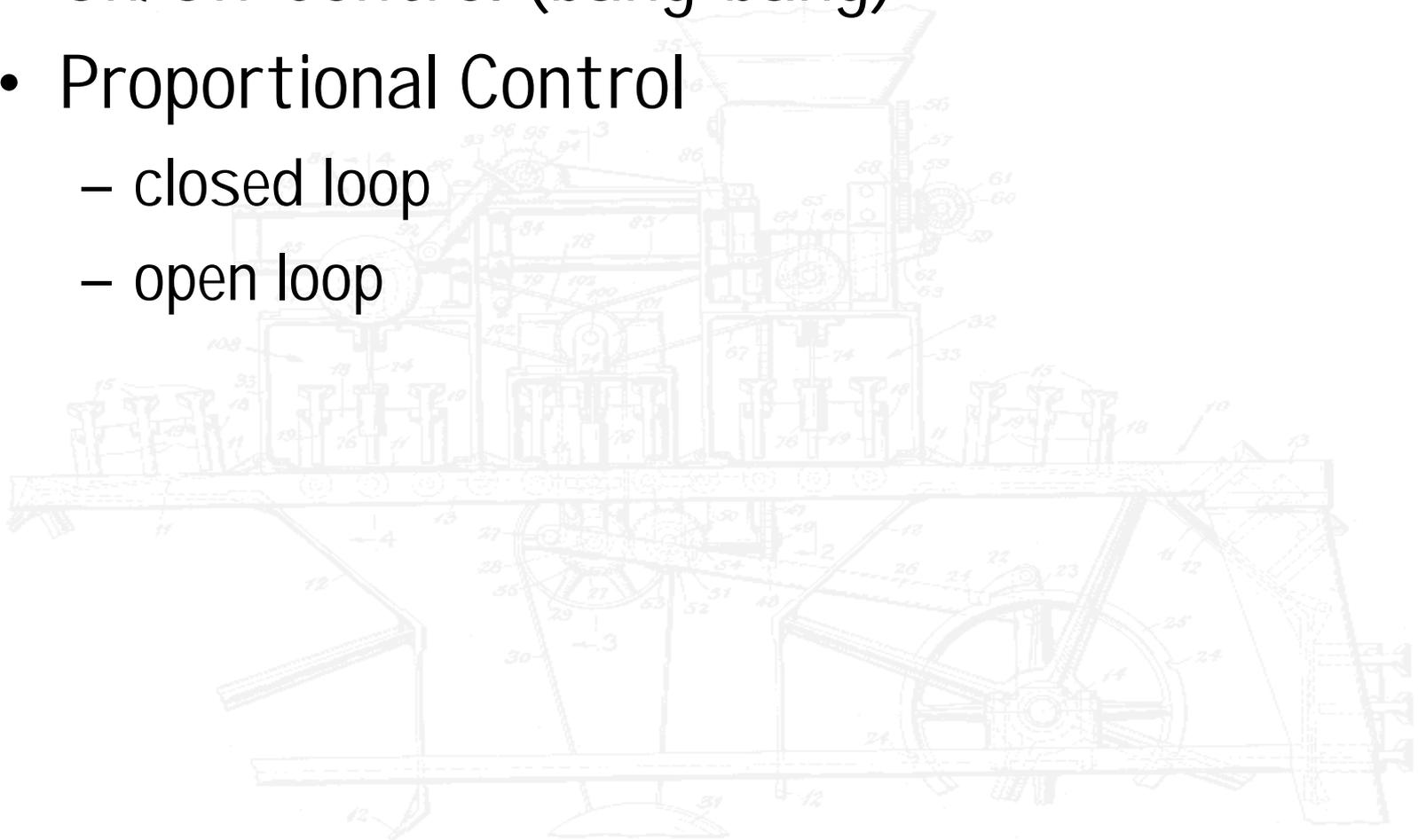


Control of Motion

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



Digital Logic Expressions

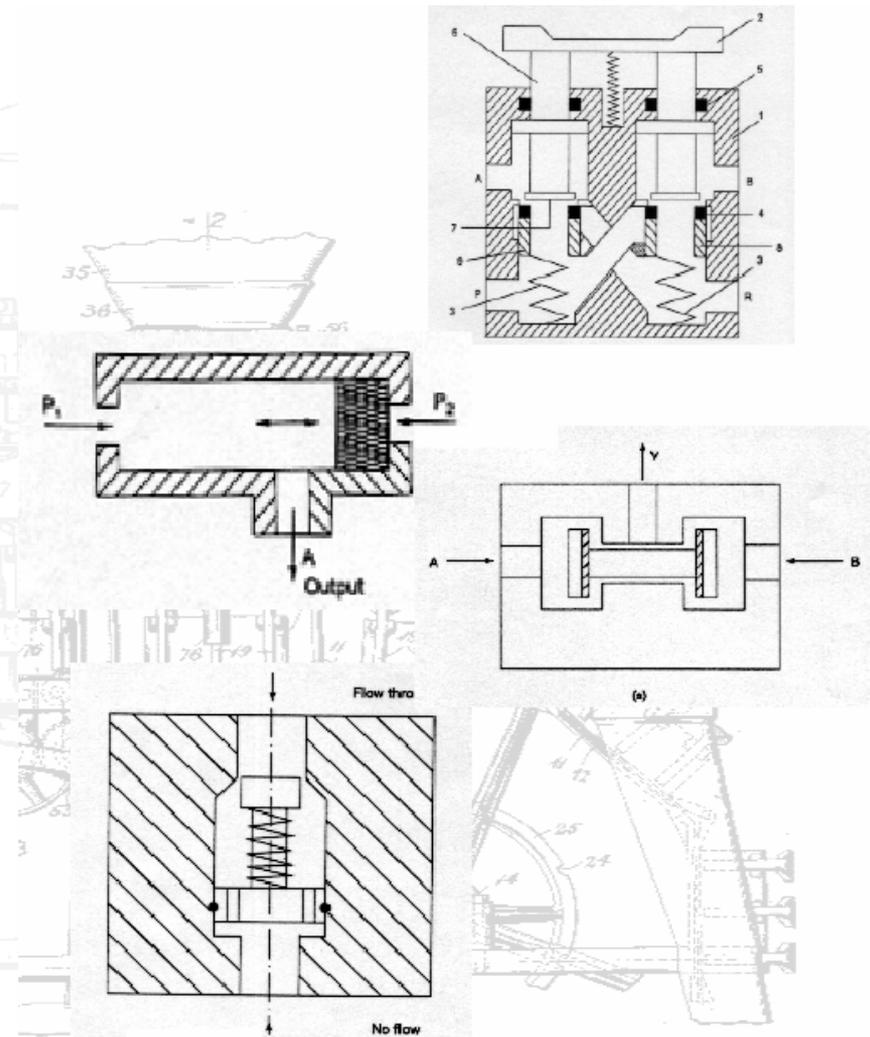
$$oCUT = (iPARTRDY \cdot iCYLRETRACT + oCUT \cdot /iCYLEXTEND) \cdot /iESTOP$$

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

- 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.

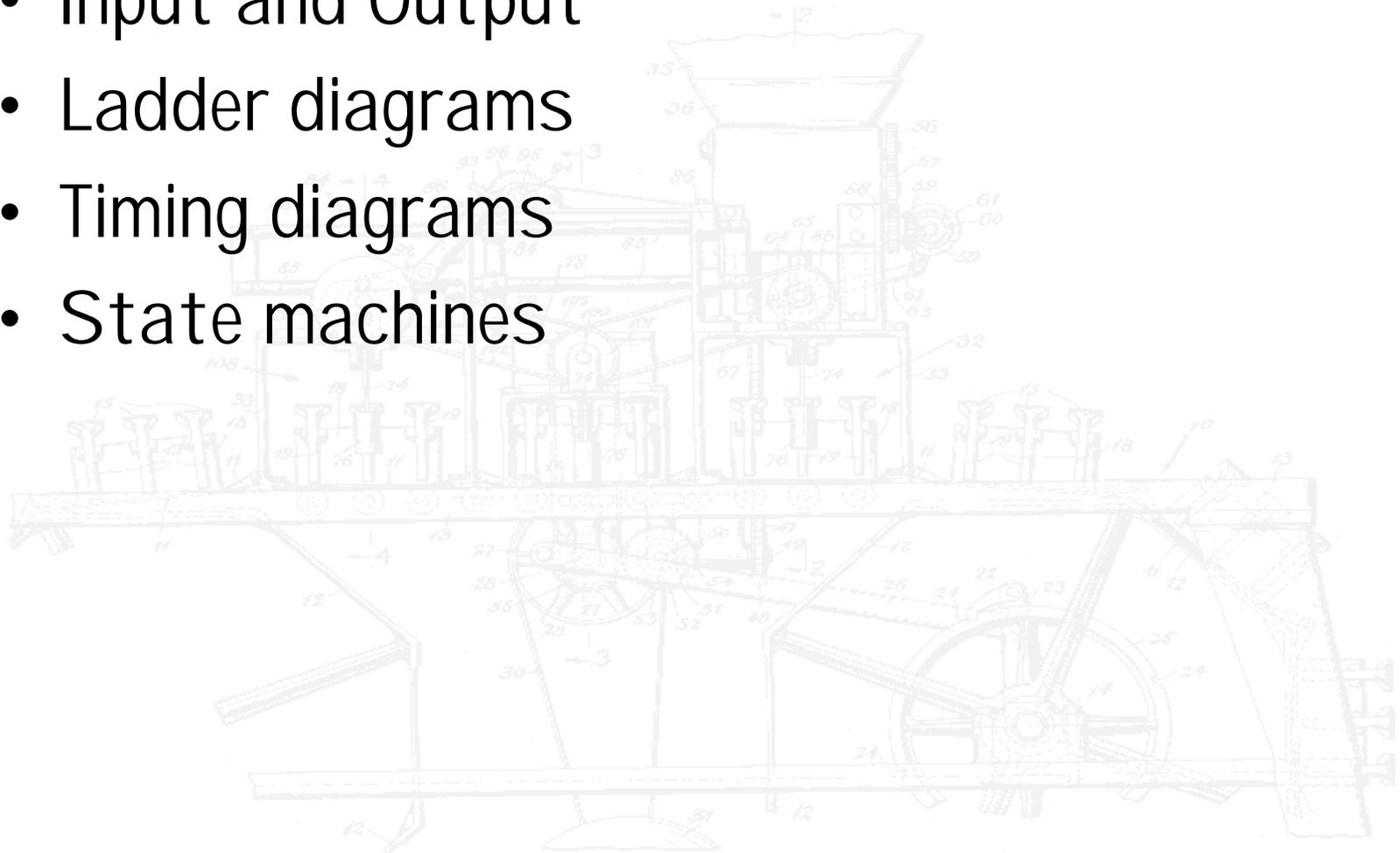
Pneumatic Logic Elements

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



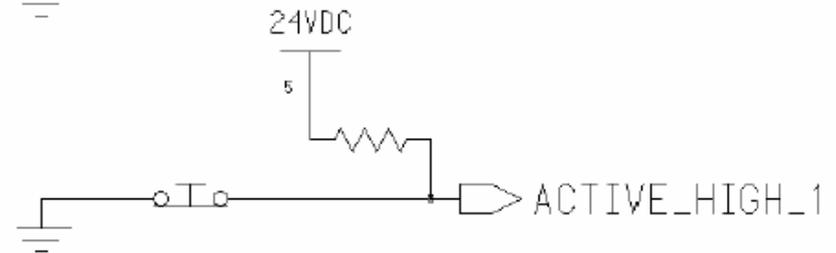
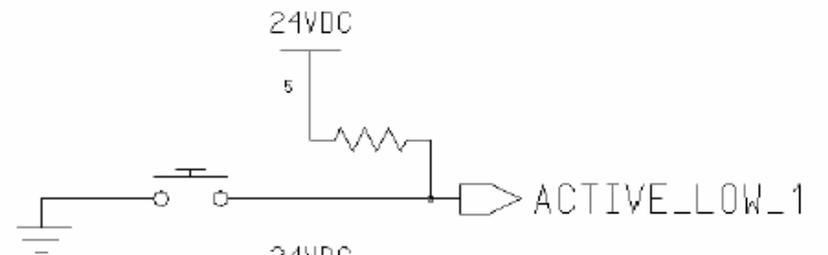
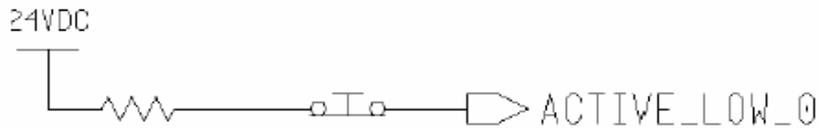
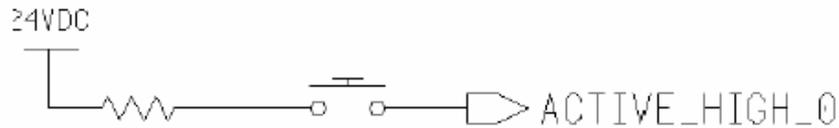
Electric Logic Control

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

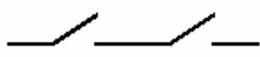
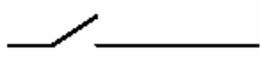
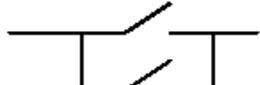
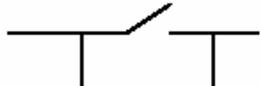
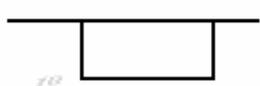


I/O Activity Levels

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



Boolean Arithmetic

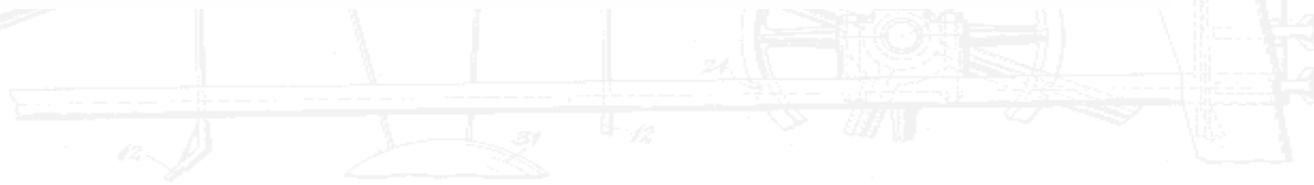
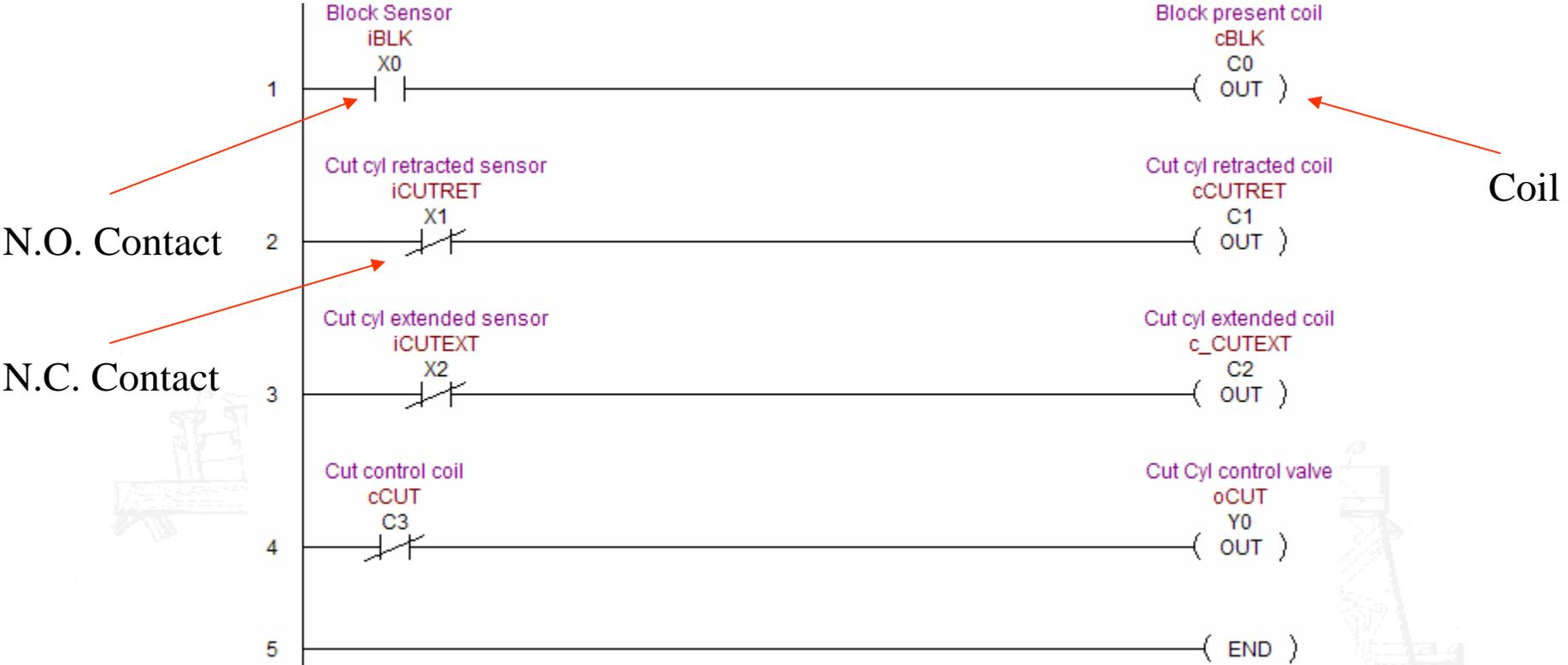
- 0 and 0 = 0 ($0 \cdot 0 = 0$) 
- 0 and 1 = 0 ($0 \cdot 1 = 0$) 
- 1 and 1 = 1 ($1 \cdot 1 = 1$) 
- 0 or 0 = 0 ($0 + 0 = 0$) 
- 0 or 1 = 1 ($0 + 1 = 1$) 
- 1 or 1 = 1 ($1 + 1 = 1$) 
- not 0 = 1 ($/0 = 1$)

$$A + /A = 1$$

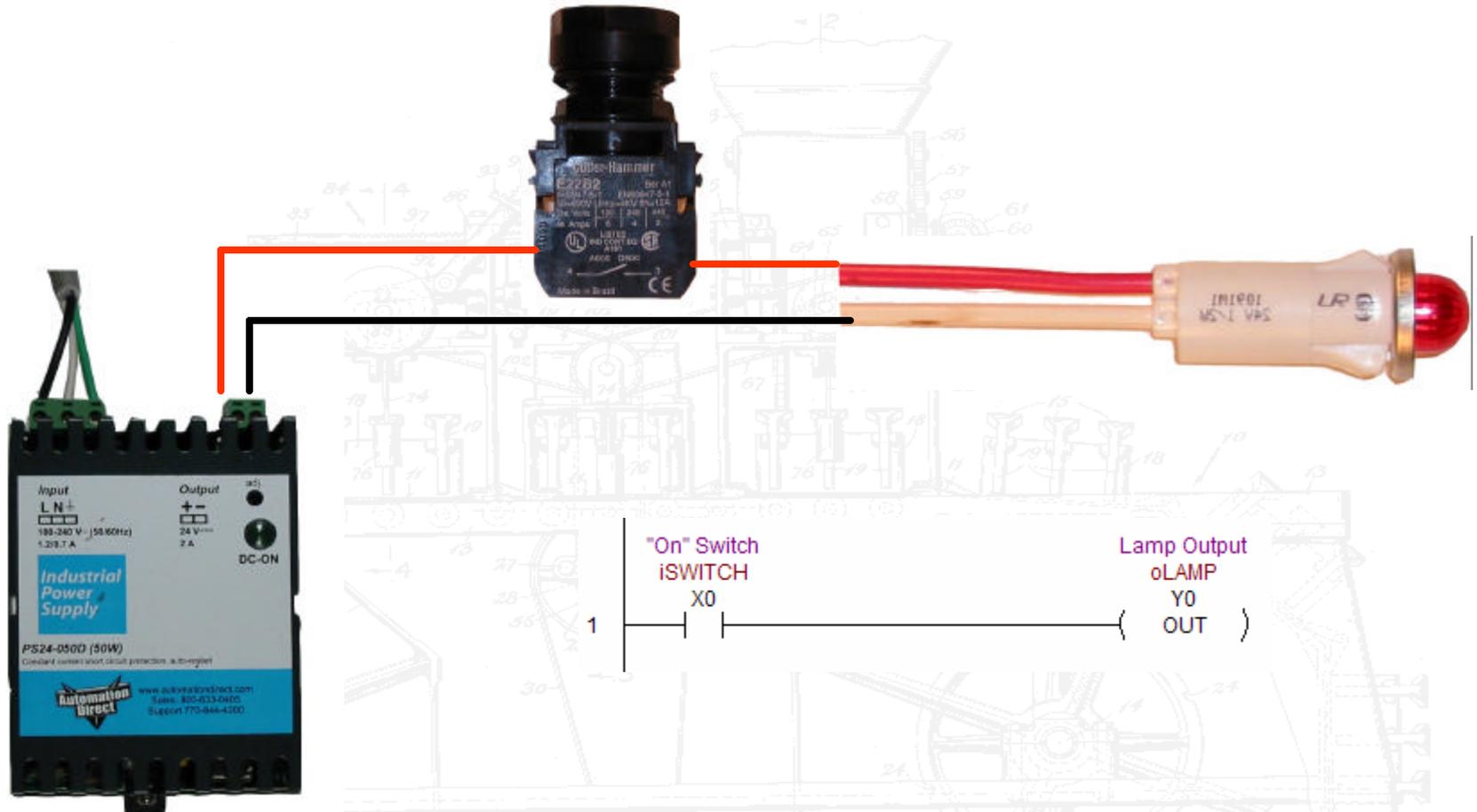
$$A \cdot B = B \cdot A$$

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

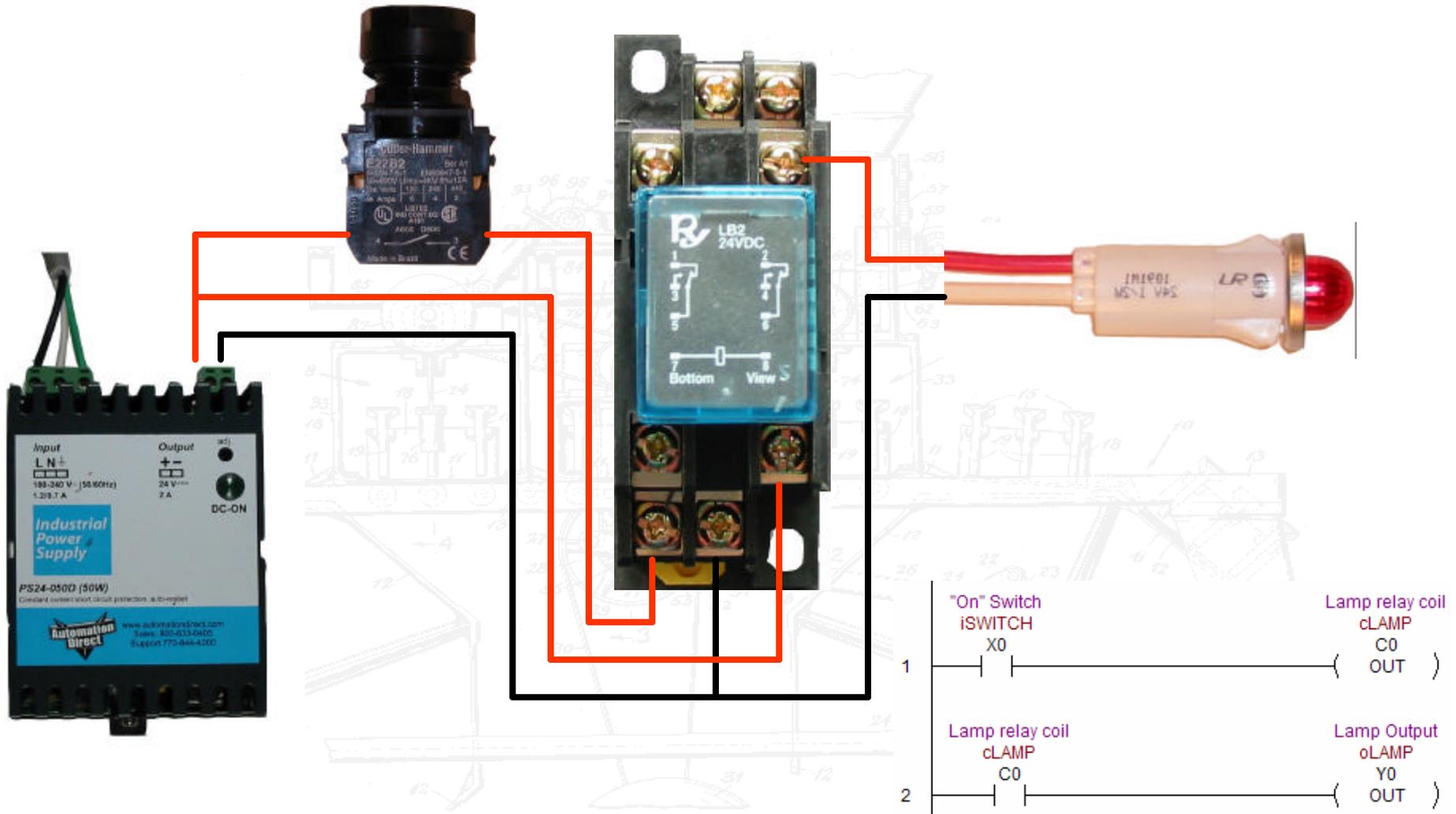
Ladder Diagrams



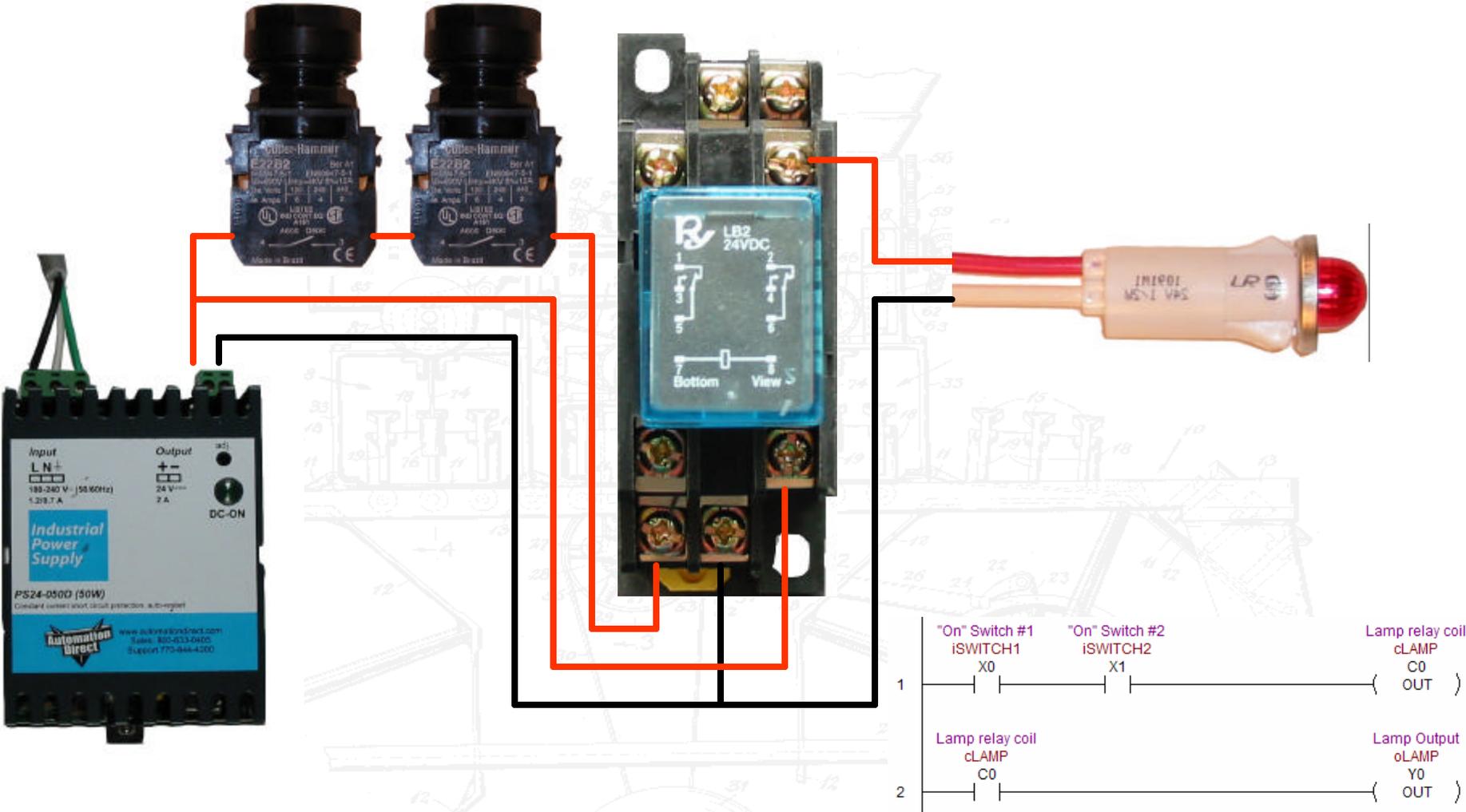
Example – Light Switch



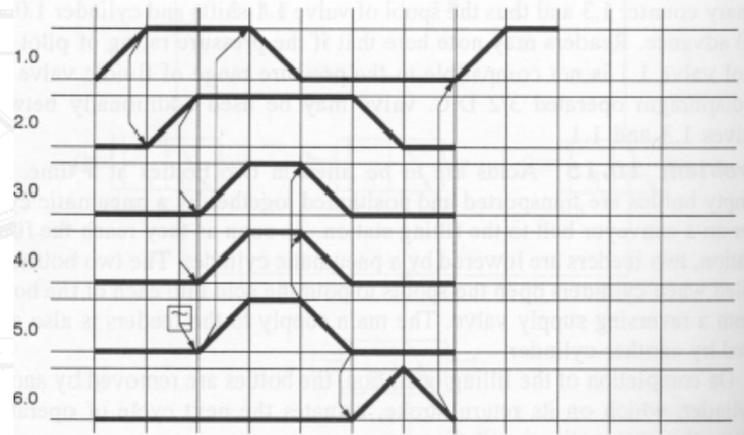
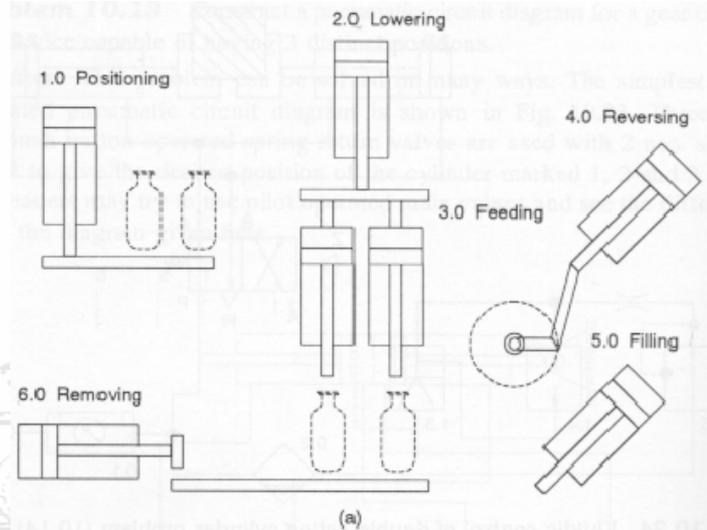
Example – Light Relay



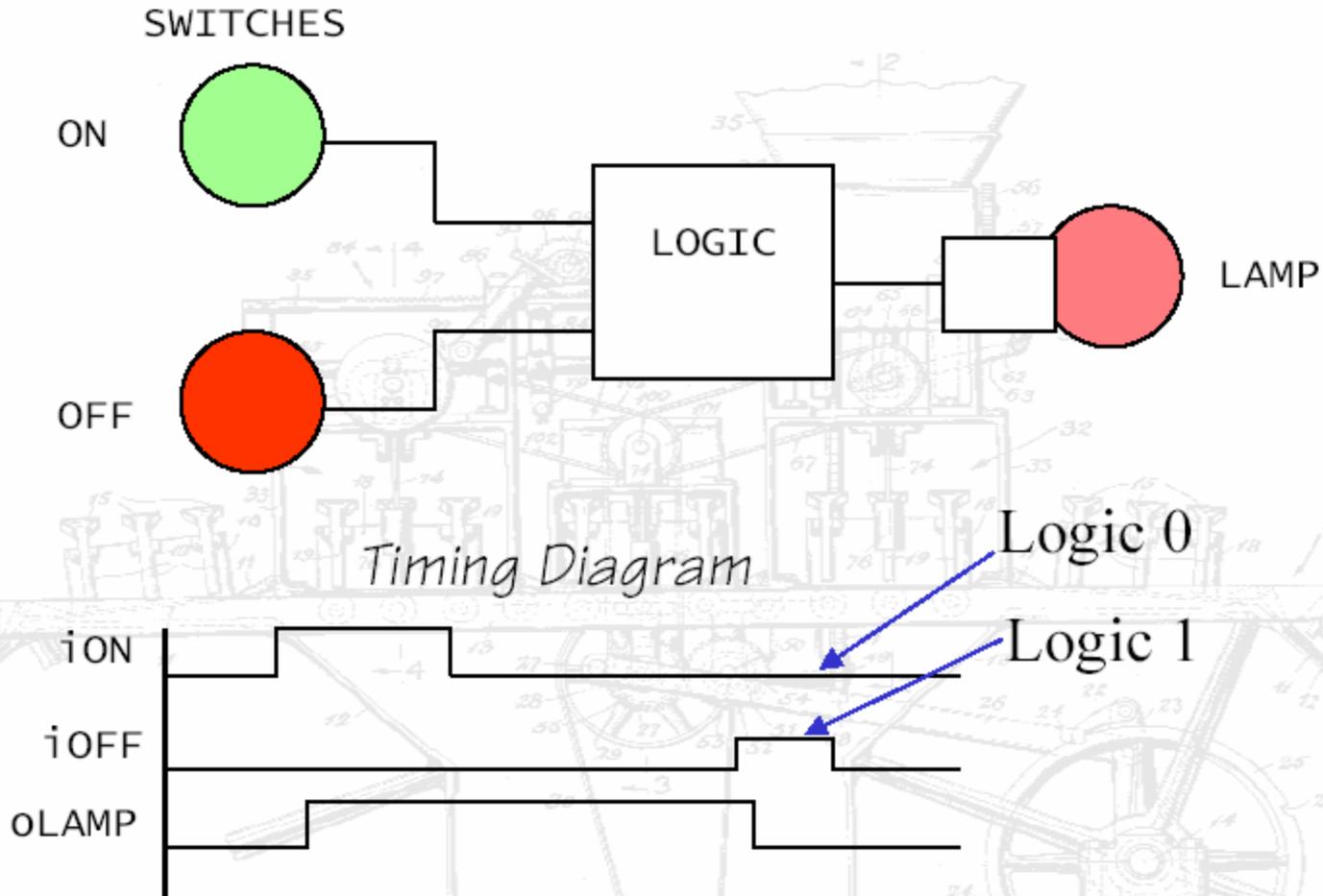
Example – Light Relay, “And” Logic



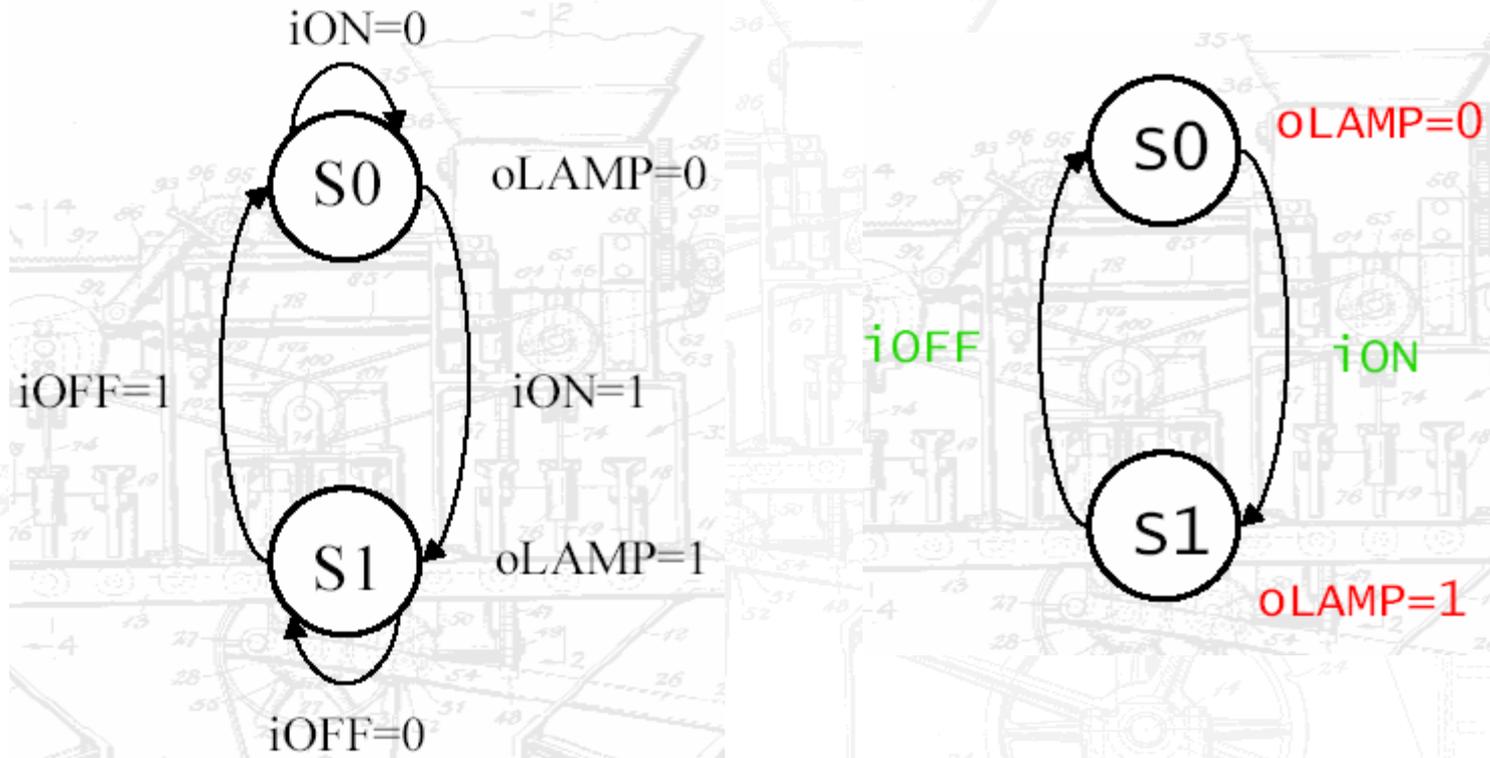
Timing Diagrams



State Machines



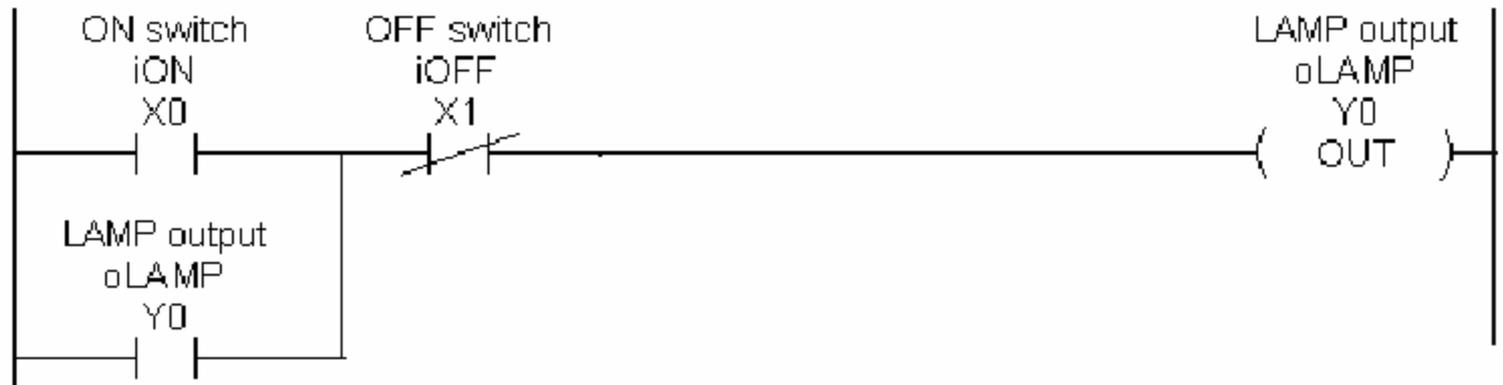
State Diagram



Logic Equation and Ladder Diagram

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

24VDC



Example – Latching Relay Logic

