It is then stored at 5°C with the cells filled with water and without disassembling.

In a typical test, 17,800 ml of dilute fungal enzyme preparation were concentrated to yield 170 ml of concentrate in the receiving vessel and connecting tubes and 632 ml in the cells and manifolds. The operation, carried out at 5°C, required 5 days with an 8-cell unit. The material in the receiving vessel was found to contain 49 percent of the original enzyme, concentrated 51-fold; the material remaining in the cells contained 39 percent of the original enzyme, concentrated 11-fold. About 5 percent additional enzyme was recovered in rinsings.

The effects of volume filtered and of pressure used on the rate of filtration of distilled water and on the rate of filtration of a fungal enzyme preparation are shown by the sample data plotted in Fig. 3. The rate

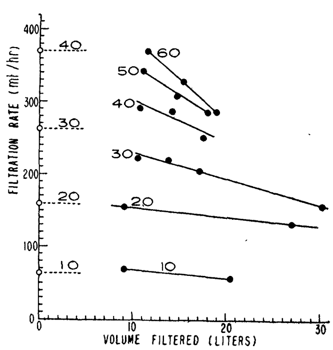

Fig. 3. Effects of volume filtered and of pressure on rate of filtration. Open circles and dotted lines represent data for distilled water; solid circles and solid lines represent data for enzyme solution. Numbers above lines represent pressures (lb/in.^{2}). Tests were made at 5°C with an 8-cell unit.

of filtration of distilled water remained constant regardless of the volume filtered. Furthermore, an approximately linear relationship obtained between the pressure and the filtration rate. The rate of filtration of the enzymes preparation decreased, however, as the volume filtered was increased, and in this case a linear relationship was no longer maintained between the pressure and the filtration rate.

The decrease in the filtration rate of the fungal enzyme preparation was caused by the accumulation of colloidal concentrate near the membranes and by the formation of an insoluble film on the surfaces of the membranes. Partial restoration of the filtration rate was brought about when the accumulated concentrate was removed by draining the cells. Final restoration was effected by removing the insoluble film, which was accomplished by partially filling the cells with water and shaking the apparatus vigorously.

Some accumulation of colloidal material at the membranes resulting in a loss in filtration rate, appears to be unavoidable. It is probably minimal, however, in this new apparatus since the membranes are mounted vertically rather than horizontally and the convective process continuously removes most of the colloid from the neighborhood of the membranes.

References and Notes

1. F. B. Seibert, *Am. Rev. Tuberc.* **30**, 713 (1934).
2. J. J. Bullen, C. Thurlbourn, and P. Brown, *Nature* **173**, 254 (1954).
3. Stainless steel pressure tank, capacity 35 liters.
4. Schleicher and Schuell Co., Type II ultrafilter, very dense, diameter 150 mm.
5. Whatman No. 4.
6. Norton Alundum filter plate, coarse, RA 98, diameter 125 mm.
7. Seitz filter, Model L6.

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Adaptable Time Switch

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In experiments with the citrus red mite (*Metatetranychus citri* McG.) it became necessary to spray water at frequent intervals on infested lemons as they revolved on a turntable. The time schedule called for 48 sprays of ½-min duration at 15-mm intervals each day. Since there was no inexpensive time switch available that would control the necessary solenoid air valve and the turntable motor with this frequency, a special time switch was constructed, which may be useful in other types of scientific work.

This device (Fig. 1) consists of a revolving paper disk *A* attached to a clock *B*. Perforations are made in the disk and so placed that silver contact points *D*, otherwise held apart by the paper, make contact at the required times. A 24-hr recording thermometer chart approximately 9½ in. in diameter is a satisfactory disk.

The switch mechanism *C* is composed of two spring brass strips *E*, approximately ¼ in. wide and 2½ in. long, each fastened at one end to an insulating wooden or plastic block *F*. To the free ends are soldered two rounded silver contact points *D*, which are held in ontact by slight tension of the brass strips. To prevent damage to the points, an electromotive force of not more than 10 v is used. This current is supplied by the transformer *G*, which is connected in series with the coil of relay *H*. This relay (*1*) is a high-capacity sen-

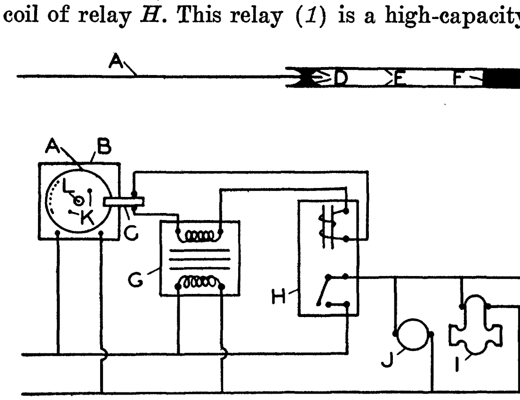

Fig. 1. Below, parts and wiring diagram of time switch. Above, enlarged sectional view of switch mechanism *C*.

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

1. R. A. Fulton and F. Munger, *Science* **104**, 373 (1946).

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*).

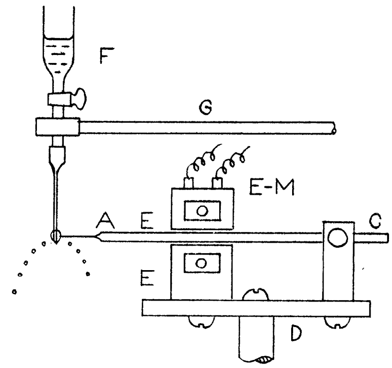

Fig. 1. Vibrator unit for production of drops of uniform size.

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.

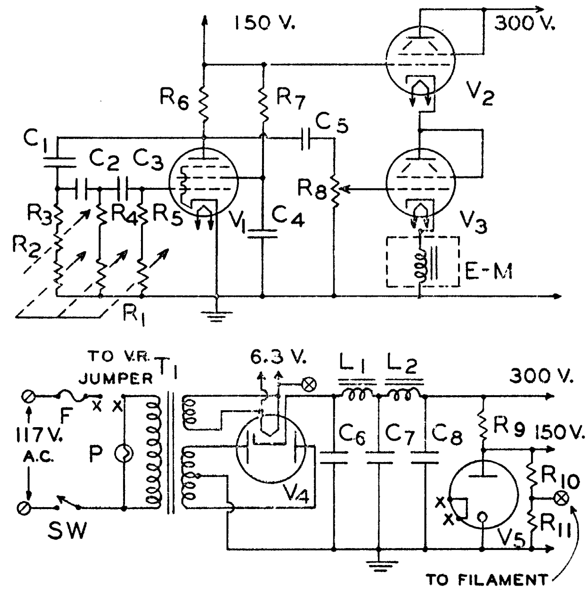

Fig. 2. Electronic circuit (*6*) for controlling vibrator.