A SIMPLE FLIP-FLOP CIRCUIT

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Figure 1 is the schematic of an inexpensive, reliable, bi-stable multivibrator, or flip-flop. Since the circuit includes only relays and rectifiers, it can be built in a few minutes with snap leads and standard operant-conditioning equipment.

Relays were chosen which had a fairly short response time. Relays A1 and B1 were TKLX93, made by American Relay and Controls. Relays A2 and B2 were 463, made by

Similarly, B1 controls B2. If A1 and A2 are energized, grounding the input lead allows B1 to be energized through the NC contacts of B2. The opening of the NC contacts of B1 de-energizes A1, and the closing of the NO contacts of B1 energizes B2. Also, A2 stays energized until the input pulse terminates. While A2 stays energized, the input pulse is effectively isolated and oscillation is prevented.

The make time of A1 and B1 in the operating flip-flop was 8-9 msec, and the drop-out time was 13-14 msec. The device could follow inputs up to 55/sec. This performance was compared with that of a commercially available ratchet relay (Potter and Brumfield AP17D). The response time of the ratchet relay varied from 25-30 msec, and it could be made to follow inputs of only 8-20/sec, depending on its orientation.

The response time of this device is short enough for most purposes for which it might be used in a psychological laboratory, but is rather long compared with an equivalent electronic device. Consequently the flip-flop we have described has the advantage of not being subject to unintended multiple operation through contact bounce when controlled by an external relay. No special shaping of the input pulse is necessary, and, of course, the length of the input pulse is not critical so long as it exceeds the response time of A1 or B1.

Fig. 1. Schematic diagram of the flip-flop.

Cook. Relays A1 and B1 had 4PDT contacts, which allowed 6 outputs to be controlled independently.

Because A1 operates through the NC contacts of B1 and vice versa, A1 or B1 (but not both) must be energized. If A1 is energized, so is A2, through the NO contacts of A1.