Chapter III

CONTROLLER DESIGN

3.1 Thermistor Bridge Circuit Design

The following data of NTC thermistors are given in an electrical data handbook :

B = Temperature characteristic constant, in Kelvin.

k = Dissipation factor, in mW/^{o}C .

P_{max} = Maximum dissipation, in W .

R_{25} = Resistance at 25^{o}C, in ohm .

R_{min} = Minimum resistance of functioning, in ohm .

$$E_{max}^2 = P_{max} R_{min} \tag{3.1}$$

where E_{max} is an allowable maximum voltage across the thermistor.

$$E_d = \sqrt{Dk10^{-3} R_{25}} \tag{3.2}$$

where E_d is an allowable maximum designed voltage across the thermistor, in volt.

D is a designed precision effected by self-heat of the thermistor, in ^{o}C .

Referring to Figure 2.3 :

$$I_{Tmin} = \frac{E_d}{R_{25}} \tag{3.3}$$

$$V_{min} = I_{Tmin}(R_b + R_{25}) \tag{3.4}$$

$$I_{rmin} = \frac{V_{min}}{R_b + R_{min}} \tag{3.5}$$

$$R_d = \frac{E - V_{min}}{I_{Tmin} + I_{rmin}} \tag{3.6}$$

Then, by design values of D, R_b, and E, the value of R_d can be obtained from eqns. (3.2) to (3.6). The value R_b should be greater than R_{110} and less than R_{25} . (See calculation in Appendix B).

3.2 Relay Circuit

The voltage e from the bridge is so small that it can not directly operate a control relay. It is fed to a voltage comparator and the output signal is then applied to the base of an NPN transistor which in turn drives the control relay. The relay circuit is shown in Figure 3.1 .

3.3 Given Oven

The parameters of the given electric oven are as follows :

P = 275-500 watts

G = 3.75 watts/^{o}C

M = constant

τ = 13.55 min

As mentioned in Article 2.3 the suitable oven power can be found as follows :

$$\frac{P}{G} + T_o = T \tag{3.7}$$

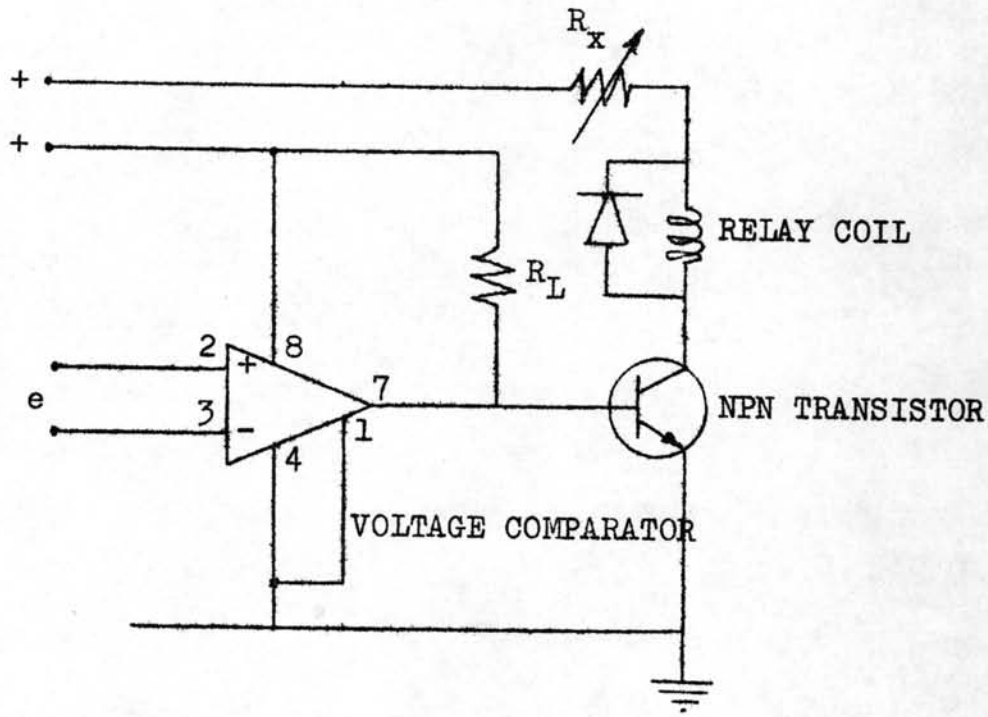

FIGURE 3.1

RELAY CIRCUIT.

$$\frac{P}{G} = T - T_o \tag{3.8}$$

$$P = G(T - T_o) \tag{3.9}$$

If $T = 110^{\circ}$ C and $T_o = 30^{\circ}$ C

$$P = 3.75\ (110 - 30)$$

$$P = 300.00 \text{ watts}$$

If $T = 130^{\circ}$ C and $T_o = 30^{\circ}$ C

$$P = 3.75\ (130 - 30)$$

$$P = 375.00 \text{ watts}$$