plete control was obtained with Bayer L 13/59 at 0.1 p.p.m.

Tests with *Aedes* larvae in water samples from the plots showed that the treated water lost none of its toxicity while flowing as much as ½ mile through the fields. Samples taken 2 days after application of Bayer L 13/59 were completely effective, but others collected on the eighth day were ineffective. There was no control in treated plots that were dried and reflooded with untreated water. Lack of residual toxicity may be due to the alkaline soil in the fields that were treated.

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AN APPLICATOR FOR ADDING CHEMICALS TO FLOWING WATER AT UNIFORM RATES [1]

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A study of water-soluble insecticides for the control of mosquito larvae in irrigated fields focused attention on the need for an improved applicator for adding chemicals to flowing water.

Wisecup *et al.* (1946) tested various valves, pumps, and siphons for introducing DDT emulsions into rice-field water, but found all needed constant attention for uniform operation. They finally placed primary dependence on drip cans equipped with a metered valve from an oil heating stove, and maintained a constant vigil so the flow could be adjusted as needed.

Knowles and Fisk (1945), who worked concurrently on the same problem, favored a pump ordinarily used for chlorination to transfer water into an airtight bottle and force the displaced air into another airtight bottle that held a DDT emulsion. As the air in the latter bottle increased, the larvicide was ejected through an outlet tube.

Geib and Smith (1949) described a siphon attached to a 50-gallon drum to introduce DDT emulsions into irrigation water in California. The siphon consisted of a small rubber hose and copper tube with a glass metering tip that had an orifice large enough to permit 50 gallons of the emulsion to flow through in 24 hours at about 3 feet of head. The tip was suspended in the irrigation stream. They reported satisfactory operation with this device, but felt that further work was needed on refining the metering tip and on developing an apparatus that would maintain a constant head.

Lt. Comdr. F. R. DuChanois and other U. S. Navy personnel (personal communication) solved the problem of maintaining a constant head by directing the liquid from a reservoir tank into a 5-gallon auxiliary tank in which a steady level was maintained with a float valve similar to those used in toilet flush tanks. The insecticide preparations were released from this auxiliary tank at a uniform rate through a sight needle valve and tube attached near the base of the container.

Maintenance of a constant head is essential to an even discharge from dispensers with a gravity feed, as slight variations in the weight of the water column affect the flow rate. When the water level declines, as it did with some of the dispensers mentioned, the output gradually slows down and may stop completely unless frequent adjustments are made.

The apparatus described in this paper

[1] This work was conducted at the Orlando, Fla., laboratory of the Entomology Research Branch under funds allotted by the Department of the Army.

furnishes a simple means of maintaining a constant head on the liquid column and an even application rate. There are no moving parts, and no outside source of power is required. The unit is compact and rigid; so will not be easily broken. After the discharge has been started, no further attention is required until the supply of chemical is exhausted.

Essentially, the applicator consists of a balancing well, made of metal pipe, with a small hole in the bottom through which the liquid escapes. Near the top of the well is a lateral opening into a pipe to an airtight reservoir. The applicator starts to function when a valve between the well and the reservoir is opened and the well starts to fill. When the liquid level in the well is high enough to cover the lateral opening, the air supply to the reservoir is cut off, a vacuum forms in the reservoir, and the flow ceases. As soon as sufficient liquid escapes from the bottom of the well to uncover part of the lateral opening, air enters the reservoir and displaces sufficient liquid to seal the opening again; so the level in the well changes very little.

A satisfactory applicator can be constructed from pieces of galvanized iron pipe, a brass shut-off valve or stopcock, and an insecticide-sprayer nozzle. The parts can be purchased for $6 to $8 in any hardware store, and no special knowledge of mechanics is needed to put them together. A detailed drawing of the assembled apparatus is shown in Figure 1. A piece of 2-inch pipe (*C*) is capped on one end (*E*) and attached to a 2- by 2- by ¾-inch tee joint (*B*) on the other end. A threaded hole in the center of the cap permits the attachment of short lengths of ¼-inch pipe (*D*), both inside and outside of the balancing well that has been formed. A compressed-air sprayer nozzle (*F*), with the whirl plate removed, is attached to the outside piece of ¼-inch pipe, and the inside piece is covered with copper screening to prevent dirt particles from clogging the nozzle. Two ¾- by 2-inch galvanized iron pipe nipples (*G*) are screwed into the openings of a ¾-inch brass gate valve (*H*), and this control assembly serves as the junction between the tee joint and the reservoir (*I*).

While the applicator is in operation, this assembly must be kept approximately level. If the end of the reservoir to which the applicator is attached is higher than the other end, air cannot enter the reservoir and the apparatus ceases to function. An additional piece of 2-inch pipe (*A*) above the tee joint serves as a stack and gives extra depth to the well to prevent overflow in case an unusually large amount of liquid is discharged from the reservoir at one time.

A 55-gallon metal drum with a lacquered interior is a suitable reservoir. The interior must be coated to prevent rusting. The drum is laid on its side in a rack or stand with the ¾-inch opening in the head down. The applicator is attached to this opening with the well in a perpendicular position. The drum is filled through the 2-inch hole (Fig. 2). Filling will be simplified if this hole is on the top while the drum is in the rack, but containers with both openings in the head are usable. A good gasket will be needed beneath the cap covering this hole, as it must be airtight. The drum must be shaded, as sunshine falling on the uncovered metal causes the air inside to expand and push an excess of liquid into the stack of the applicator, which temporarily raises the head pressure and application rate. A cover consisting of a flat board 2 by 3½ feet has been used successfully to prevent this sudden rise in temperature and the resultant excess flow. Two strips of wood nailed 6 inches apart to the underside of the board near the center will prevent tipping. A covering of asbestos or wet sacks will accomplish the same purpose.

If the reservoir is only partially filled at the time it is closed, 1 or 2 minutes may be required for the vacuum to form. During this period the discharge rate is uncontrolled, and the well may flood unless a stack high enough to equalize the head pressure in the applicator and reservoir is attached to the open end of the tee joint. It can be removed after the vacuum forms and the water level again falls below

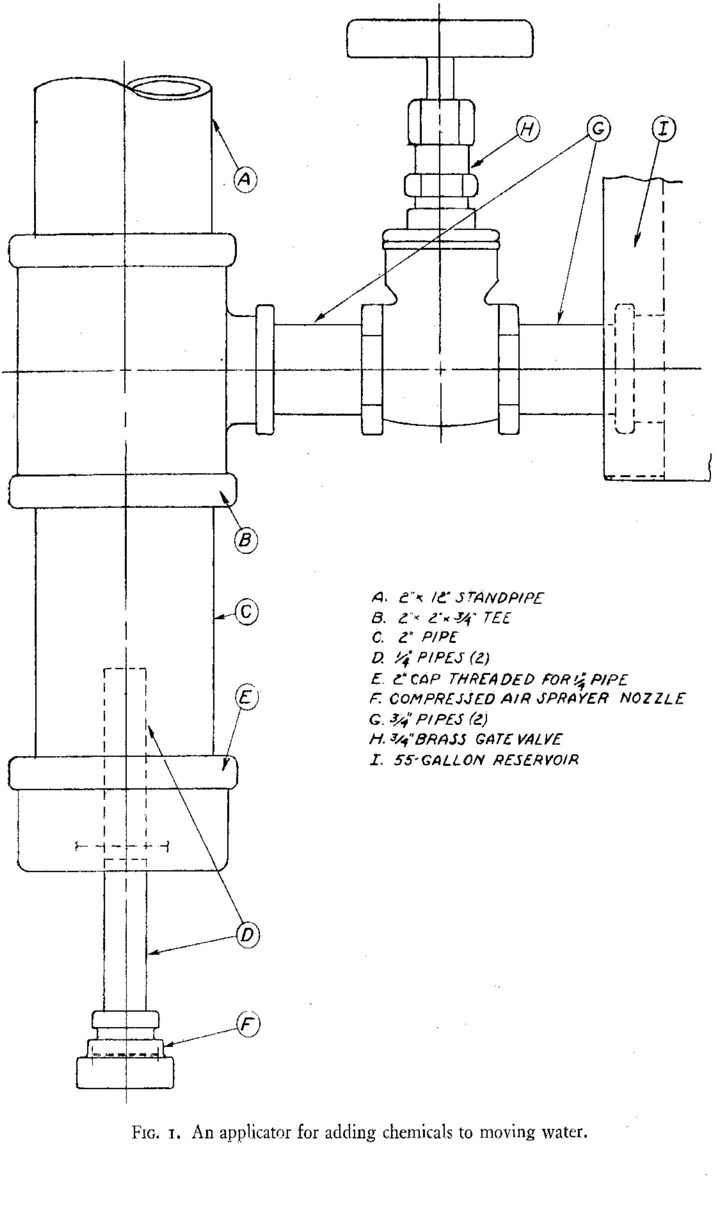

Fig. 1. An applicator for adding chemicals to moving water.

the top edge of the tee joint. When the tank is full, the vacuum forms within a few seconds after the apparatus is started and no flooding occurs.

There are three easy ways of controlling the amount of chemical applied with the applicator. The simplest method is to vary the concentration of the formulation used in the reservoir. The liquid used as a diluent must be clean, as any solid material may cause stoppage in the nozzle. If a nozzle with interchangeable disks is used, a range of delivery rates can be obtained with a series of disks of different orifice sizes. The authors have successfully used rates of flow between 50 and 400 ml. per minute, but others are possible. The third method consists of changing the head on the column of water by increasing or decreasing the depth of the well. This adjustment can be made by using nipples of different lengths between the tee joint and the nozzle.

Although this apparatus was developed primarily for applying insecticides to irrigation water, it can be used to add any liquid to moving water. Examples are the application of soluble fertilizers or pH adjusters to irrigated fields and the chlorination of water supplies or swimming pools.

SUMMARY. An apparatus that automatically applies chemicals to moving water at a uniform rate is described. It furnishes a simple means of maintaining a constant hydrostatic head on the liquid column in a gravity feed device. The applicator consists of a well made of metal pipe, from which the liquid gradually escapes through a sprayer nozzle in the bottom. Near the top of the well is a lateral opening that connects to an airtight reservoir. When the liquid level in the

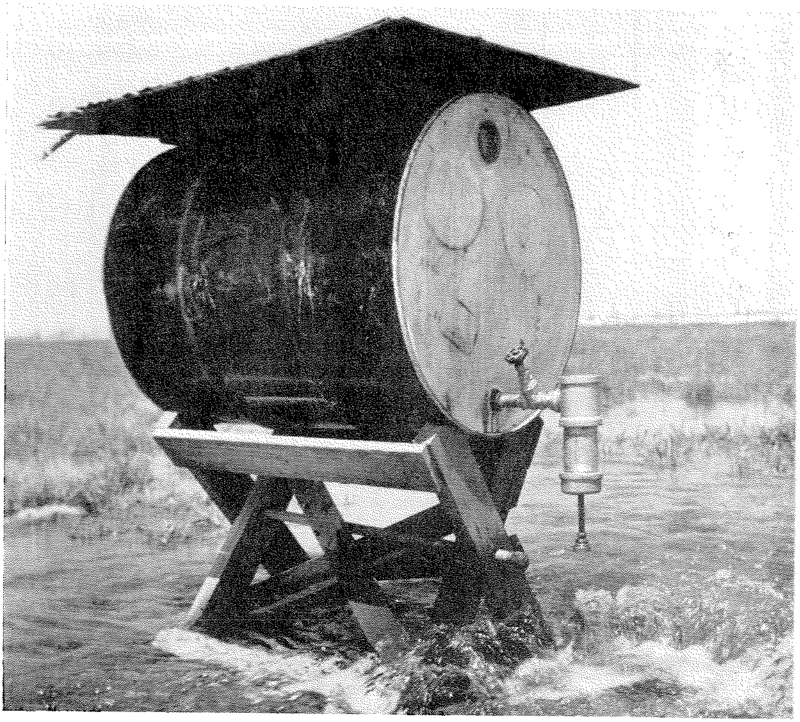

FIG. 2. Applicator in operation in an irrigated pasture infested with mosquitoes.

well is high enough to cover the lateral opening, the air supply to the reservoir is cut off, a vacuum forms, and the flow ceases. As soon as sufficient liquid escapes from the bottom of the well to uncover part of the lateral opening, air enters the reservoir and displaces sufficient liquid to seal the opening again. A 55-gallon metal drum with a lacquered interior is a convenient reservoir. The apparatus was developed primarily for applying insecticides to irrigation water, but also has other uses.

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A REVISED PROCEDURE FOR MAKING RAPID PERMANENT MOUNTS OF MOSQUITO LARVAE

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In two previous articles (1953, 1954) various procedures for making permanent mounts of mosquito eggs, larvae, pupae, and adults were described. In an area of high humidity such as the coast of Liberia, some of these methods did not produce satisfactory results. It was also found by experimentation that storage or dehydration in 70 per cent alcohol was entirely unnecessary. Specimens kept too long in beechwood creosote turned quite dark and were unsatisfactory for mounting. A revised procedure was determined as follows:

(1) Kill larva in hot water (preferably) or in 95 per cent alcohol.
(2) Dehydrate in 95 per cent alcohol for 2 hours.
(3) Clear in beechwood creosote for no more than 10 minutes.
(4) Transfer to xylene or toluene for 30 seconds to 1 minute. Swish specimen around gently.
(5) Mount in Permount, either the xylene or toluene mixture.

Permount dried more rapidly than any of the other mounting media previously described, and gave no difficulty with formation of a whitish precipitate around the specimen, provided step (4) was followed. Xylene may be used even if the Permount is made with toluene, and vice-versa.

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