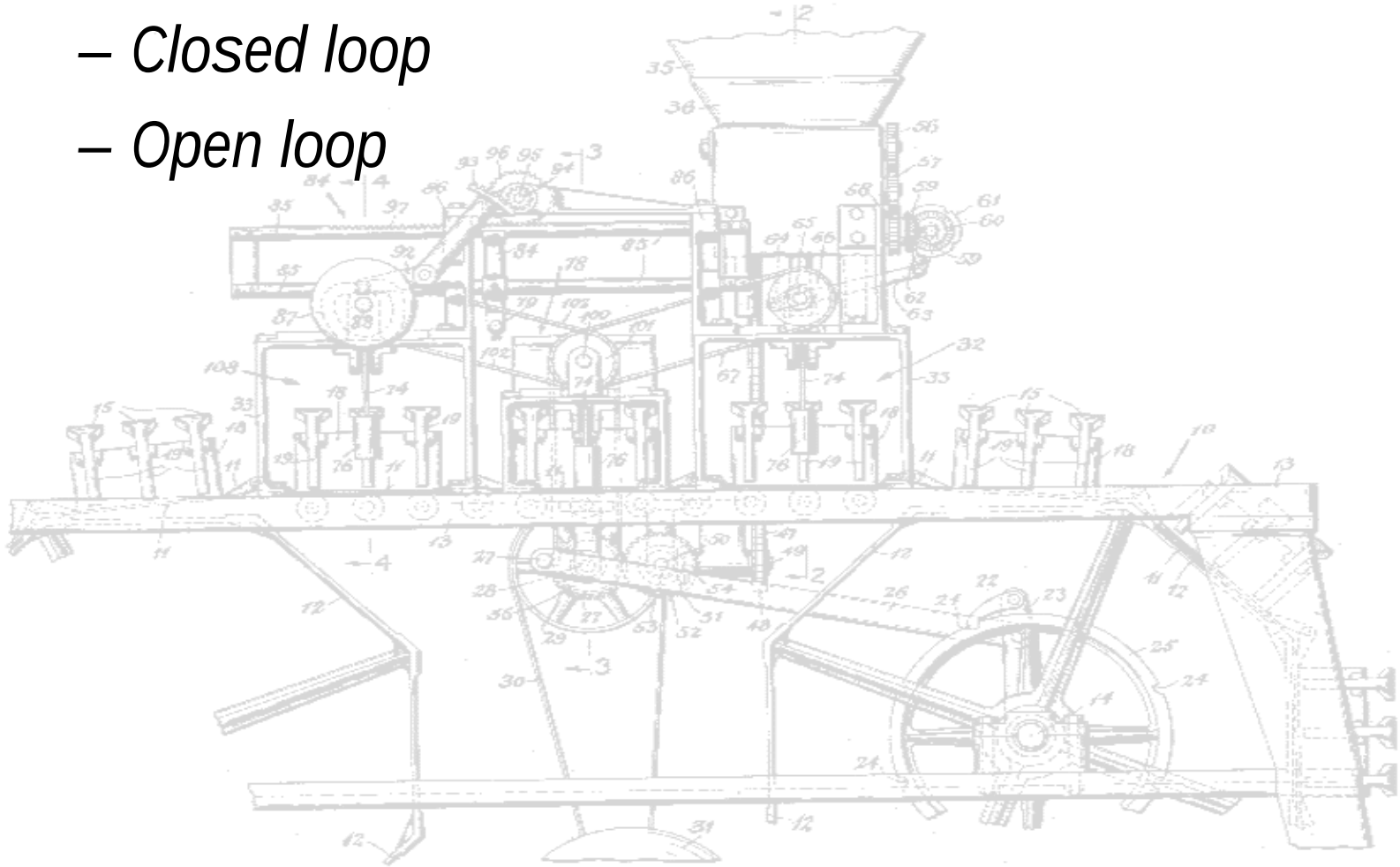
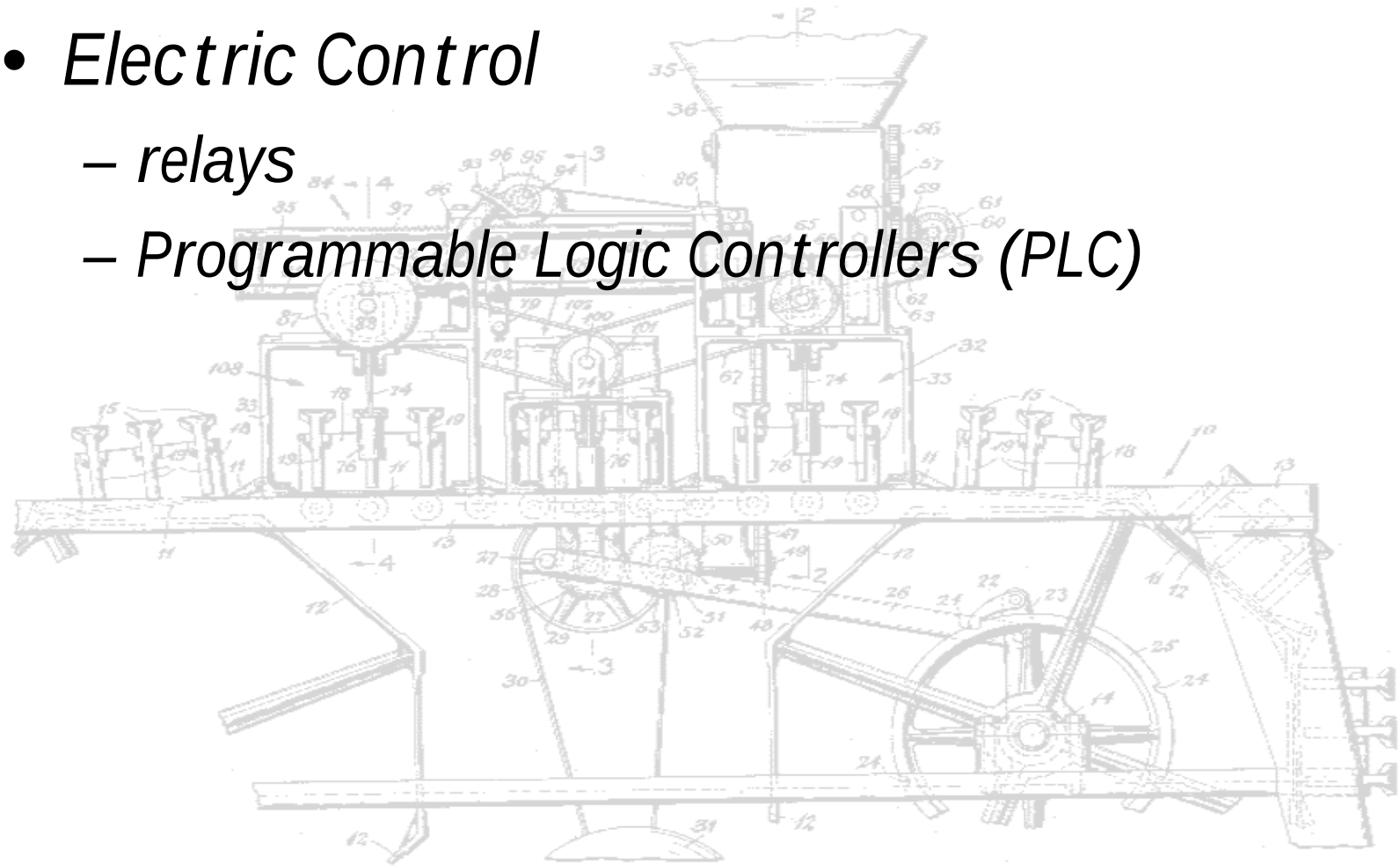
Control of Motion

- *On/Off Control (bang-bang)*
- *Proportional Control*
  - *Closed loop*
  - *Open loop*



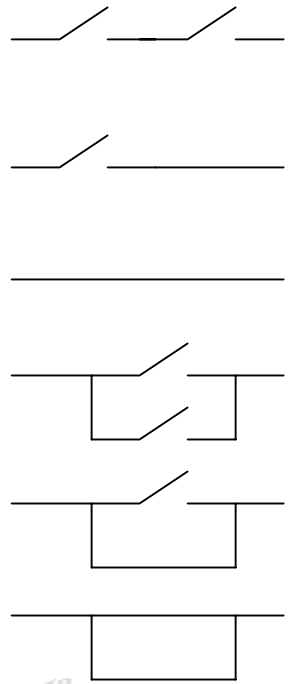
On/Off Control

- *Boolean Arithmetic*
- *Pneumatic logic elements*
- *Electric Control*
  - *relays*
  - *Programmable Logic Controllers (PLC)*



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

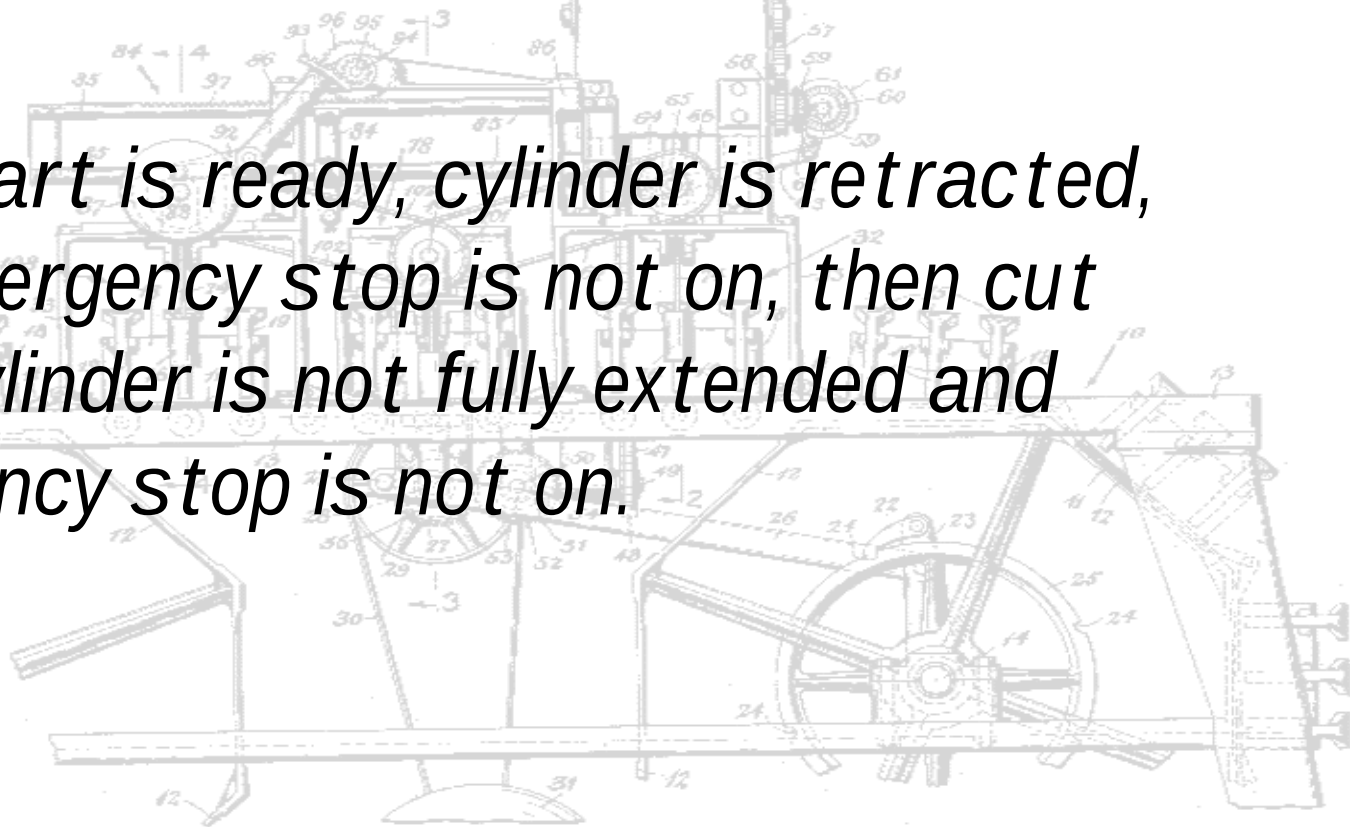
A · B = B · A

A · B + A · C = A · (B+C)

Digital Logic Expressions

oCUT = (iPARTRDY·iCYLRETRACT
+ oCUT·/iCYLEXTEND)·/iESTOP

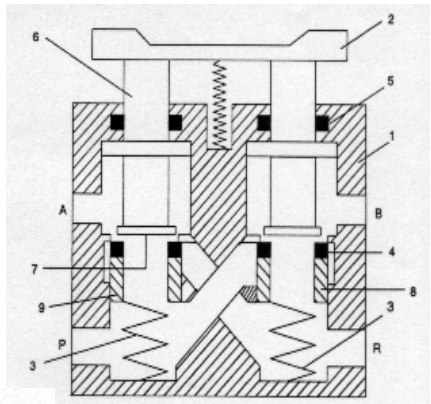
oCUT = iPARTRDY·iCYLRETRACT·/iESTOP
+ oCUT·/iCYLEXTEND·/iESTOP

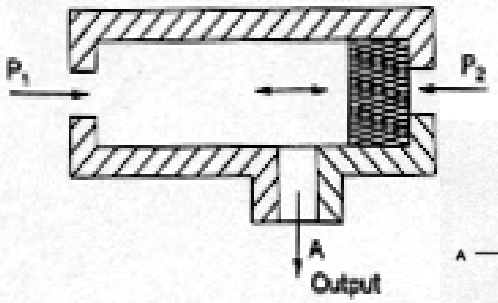


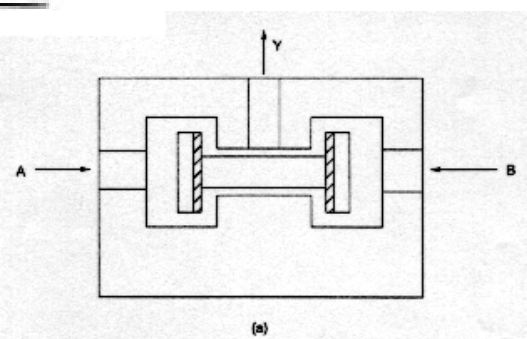
When part is ready, cylinder is retracted, and emergency stop is not on, then cut while cylinder is not fully extended and emergency stop is not on.

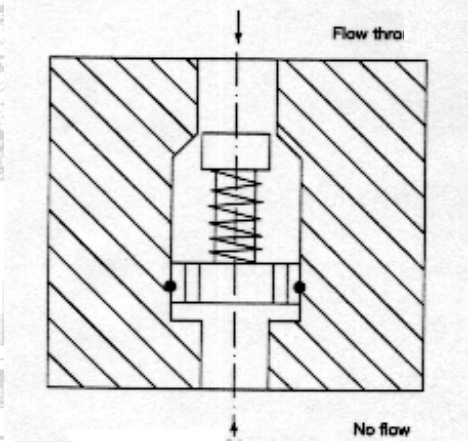
Pneumatic Logic Elements

- *Directional control valve (p.235-242)*
- *Shuttle valve - OR function*
- *Twin pressure valve - AND function*
- *Other functions*
  - *Check valve*
  - *Speed control valve*
  - *Time delay valve*



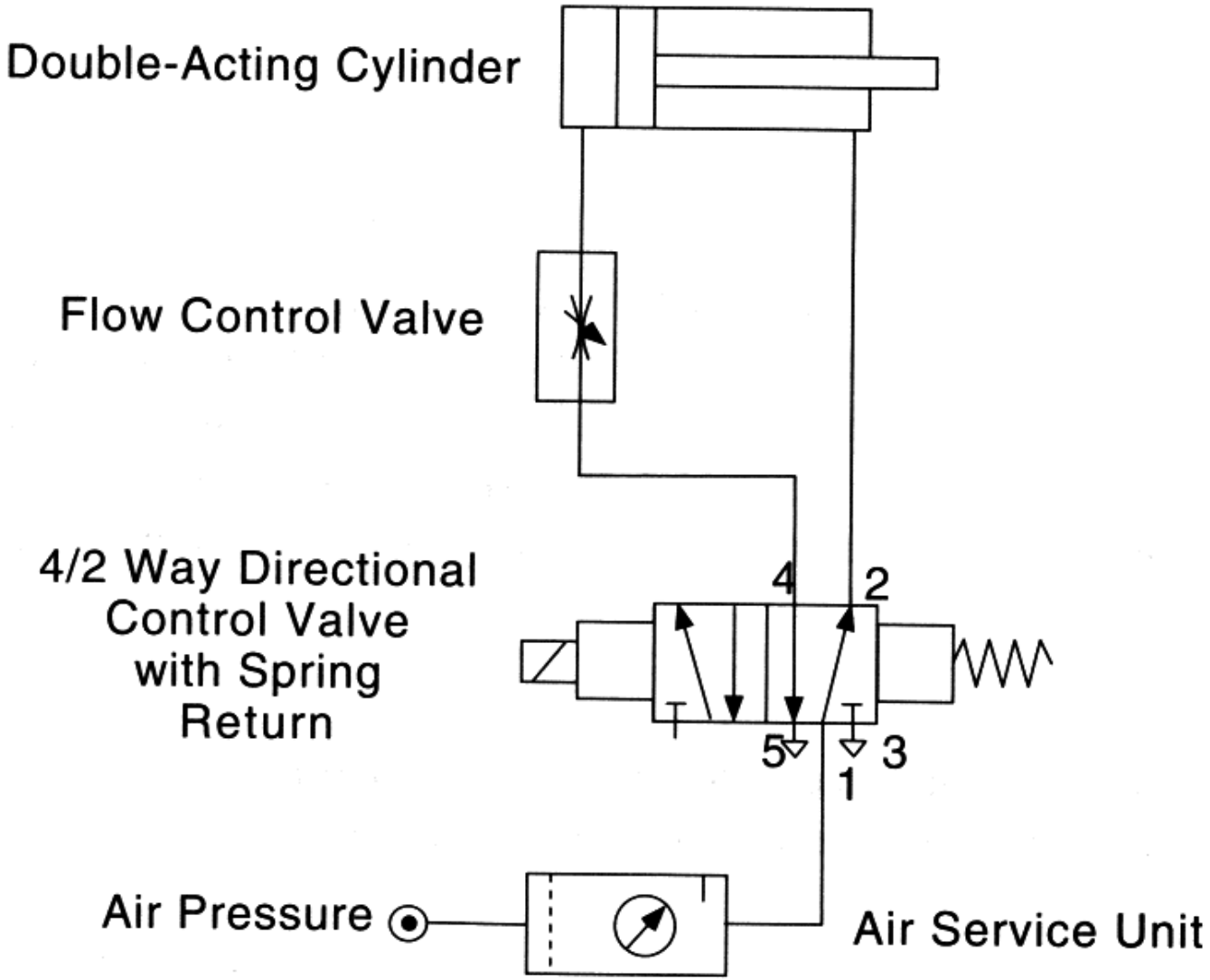






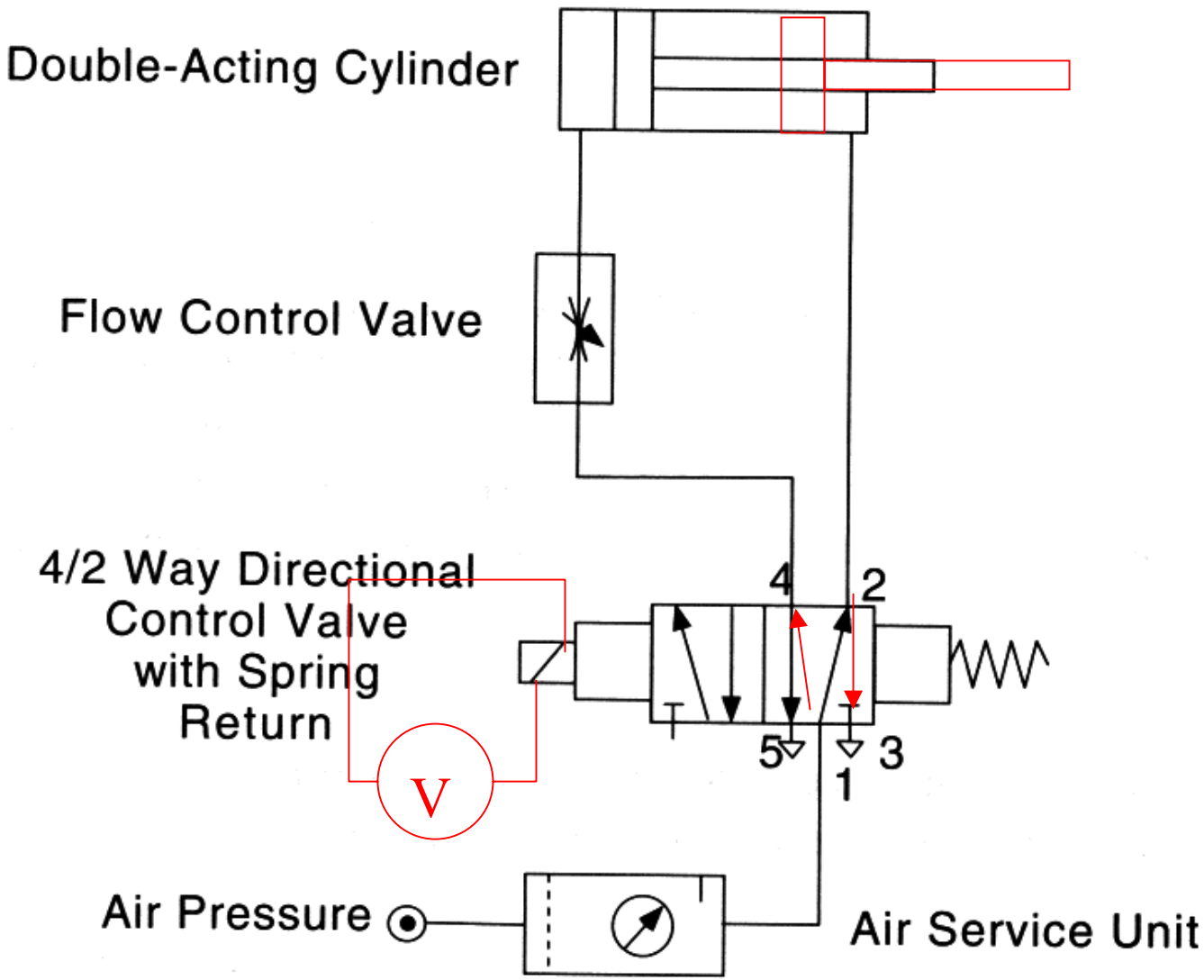
Pneumatic Schematics

Not actuated

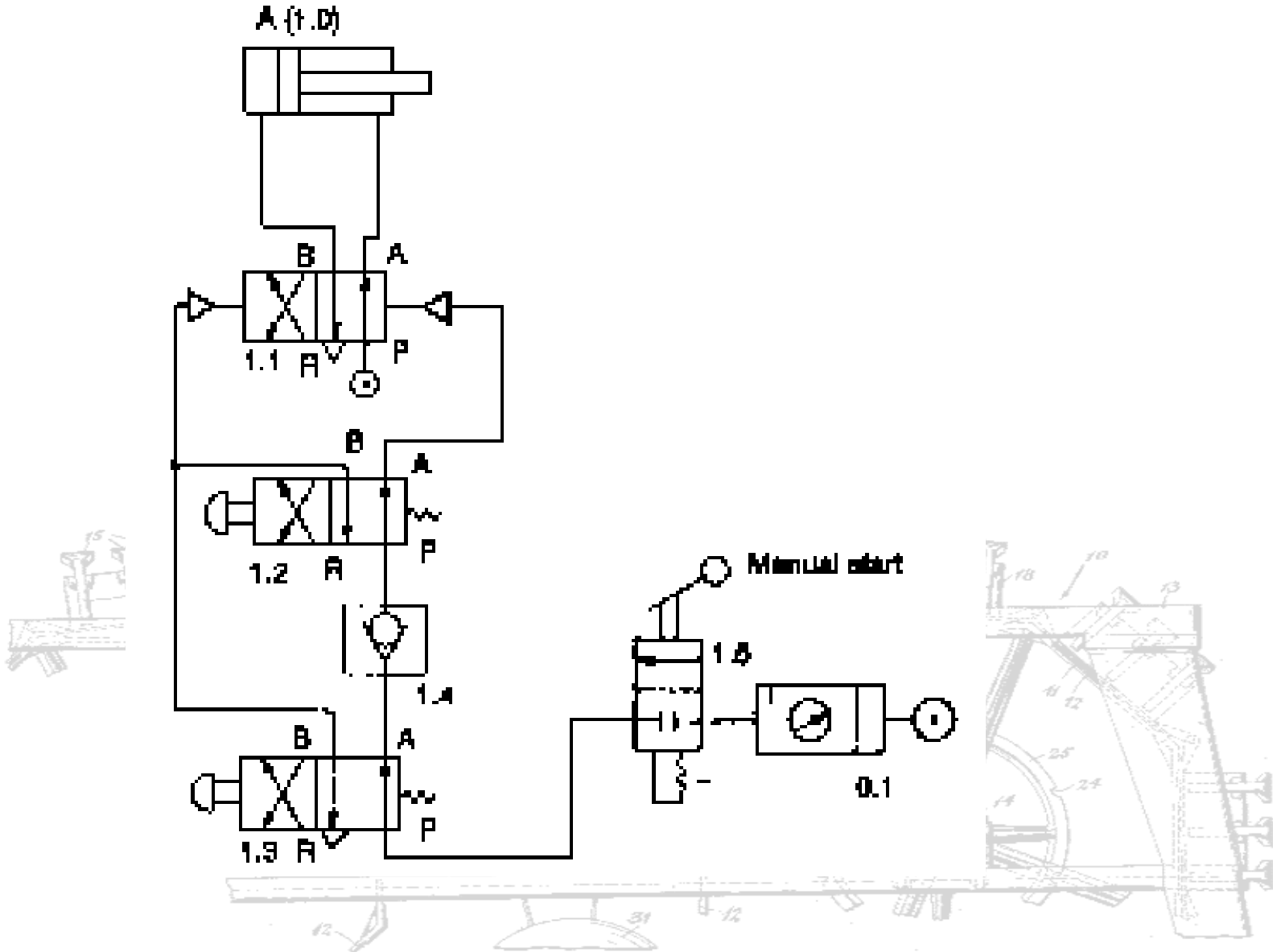


Pneumatic Schematics

Actuated

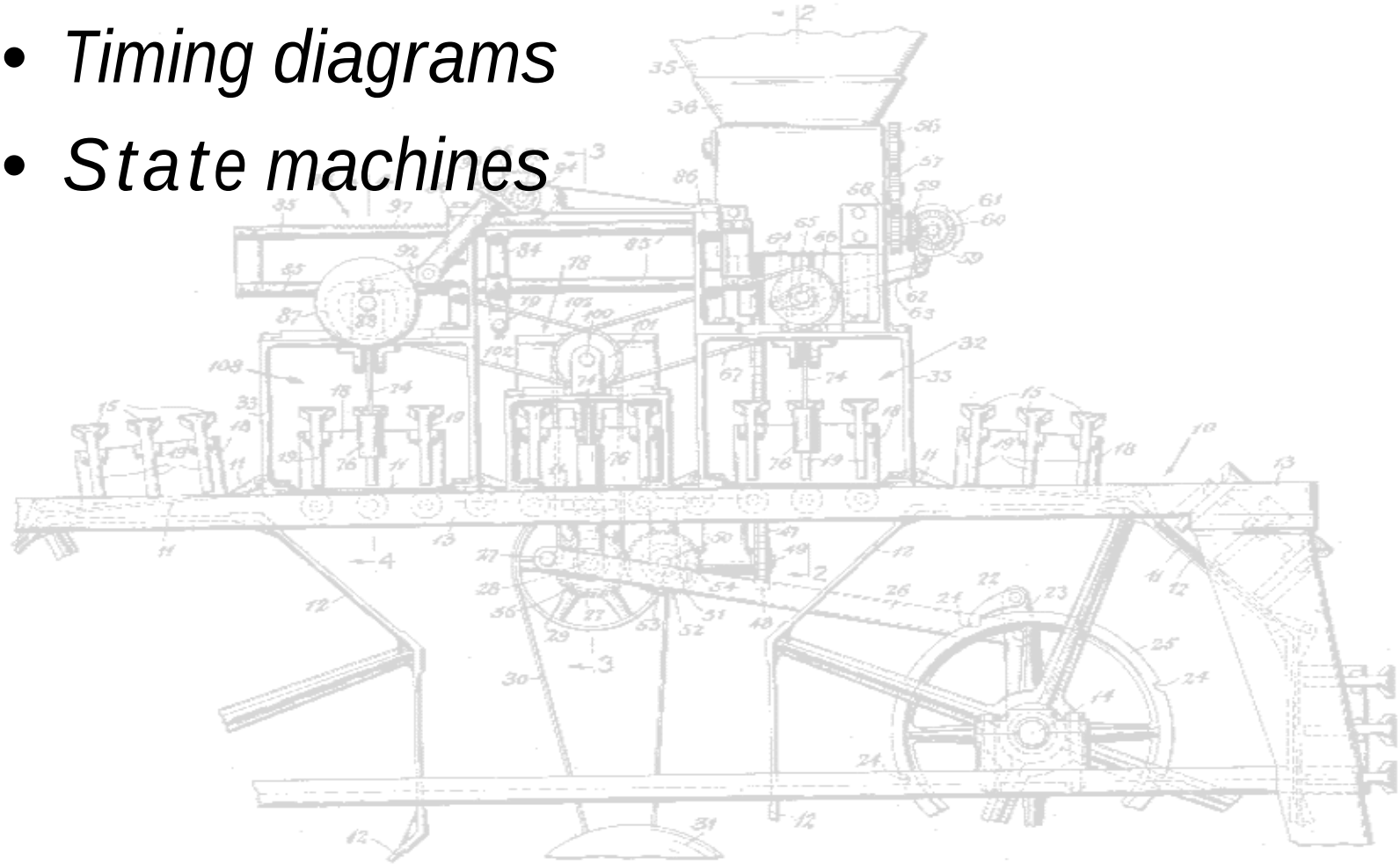


Example Pneumatic Circuit



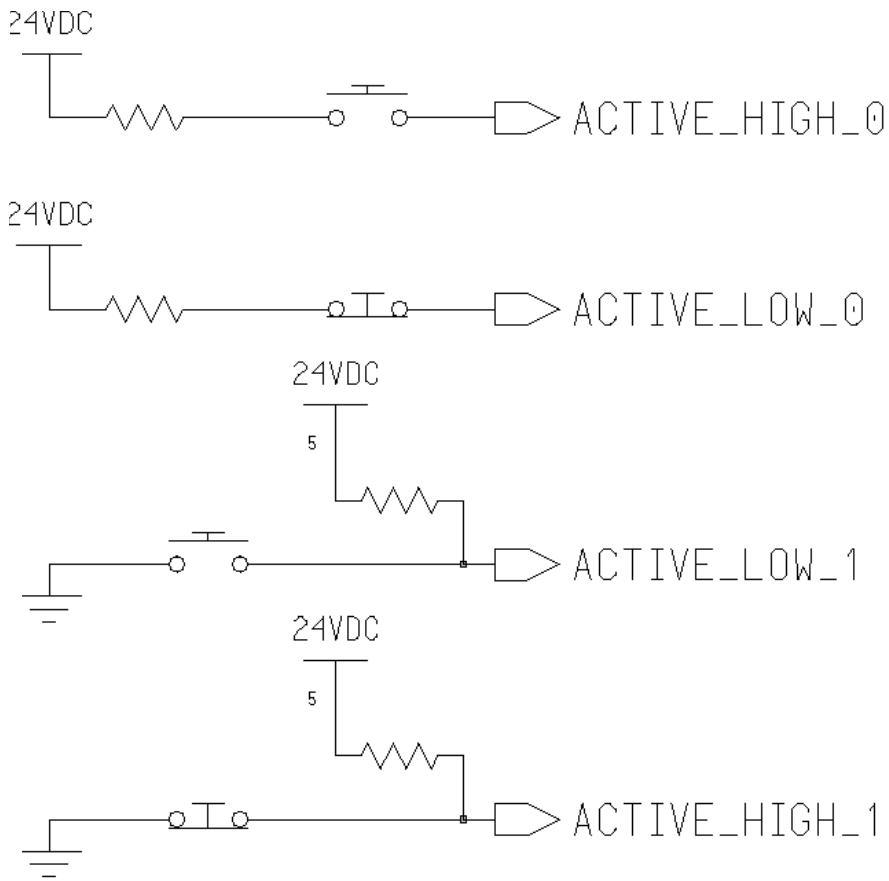
Electric Logic Control

- *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