

Industrial automation 1

EE 512

Lecture 3: hardware control system

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Type of automated control system

- **Hardwire control system**
 - Relay logic control
 - Solid state controller
- **Programmable controller**
 - Programmable logic controller
 - Microprocessor based control

Essential elements to build automation system

1. Power and control circuit
2. communication system
 - Man-machine- interface (buttons, lamps, buzzer, ...,etc)
 - Control system and machine (sensor and actuator)
2. Power supply
 - control circuit (low voltage low power; 5, 24, 110, 220)
 - power circuit (high voltage and power 220, 380, 6.6kv, 11kv, etc...)

Hardwire Control: relay logic control

- Basic components of relay logic

1. Control transformer

- To reduce the supply
- To isolate the control circuit

2. Fuses

- In order to protect the control circuit



Figure 1-2 -
Fuse

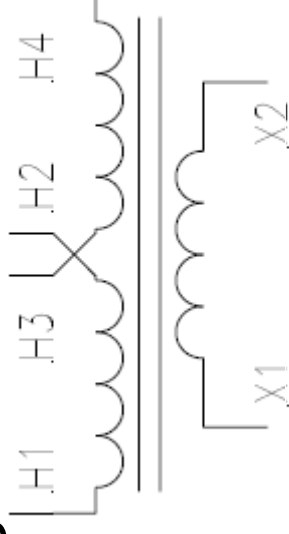


Figure 1-1 - Control Transformer

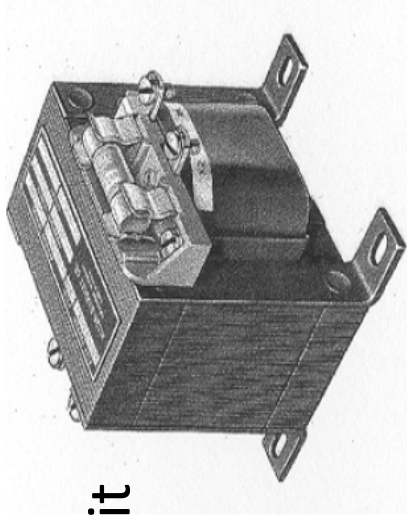


Figure 1-3 - Control Transformer with
Secondary Fuse Holder
(Allen Bradley)

Relay logic components

3- switches

pushbutton

Mushroom head

selector switch

limit switch



Figure 1-6 - Switch Actuators

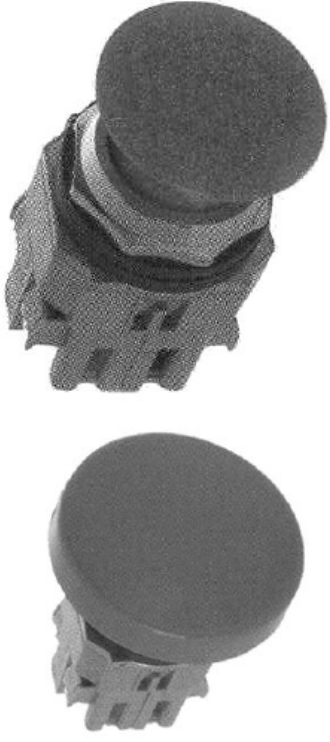


Figure 1-7 - Mushroom Head Pushbuttons

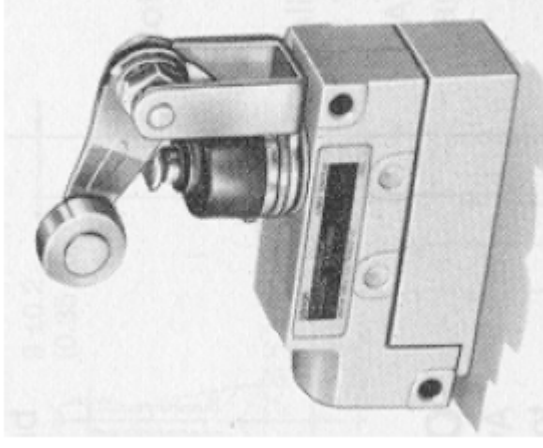


Figure 1-11 - Limit Switch

Relay logic components

- Symbol of pushbutton



Figure 1-4 - Momentary Pushbutton Switches

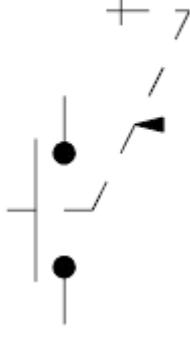


Figure 1-5 -
Maintained Switch

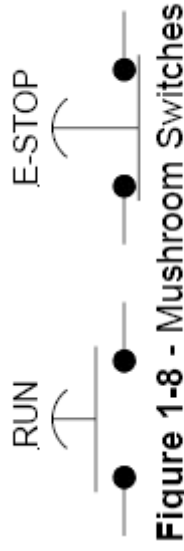


Figure 1-8 - Mushroom Switches

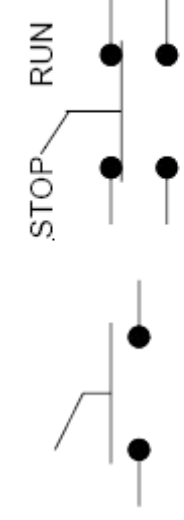


Figure 1-9 - Selectors

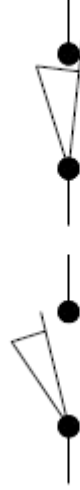


Figure 1-10 - Limit Switches

Relay logic components

4- indicating lamp

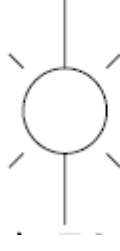


Figure 1-12 - Lamp

5- Relay (contactor)

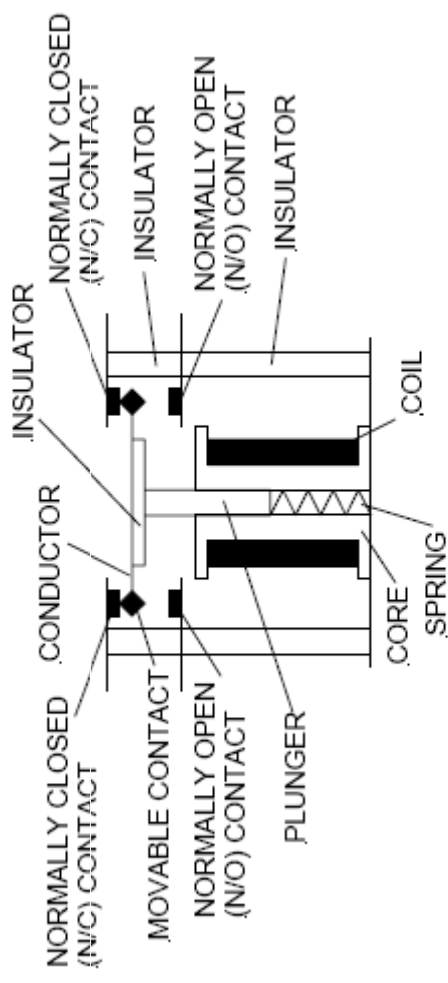


Figure 1-13 - Relay or Contactor

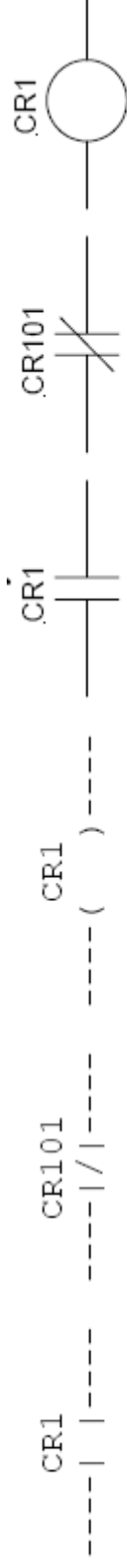


Figure 1-15 - ASCII Relay Symbols

Figure 1-14 - Relay Symbols

Relay logic components

6- Time delay relay

a- on delay timer

b- of delay timer

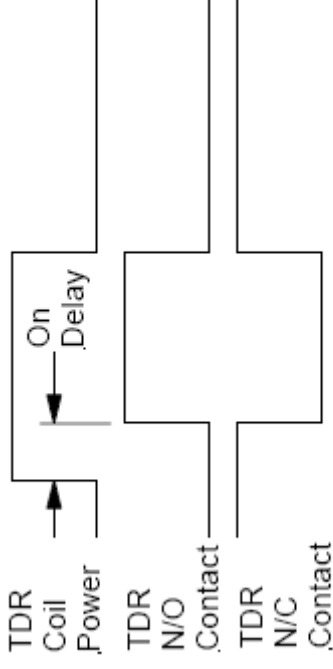


Figure 1-16 - Delay-On Timer Relay

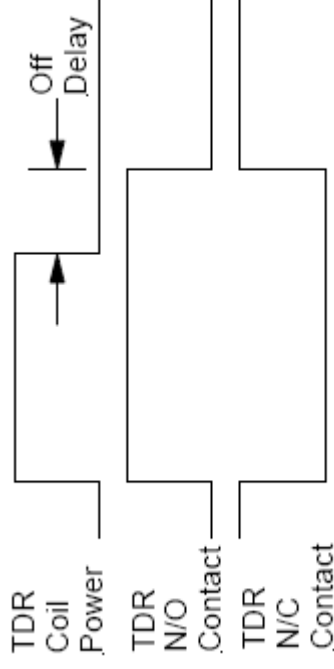


Figure 1-17 - Delay-Off Timer Relay

Relay logic ladder diagram

- Basic control circuit
- Wiring
- Reference designator

T	transformer
CR	control relay
R	resistor
C	capacitor
LS	limit switch
PB	pushbutton
S	switch
SS	selector switch

TDR or TR	time delay relay
M	motor, or motor relay
L	indicator lamp or line phase
F	fuse
CB	circuit breaker
OL	overload switch or overload contact

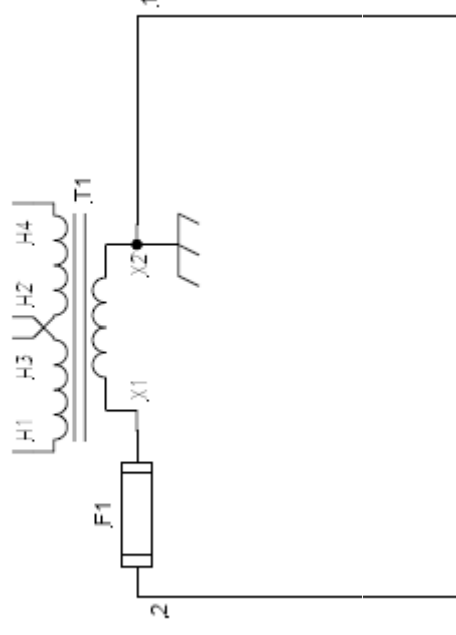


Figure 1-18 - Basic Control Circuit



Figure 1-19 - Wire Marker

Boolean logic and relay logic

- AND

$$Lamp1 = (Switch1) \bullet (Switch2)$$

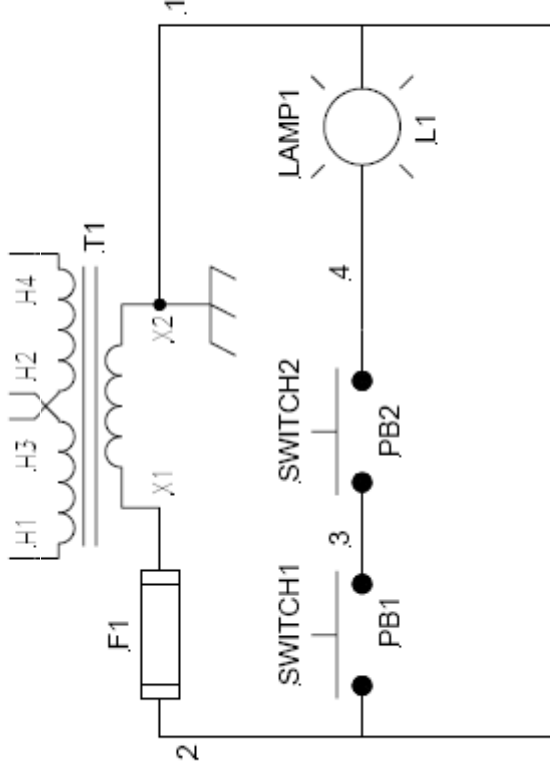


Figure 1-22 - Ladder Diagram

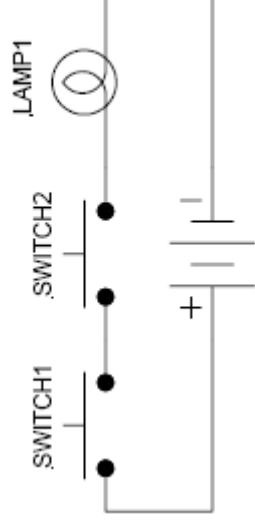


Figure 1-20 - AND Lamp Circuit

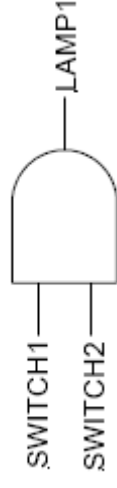


Figure 1-21 - AND Circuit

Boolean logic and relay logic

- OR

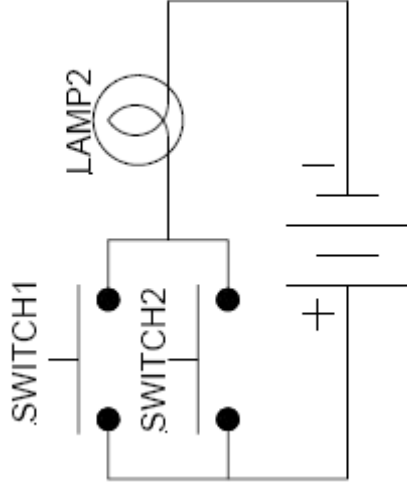


Figure 1-23 - OR Lamp Circuit

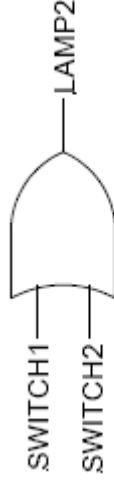


Figure 1-24 - OR Circuit

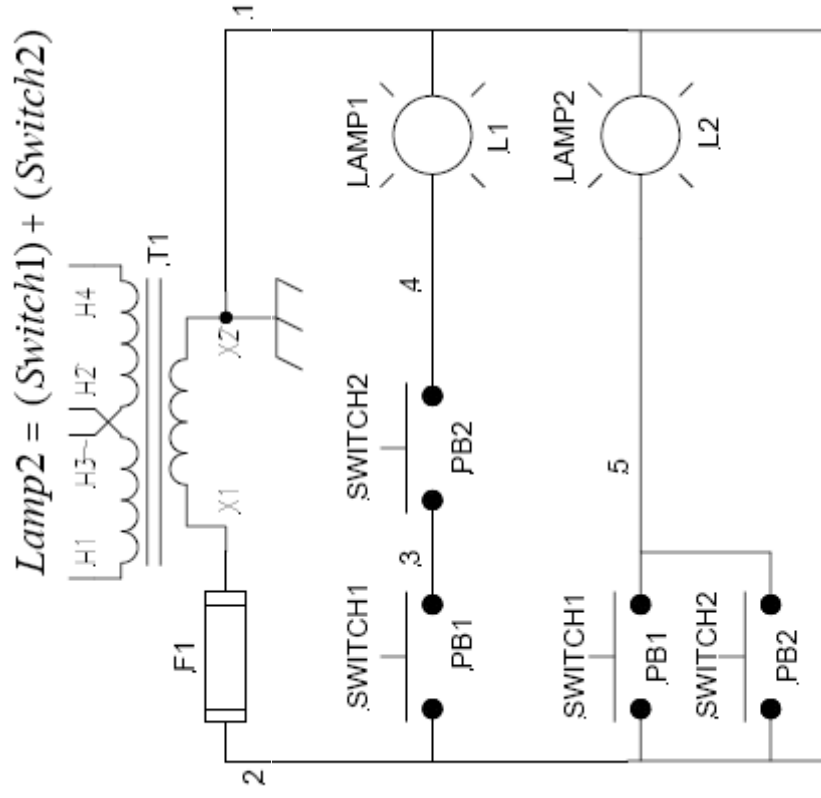


Figure 1-25 - Add Rung 2

Boolean logic and relay logic

3- AND OR and OR AND

$$Lamp3 = (Switch1 \bullet Switch2) + (Switch3 \bullet Switch4)$$

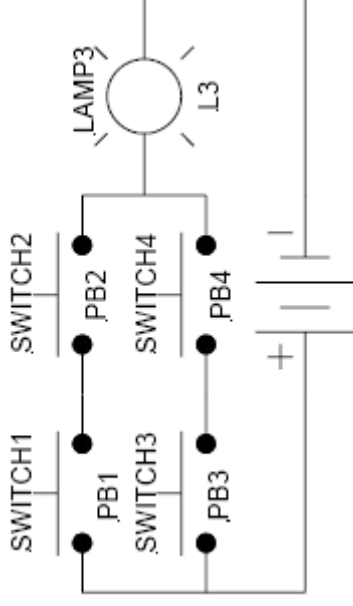


Figure 1-26 - AND-OR Lamp Circuit

$$Lamp3 = (Switch1 + Switch2) \bullet (Switch3 + Switch4)$$

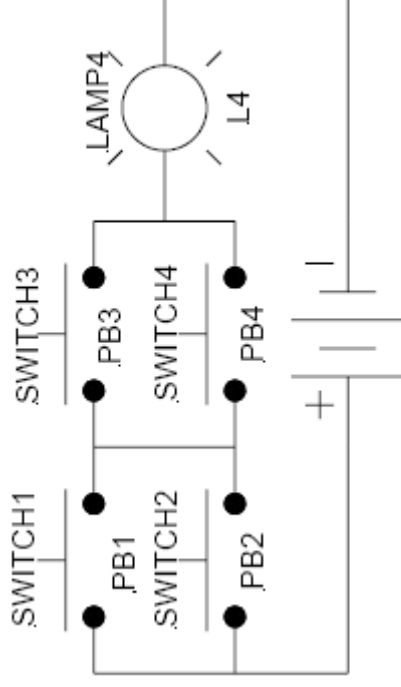


Figure 1-27 - OR-AND Lamp Circuit

Boolean logic and relay logic

4- Latch circuit

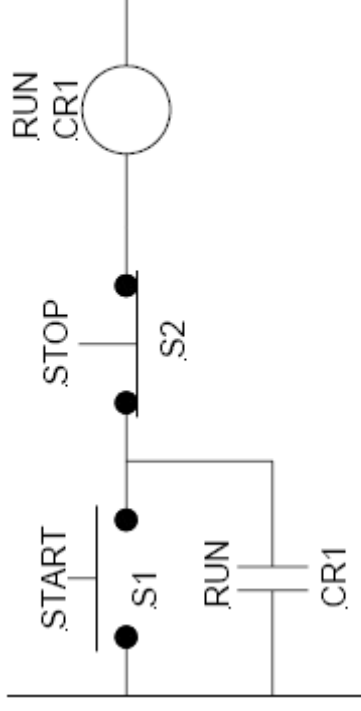


Figure 1-30 - Latch Circuit

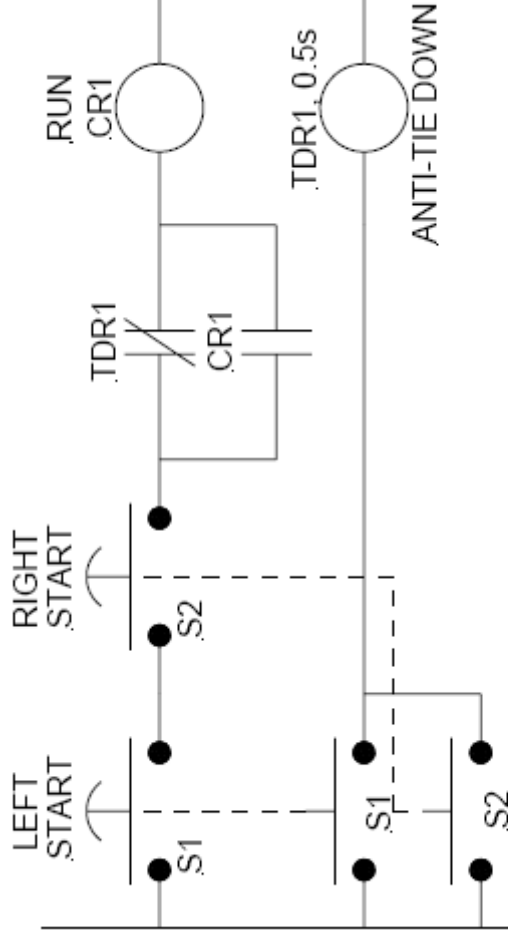
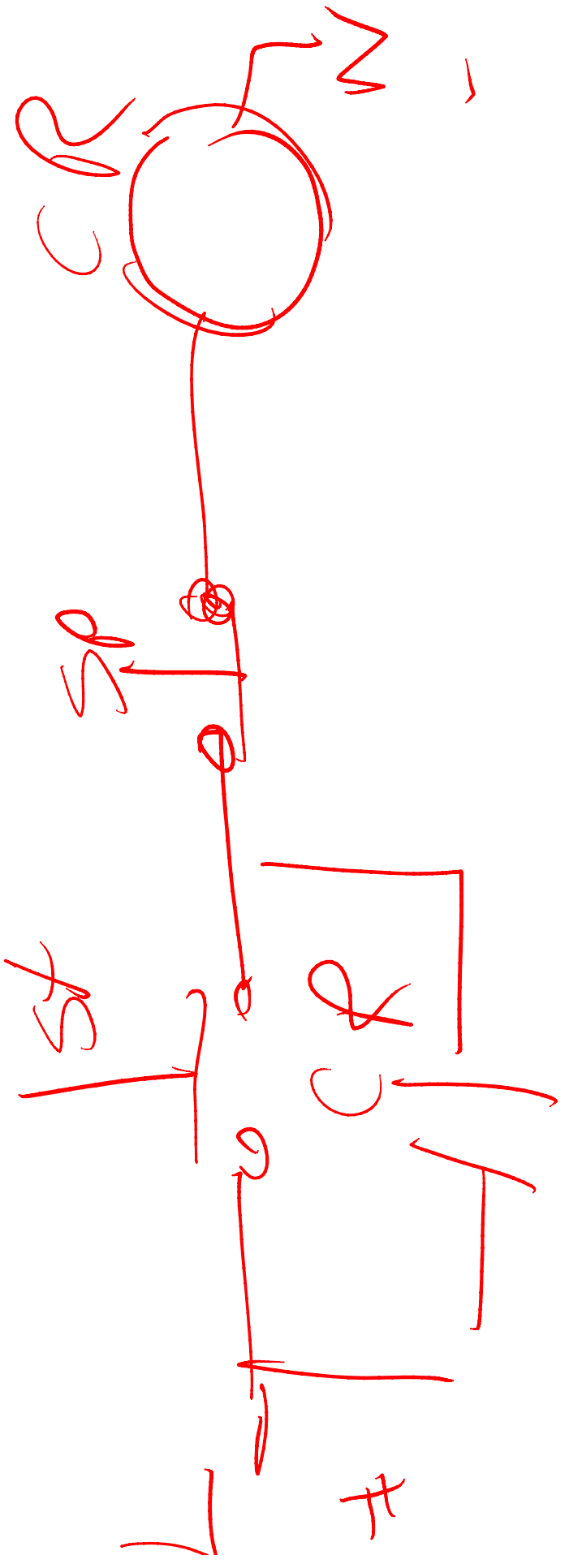
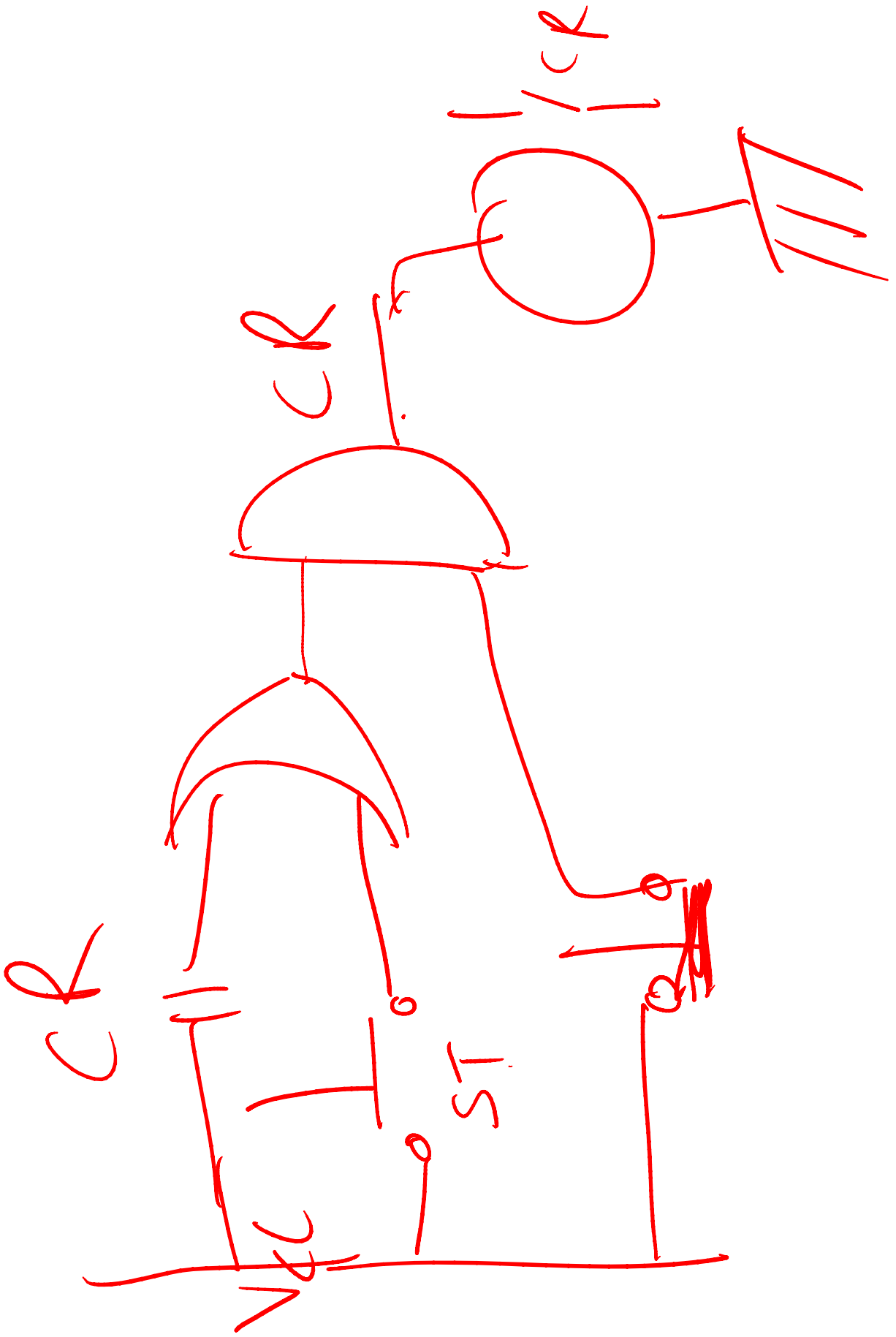


Figure 1-32 - 2-Handed Operation with Anti-Tie Down and Anti-Repeat





Boolean logic and relay logic

5- single scan

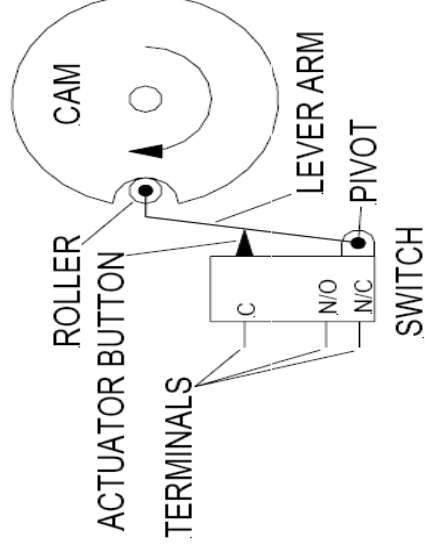
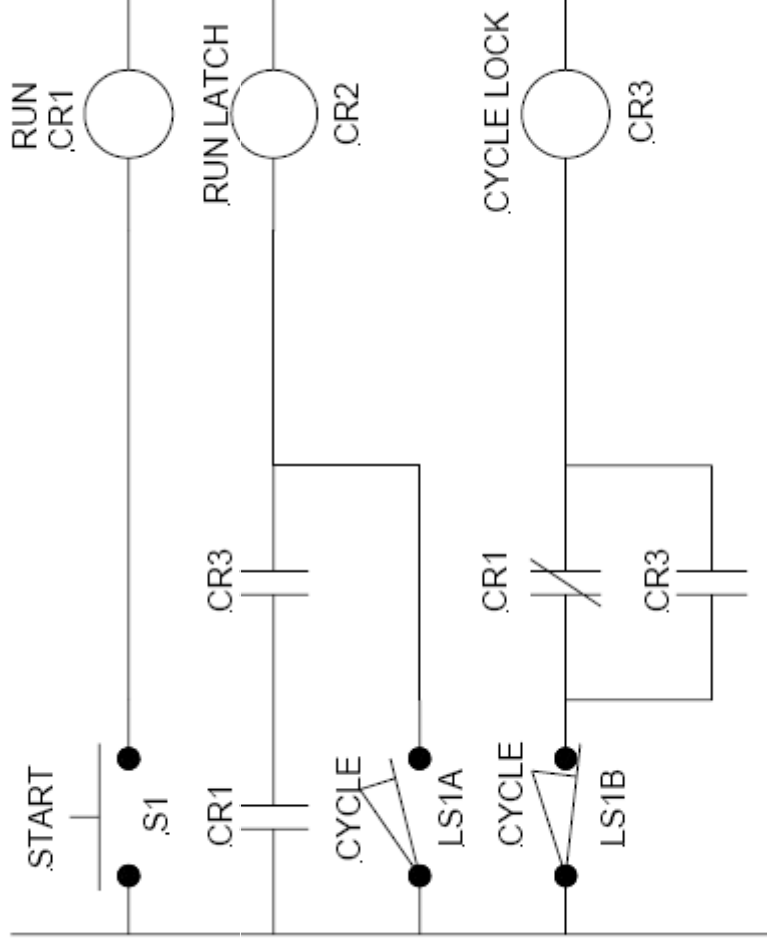


Figure 1-33 - Cam-operated Limit Switch

Figure 1-34 - Single-Cycle Circuit

Relay logic

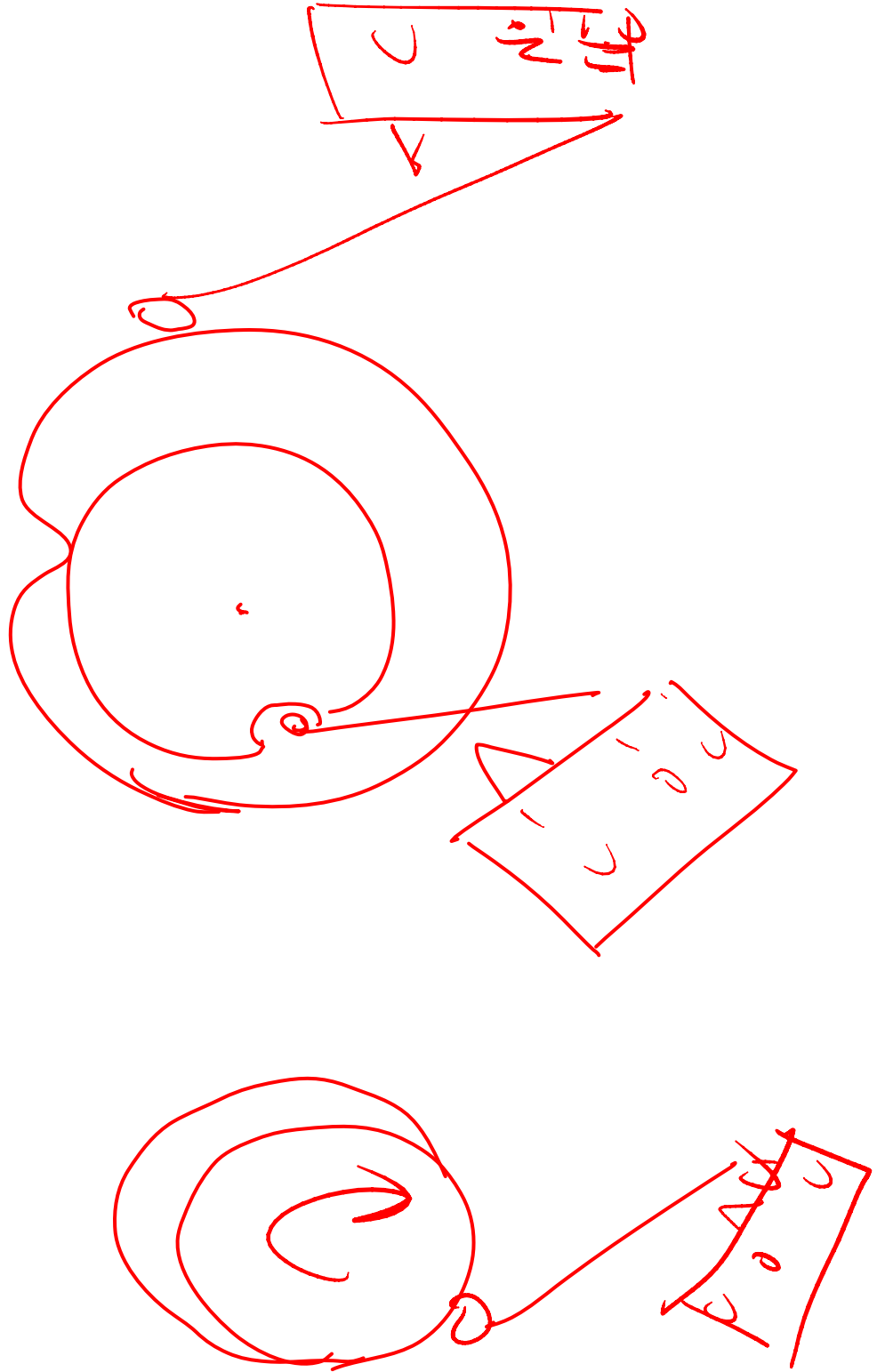
- Machine control terminology

ON This is a machine state in which power is applied to the machine and to the machine control circuits. The machine is ready to **RUN**. This is also sometimes call the **STANDBY** state.

OFF Electrically, the opposite of **ON**. Power is removed from the machine and the machine control circuits. In this condition, pressing any switches on the control panel should have no effect.

RUN A state in which the machine is cycling or performing the task for which it is designed. This state can only be started by pressing **RUN** switches. Don't confuse this state with the **ON** state. It is possible for a machine to be **ON** but not **RUNNING**.

STOP The state in which the machine is **ON** but not **RUNNING**. If the machine is **RUNNING**, pressing the **STOP** switch will cause **RUNNING** to cease.



JOG

A condition in which the machine can be "nudged" a small amount to allow for the accurate positioning of raw material while the operator is holding the material. The machine controls must be designed so that the machine cannot automatically go from the **JOG** condition to the **RUN** condition while the operator is holding the raw material.

INCH

Same as **JOG**.

CYCLE

A mode of operation in which the machine **RUNs** for one complete operation and then automatically **STOPs**. Holding down the **CYCLE** button will not cause the machine to **RUN** more than one cycle. In order to have the machine execute another **CYCLE**, the **CYCLE** button must be released and pressed again. This mode is sometimes

2 HAND OPERATION

A control design method in which a machine will not **RUN** or **CYCLE** unless two separate buttons are simultaneously pressed. This is used on machines where it is dangerous to hand-feed the machine while it is cycling. The two buttons are positioned apart so that they both cannot be pressed by one arm (e.g., a hand and elbow). Both buttons must be released and pressed again to have the machine start another cycle.

applications

- Start stop of Induction Motor
- Star-Delta operation of IM
- Elevator control