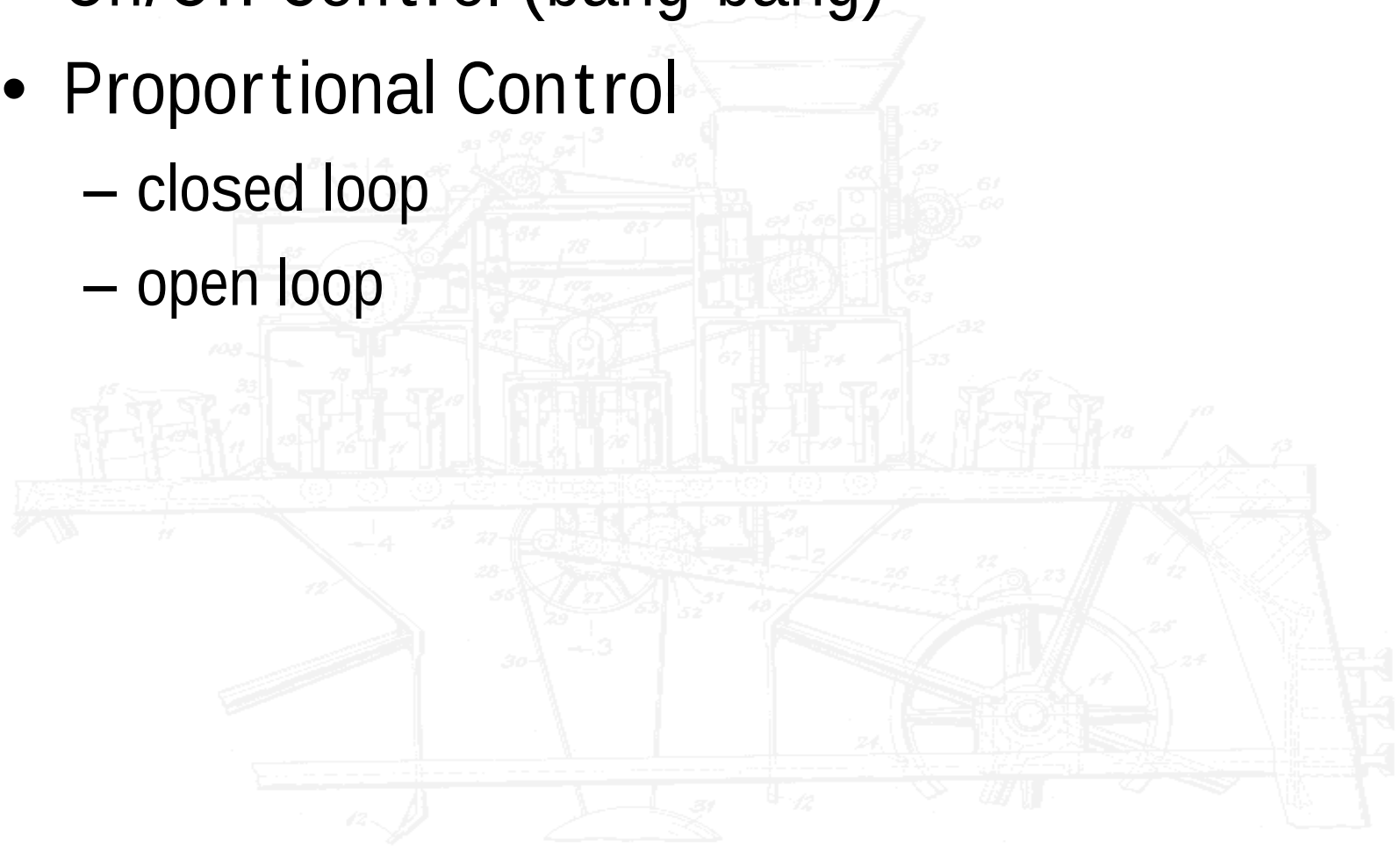
Control of Motion

- On/Off Control (bang-bang)
- Proportional Control
  - closed loop
  - open loop



Digital Logic Expressions

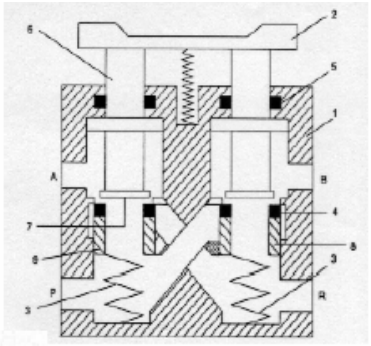
$$oCUT = (iPARTRDY \cdot iCYLRETRACT + oCUT \cdot /iCYLEXTEND) \cdot /iESTOP$$

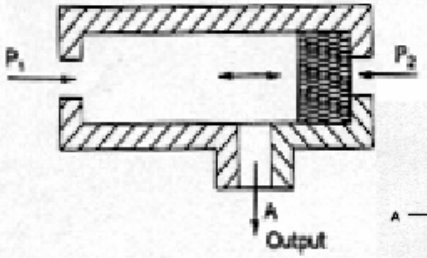
$$oCUT = iPARTRDY \cdot iCYLRETRACT \cdot /iESTOP + oCUT \cdot /iCYLEXTEND \cdot /iESTOP$$

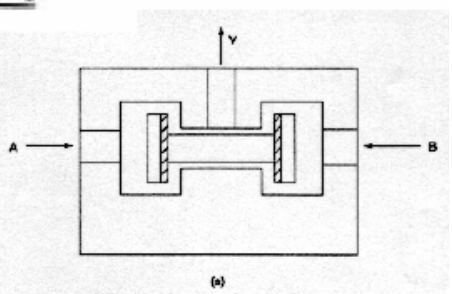
- Cut when part is ready, and cylinder is retracted, and emergency stop is not on, or while cylinder is not fully extended and emergency stop is not on.

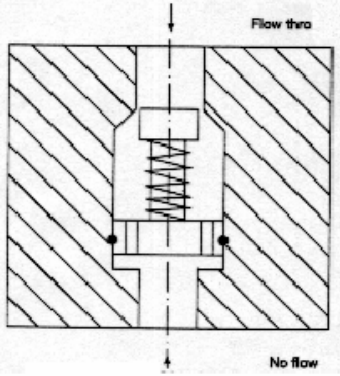
Pneumatic Logic Elements

- Directional control valve
- Shuttle valve - OR function
- Twin pressure valve - AND function
- Other functions
  - Check valve
  - Speed control valve
  - Time delay valve



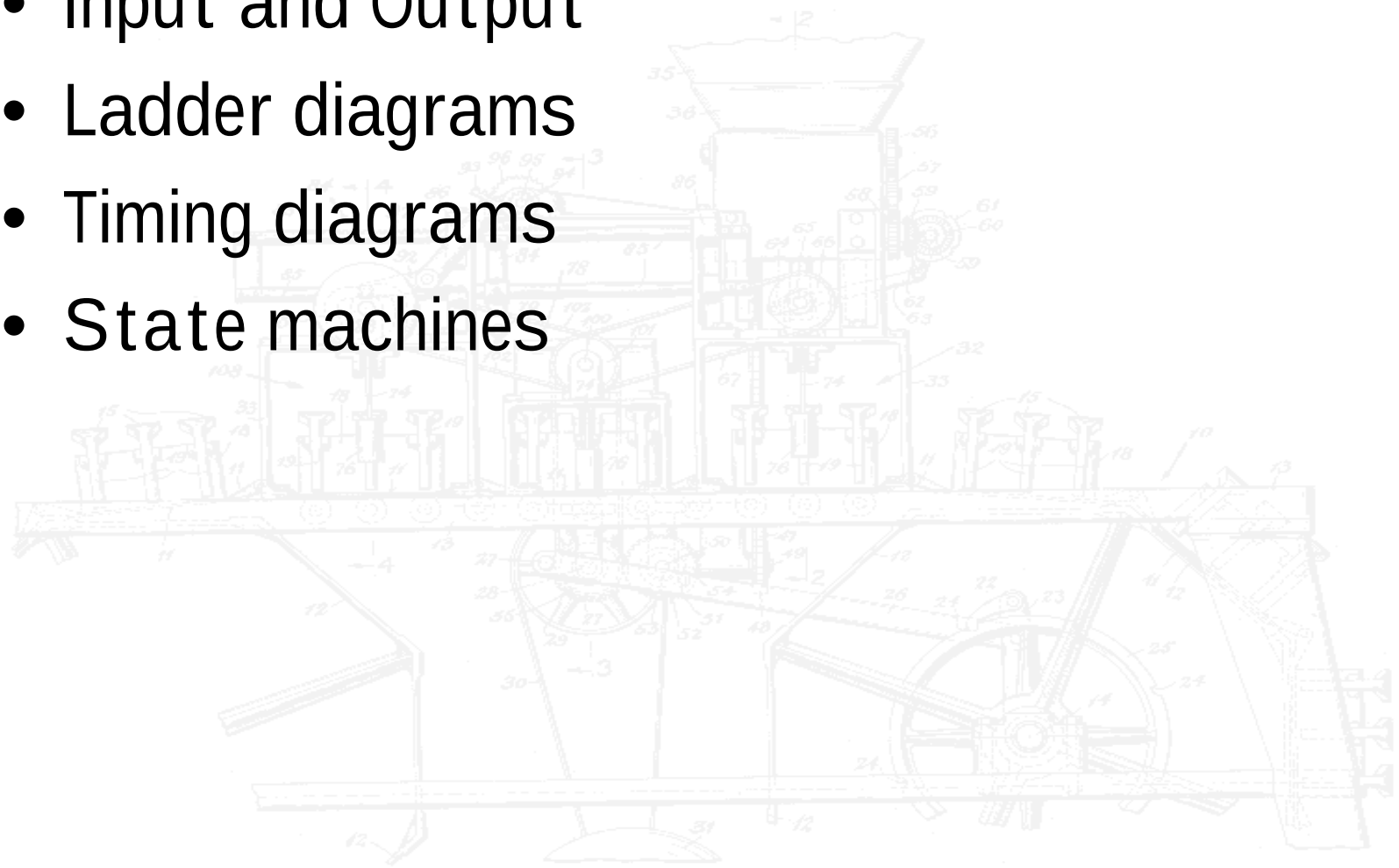






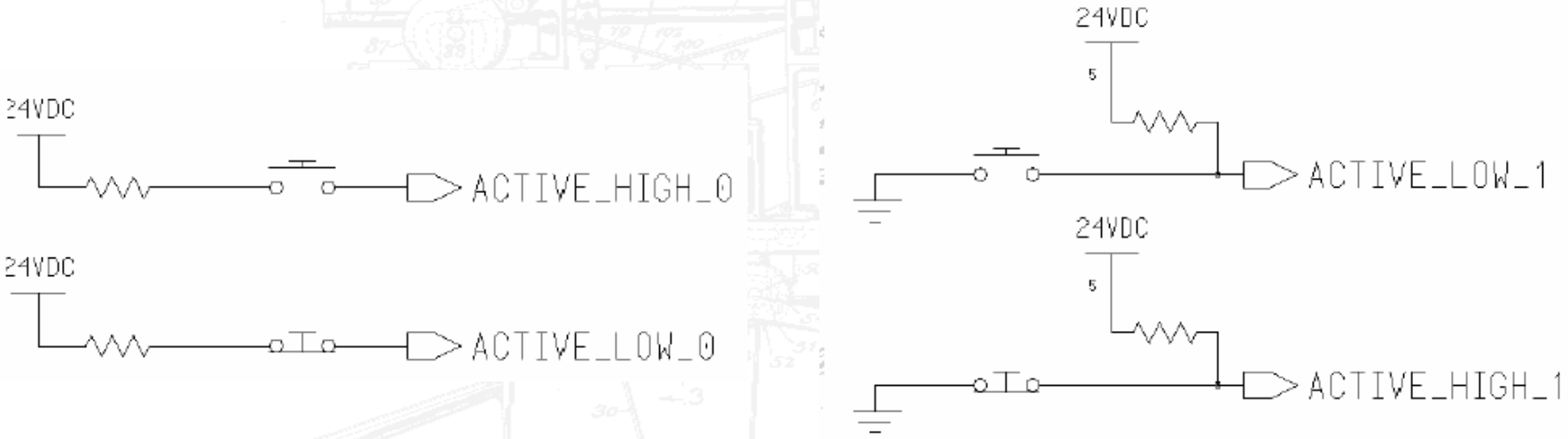
Electric Logic Control

- Input and Output
- Ladder diagrams
- Timing diagrams
- State machines

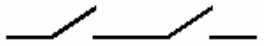
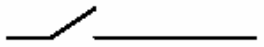
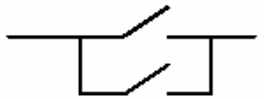
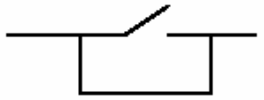
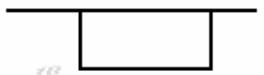


I/O Activity Levels

- Active = TRUE Inactive = FALSE
- Active High - **active** level is +24 volts
- Active Low - **active** level is 0 volts (GND)



Boolean Arithmetic

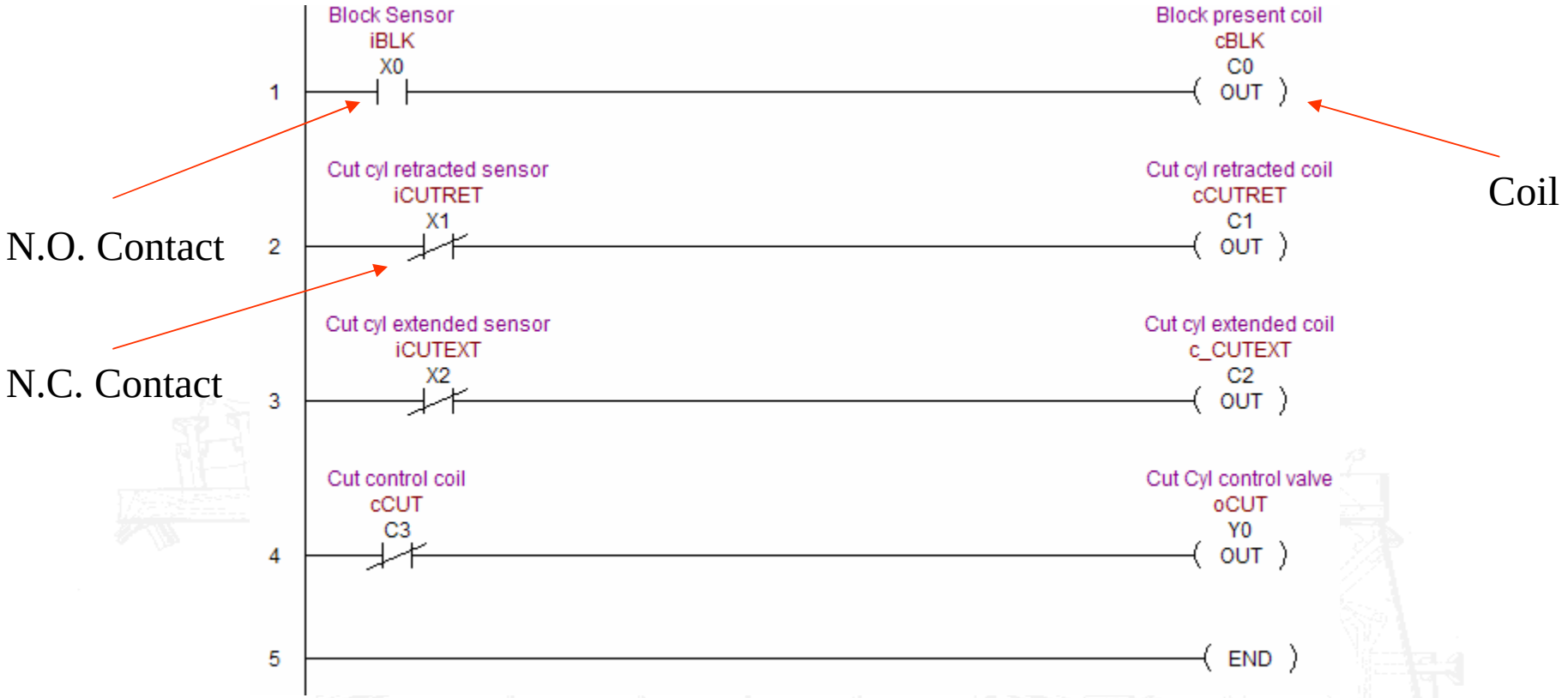
- 0 and 0 = 0 (0 · 0 = 0) 
- 0 and 1 = 0 (0 · 1 = 0) 
- 1 and 1 = 1 (1 · 1 = 1)
- 0 or 0 = 0 (0 + 0 = 0) 
- 0 or 1 = 1 (0 + 1 = 1) 
- 1 or 1 = 1 (1 + 1 = 1) 
- not 0 = 1 (/0 = 1)

$A + /A = 1$

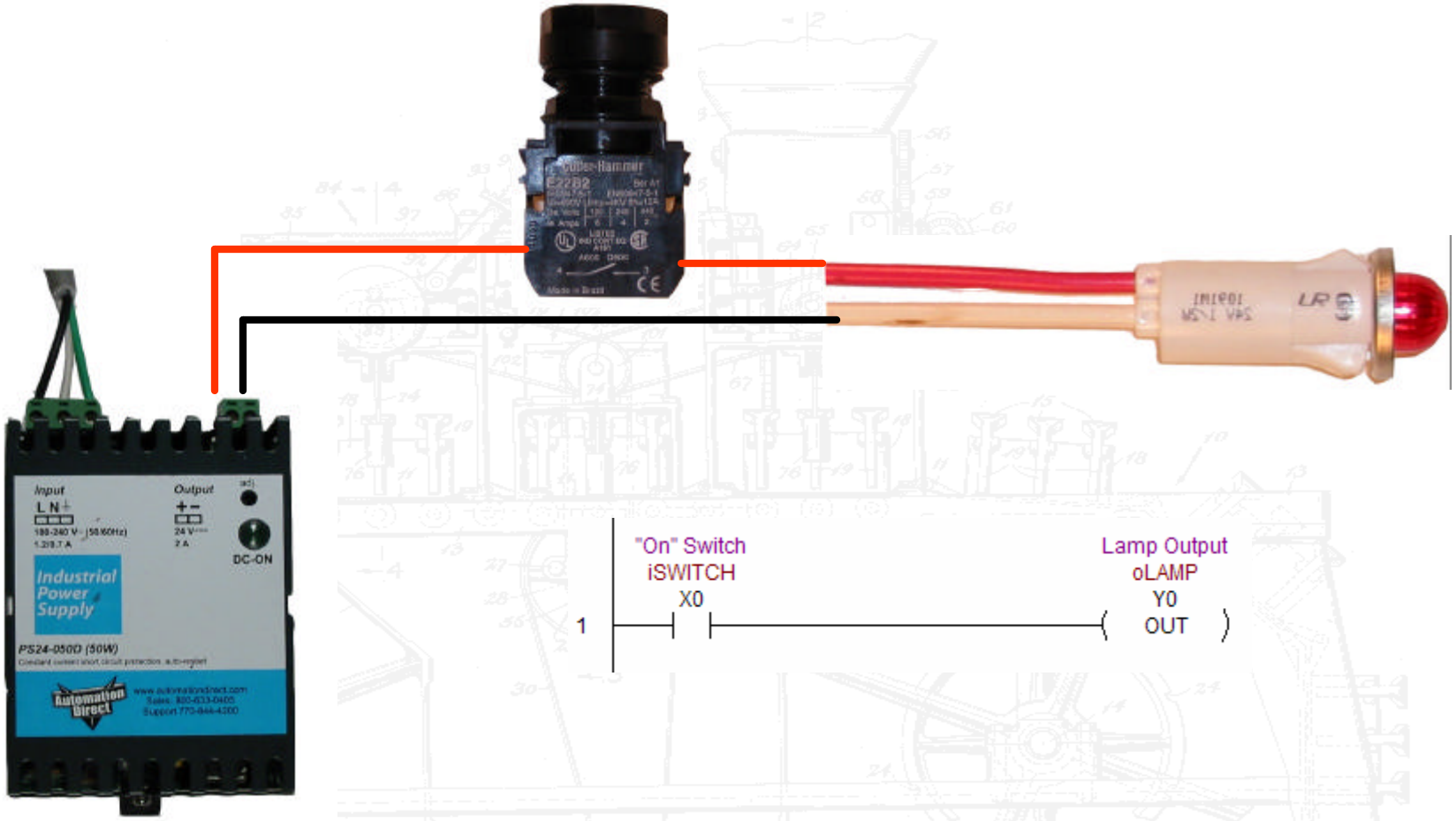
$A \cdot B = B \cdot A$

$A \cdot B + A \cdot C = A \cdot (B+C)$

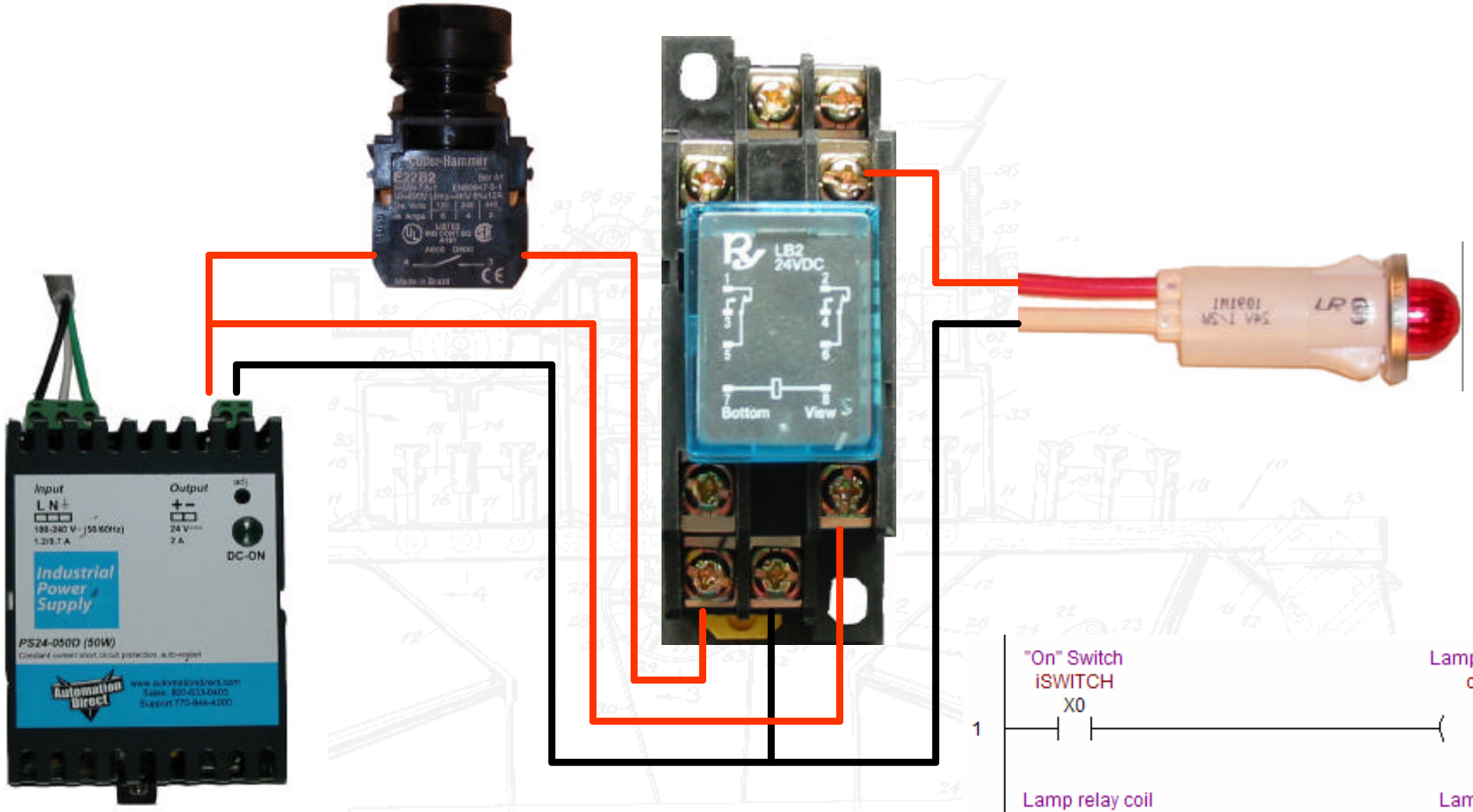
Ladder Diagrams



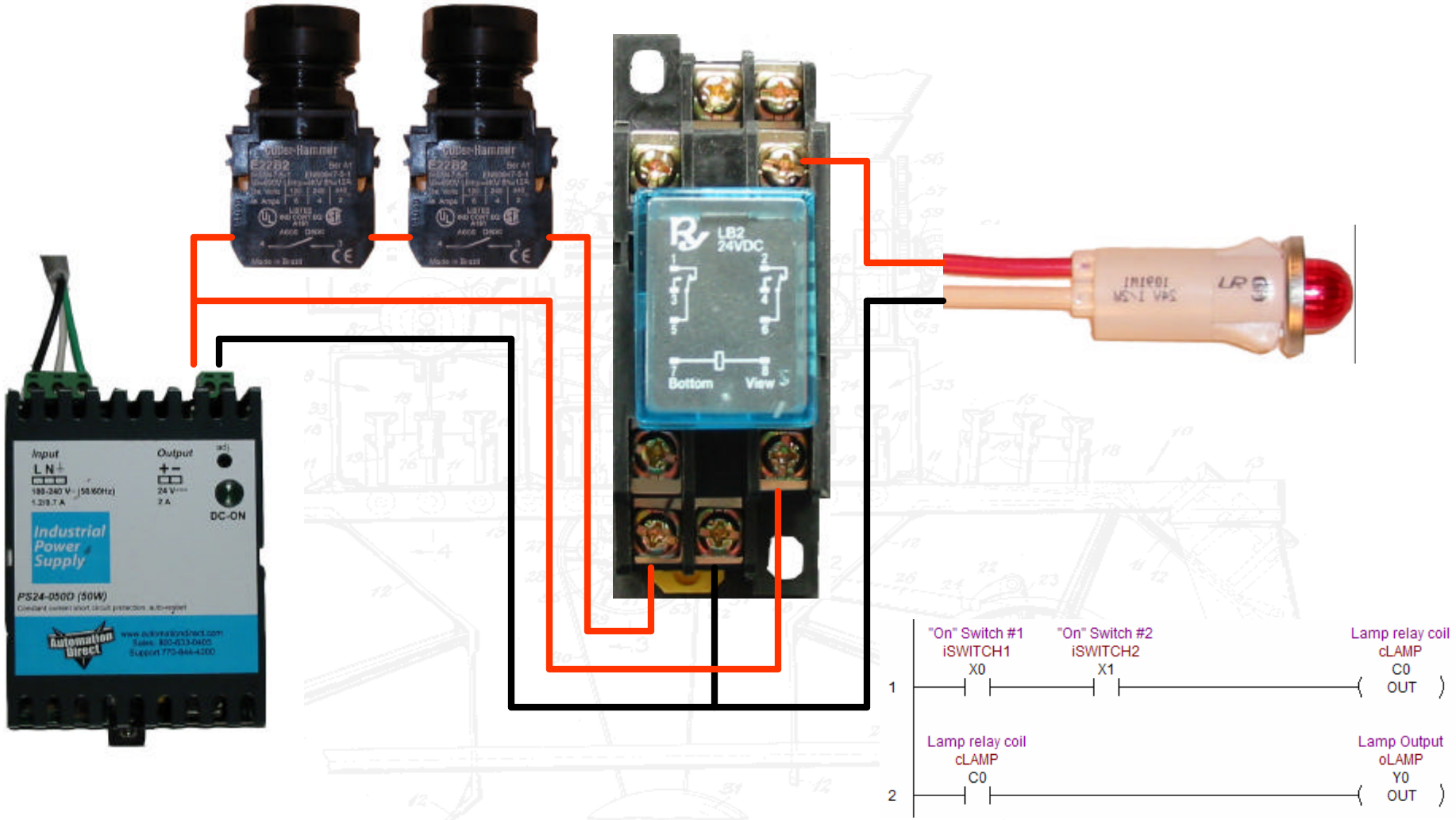
Example – Light Switch



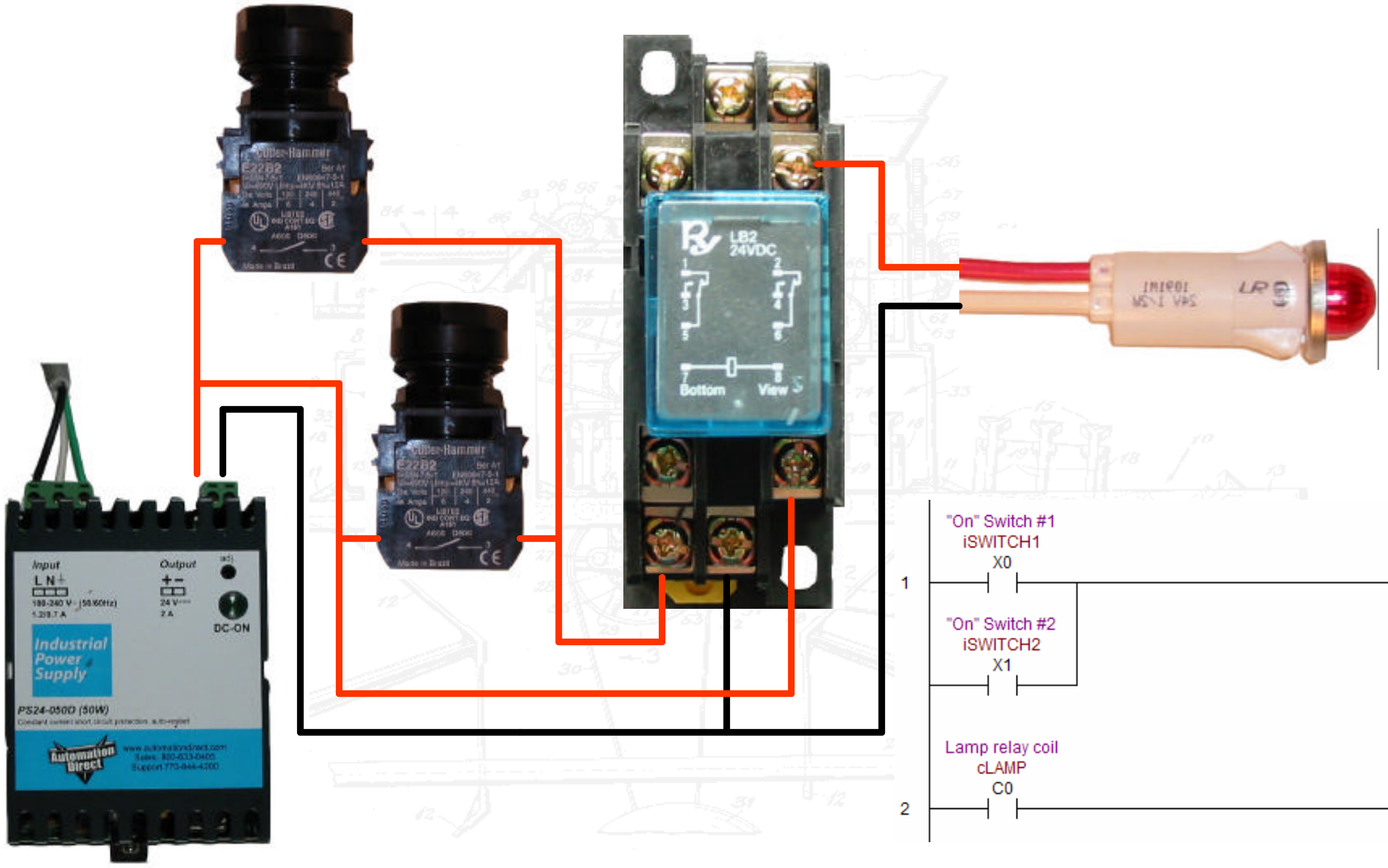
Example – Light Relay



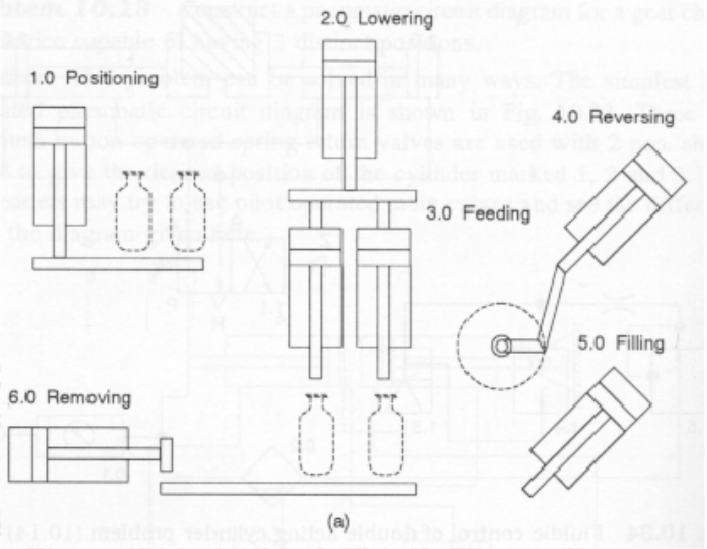
Example – Light Relay, "And" Logic

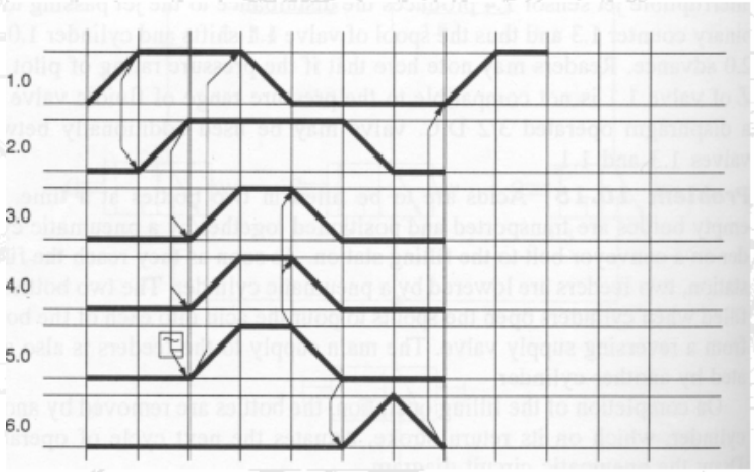


Example – Light Relay – "OR" Logic

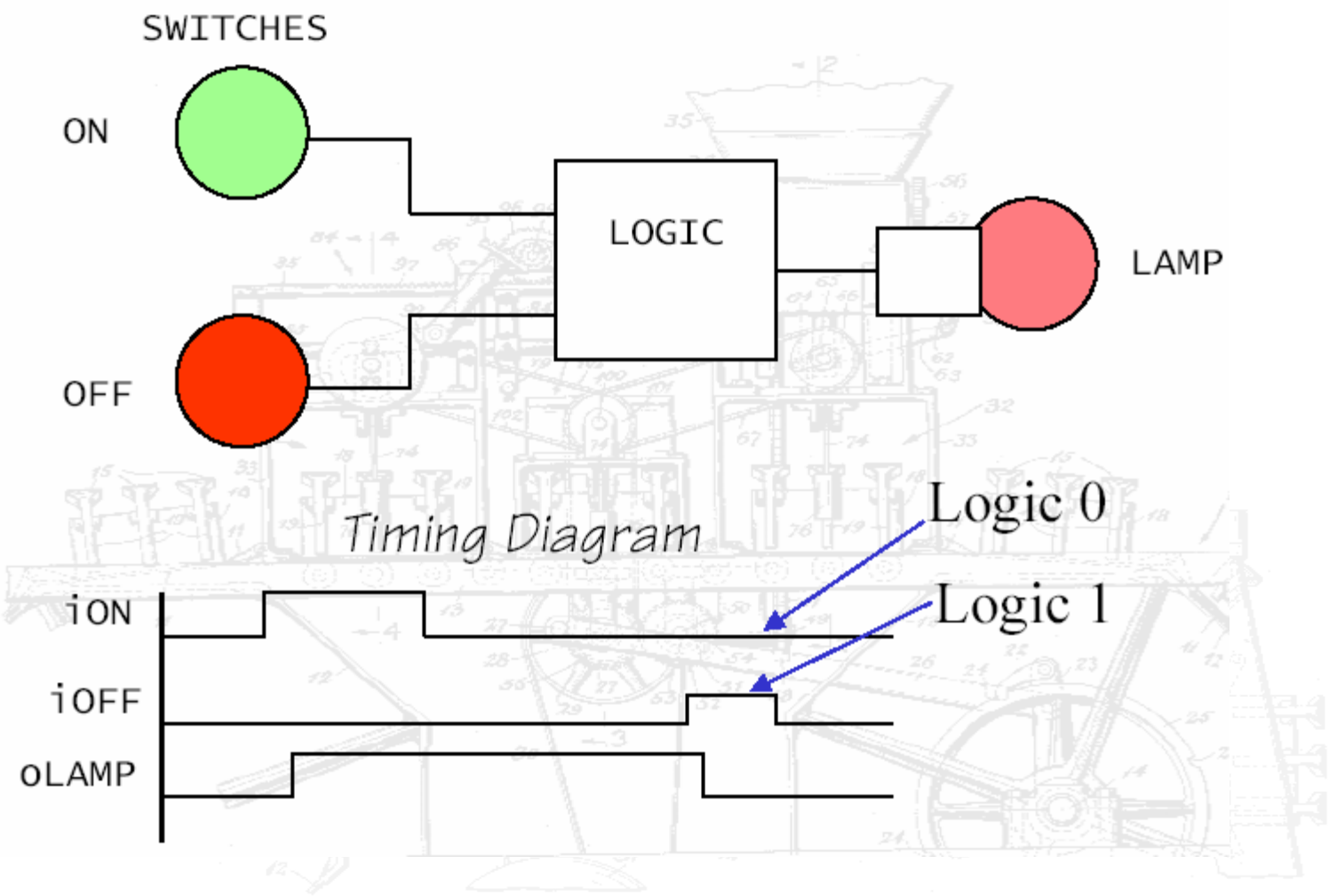


Timing Diagrams

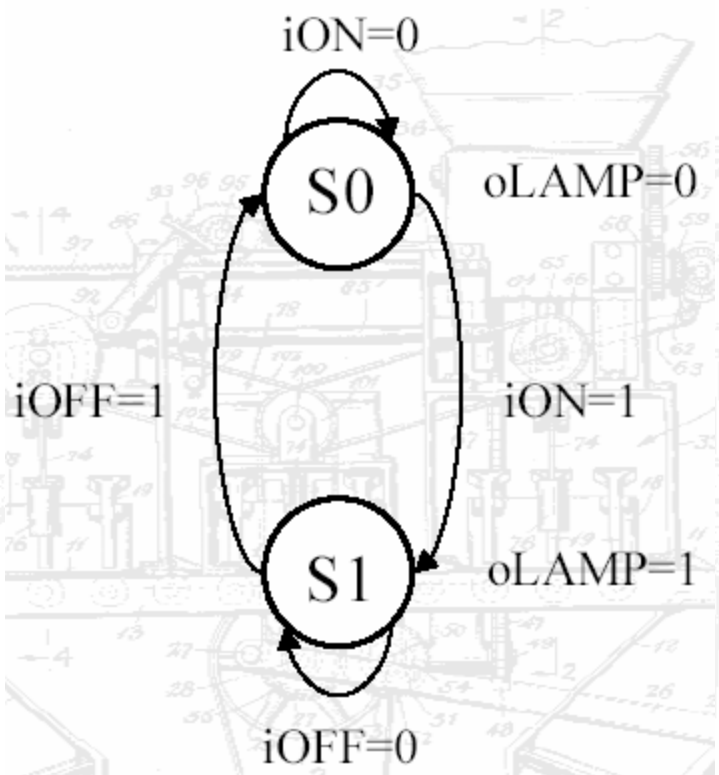


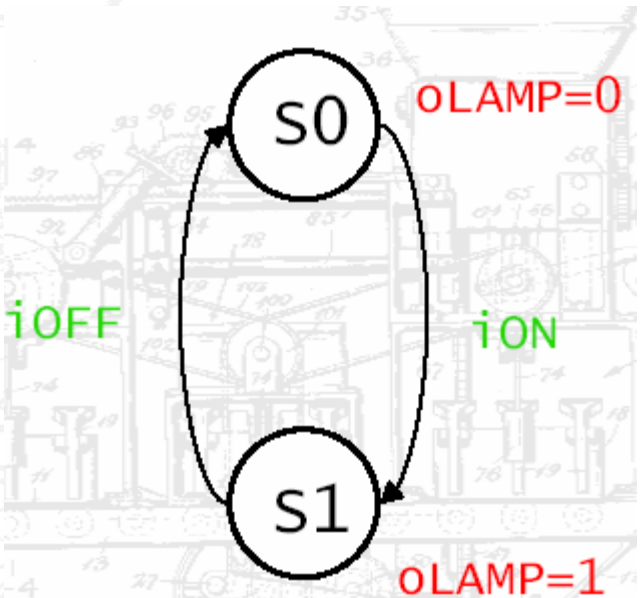


State Machines



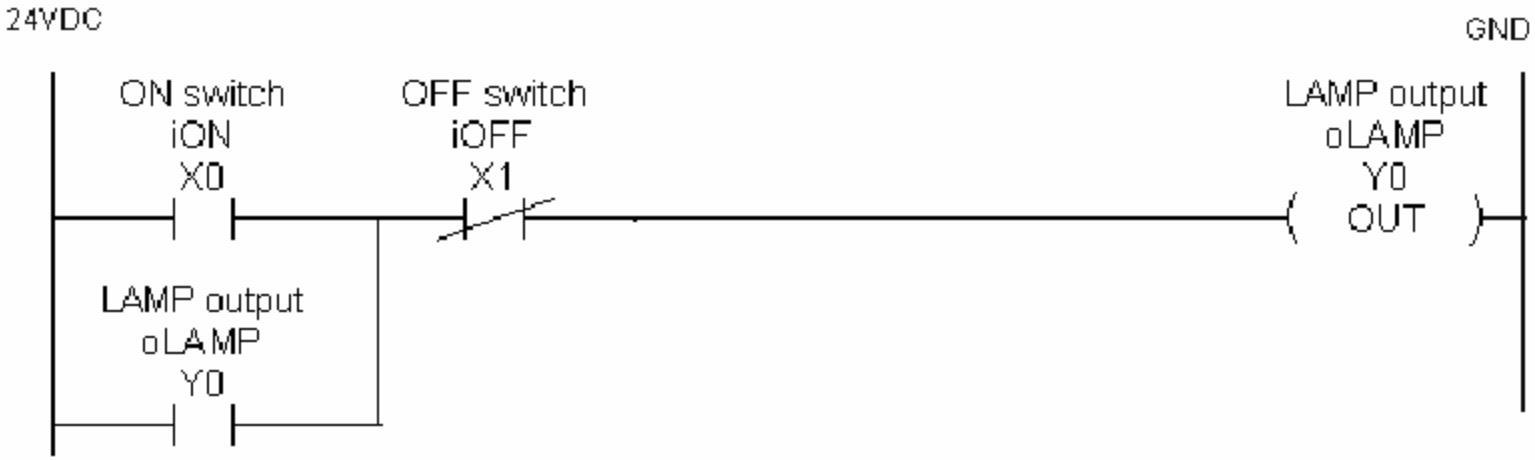
State Diagram





Logic Equation and Ladder Diagram

$$oLAMP = /iOFF \bullet (iON + oLAMP)$$



Example – Latching Relay Logic