A MODIFIED MONKS WOOD LIGHT TRAP INCORPORATING A FLASHING LIGHT

D. ROSS

Physics Department, Calday Grange Grammar School, West Kirby, England

M. W. SERVICE

Liverpool School of Tropical Medicine, Department of Medical Entomology, Liverpool, L3 5QA, England, U.K.

ABSTRACT. Preliminary trials in Colombia, Ghana and Kenya have shown that a flashing fluorescent light tube in a battery-operated light trap can be very useful in trapping mosquitoes and other medically important insects. A light source that repeatedly flashes on and off also reduces the power consumption of the trap, and consequently extends the intervals between battery recharging. A description is given of a modified Monks Wood light trap in which the fluorescent light can either operate continuously or be made to flash on and off at different rates. A photoconductive cell is also incorporated in the circuit which allows the trap to automatically switch on at different light levels.

INTRODUCTION

Monks Wood battery-operated light traps employing 23-cm fluorescent tubes of varying spectral emission have been used in many countries to catch mosquitoes, Ceratopogonidae and other insects of medical importance (Bailly-Choumara 1973, Chandler et al. 1976, Service 1976, 1979, Walker and Boreham 1976). The electronic components of the trap have been redesigned and modified several times since the original description (Service 1970). Recently a modification has been developed which allows the fluorescent light tube to repeatedly flash on and off.

In 1977 Monks Wood traps having either white or ultraviolet light tubes operating either continuously or flashing on and off 20–30 times a minute were evaluated at Auraracuara near the Rio Caqueta in the Colombian amazonas jungle. Numerous adults of *Anopheles oswaldi, An. pergassui,* various culicine mosquitoes, Ceratopogonidae and also smaller numbers of other *Anopheles* species and sand flies of the genus *Lutzomyia* were caught in traps with flashing lights. Certain mosquito species were caught in greater numbers and others in smaller numbers in traps with flashing lights than in those with a continuous light (Service, unpublished).

At Hola in Kenya a white light tube flashing on and off 30 times a minute for 3 nights in 1978 caught 2 female *An. gambiae* complex, 2 female *An. funestus/rivulorum,* 1 female *An.* sp., 13 female, 2 male *Mansonia uniformis,* 8 female 1 male *Ma. africana,* 2 female *Ma. fuscopennata,* 1 female *Culex poicilipes,* 10 female, 7 male *Cx.* spp., 9 female, 4 male phlebotomine sand flies, 30 female *Culicoides leucostrictus,* 3 female *C. nivosus,* 1 female, 2 male *C. milnei,* 2 female *C. imicola,* and 1 female and 1 male *Forcipomyia* spp. In addition several *Paedurus sabaeus,* a vesicant-producing beetle, and numerous other Coleoptera and Hymenoptera, Isoptera and Reduviidae were caught. A single night's catch on a very windy night with an ultraviolet tube flashing about 30 times a minute caught 2 female *Aedes albothorax,* 1 female *Ae. albicosta,* 1 female *C. leucostrictus* and 1 female *Forcipomyia* sp. and in addition various insects of non-medical importance.

In Ghana 6520 *Simulium damnosum* complex considered to be *S. squamosum* were caught in a single night in a Monks Wood trap having an ultraviolet tube flashing about 30 times a minute and placed near Boti waterfalls on the Pawmpawm river (Service 1979). This represents the biggest recorded single night's catch of blackflies. When the trap had a flashing white fluorescent tube and was placed for 2 nights in the Akosombo area near Aimasi stream and another 2 nights near the Volta River 6 female, 1 male *An. gambiae* complex, 29 female *An. nili,* 2 female *Ae. aegypti,* 23 female *Uranotaenia balfouri* and 6 female *Aedes* spp. were caught. A trap in the same site but having an ultraviolet flashing light caught on 4 nights 2 female *Culex nebulosus,* 1 *Culicoides distinctipennis,* 1 male *Forcipomyia* sp., 1 male *Atrichopogon* sp. and 1 female *Bezzia* sp.

An operational advantage of a light trap with a flashing light is that the power consumption of the light source is reduced—by half if the on and off periods are equal—and this extends the interval between battery rechargings.

Because of these promising preliminary results and the potential of a light trap having a flashing light, a description is given of a Monks Wood light trap which (1) allows the light to flash on and off for different periods and (2) has a photoconductive cell circuit that can be adjusted to let the trap be automatically switched on at different light levels.

MATERIALS AND METHODS

DESCRIPTION OF THE MONKS WOOD TRAP. (Fig. 1.) The light source is a 23-cm 6-W fluorescent tube which can be a white light, a tube emitting large amounts of ultraviolet light or a so-called "black" or "blue light" which filters off most white light and emits mainly ultraviolet light. The exact spectral emission will vary between different types of light and also between light tubes from different manufacturing companies. In most tests and field operations Osram white lights or Philips UV lights have been used. The light tube is centered in the middle of 3 vertical plastic baffles which slot into a clear plastic cylinder (19 cm long, 10 cm diam.). A small removable wire mesh screen is held in position by a metal ring secured by 3 small screws and is fixed to the top of the plastic cylinder. A small fan blade (75 mm diam.) powered by a 12-volt d.c. Maxon motor draws the catch down into a terylene bag. The motor operates directly from a 12-volt car battery, and the light tube from the same battery but via a transistor ballast (= inverter) contained in a metal box. The current consumption of the motor is 75 mA and that of the light tube 500 mA. A circular glassfibre roof can be fitted over the top of the light trap to help exclude rain.

A photoconductive light cell is mounted in the top of the metal box (280 mm × 75 mm × 55 mm) which contains the electronic components (fig. 2.). The switches are on the side of the box and from left to right consist of (1) a four-position switch (mode) allowing either a continuous or flashing light both when the trap is switched on and off manually and when it is automatically switched on through the photoconductive cell, (2) a 6 pin-Din plug and power cable to the light tube, (3) a screw-in 2-A fuse connector, (4) a 2-position on/off power switch, (5) a variable switch allowing the light off pe-

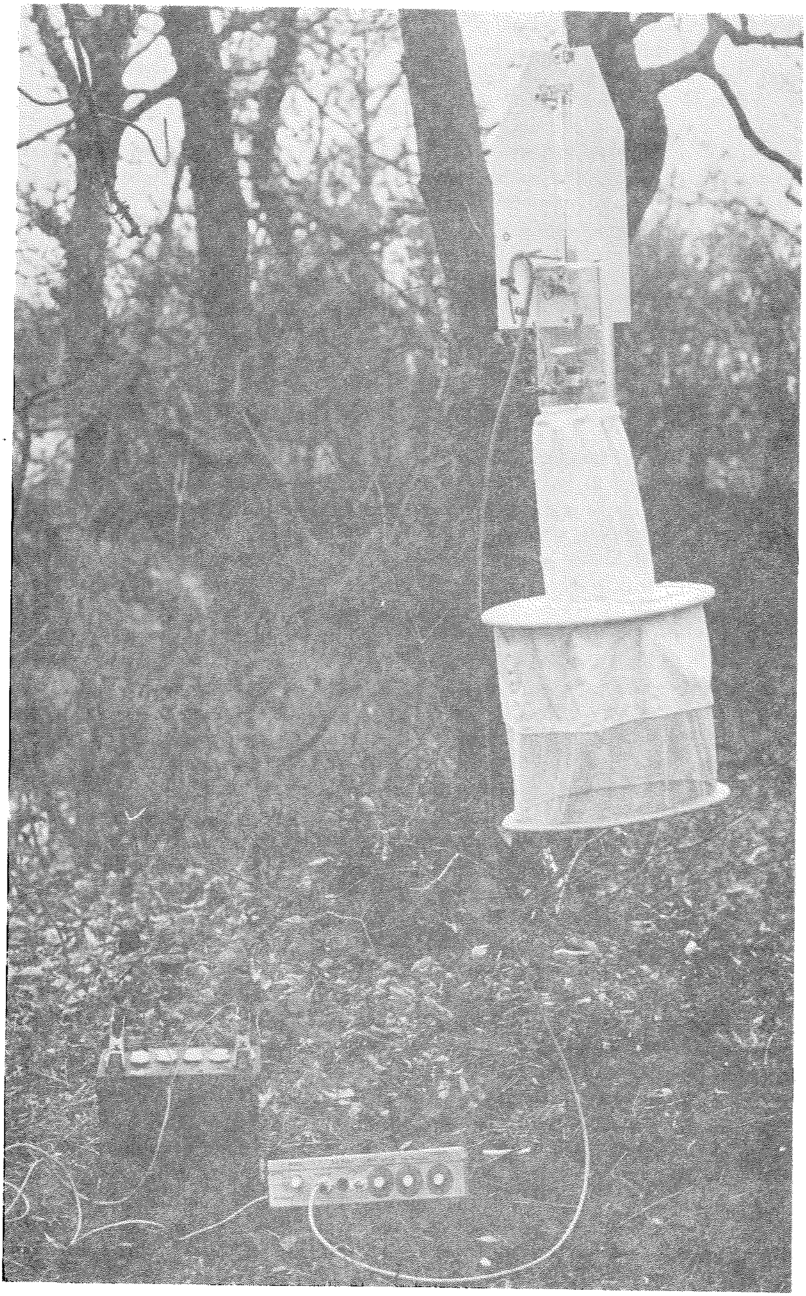

Fig. 1. Monks Wood light trap together with a 12-V battery and ballast (= inverter).

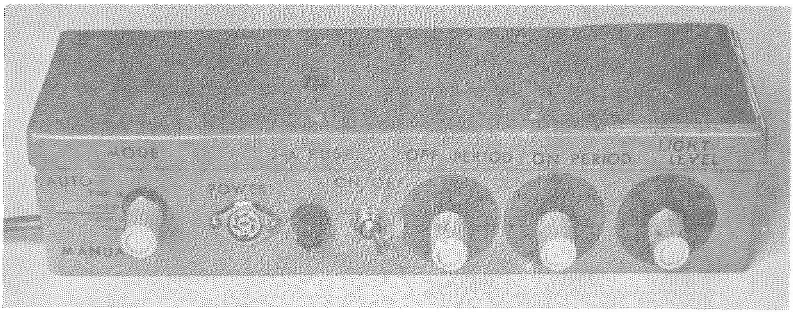

Fig. 2. Ballast (= inverter) box showing the controls and photoconductive cell mounted on top of the lid.

riods to vary between about 0.5–8 secs, (6) a similar switch allowing the light on periods to vary within the same range and (7) a variable switch which adjusts the light level that activates the photoconductive cell and automatically switches on the trap.

ELECTRONICS OF THE MONKS WOOD TRAP. The circuit was redesigned around the 741 operational amplifier, the CMOS 4001 quad 2-input NOR-gate integrated circuits and the ORP 12 light dependent resistor.

The ORP 12 is a Cadmium sulfide photoconductive cell which has a spectral response similar to that of the human eye, making it ideal for sensing varying levels of visible light. The cell resistance rises with falling light intensity. Using the cell shown in the circuit diagram (fig. 3), the potential difference (p.d.) across R1 falls with falling light intensity as the resistance of the photoconductive cell (LDR) increases. Any difference in the p.d. applied to the inverting and non-inverting inputs of the operational amplifier IC1 will cause its output to be either at or very nearly 0 or 12 volts. Thus, by adjusting the variable resistor VR1 and therefore the p.d. to the inverting input, the point at which 'switching' takes place can be pre-determined since the p.d. across R1 appears at the non-inverting input. The resistors R2, R3, and VR1 are chosen to provide a suitable range of light levels. The switch SW2a selects whether the unit is to be switched on manually (using SW1) or automatically via the circuit already described.

Gate 1C2c is used as an inverter so that transistor TR1 is switched on when the input to 1C2c is at OV. TR1 controls the fan motor so that it remains on when the lamp is used in its continuous or flashing mode.

The flashing sequence is produced by a conventional astable multivibrator designed around 1C2a and 1C2b. The output (to SW2b) is a square wave whose 'mark-to space' ratio or lamp on/off periods can be altered by VR2 and VR3. The time periods depend upon the values of C1, C2, R5, R6, VR2, and VR3, and in this design are chosen to give a similar range of 0.5 to 8.0 seconds for both the on and off periods.

The time period of the circuit is also dependent on the transfer voltage of the particular 4001 integrated circuit that is used and this can vary considerably between one 4001 and another. Typically this is 40% to 60% of the supply voltage. Consequently the timing components might have to be adjusted to give a particular timing period. The transfer voltage of a particular 4001 is constant for a wide variation of temperature and supply voltage, thus the circuit has very good stability once the time period is set.

Switch SW2b selects whether the lamp is to flash or remain on continuously. TR2 is only on when both inputs to the

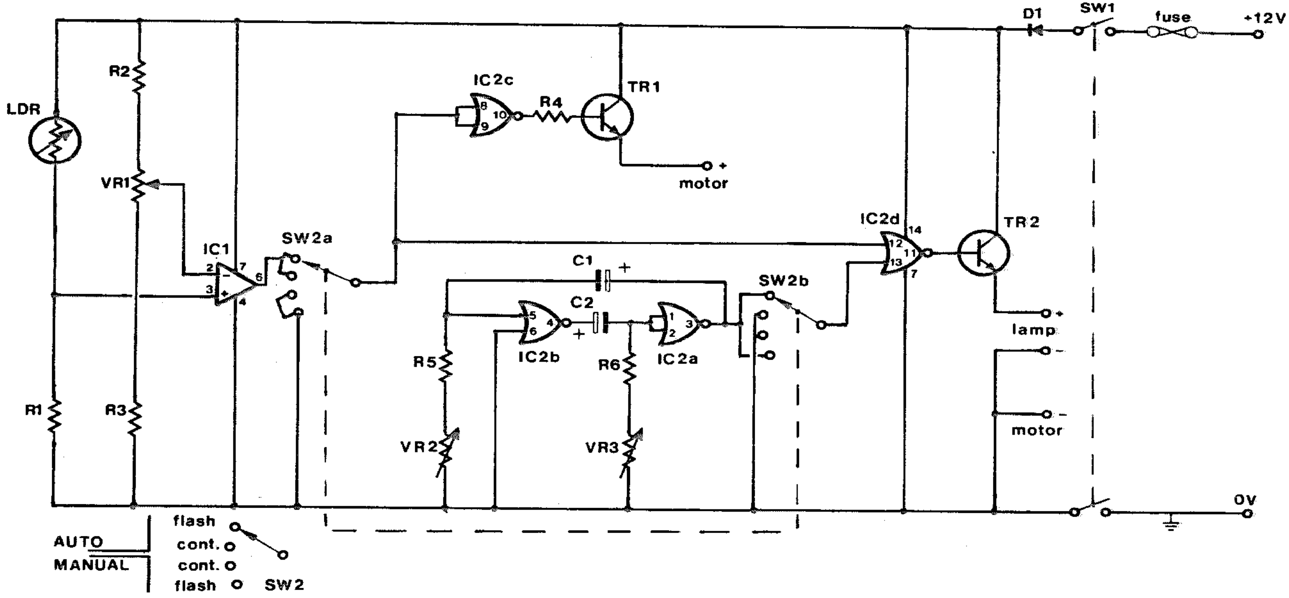

Fig. 3. Circuit diagram for the Monks Wood light trap. SW1, Se2, VR1, VR2 and VR3 are placed in the box housing the electronic components and ballast (=inverter). For convenience R3 is mounted between VR1 and VR2. All other components are mounted on the printed circuit board illustrated in Fig. 4.

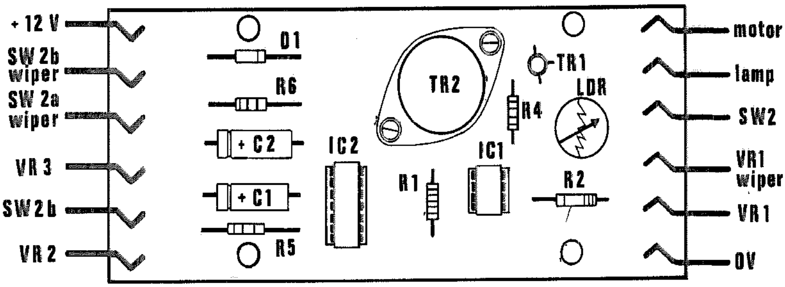

Fig. 4. The printed circuit board viewed from the component side (reduced size × 0.061; original size 148 × 62 mm).

NOR-gate, 1C2d, are at OV. Diode D1 is included to prevent accidental reversal of the supply leads damaging the circuit components.

Figure 4 shows the components mounted on a printed circuit board designed so that all connections are terminated at either end with push-on connectors to facilitate replacement should a fault occur. Figure 5 shows the printed circuit board copper pattern, size reduced.

Controls:—Potentiometer VR1—light level: Potentiometer VR2—Off period: Potentiometer VR3—On period: Switch SW1—main on/off and Switch SW2—manual/automatic, flash/continuous.

Components:—R1—5.6kΩ; R2—1.5kΩ; R3—10kΩ; R4—10kΩ; R5—5.6kΩ; R6—6.8kΩ; VR1—50kΩ; VR2—100kΩ; VR3—100kΩ; LDR—ORP 12; C1—100μ F; C2—68μ F; TR1—BC 107; TR2—MJ 3001 D1—IN4001; IC1—741; IC2—4001; SW1—2 pole on/off and SW2 2 pole 4 way.

Supply Sources. All electronic components and switches were obtained from R.S. Components Ltd., P.O. Box 427, 13–17 Epworth Street, London EC2P 2HA, England. The transistor ballast (= inverter) was Type AME R2679 obtained from Smart and Brown Lighting, Bond Street, Mitcham, Surrey, England, the 12-volt d.c. motor was a Swiss made

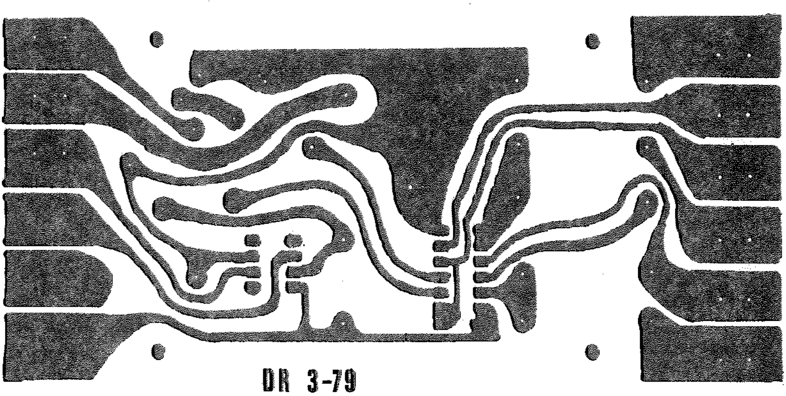

Fig. 5. The printed circuit board copper pattern (reduced size × 0.81; original size 148 × 62 mm).

Maxon no. 2125/912/11/111000, obtained from Trident Engineering Co. Ltd., Wokingham, Berkshire, England. All other parts of the trap, including the printed circuit board were made by the authors.

References Cited

Bailly-Choumara, H. 1973. Etude preliminaire d'une récolte d'*Anopheles labranchiae* par piège CDC réalisée dans la région de Larache, Maroc. Bull. Wld. Hlth Org. 49: 49–55.

Chandler, J. A., R. B. Highton & M. N. Hill. 1976. Mosquitoes of the Kano Plain, Kenya. II Results of outdoor collections in irrigated and non-irrigated areas using human baits and animal baits and light traps. J. Med. Entomol. 13: 202–207.

Service, M. W. 1970. A battery-operated light-trap for sampling mosquito populations. Bull. Wld Hlth Org. 43: 635–641.

Service, M. W. 1976. *Mosquito Ecology: Field Sampling Methods,* Applied Science, London, 583 pp.

Service, M. W. 1979. Light trap collections of ovipositing *Simulium squamosum* in Ghana. Ann. Trop. Med. Parasitol. 73: (in press).

Walker, A. R. & P. F. L. Boreham. 1976. Saline as a collecting medium for *Culicoides* (Diptera, Ceratopogonidae) in blood feeding and other studies. Mosquito News 36:18–20.