CHAPTER 4

CONCLUSION

The designed relay produces the inverse time-lag characteristics similar to that of a typical electromechanical relay. The main difference is that the designed solid-state relay produces the operating time - inversely proportional to the relay operating current while a typical electromechanical relay produces the operating time inversely proportional to the square of the operating current. The pick-up current setting of the designed relay can be set continuously from 1 to 3 amp, by adjusting the variable resistor R_p in the input circuit. The maximum setting is limitted by the saturation of the current transformer. A proporly-designed transformer may replace the current and potential transformer in the input circuit. There are 10 operating characteristics, each corresponding to each numberof dial setting which is accomplished by adjusting the potentiometer R_4 in the comparator-1 circuit.

The definite minimum time-lag or instantaneous unitcan be adjusted continuously, by means of the potentiometer R_{13} in the comparator-3 circuit, for the pick-up current of 5 to 25 times the time-lag pick-up current setting (I_p). The operating time of this unit varies from 0.32 to 0.04 sec. The minimum operating time is 0.04 sec. which corresponds to 2 cycles/sec. of the power frequency (50 Hz.). The operating time of 0.32 sec. at low operating current is too slow, this is because of the capacitor C in the input circuit. To reduce the operating time of this unit, the voltage to drive the comparater-3 circuit should be derived from the operating current by a separated rectifier from the time delay input circuit.

input circuit.

The effect of the temperature is that the pick-up current (I_p) at 50° C increases by 15 % more than that at 25° C. This is due to that the critical voltage of the comparator-2 increases with temperature. The compensation to reduce this effect is to insert a negative temperature coefficient component, such as NTC (thermistor)[1] or PTC resistor (metal and sensistor)[2], inseries with the resistor R_8 in the comparator-2 circuit. The increase of temperature to 50° C causes the operating time of the inverse time-lag unit to increase by 11.3 % (at low operating current the operating time decreases by 2.24 %, but it is concluded that the operating time increases with temperature because 2.24 % is within the accuracy of the time measuring instrument and within the limit of human error). The causes of timing variation are as follows : the collector leakage current of T_2 increases with temperature[3], thus increases the charging rate of C_1 which inturn decreases the operating time ; the capacitor C_1 increases its capacitance with temperature[4], thus decreases the charging rate, and therefore increases the operating time ; the critical voltage of the comparator-3 increases with temperature (by the experiment), hence increases the operating time. The net effect

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[1] Greiner, R.A. Semiconductor Devices and Applications. New York: McGraw-Hill Book Co. Inc. Page 205.

[2] Ibid.

[3] Ibid Page 187.

[4] Hughes, L.E.C. and Holland, F.W. 1967. Electronic Engineering's Reference Book. An imprint of Iliffe Books Ltd., Dorset House, Stamford street, London S.E.I. Page 331.

is that the operating time increases with temperature. The compensation is the same as before, by using the negative temperature coefficient component, in series with R_4 in the comparator-2 circuit. The amplifiers operate correctly at 50°C so no compensation is needed.

The main advantages of the designed relay are low burden, no overtravel or overshoot and fast reset time (within 160 ms). The operating time range may be varied, if desired, by the value of C_1. The main disadvantage of the relay is that continuous power of 2.98 watts is needed. This may be eliminated by deriving the d.c. power supply from the current transformer.

The designed relay proved that a static inverse time overcurrent relay can produce a similar characteristics to the electromechanical relay and may replace the conventional overcurrent relay if it proves more reliable, more economic and lower maintenance.