Most of the parts can be purchased or made easily. A few of the more unique items are: (1) narrow-mouth bottle, Nalge 2, 30 ml; (2) nipple, N-30 "Nip," Poly Nurser Products, Brooklyn, New York; (3) thermal switch, Fenwal, 3000-0; (4) heating tape, B-41, Brisco Mfg., Columbus, Ohio; (5) clock, Haydon elapsed-time indicator in minutes; and (6) connectors, Amphenol 126 series, 5-pin hexagonal, male and female.

The surrogate consists of a Plexiglas cylinder (5 cm in diam and 25 cm long) that attaches to the side of the animal's home cage. The angle of the cylinder, with respect to the floor, can be adjusted by means of a pivot. A small plastic bottle with a miniature nipple fits in a hole in the cylinder, and a Plexiglas tube in the hole keeps the bottle in place and prevents leakage into the cylinder. Heat is provided by a flexible heating tape fastened to the inside of the cylinder and attached to a thermal switch. Tape temperature is controlled by an adjustment screw on the switch and, in our studies, was kept at 34°C, as measured under the fur cover.

The amount of time that the infant spends on the surrogate is recorded automatically. The animal's weight on the cylinder moves the pivot, which closes a switch and starts a clock. The different parts of the unit (cylinder, pivot, clock) are connected by pieces of metal tubing that also contain wires connecting the different electrical components to appropriate power sources.

One convenient feature of the surrogate is that it can easily be removed for cleaning or repairs. This is accomplished by a sleeve and connector arrangement, shown in Fig. 1, which can be used to separate the surrogate from the pivot and clock.

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A Multifunction Multirange Interval Timer*

R. FRANK WALLACE

University of California, San Diego
La Jolla, California 92037

One of the most expensive items in electro-mechanical programming has traditionally been interval timers, both in terms of individual unit cost and the number of units required to offer a broad span of time ranges. With the advent of interval timers that utilize gearing systems to allow the selection of one of several time ranges, the need to stockpile timers of different ranges is eliminated. The Tenor Timer (Model 625-5-H) uses a 0-6 scale on the front panel with six multipliers via internal gear trains. By the rotation of an external knob, one can convert instantly the basic unit into a 0-6 sec, 0-60 sec, 0-6 min, 0-6 h, or 0-60 h timer with continuous time settings between the extremes on each range.

The schematic presented here (Fig. 1) offers an extremely versatile circuit for the adaptation of the Tenor Timer for use with snap lead or other electro-mechanical equipment. The completed module can function in the following modes: (1) Pulse-Operate—A negative pulse to the "operate" stud starts the timing interval which continues until the timer reaches zero or a negative pulse is applied to the "reset" stud: (2) Power-On Operate—The interval times out while power is supplied to the "operate" stud and returns to its setting when power is removed; and (3) Auto-Restart—Once a negative pulse is supplied to the "operate" stud, the timer continues to time-out, reset, and restart itself until interrupted. Table 1 lists the external operation of toggle switches and studs to select the mode of operation.

The timer operates as follows.[1] Relays 1 and 2 (Ry 1, Ry 2) function as a typical lock-up circuit when Toggle Switch 1 (TS 1) is in the closed position. When a pulse is supplied, Ry 1 locks up, holding power on the motor and clutch of the timer until it has timed out or a reset has been received. One set of Ry 1 contacts supply external switching during the timing interval. At the end of the timing interval, Relay 3 (Ry 3) is operated via contacts in the timer and in turn operates Ry 2 to release the lock-up. A set of contacts on Ry 3 provides external switching at the end of the timing interval.

With TS 1 open, Ry 1 cannot lock and will operate only as long as negative is supplied to the "operate" stud. If negative is supplied long enough for the timer to time out, ac power to the motor is cut off though contacts in the timer, taking strain off the motor and the gears. External switching contacts operate in a similar manner to the "pulse-operate" mode, except that they return to their normal state only when negative is removed from the operate stud.

When TS 1 is closed, and the "auto-restart" stud is connected to the negative, Capacitor C1 charges during

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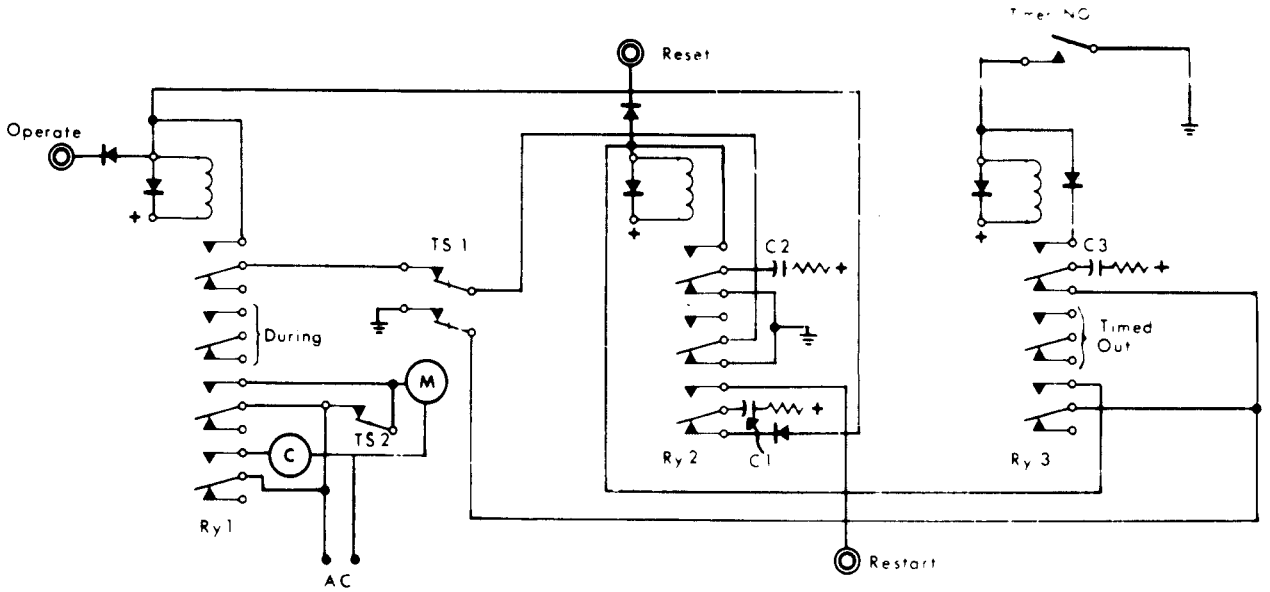

Fig. 1. A diagram for adapting the Tenor Timer. Motor (M) and clutch coil (C) are operated by 110 V ac.

Table 1
External Control of Timer Modes

Mode	TS 1	TS 2	"Operate" Stud	"Reset" Stud	"Restart" Stud
Pulse Operate	Closed	*	Pulse	Pulse	Open
Power-on Operate	Open	*	Continuous	Nonfunctional	Open
Auto Restart	Closed	*	Pulse	Pulse	Negative

**Recommended "closed" anytime program calls for frequent starting and stopping of motor.*

the operation of Ry 2. At the end of the reset phase C 1 is allowed to discharge through Ry 1, thus restarting the timer. External switching contacts function in the same manner as in the "pulse-operate" mode. Capicators C2 and C3 are used for timing the reset function and the output pulse, respectively. Toggle switch TS 2 bypasses the contacts in Ry 1 and supplies ac to the timer motor continuously.

NOTE

1. Parts specification for prototype timer: Timer—Tenor Timer model 625-5-H, Tenor Co. Inc., New Berlin, Wis., $49.50 each; relays—Sigma 62R4-24DC-SCO; capacitors—C1, C3-40 mfd, 50 vdc; C2-250 mfd, 50 vdc; resistors—47 ohm, ½ W; diodes—ln4003.