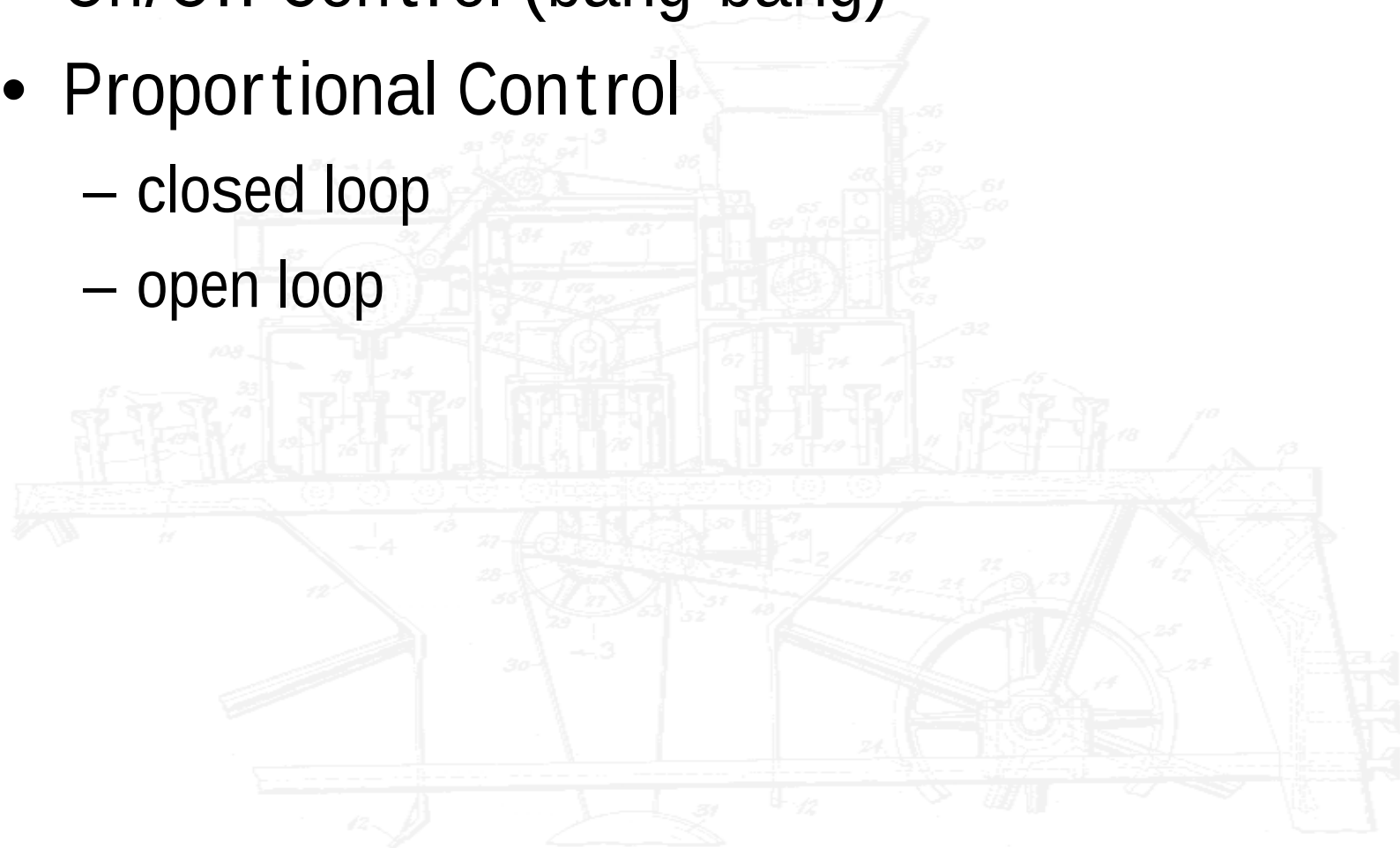
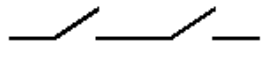
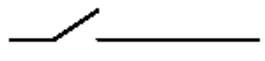
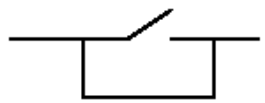
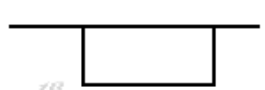
Control of Motion

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



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 · B = B · A

A · B + A · C = A · (B+C)

Digital Logic Expressions

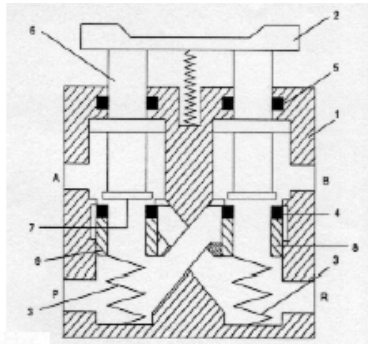
$$oCUT = (iPARTRDY \cdot iCYLRETRACT + oCUT \cdot /iCYLEXTEND) \cdot /iESTOP$$

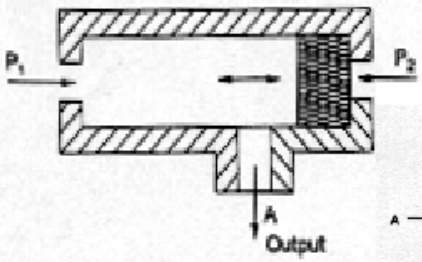
$$oCUT = iPARTRDY \cdot iCYLRETRACT \cdot /iESTOP + oCUT \cdot /iCYLEXTEND \cdot /iESTOP$$

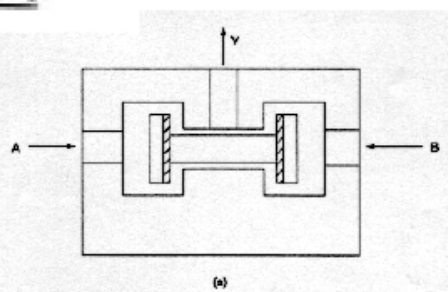
- When part is ready, cylinder is retracted, and emergency stop is not on, then cut while cylinder is not fully extended and emergency stop is not on.

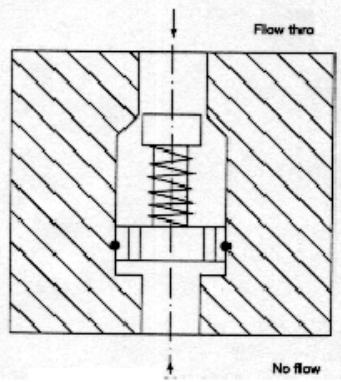
Pneumatic Logic Elements

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

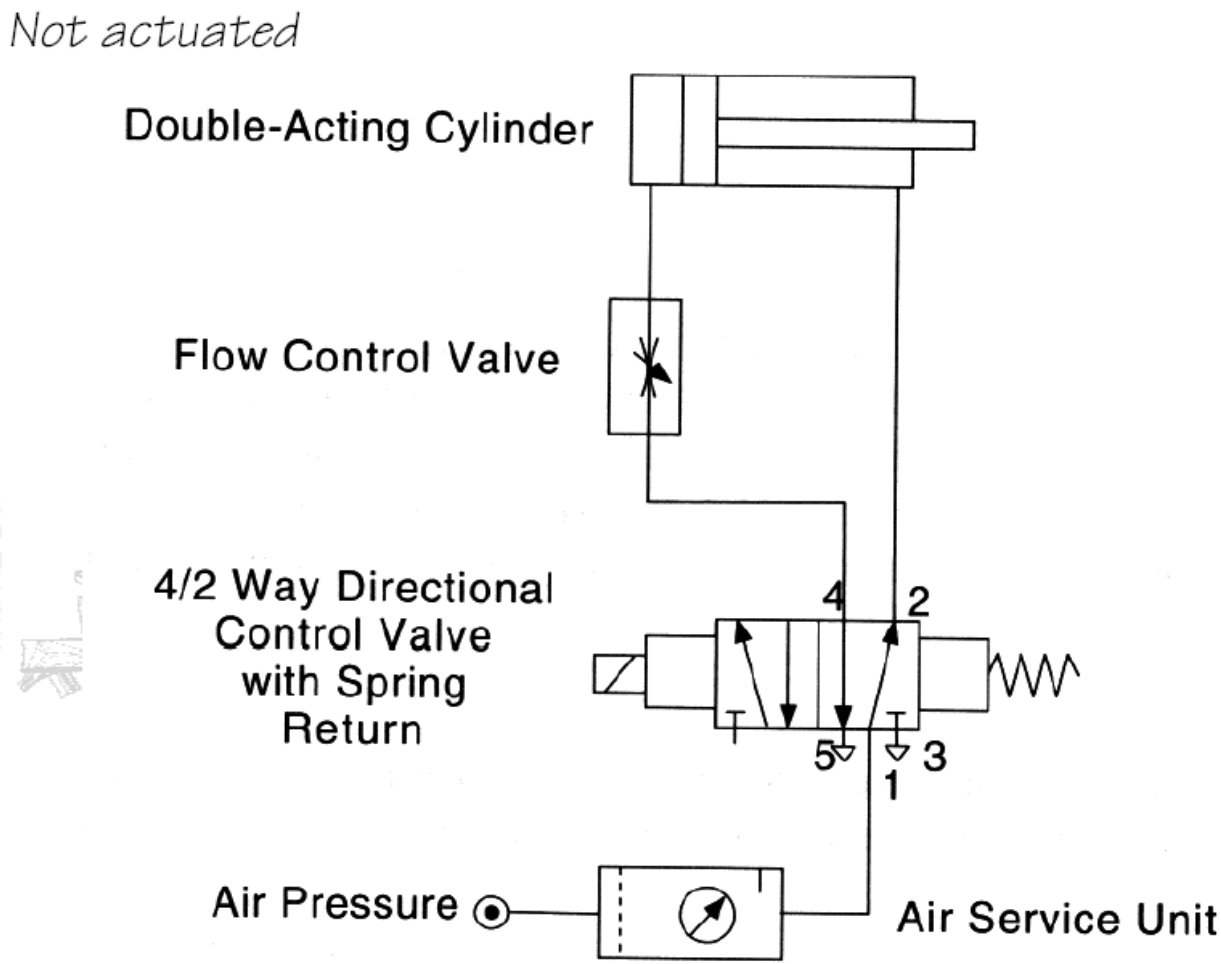




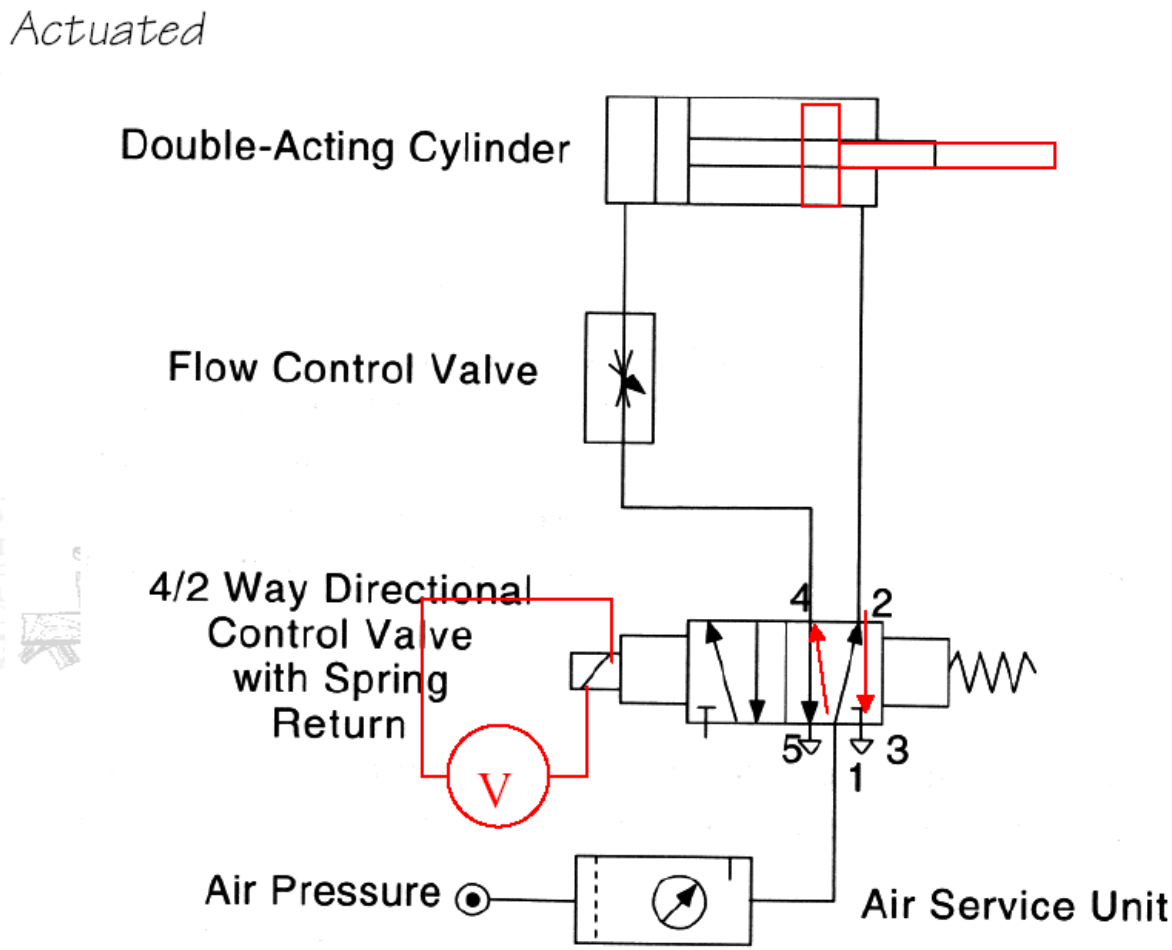




Pneumatic Schematics

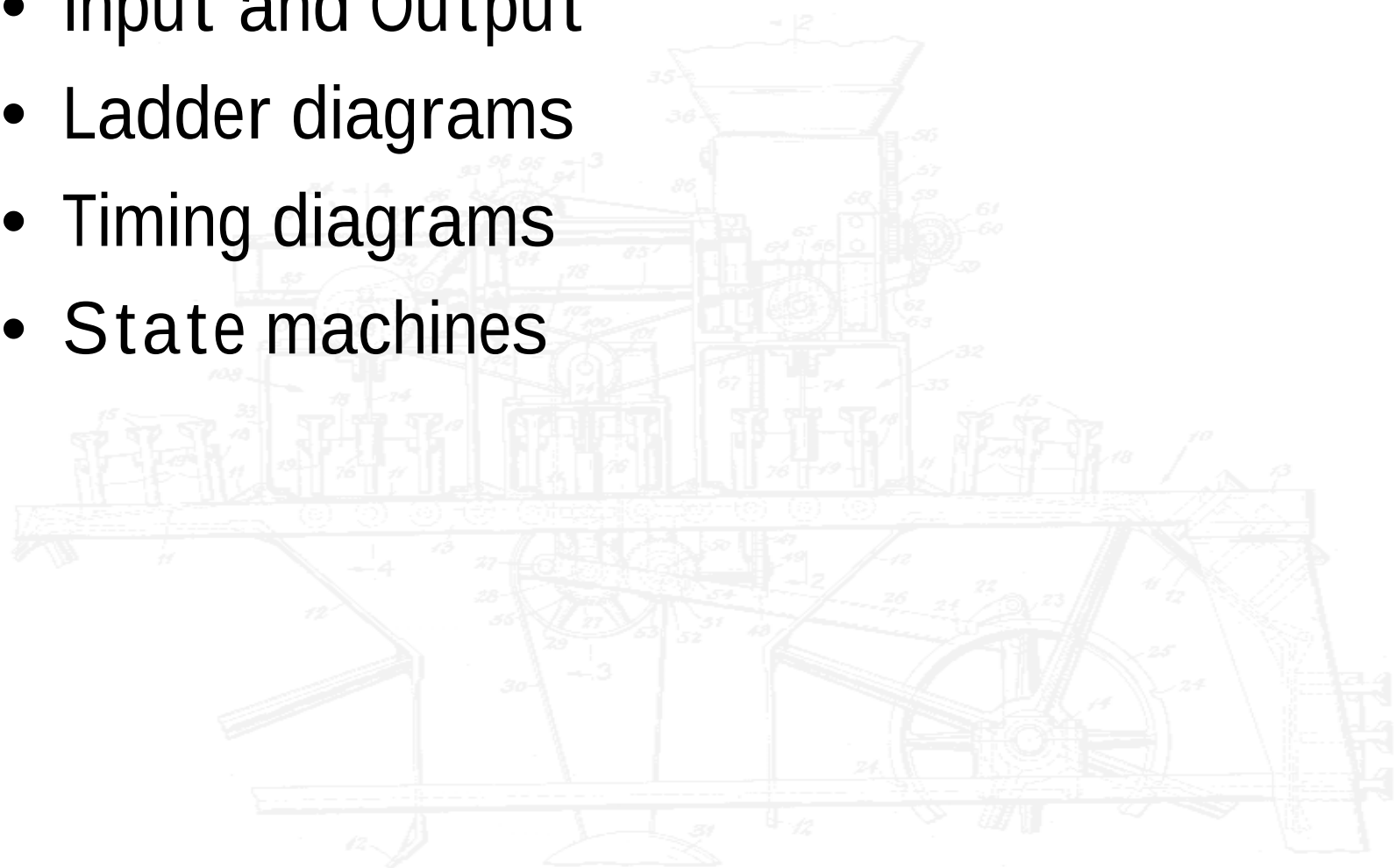


Pneumatic Schematics



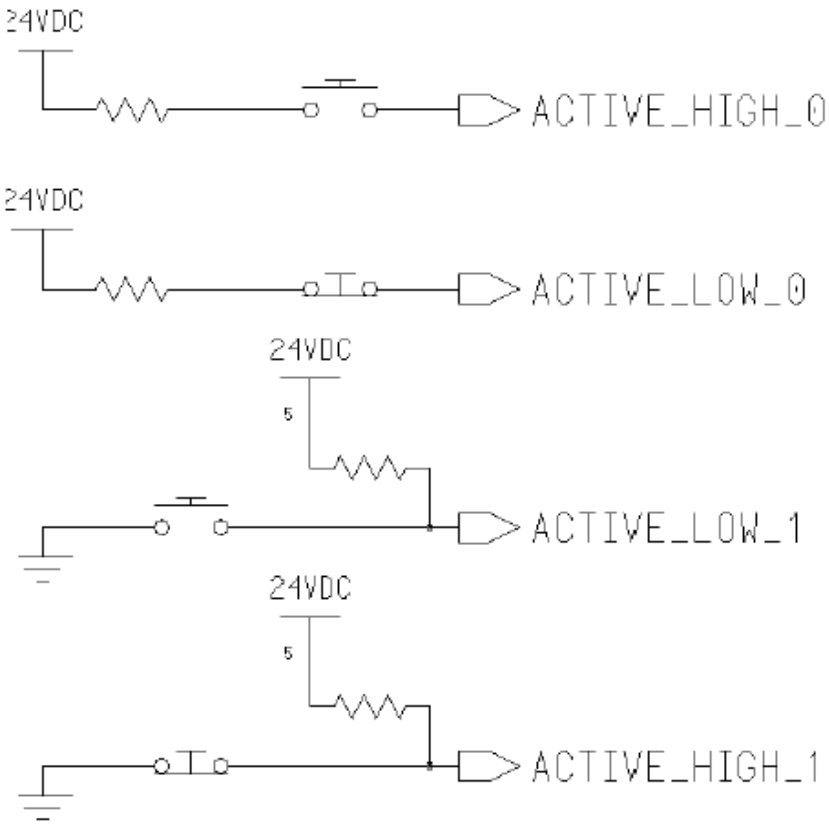
Electric Logic Control

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

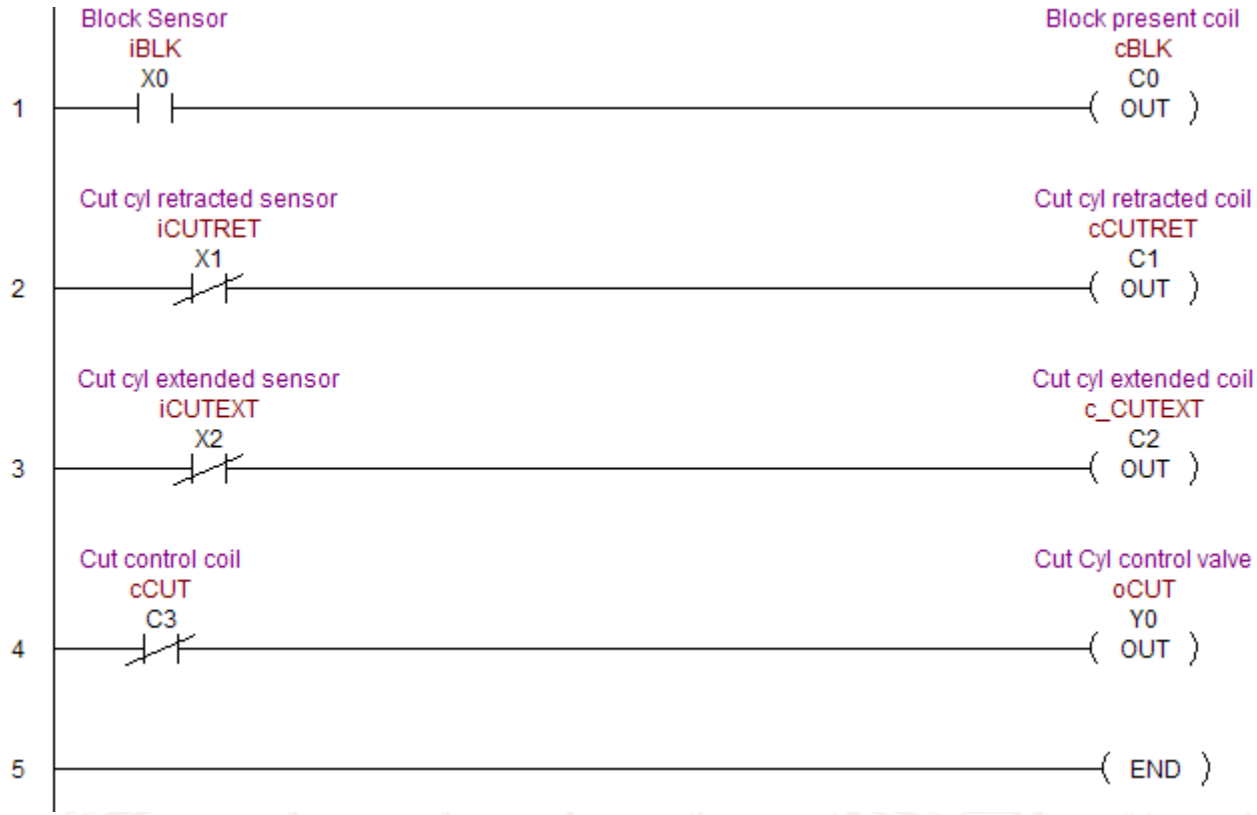


I/O Activity Levels

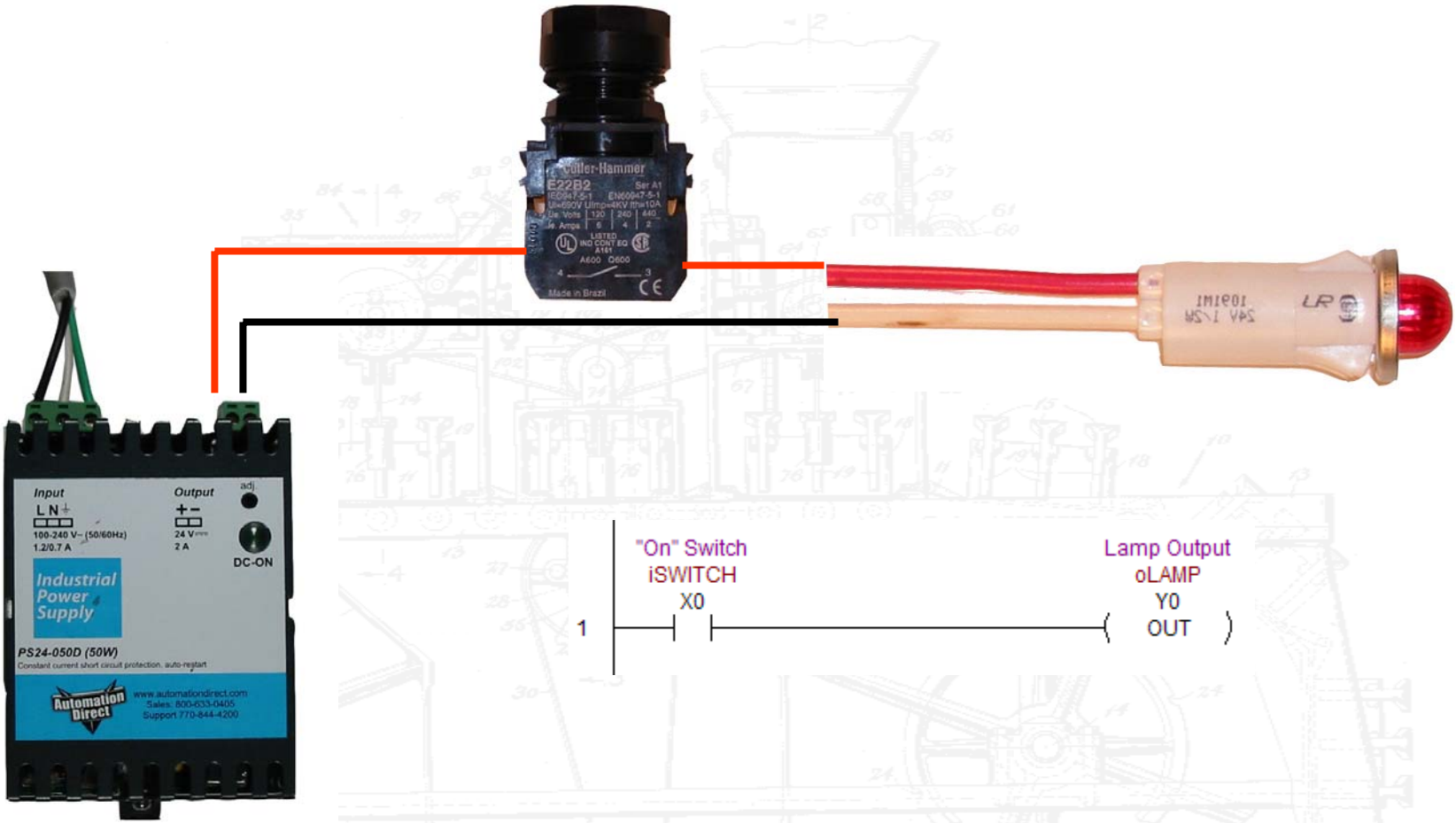
- Active High - active level is logic 1 (+V)
- Active Low - active level is logic 0 (GND)



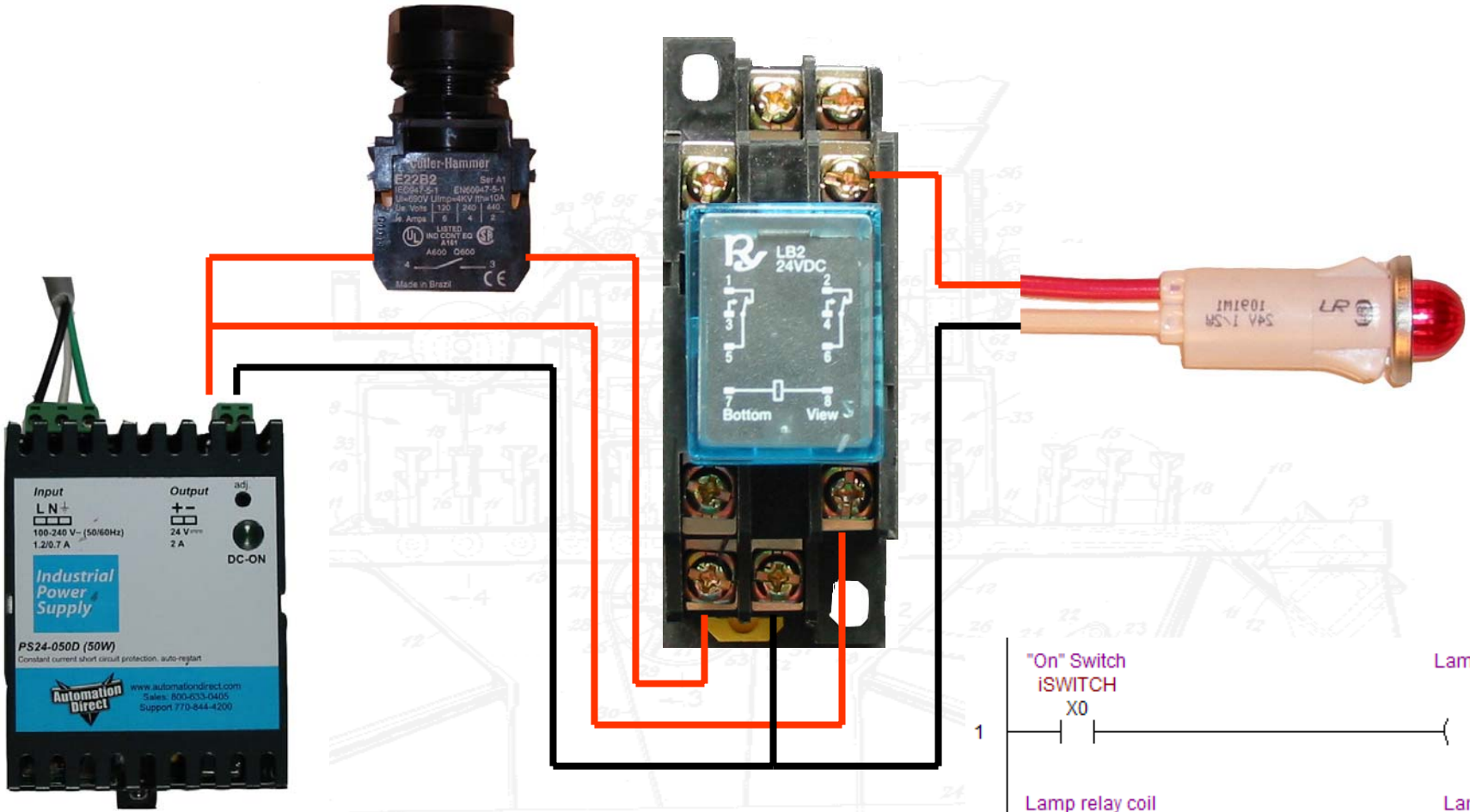
Ladder Diagrams



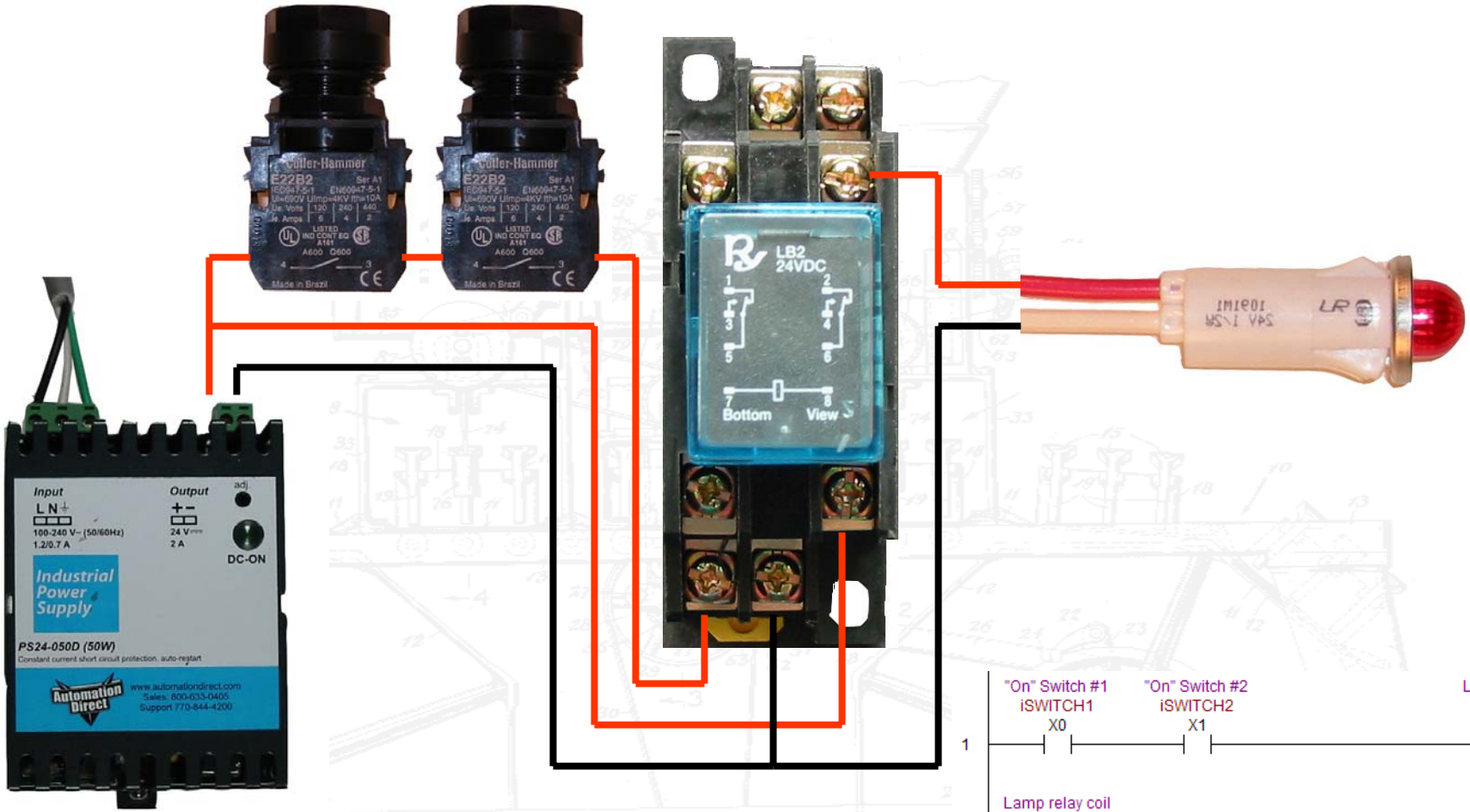
Example - Relay Logic



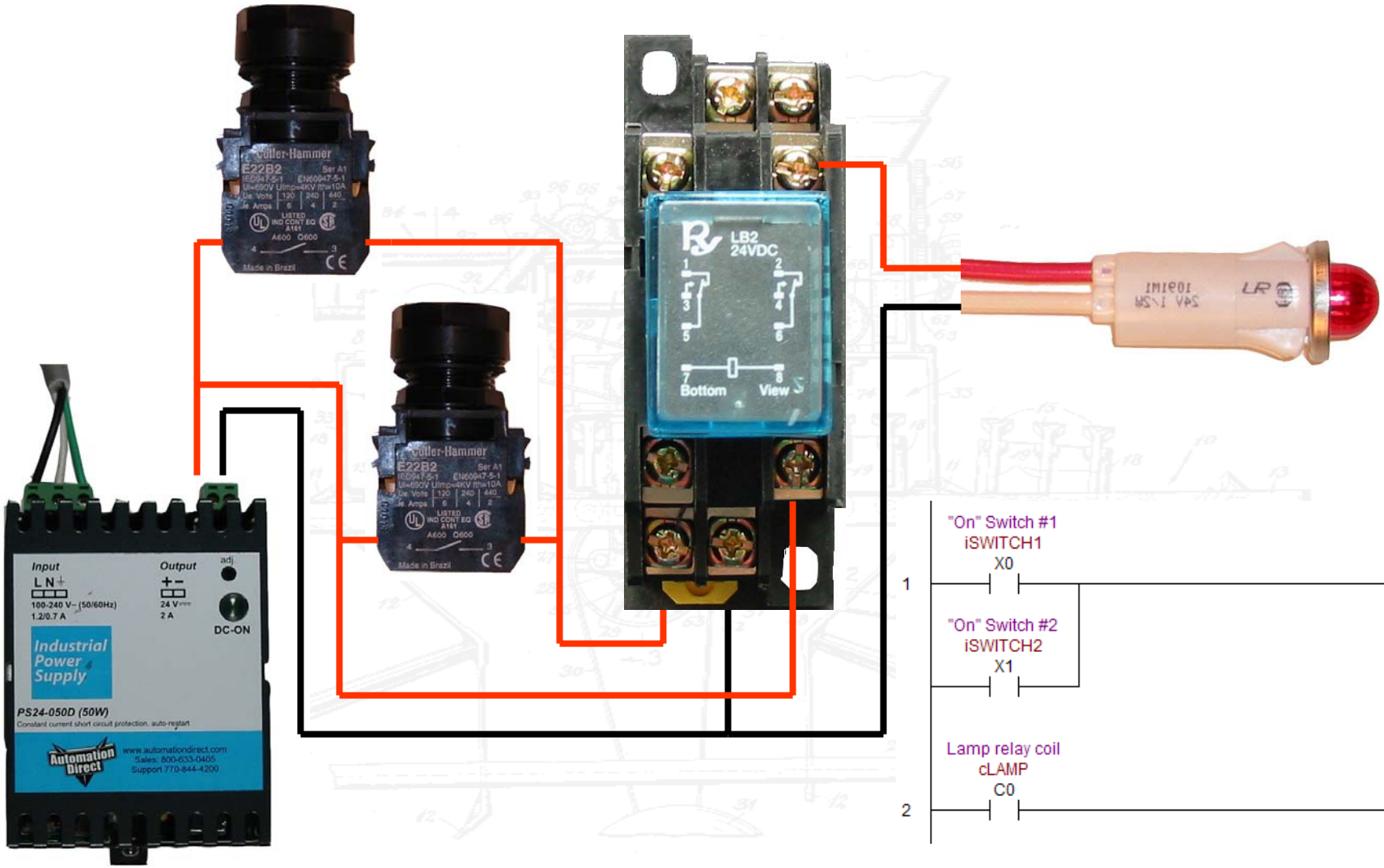
Example - Relay Logic



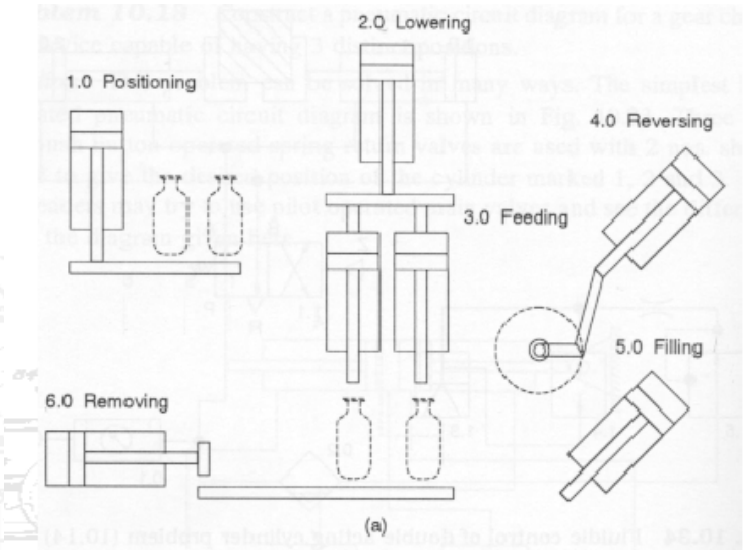
Example - Relay Logic

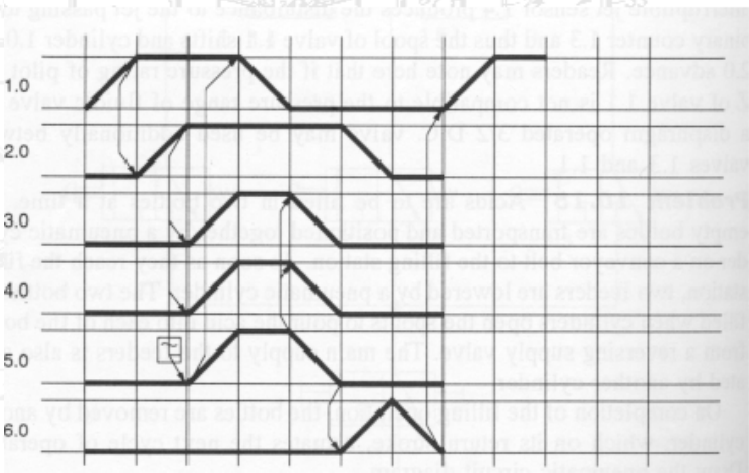


Example - Relay Logic

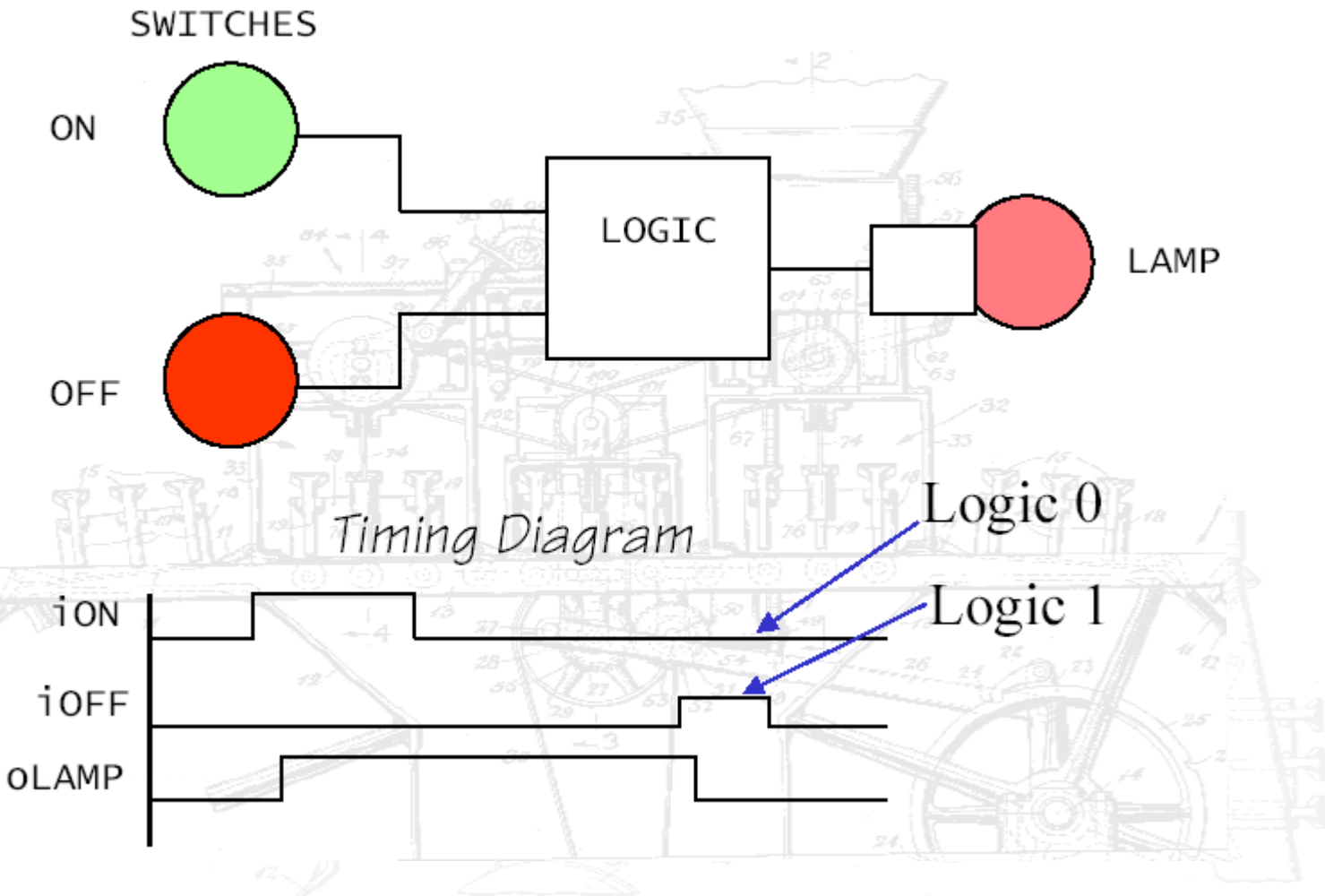


Timing Diagrams

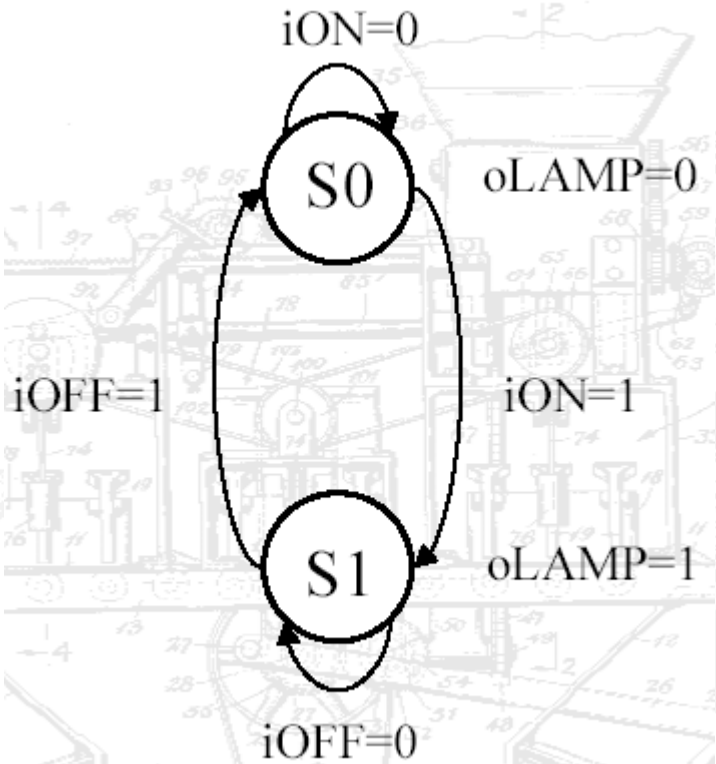


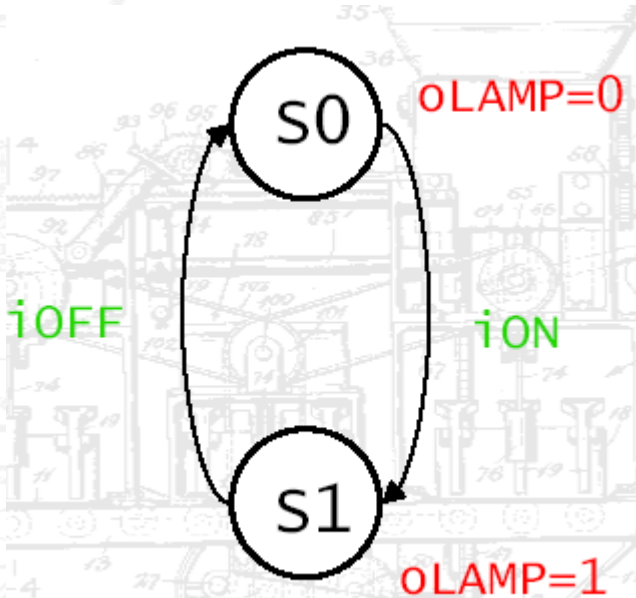


State Machines



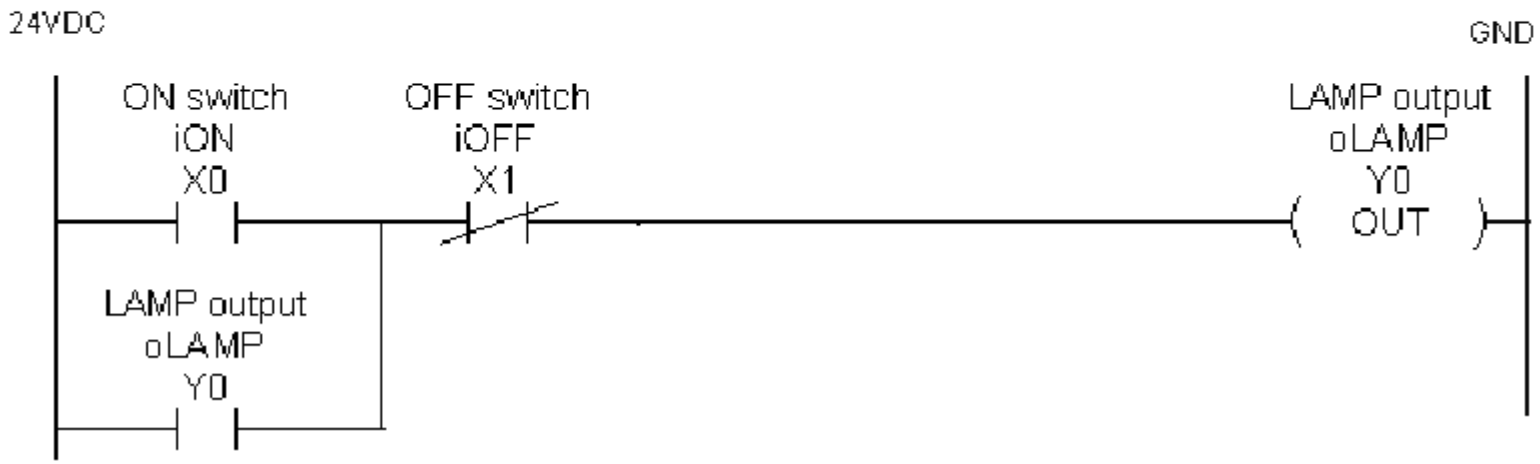
State Diagram



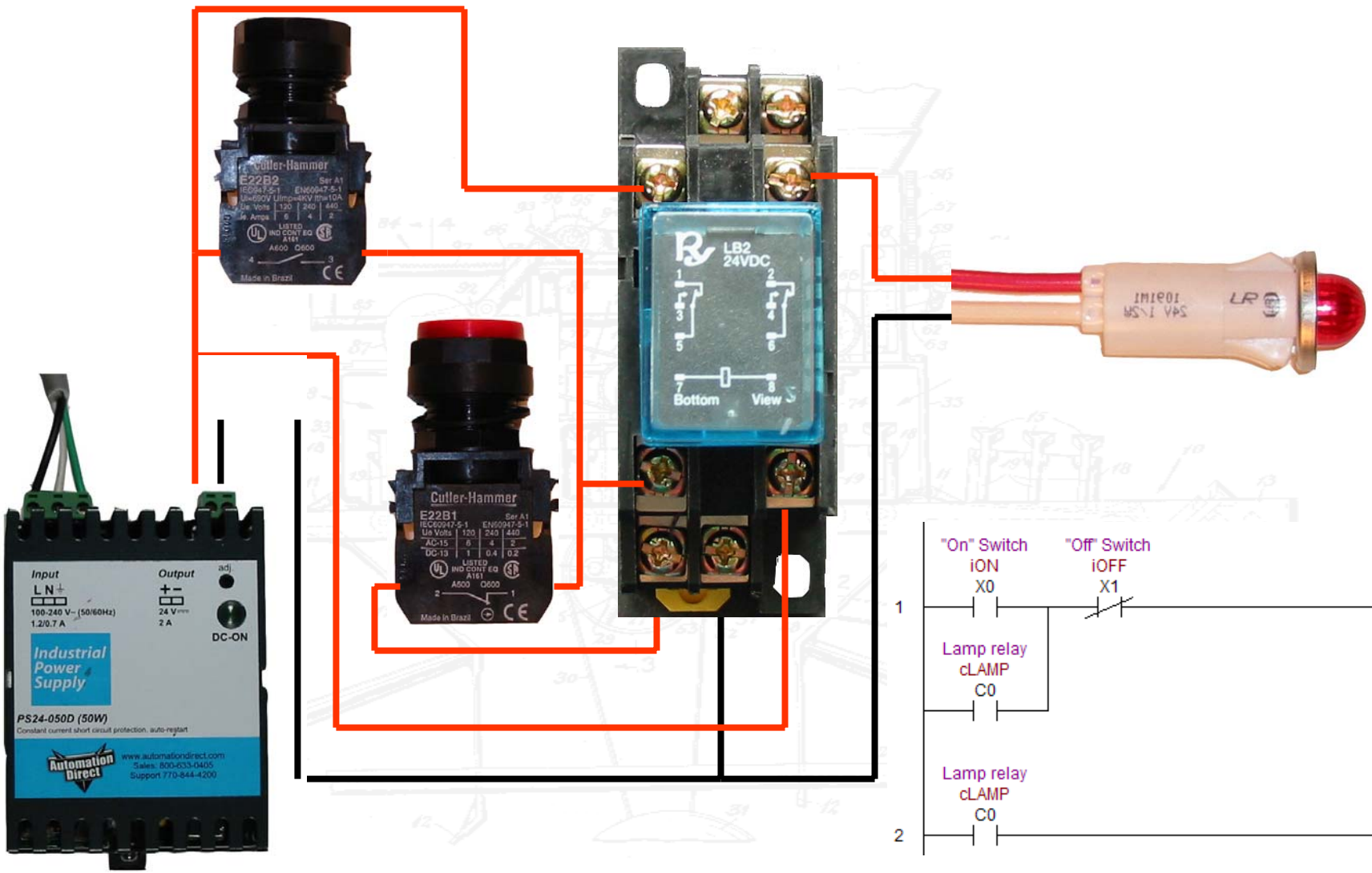


Logic Equation and Ladder Diagram

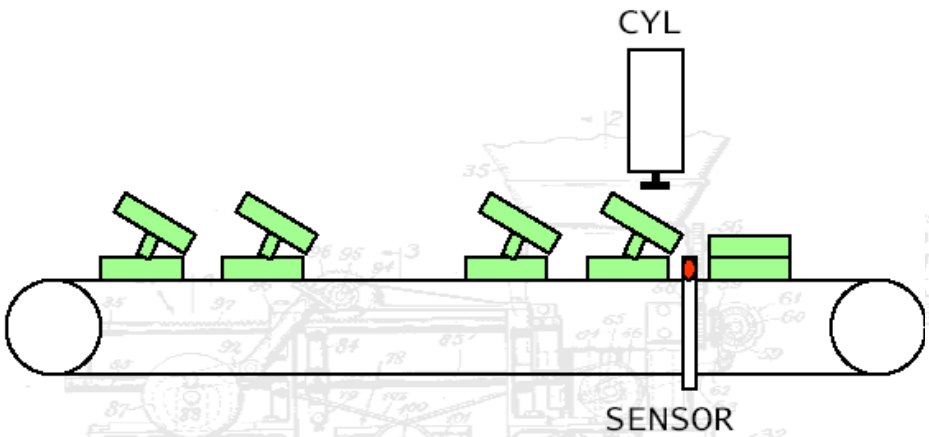
$$oLAMP = /iOFF \bullet (iON + oLAMP)$$

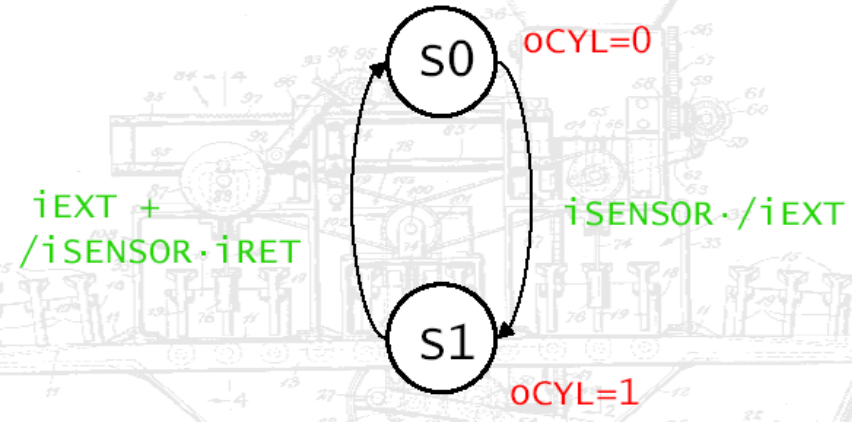


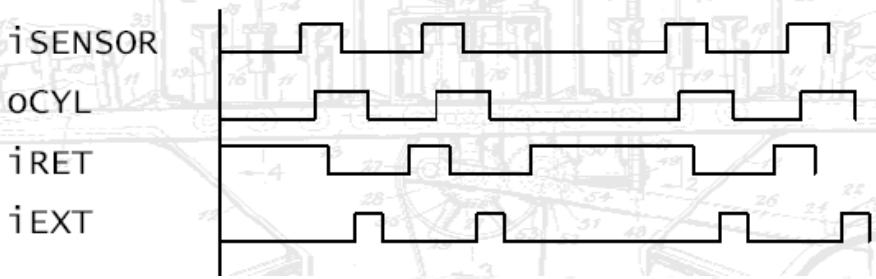
Example - Relay Logic

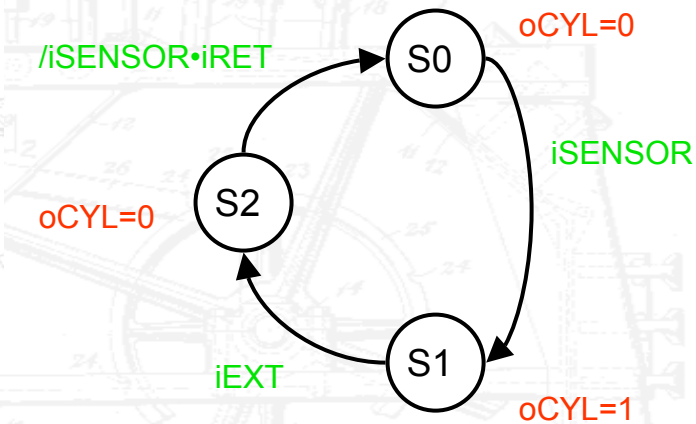


Another Example

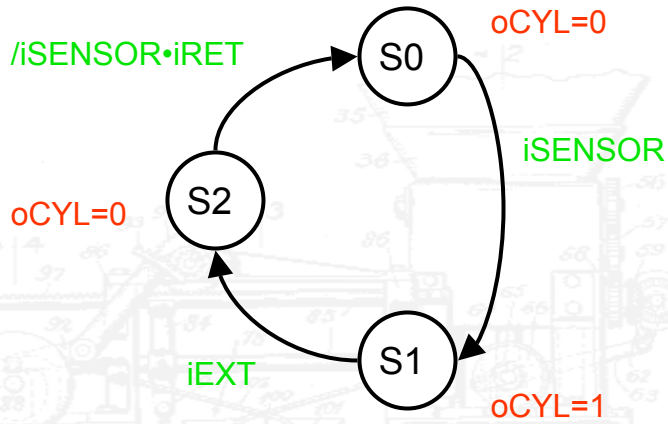








Example #2 State Diagram



cS0 = cS2•/iSENSOR•iRET + cS0•/iSENSOR + /cS0•/cS1•/cS2

cS1 = cS0•iSENSOR + cS1•/iEXT

cS2 = cS1•iEXT + cS2•/(/iSENSOR•iRET)

= cS1•iEXT + cS2•(iSENSOR + /iRET)