TECHNICAL NOTE

A TWO-RELAY FLIP-FLOP[1]

Figure 1 shows a flip-flop that is functionally similar to those described by Hendry and Perry (1962) and by Revusky (1966). It requires fewer relays than the former and less specialized components and wiring than the latter. The circuit is easily constructed with snap leads from standard relay rack components.

Beginning with the condition in which the relays are unoperated and the capacitor discharged, the system operates in the following sequence: (a) Closure of the input switch operates relay A through the top NC contact of relay B charging the capacitor through the bottom NC contact of relay B. If the time required to charge the capacitor is considered negligible, the minimum closure time for the input switch is equal to the operate time of relay A. (b) Opening the input switch releases relay A, allowing the capacitor to operate relay B. The input switch must remain open for a time no less than the release time of relay A plus the operate time of relay B. At this point relay B is locked up through its middle NO contact and the top NC contact of relay A. (c) The next closure of the input switch supplies current to both relays through the top NO contact of relay B. An input switch closure of sufficient duration to operate relay A breaks the lockup of relay B while not allowing the capacitor to charge. (d) Opening the input switch de-energizes both relays returning the system to its original condition. The net result is that relay B alternates positions with each successive opening of the input switch. Additional contacts (not shown) on relay B control other independent circuits.

The sequence of events that initially operates relay B (steps a and b) requires more time than is needed to return the system to its original condition (steps c and d). It is possible for the input switch to return to its normal position before the operation of relay B in step b. The significance of these characteristics depends on the speed of the relays used and the particular application of the system.

The optimal capacitance depends on the operate time and coil resistance of relay B. Capacitance should be adjusted to the minimum value that will reliably operate relay B. Insufficient capacitance will operate relay B only intermittently or not at all. Excessive capacitance results in a failure of relay B to unlock at the offset of the second input: it unlocks momentarily but is instantly reoperated by a capacitor that has not completely discharged. This can be avoided by connecting the bottom NO contact of relay B to +28 v dc.

The apparatus was tested using two 6-PDT relays (28-v dc, 175-ohm coil),[2] a 75-μf capacitor in series with a 23-ohm resistor, and a 30-v dc power supply. No malfunction occurred in 2000 operations at 12 per sec.

REFERENCES

Hendry, D. P. and Perry, A. M. A simple flip-flop circuit. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 442.

Revusky, S. H. An electro-mechanical flip-flop with applications to counting, timing, and randomization. *Journal of the Experimental Analysis of Behavior*, 1966, 9, 431.

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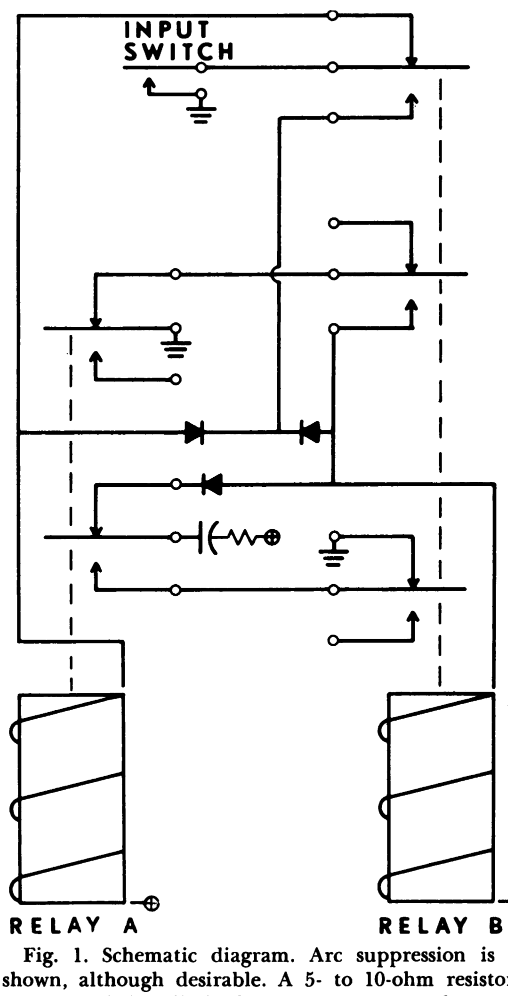

Fig. 1. Schematic diagram. Arc suppression is not shown, although desirable. A 5- to 10-ohm resistor is recommended to limit the current surge as the capacitor charges, thereby increasing contact life.

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[2]Leach part number 9226-4187.