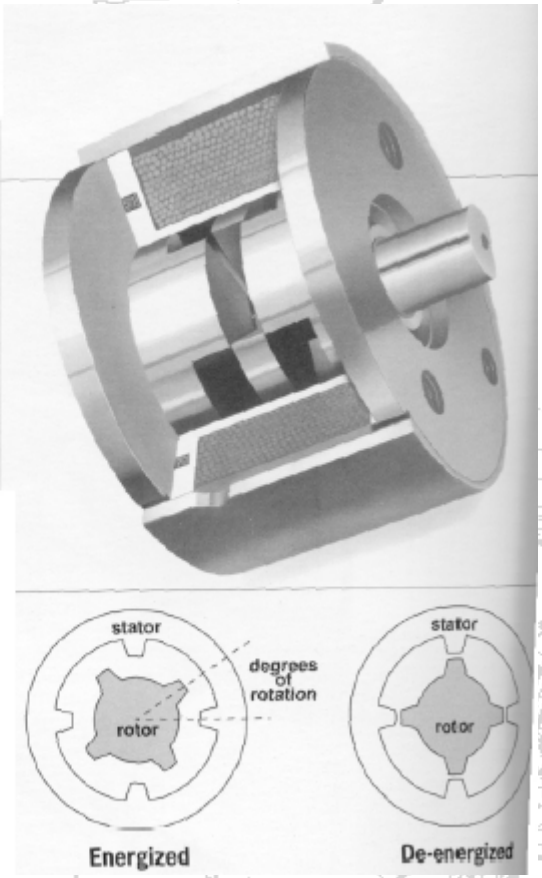
Electric Solenoids



Force $\propto$ stroke^{-1}

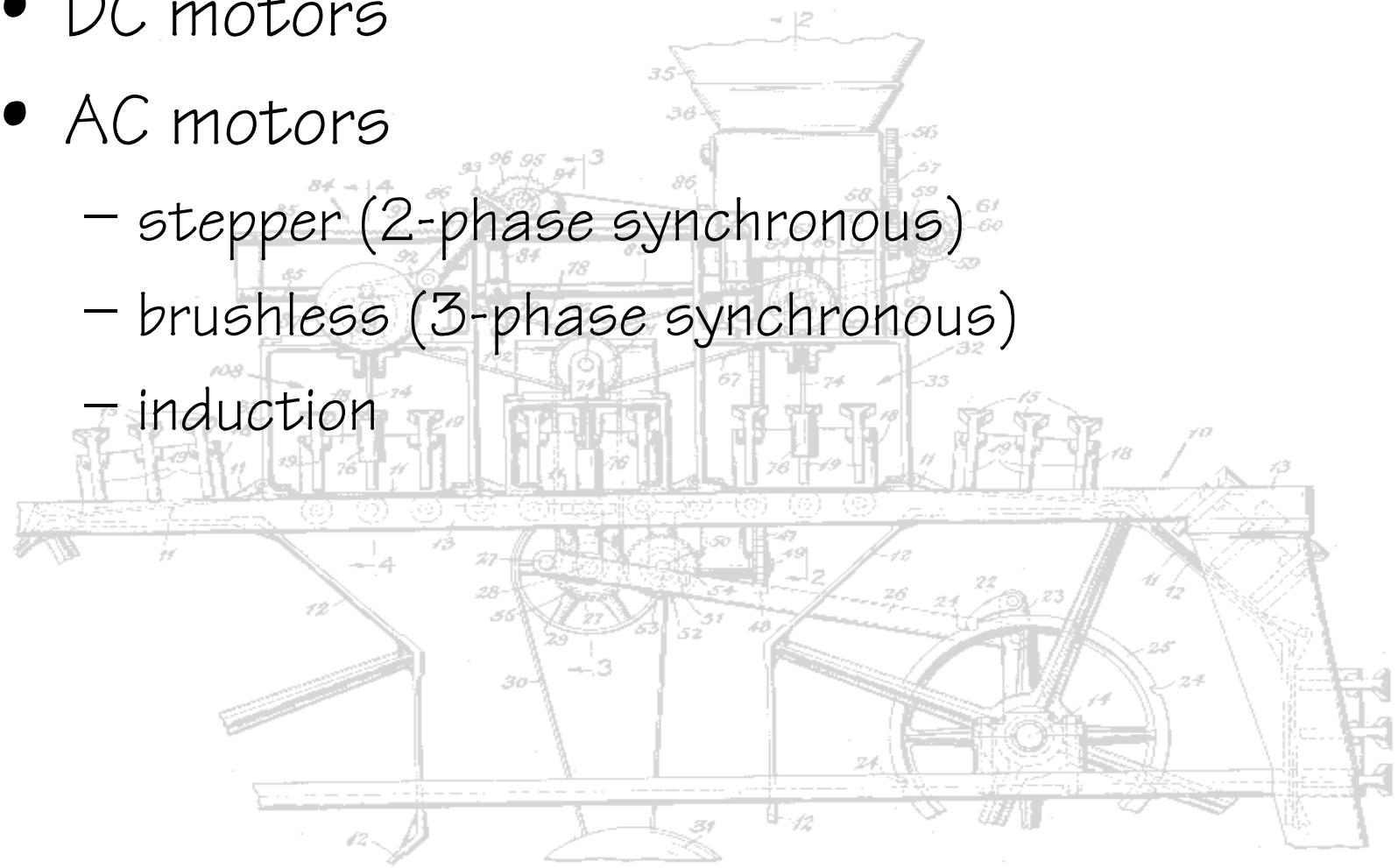
Electric Rotary Actuator (solenoid)





Electric Rotary Actuators (motors)

- DC motors
- AC motors
  - stepper (2-phase synchronous)
  - brushless (3-phase synchronous)
  - induction



Step Motors

Figure 2. "One phase on" stepping sequence for two phase motor.

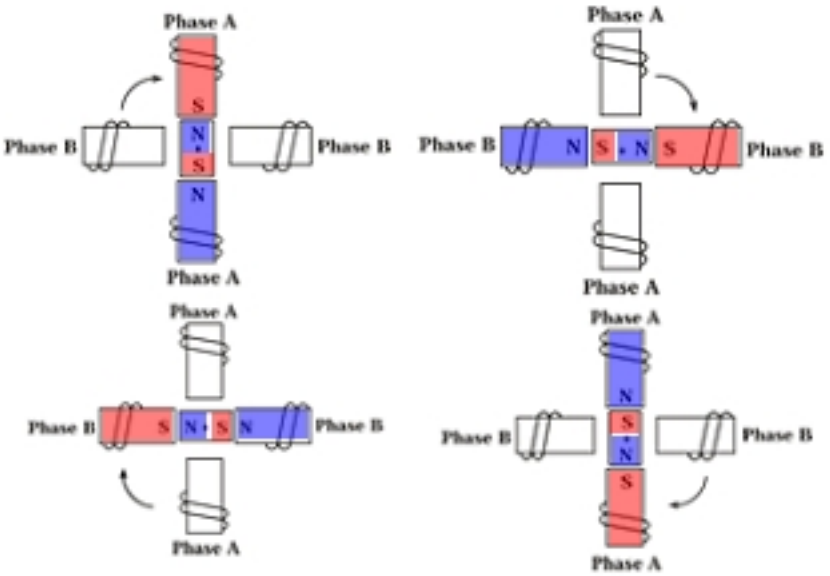
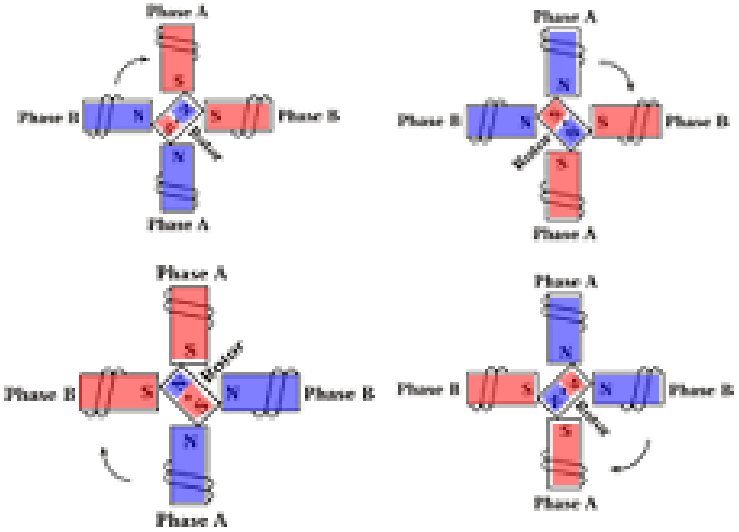


Figure 3. "Two phase on" stepping sequence for two phase motor.



Step Motors

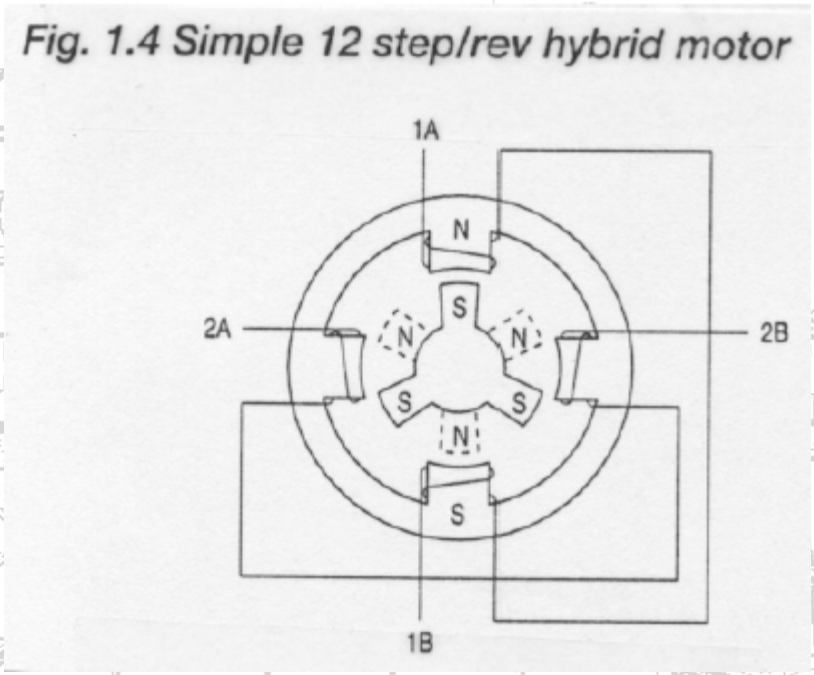
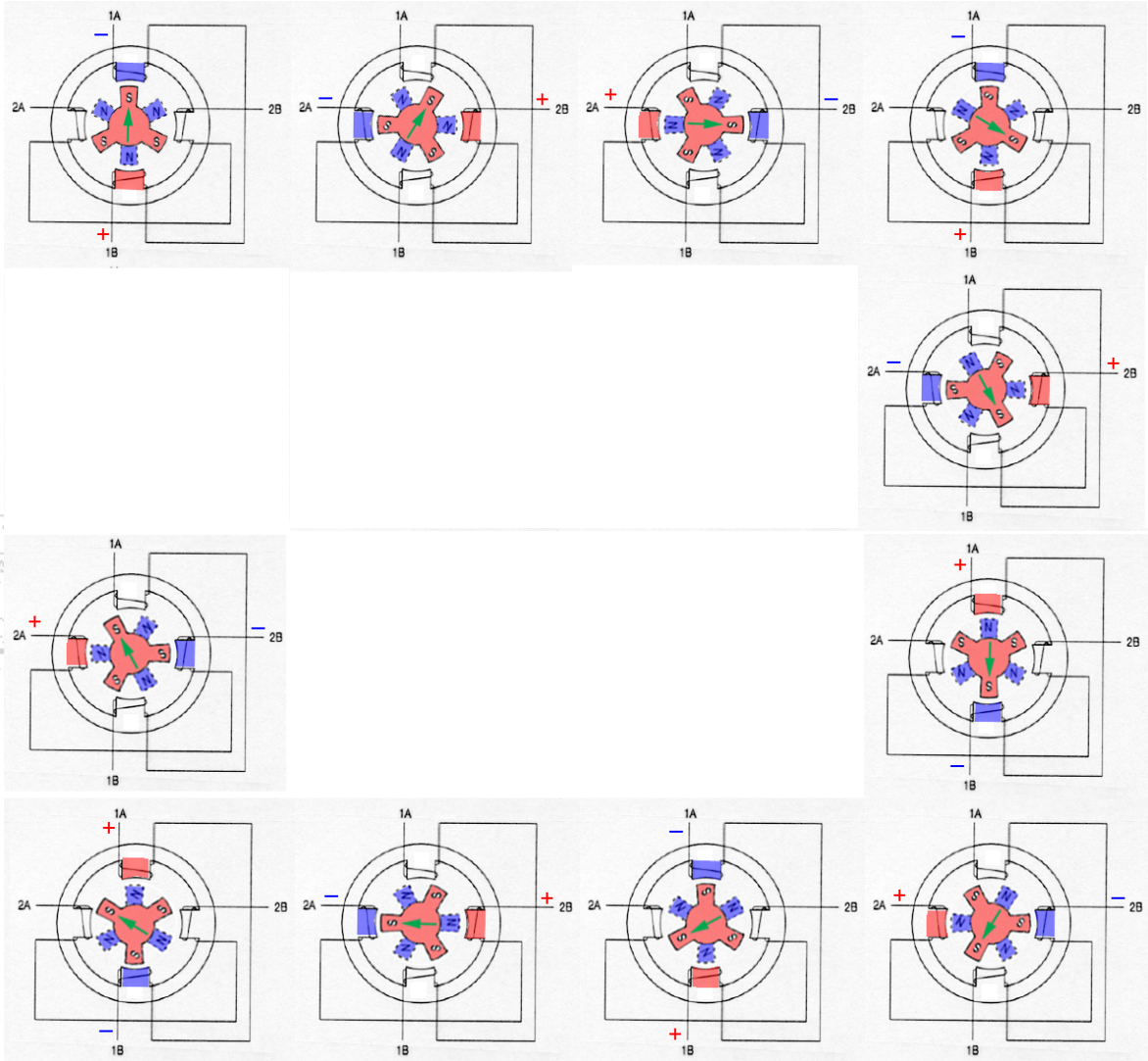
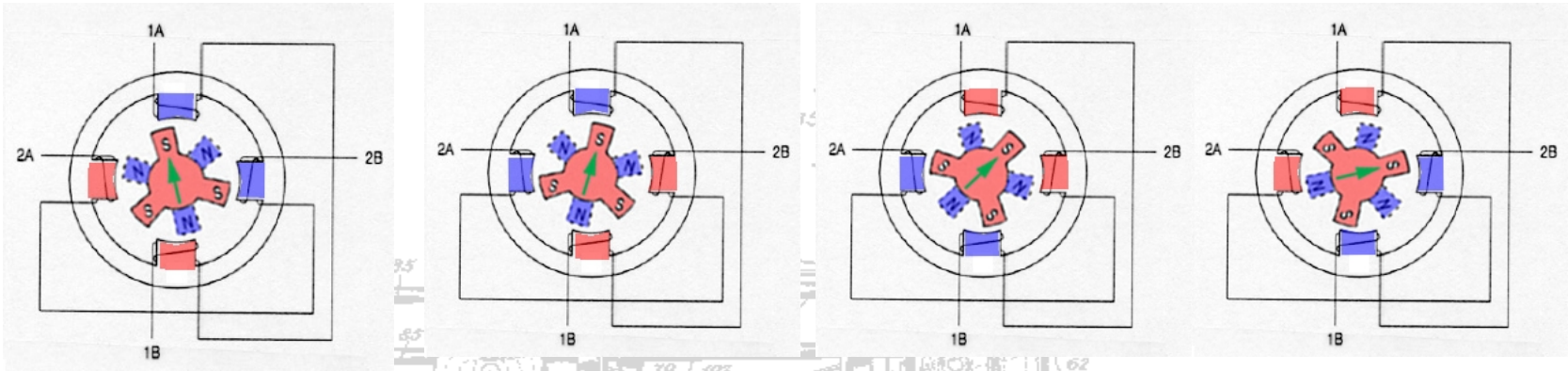


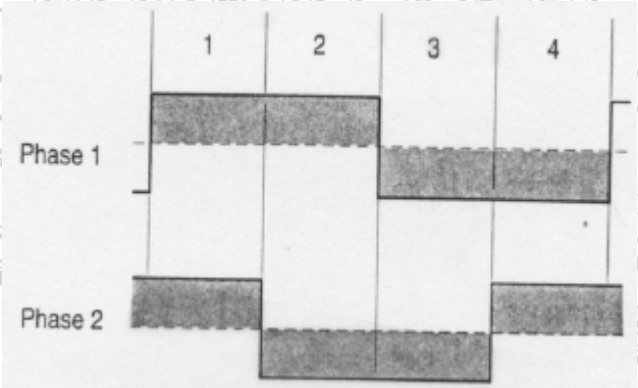
Fig. 1.4 Simple 12 step/rev hybrid motor

Step Motor
12 step/rev, 1 phase on

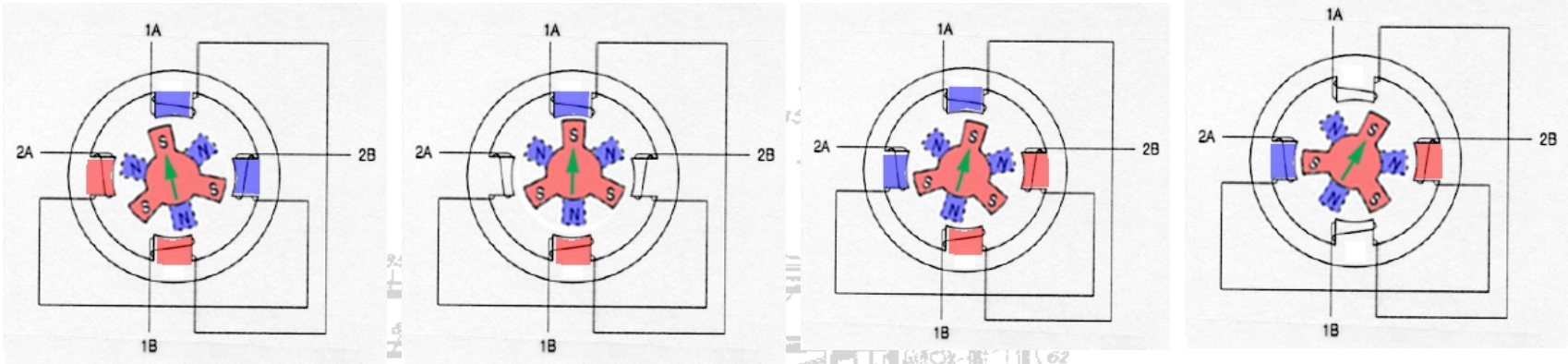


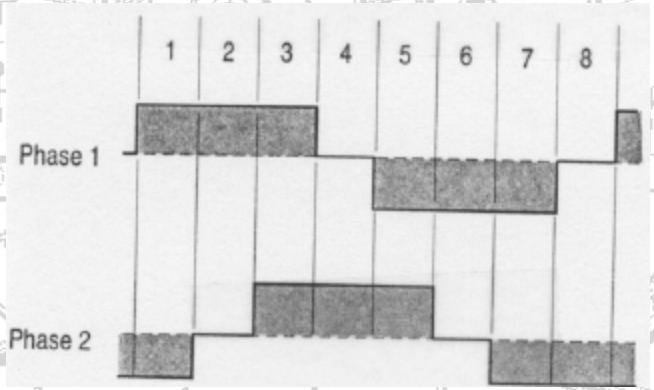
Step Motor
12 step/rev, 2 phase on





Step Motor
12 step/rev, half-stepping





Step Motors

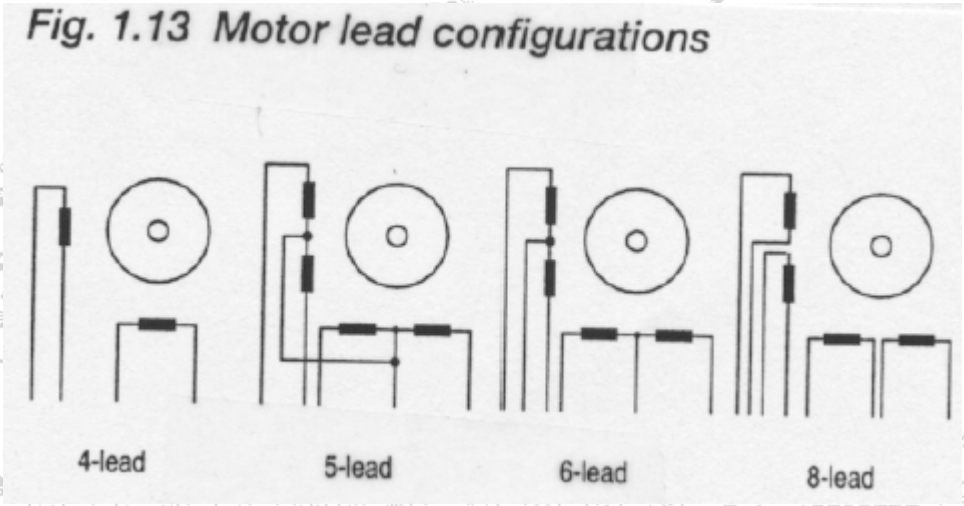
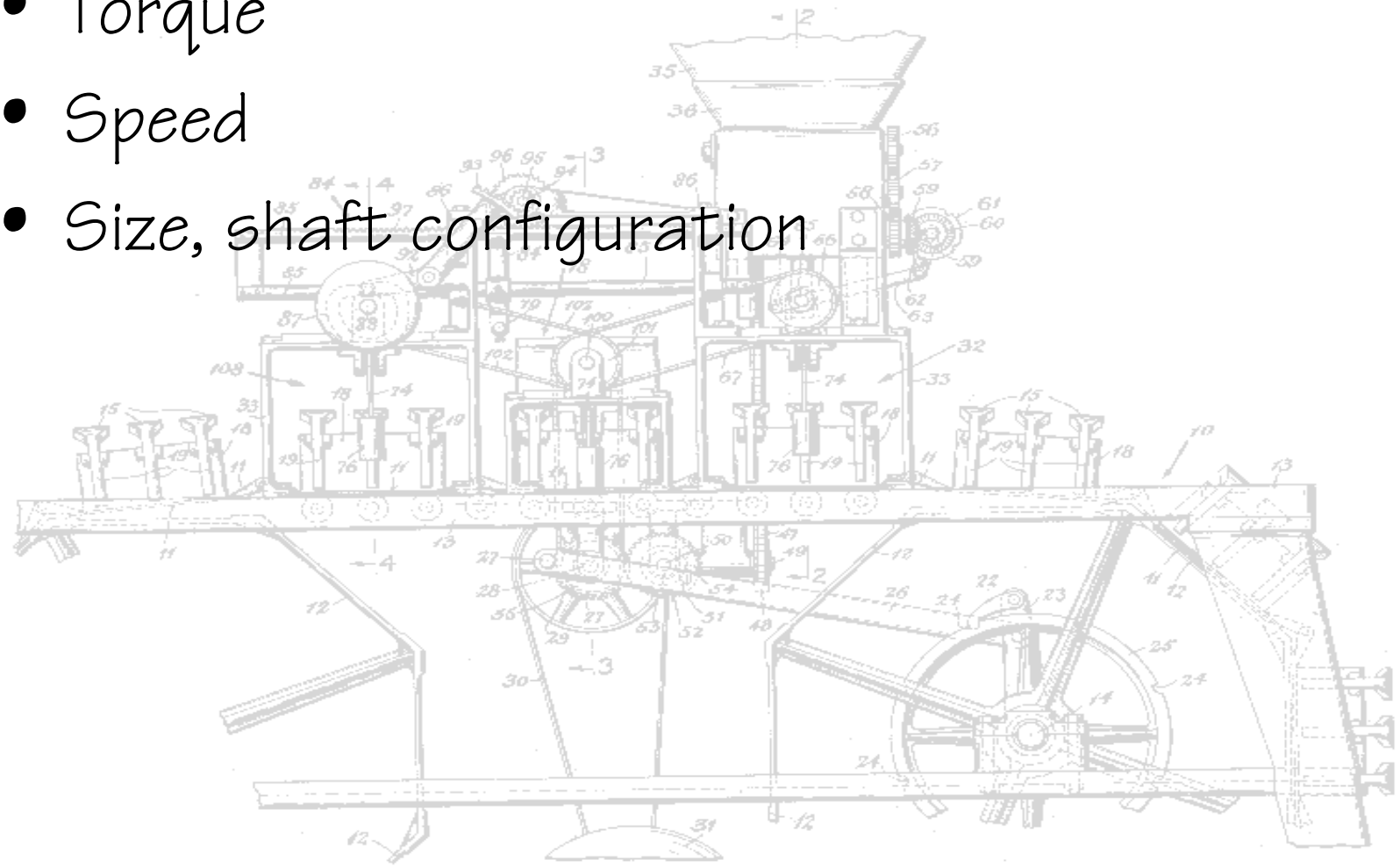


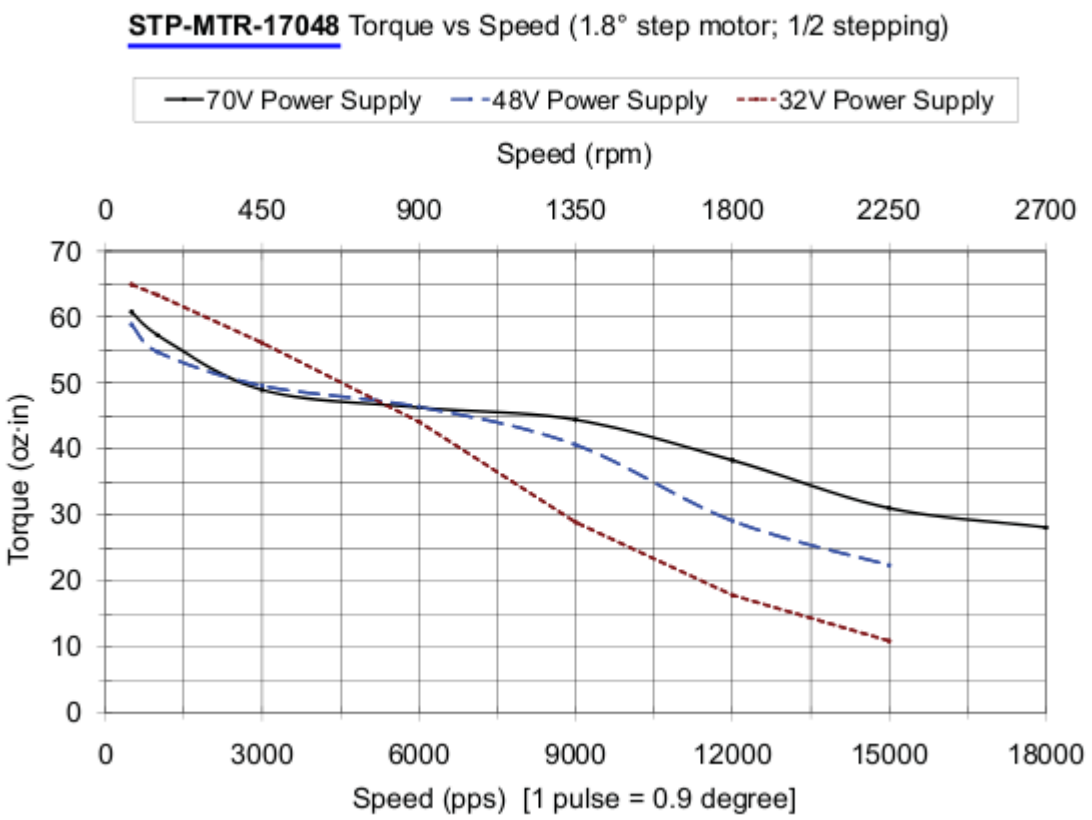
Fig. 1.13 Motor lead configurations

Selecting Step Motors

- Torque
- Speed
- Size, shaft configuration

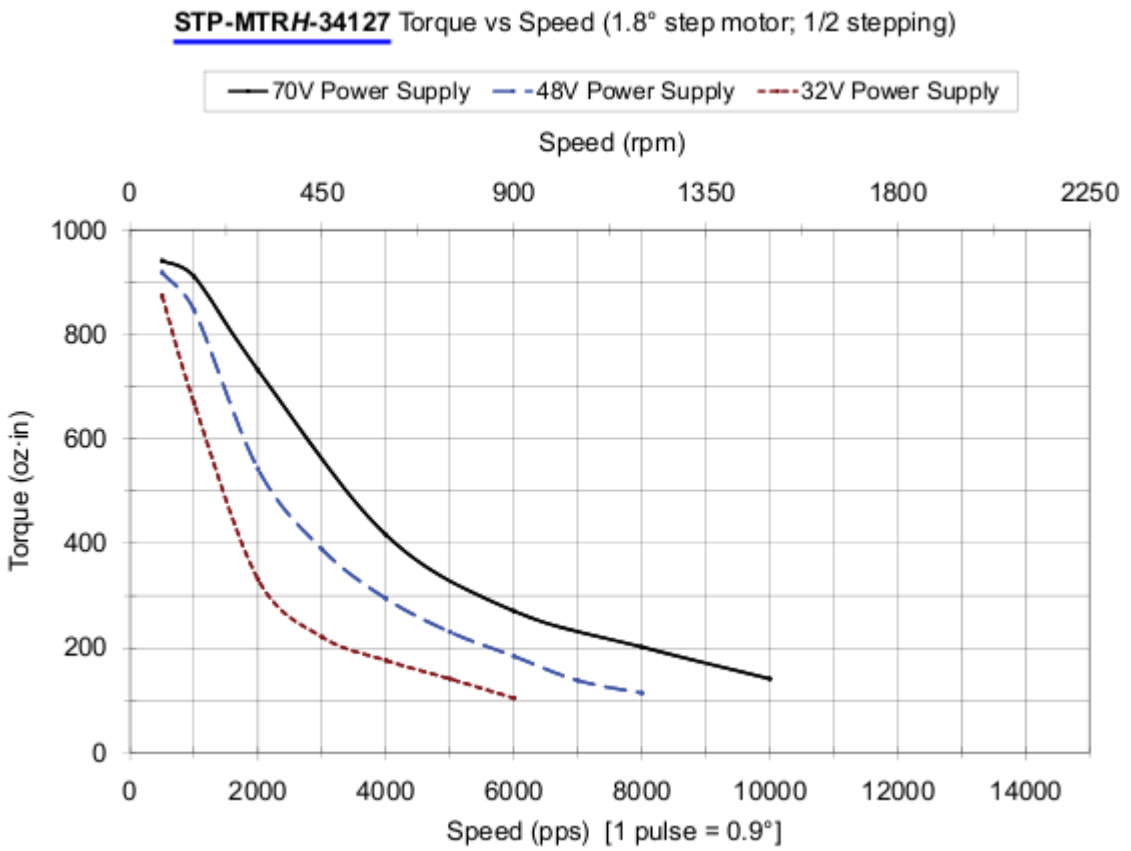


Torque/Speed



$20 motor

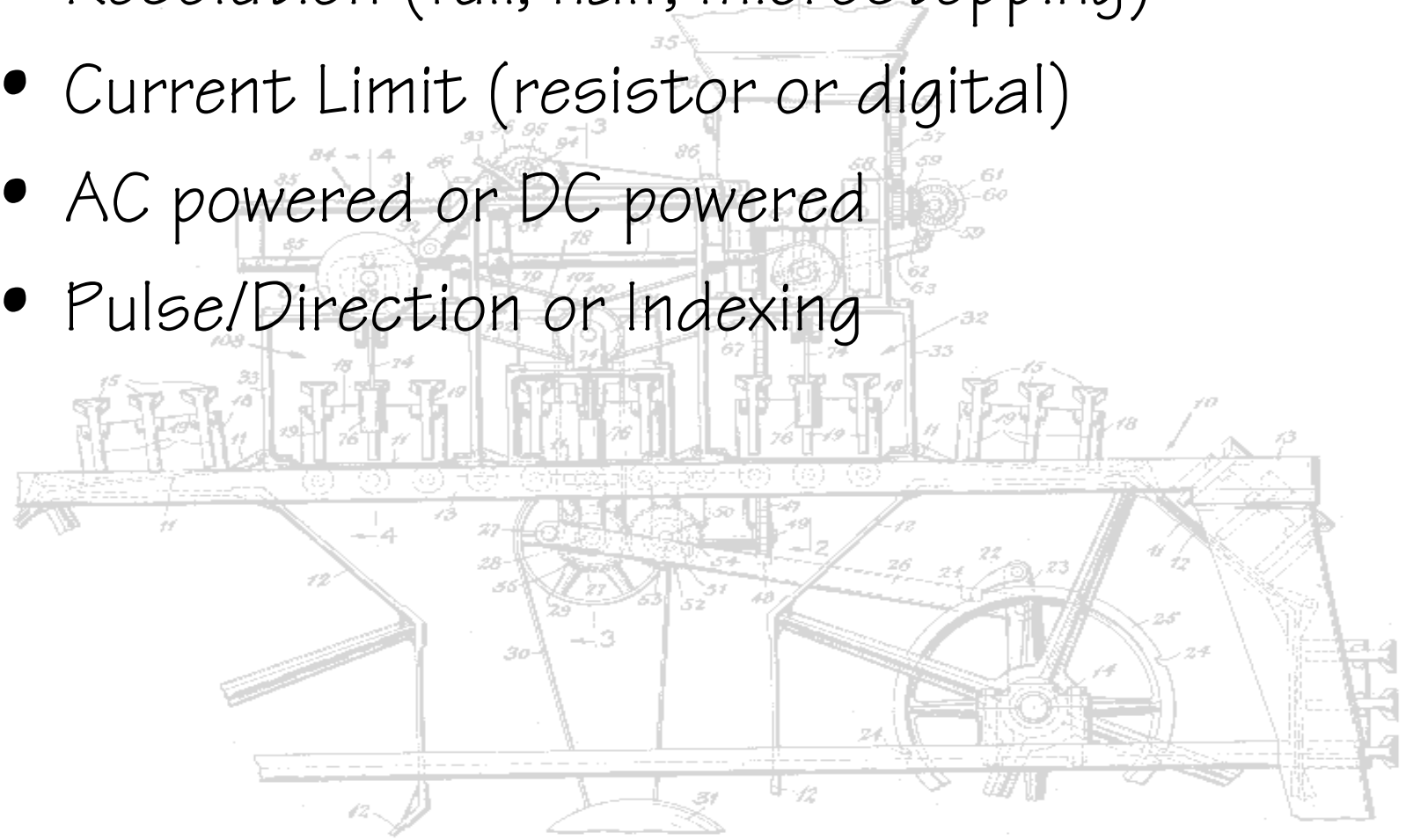
Torque/Speed

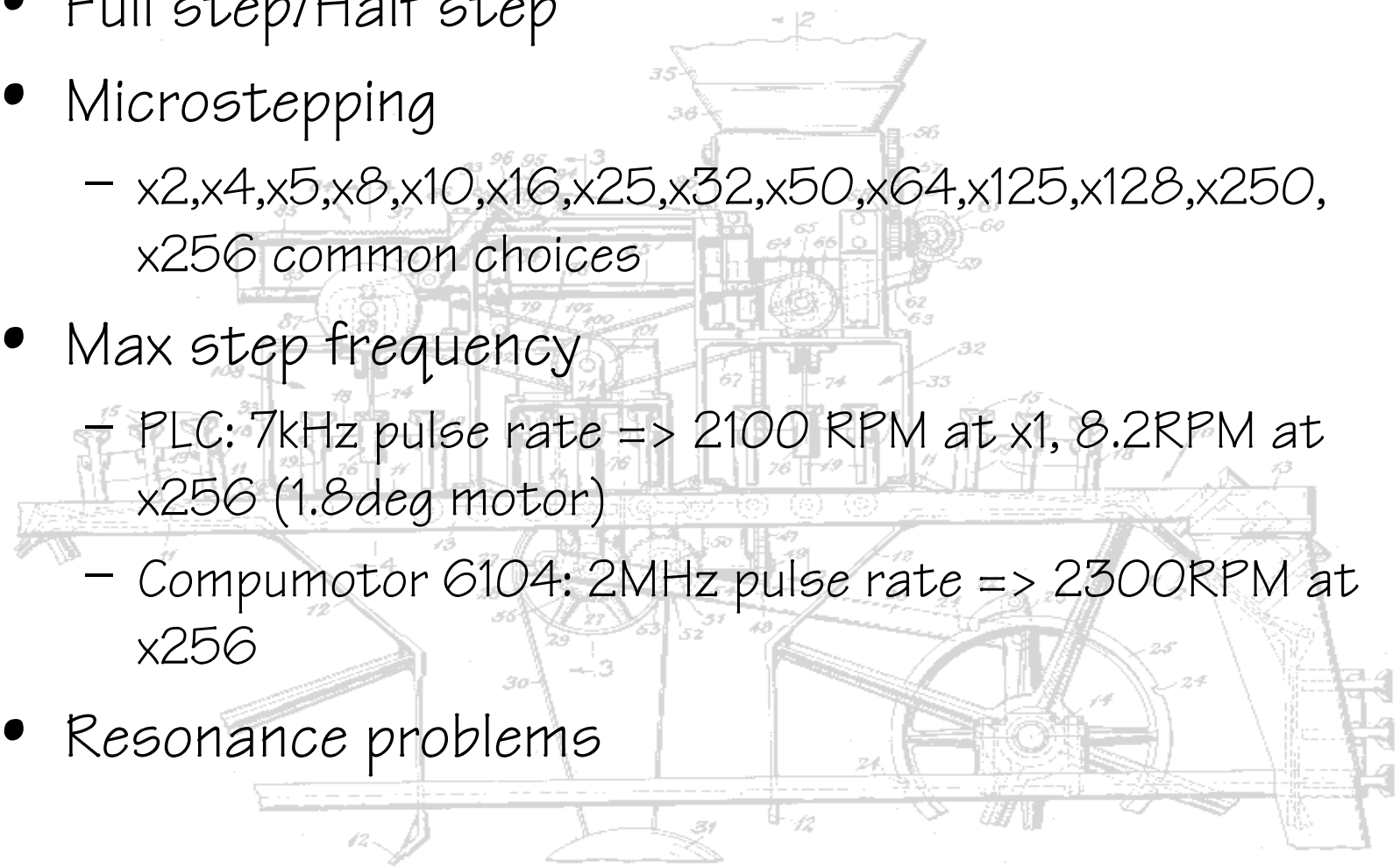


$160 motor

Step Motor Drives

- Resolution (full, half, microstepping)
- Current Limit (resistor or digital)
- AC powered or DC powered
- Pulse/Direction or Indexing



Resolution

- Full step/Half step
- Microstepping
  - x2,x4,x5,x8,x10,x16,x25,x32,x50,x64,x125,x128,x250, x256 common choices
- Max step frequency
  - PLC: 7kHz pulse rate => 2100 RPM at x1, 8.2RPM at x256 (1.8deg motor)
  - Compumotor 6104: 2MHz pulse rate => 2300RPM at x256
- Resonance problems