

Control of Motion

- Discrete Motion
 - On/off control
 - Simple logic
- Proportional Motion
 - Trajectories, velocities, acceleration
 - Open loop or closed loop

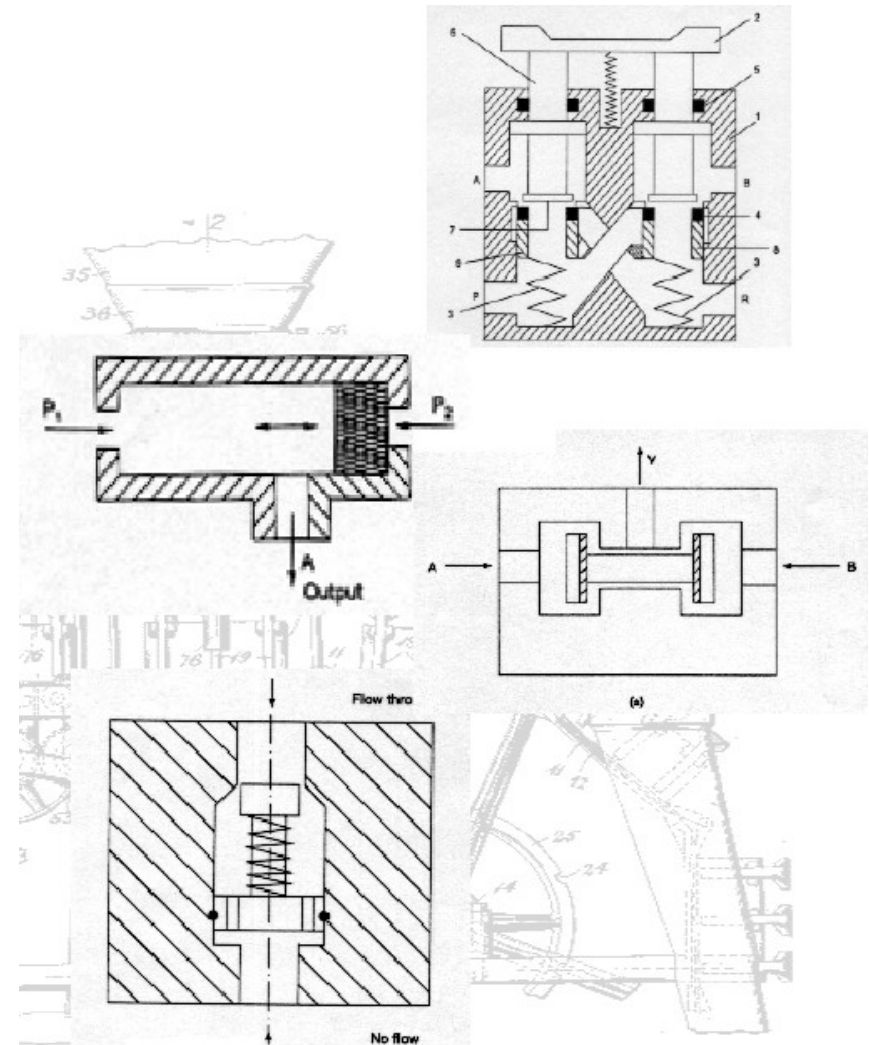
Digital Logic Expressions

$$\begin{aligned} oPICK &= iPARTRDY \cdot iCYLRETRACT \cdot /iESTOP \\ &+ oPICK \cdot /iCYLEXTEND \cdot /iESTOP \end{aligned}$$

- Pickup 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








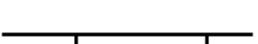

Mechanical Logic Gates

https://www.youtube.com/watch?v=5X_Ft4YR_wU

Electric Logic Elements

- wired in series = AND
- wired in parallel = OR
- Relay = NOT

Boolean Arithmetic

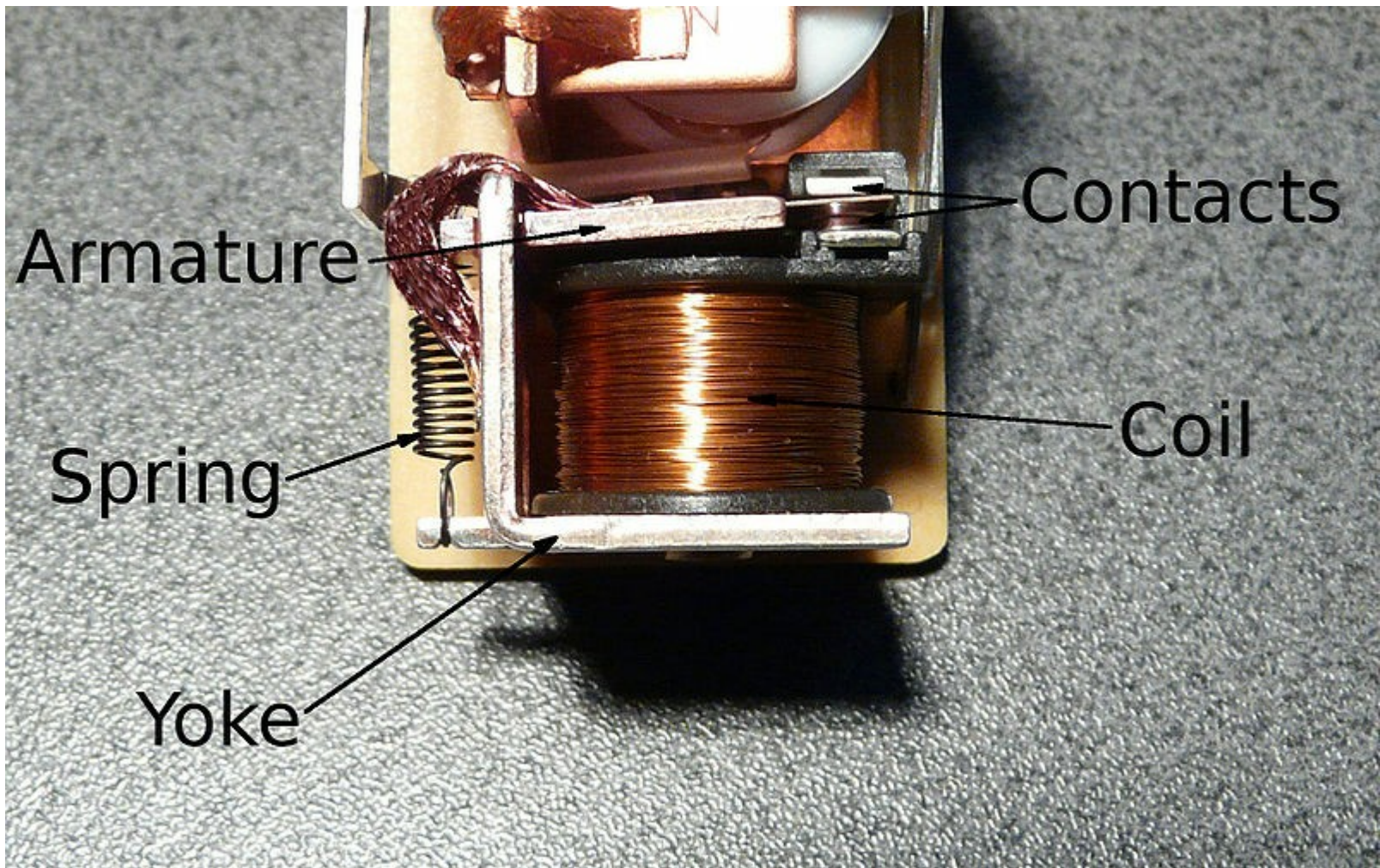
- $0 \text{ and } 0 = 0$ ($0 \cdot 0 = 0$) 
- $0 \text{ and } 1 = 0$ ($0 \cdot 1 = 0$) 
- $1 \text{ and } 1 = 1$ ($1 \cdot 1 = 1$) 
- $0 \text{ or } 0 = 0$ ($0 + 0 = 0$) 
- $0 \text{ or } 1 = 1$ ($0 + 1 = 1$) 
- $1 \text{ or } 1 = 1$ ($1 + 1 = 1$) 
- $\text{not } 0 = 1$ ($/0 = 1$) 

$$A + /A = 1$$

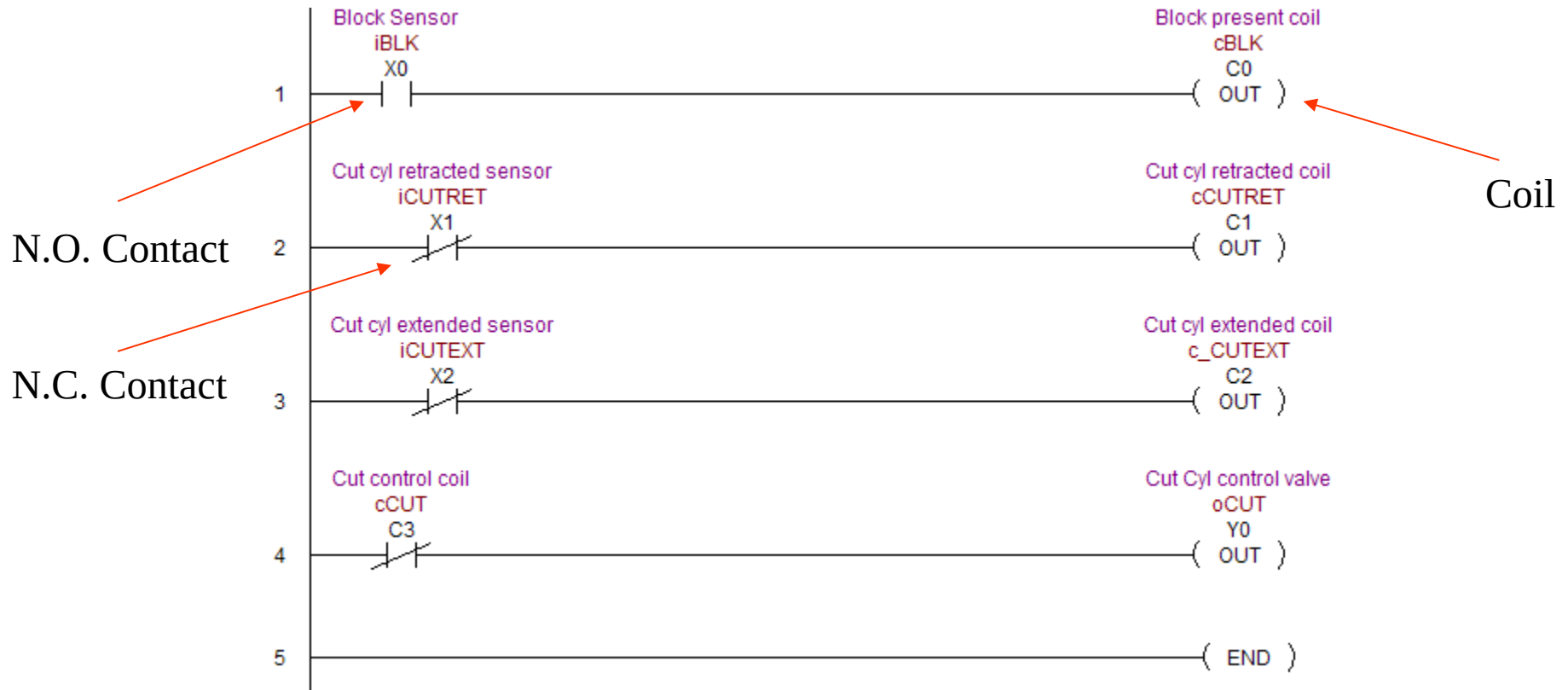
$$A \cdot B = B \cdot A$$

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

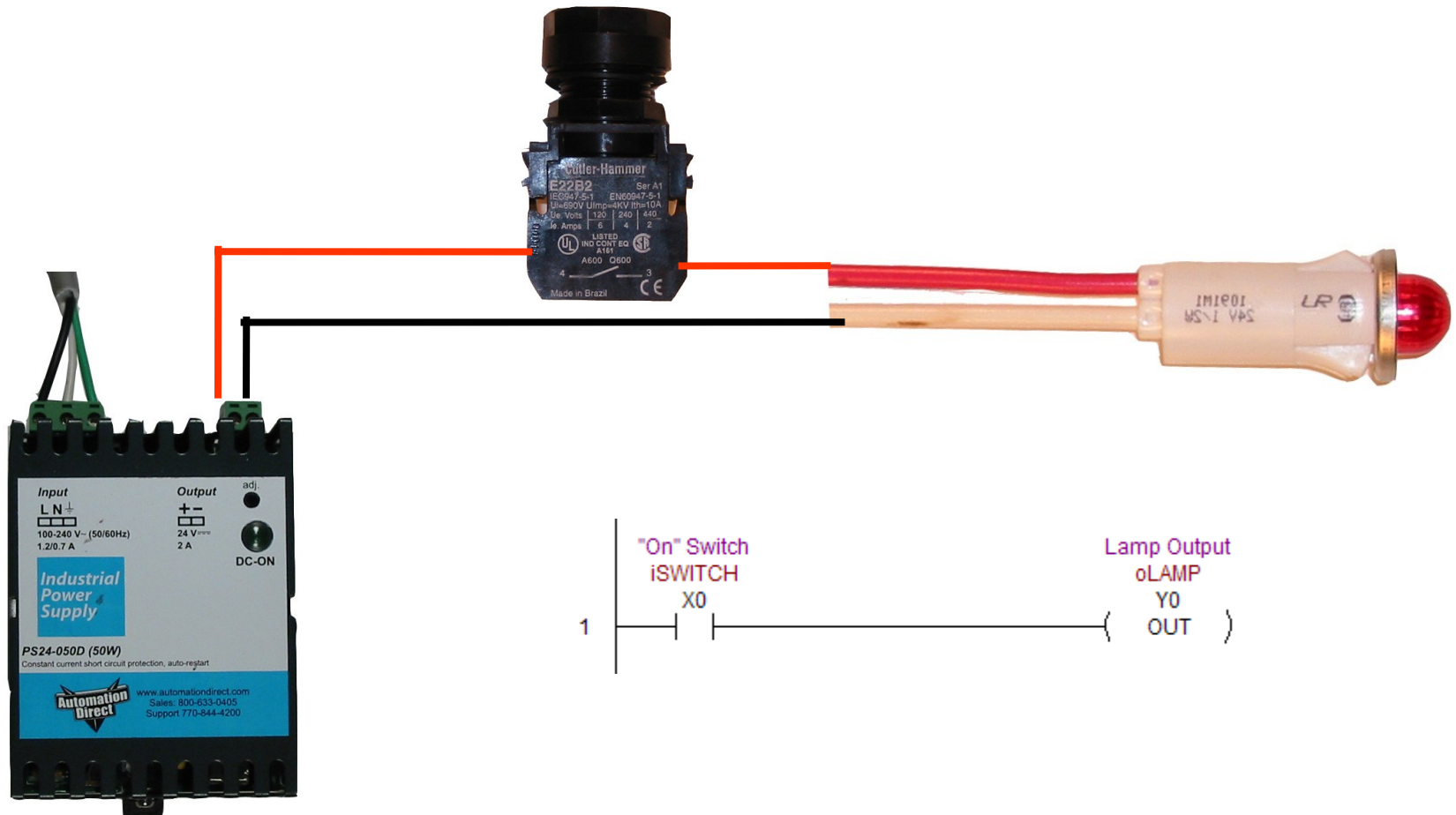
Relays



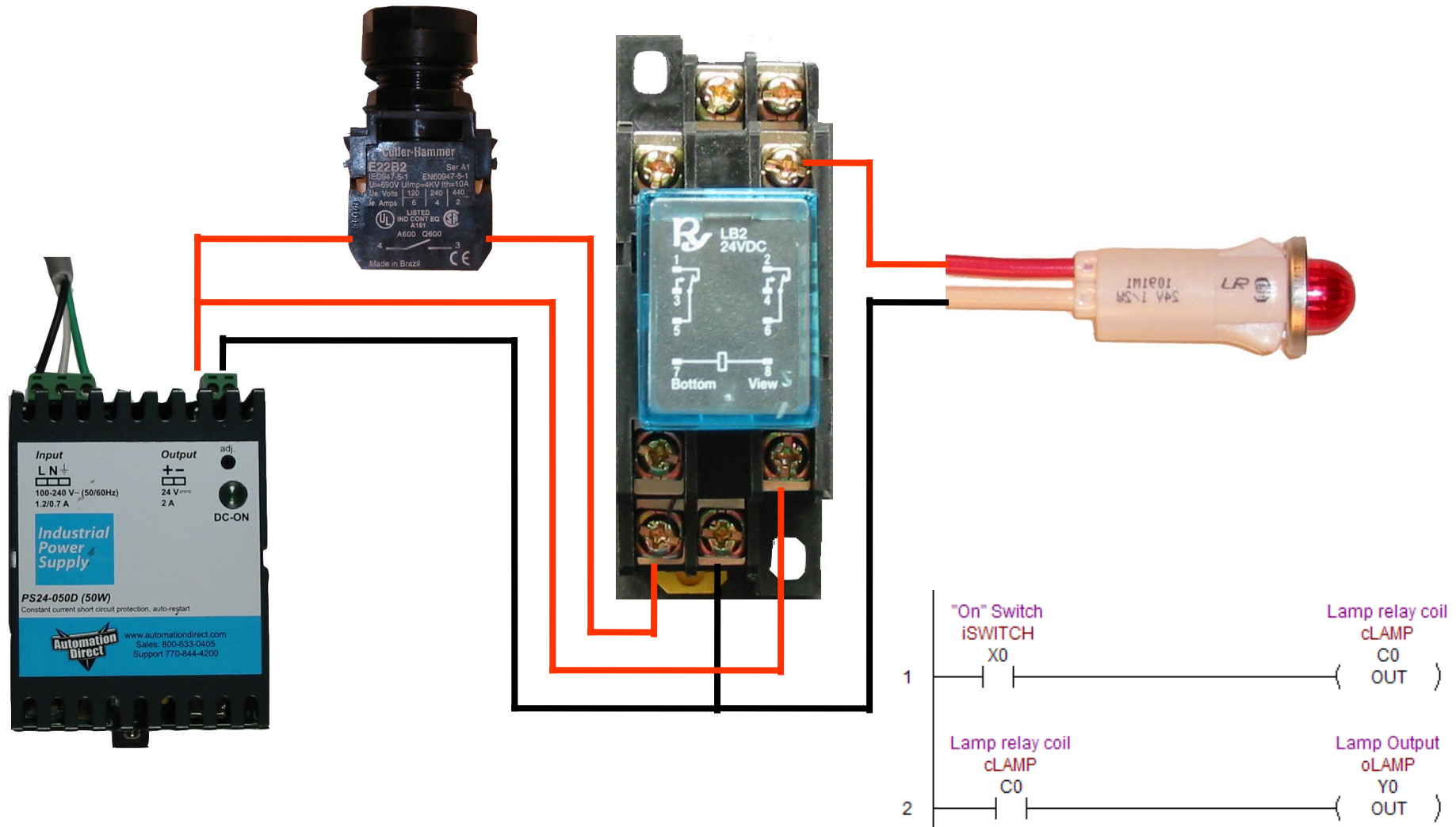
Ladder Diagrams



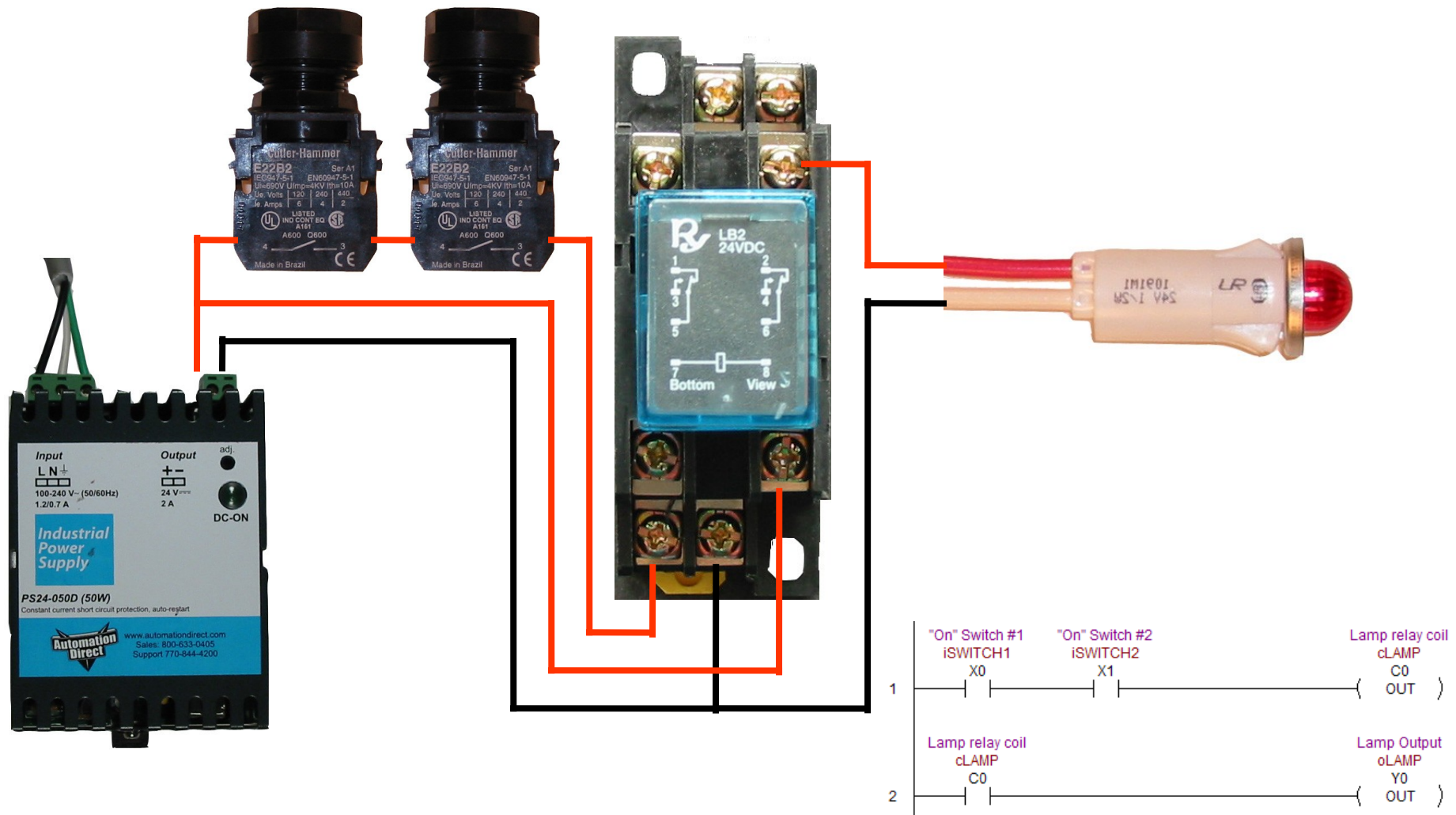
Example – Light Switch



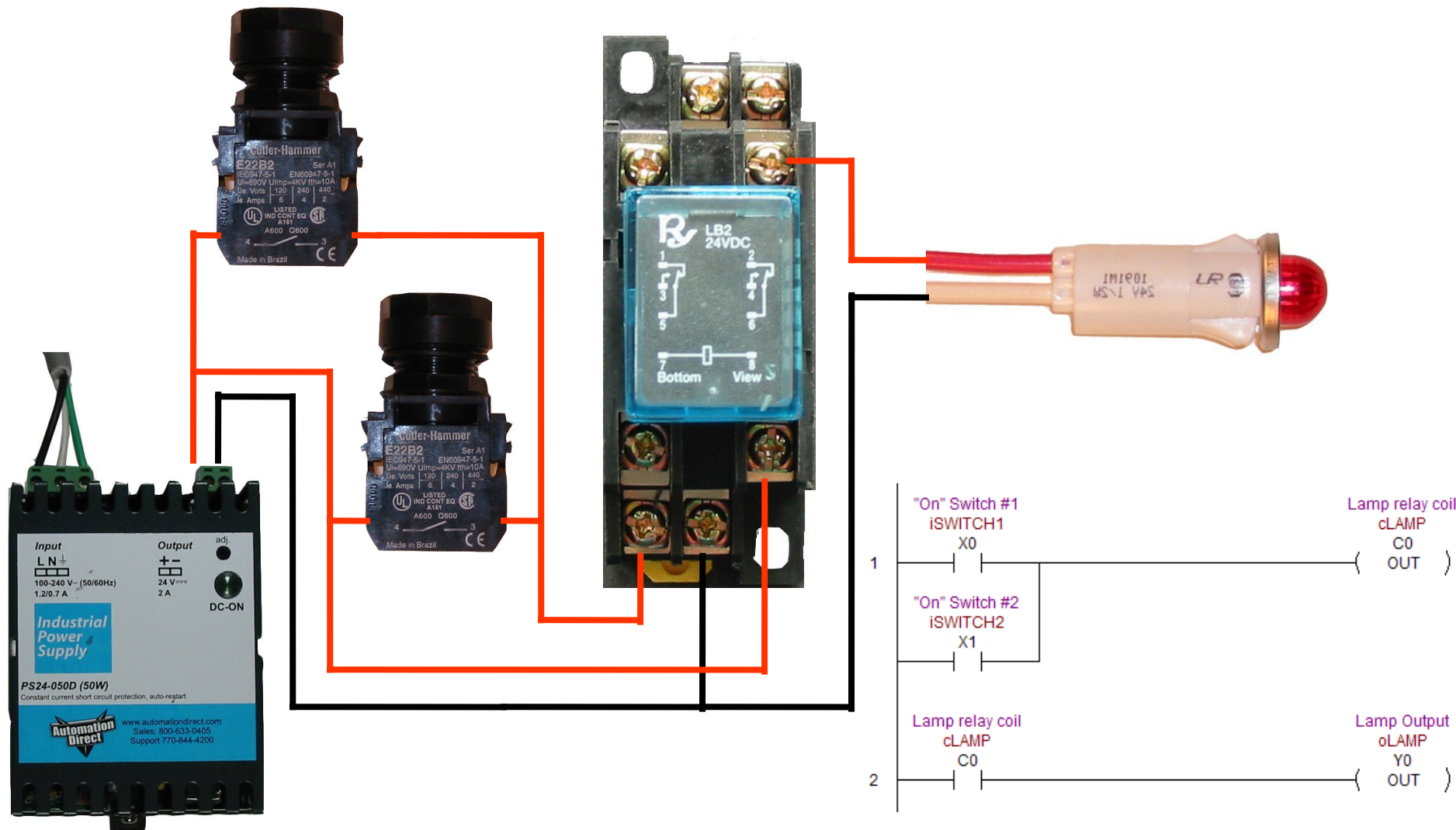
Example – Light Relay



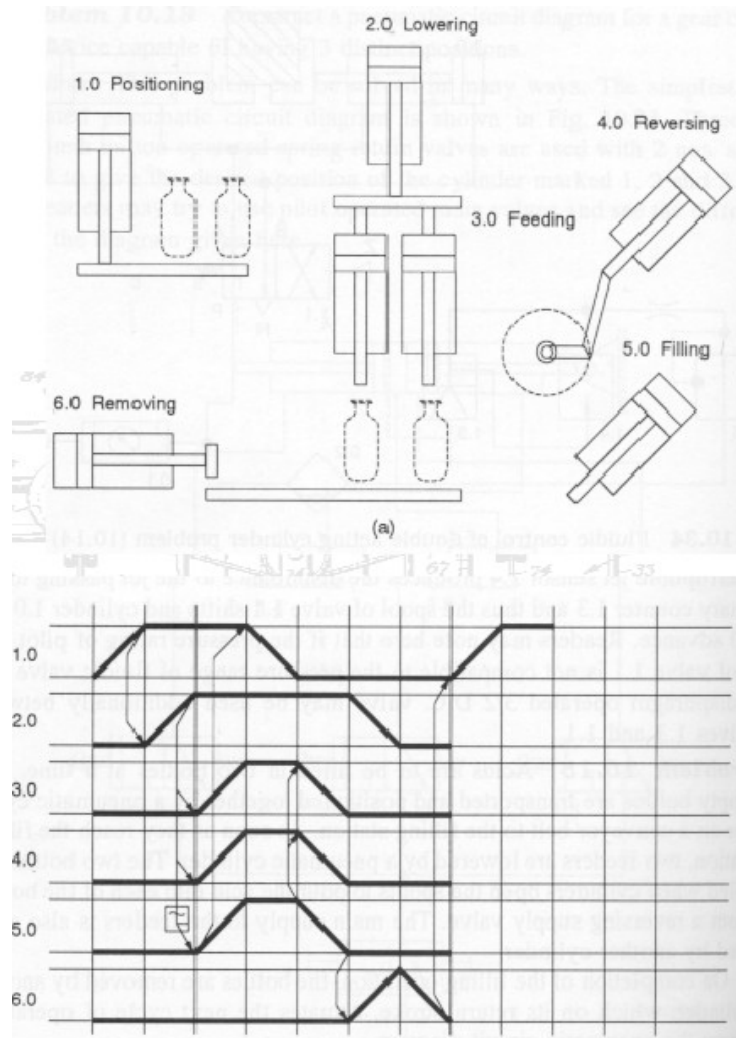
Example – Light Relay, “And” Logic



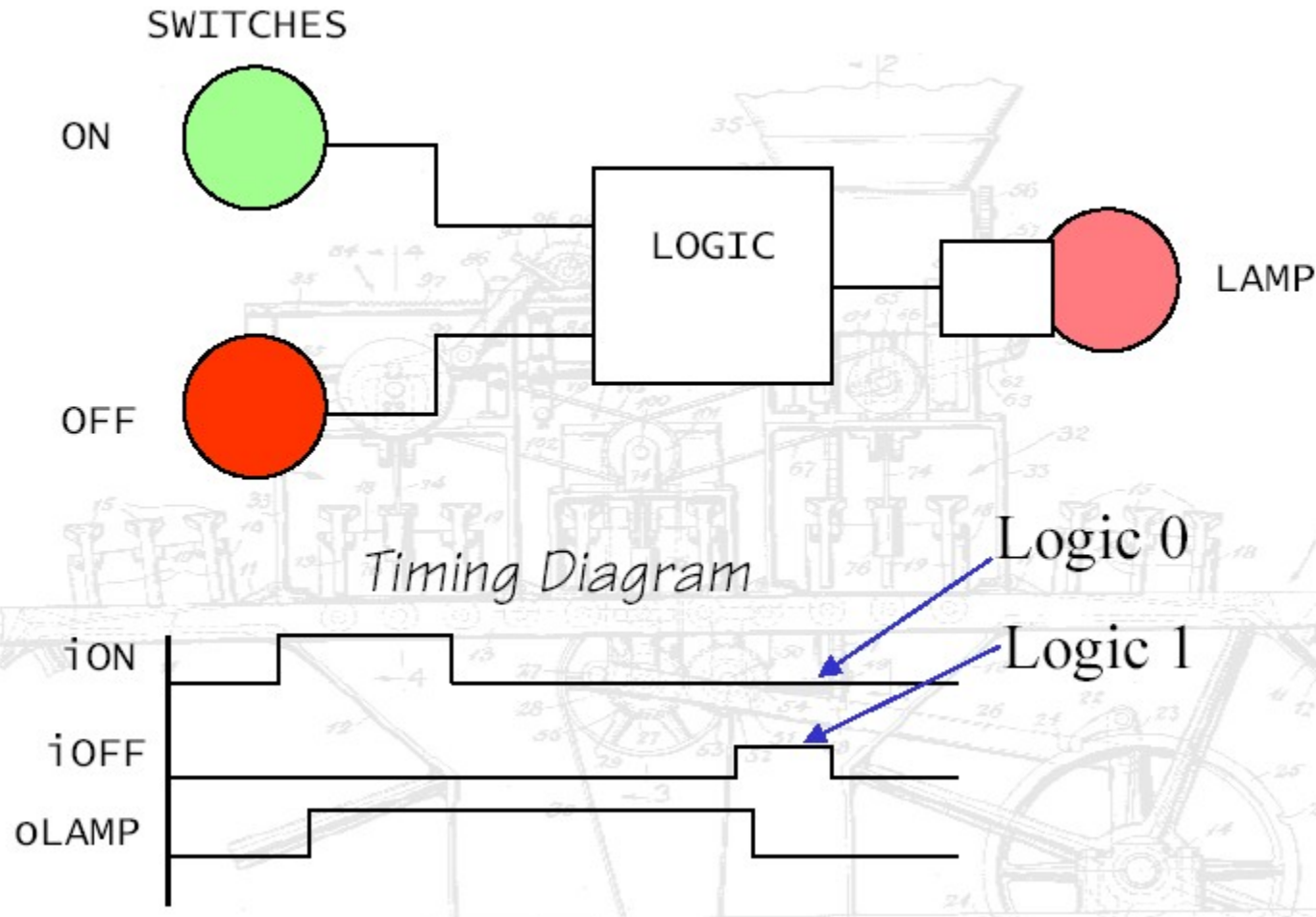
Example – Light Relay – “OR” Logic



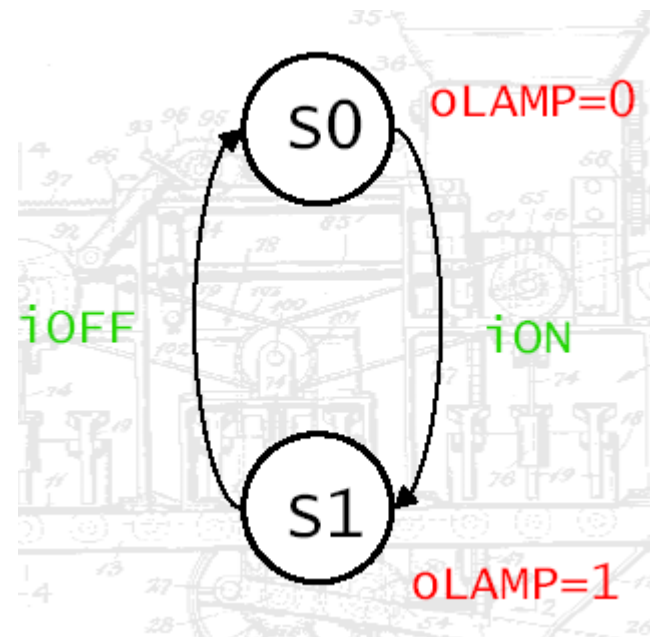
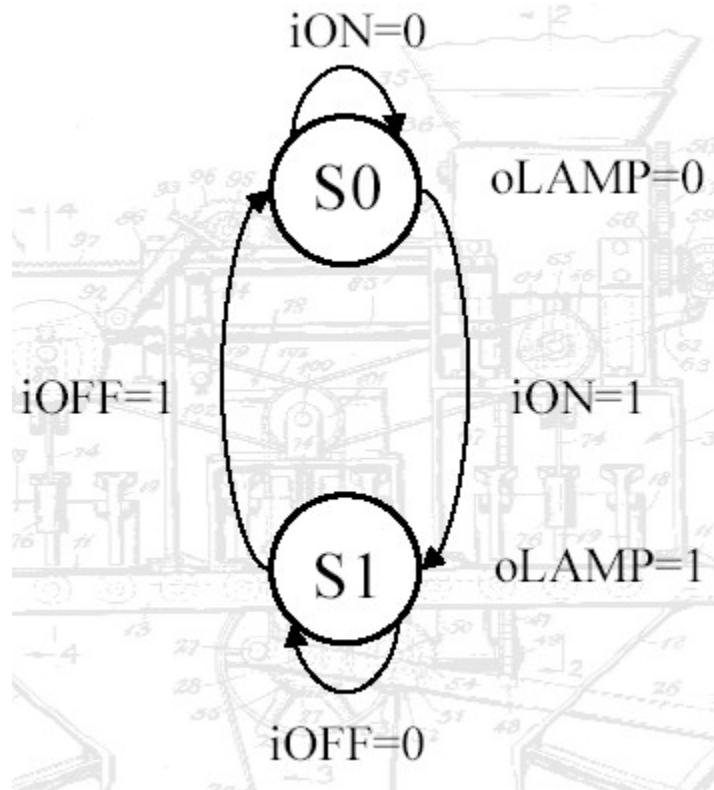
Timing Diagrams



State Machines



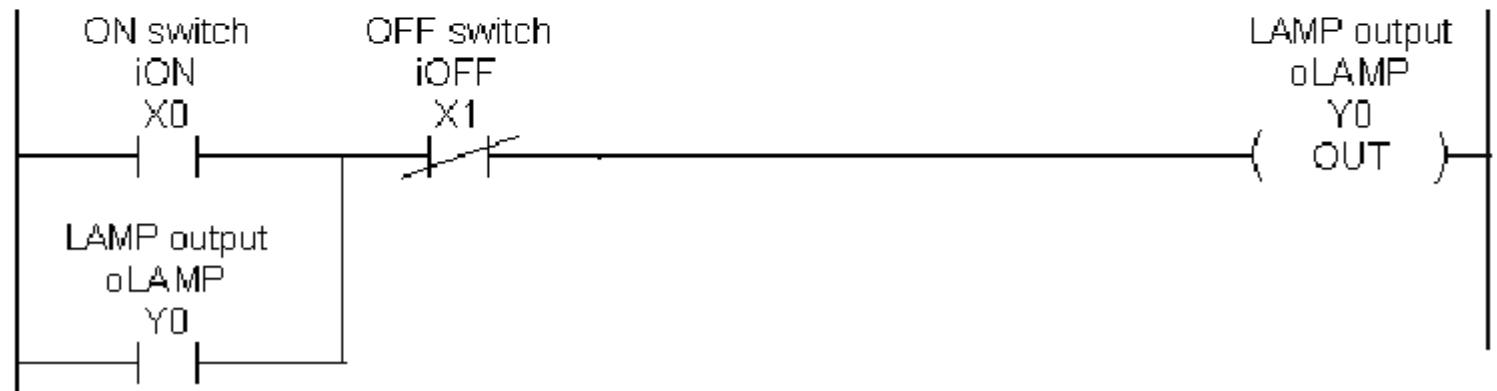
State Diagram



Logic Equation and Ladder Diagram

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

24VDC



Example – Latching Relay Logic

