sitive type that utilizes a mercury tube and controls the power circuit for the solenoid valve *I*, for the atomizer, and for the turntable motor *J*.

The clock *B* (either mechanical or electrical) is the type ordinarily used to turn on and off lights of signboards or chicken houses, and makes one revolution per day. Other rates may have to be provided for special work. On the clock selected no nonremovable parts should extend beyond the plane of the dial to interfere with the attachment of an extra dial (not shown) approximately 6 in. in diameter. This extra dial, which supports the paper disk, may be of thick Lucite or other plastic material. After the hand has been removed from the clock and a hole has been drilled in the center of the plastic dial to prevent interference with the center bolt *L*, the extra dial is fastened to the regular dial by means of two bolts *K*, which are inserted from beneath through holes of the regular dial and into tapped holes of the extra dial. These bolts are long enough to accommodate thumb nuts for fastening the perforated disk. If the controlled circuit is to be on for longer periods of time than it is off, perforations might better be provided for the off- instead of the on-time and the action of the relay reversed by turning the mercury tube end for end.

This apparatus has been in continuous operation for 10 mo, during which time it has satisfactorily controlled a solenoid valve and a small motor in accordance with prescribed schedules.

**Reference**

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10 May 1954.

## Apparatus for Producing Drops of Uniform Size*

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During the course of investigations into the effect of insecticides that are topically applied to insects, an apparatus for producing drops of uniform size in the range 70 to 400 μ in diameter was devised.

Various devices have been developed to produce uniform free drops. Dimmock (*1*) vibrated a glass capillary at its resonance frequency electromagnetically. Vonnegut and Neubauer (*2*) employed a similar method but excited the capillary with an air blast, and more recently they (*3*) produced monodisperse liquid particles by electric atomization. Davis (*4*) described an apparatus that employs a vibrating blade to detach drops from liquid feeding through a stationary capillary. Of these devices, Davis' apparatus offered the most promise. However, the results of attempts to adapt a model to toxicological experiments were unsatisfactory because of amplitude fluctuations in the vibrating reed. These fluctuations were apparently caused by variations in line frequency and voltage. The apparatus described here (Fig. 1) resolves this difficulty and incorporates additional improvements (*5*).

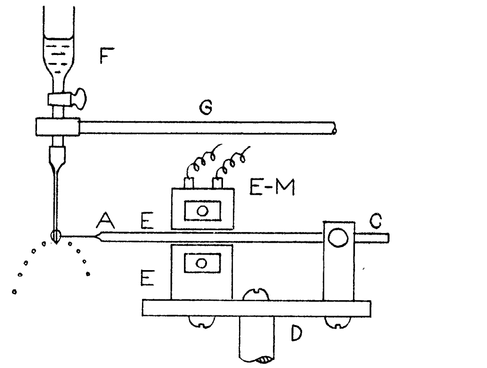


Fig. 1. Vibrator unit for production of drops of uniform size.

A coping saw blade *A* has its free end shaped to a point and sharpened at the edges. The blade tip is twisted so that it lies in a horizontal plane. Clamp *C* allows vertical and longitudinal adjustment of the blade. An electromagnet *E-M* is bolted to table *D* so that its distance from *C* may be varied. It is made up of a U-shaped, laminated iron transformer core, wound with about 4000 turns of No. 32 Formex-insulated copper wire. The liquid feed assembly *F* consists of a separatory funnel with a 27-gage hypodermic needle fitted to the tip. The assembly is held by clamp *G*, which may be positioned by micrometer adjustments.

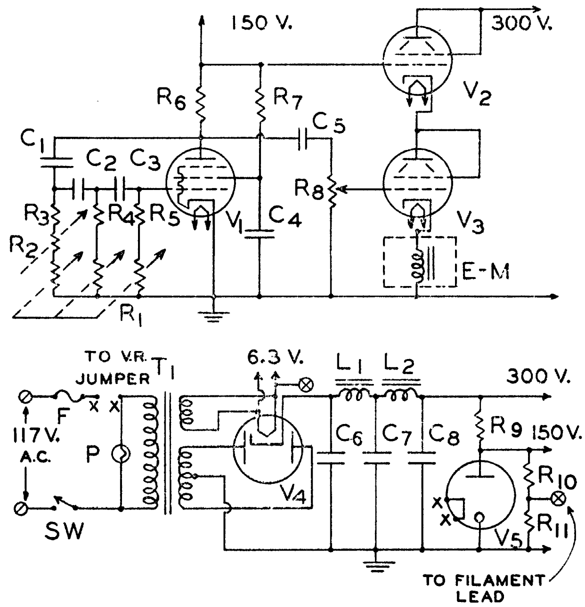


Fig. 2. Electronic circuit (*6*) for controlling vibrator.

The emf impressed across the electromagnet was made available throughout the frequency range 10 to 100 cy/sec by using a 6SJ7 tube in a phase-shift oscillator circuit (Fig. 2). An almost pure sine-wave output with good frequency stability is obtained. The amplitude is controlled by potentiometer $R_8$. Adjustment of $R_1$ gives variable frequency operation; $R_2$ provides fine control for locating the exact resonance frequency of the blade. The electronic circuit is fed from a constant voltage transformer and incorporates a voltage regulator stage $V_2$.

To operate the apparatus, the oscillator is tuned to the resonance frequency of the blade, and adjustments are made so that the vibrator tip cuts through the liquid that accumulates just above the needle tip. The amplitude of vibration is adjusted until two streams of drops are thrown off, one on each side of the needle tip. A light focused on one of the streams renders it visible. Any splash caused by liquid feeding back along the vibrating blade tip and being thrown off must be shielded out to avoid interference with the drop stream.

The size of the drops emitted depends chiefly on the rate of flow of the liquid. The frequency of the vibrator and the amplitude of the vibrating tip govern drop size to a lesser extent. To determine drop size, the frequency of generation was determined by means of a stroboscope, and the drops formed over a period of time were weighed. The mass per drop was calculated and converted to volume per drop through a density factor. Work so far has been confined mainly to oil solutions. The stains resulting from the contact of the drops with various surfaces may be made visible by dyeing the solution.

The action of the vibrator in producing drops may be seen by using a stroboscope. The blade tip emerges from the liquid, drawing a filament of the liquid after it. The filament then detaches itself from the main body of the liquid and follows in the wake of the blade, becoming spherical in shape and moving outward and downward from the needle tip.

The apparatus was developed primarily for use in insect toxicology, particularly for the topical application of drops of insecticidal solution to insects. However, it has since been found useful in other ways, for example (i) to deliver precisely measured small amounts of liquids, and (ii) as a calibration tool in insecticide spray work. Dye tracers in airplane spray experiments produce visible stain patterns on sampling surfaces. Determination of the exact relationship between stain size and drop size adds greatly to the precision of spray deposit assessments.

### References and Notes


* Contribution No. 151 Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada. Suffield Technical Paper No. 22, Defence Research Board, Department of National Defence.

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2. B. Vonnegut and R. Neubauer, General Electric Research Laboratory Occasional Rept. No. 29, Project Cirrus, Rept. No. RL-555 (1951).
3. ———, *J. Colloid Sci.* **7**, 616 (1952).
4. J. M. Davis, *U.S. Dept. Agr. Bur. Entomol. Plant Quarantine*, No. ET-295 (1951).


5. The assistance of F. E. Owen, Entomology Section, and W. L. Clink, Physics and Meteorological Section, of the Defence Research Board, Suffield Experimental Station, is gratefully acknowledged.

6. List of circuit components: $C_1$, $C_2$, $C_3$, 0.001 μf mica capacitor; $C_4$, 0.5 μf paper, 600 v; $C_5$, 0.1 μf paper, 600 v; $C_6$, $C_7$, 16 μf electrolytic, 450 v; $C_8$, 32 μf electrolytic, 450 v; *SW*-SPST switch; *F*, fuse, 1 amp; *P*, pilot lamp, 110 v; $V_1$, 6SJ7 tube; $V_2$, $V_3$, 6V6-GT; $V_4$, 6X5-GT; $V_5$, OD3 VR-150; $L_1$, filter choke, Hammond No. 152; $L_2$, filter choke, Hammond No. 156; $R_1$, frequency control, 3-gang potentiometer, 10 megohm per section; $R_2$, frequency control, potentiometer, 0.5 megohm; $R_3$, $R_4$, $R_5$, 1 megohm 0.5 w; $R_6$, 0.47 megohm, 0.5 w; $R_7$, 2.2 megohm, 0.5 w; $R_8$, amplitude control, potentiometer, 1 megohm; $R_9$, 15,000 ohm, 10 w; $R_{10}$, $R_{11}$, 68,000 ohm, 1 w; $T_1$, power transformer, 310-0-310 v rms, 70 ma.


13 September 1954.


## Semiautomatic Device for Washing Tissues


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The semiautomatic wash rack to be described was developed (*1*) in this laboratory to facilitate the handling of tissue specimens that require prolonged washing after fixation. The apparatus stops fixation and initiates washing at any desired hour of the day.

The rack (Fig. 1) is constructed of two sheets of 14-gage stainless steel, 15½ by 5½ in. after flanging, *A* and *B*, the upper sheet *A* being perforated with 16 holes of 1⅛-in. diameter. The holes are spaced 2 in. apart from center to center lengthwise and 3¼ in. apart from center to center across. The sheets are 2½ in. apart, and they are held in position by upright pieces of stainless steel, *C* 6 by ¾ by ⅛ in., which are silver soldered at the center line of the ends of the sheets.

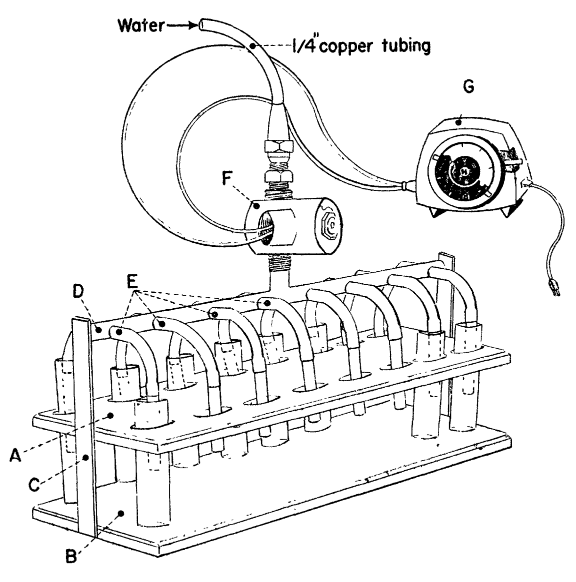


Fig. 1. Apparatus for semiautomatic wash rack.