A NEW WHEEL-MOUNTED INSECTICIDE MIST SPRAYER

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For a number of years Preventive Medicine Units and Engineer Insect and Rodent Control personnel in the military service have had a need for a portable or lightweight, insecticide mist sprayer that could be used both inside buildings for space and residual spraying and outside for residual spraying and adult insect control.

In 1950, Mr. Husman of the Orlando, Florida Laboratory of the U. S. Department of Agriculture developed a lightweight sprayer which used compressed air with the insecticide pumped at low pressure to generate a mist spray. Several sprayers similar in design were used by the Army in Korea in 1951. This field service and the work reported by the Department of Agriculture provided basic criteria and data for the design and development of a new mist sprayer. Laboratory studies were conducted and several experimental models tested before a suitable design was obtained. It is the purpose of this paper to describe this final design and briefly to discuss its performance.

The sprayer, Figure 1, consists essentially of a gasoline engine, air compressor, insecticide pump and an insecticide tank all mounted on a common base which in turn is mounted on a two-wheel push-cart chassis. As a wheel-mounted sprayer the unit may be pushed by hand into or through areas to be treated. In areas too large for this technique or over terrain too difficult for push-cart movement, the sprayer is readily removed from the wheeled chassis and can be carried in a vehicle such as a jeep or light truck. As base mounted equipment it weighs 140 lbs., and when mounted on its wheeled chassis it weighs 210 lbs. including 5 gallons of insecticide spray.

A gasoline engine is the power source for the unit. It is a typical 2 h.p. general purpose air cooled engine that is available throughout the military supply system. This is an important factor because it is the one component which may require frequent maintenance by replacement of spare parts or complete replacement of the engine. The availability of the engines and spare parts extends the operating life of this sprayer in the field. The engine has a manual throttle control for operation at speeds varying from 2,600 to 3,600 rpm and automatic governor control of a plus or minus 5 percent. An arrangement of belts and sheaves transmits engine rotary power to the air compressor and pump. To facilitate starting the engine, a centrifugal type clutch disengages the belt drives of both the compressor and pump. The air compressor is a heavy duty type of rotary design that gives a non-pulsating delivery of 8.3 cfm of air at a positive pressure of 30 psi when operating at a speed of 1,800 rpm. The insecticide pump is a helical rotary gear type of hardened steel with integral pressure relief valve and pressure fitting. It has a capacity of 1.5 to 4.5 gpm at zero psi and a speed range of from 600 to 1,725 rpm. The normal engine speed is 3,600 rpm. which gives an air compressor speed of 1,800 rpm and insecticide pump speed of 1,500 rpm. The insecticide tank is a regulation oval 5 gallon GI can. The insecticide and air are pumped through separate rubber hose to a wand and sprayhead assembly. The sprayhead consists of 4 combination air-liquid nozzles where compressed air is mixed with the insecticide to break it up into a mist. Both feed lines are equipped with valves that permit manual flow control of either the air or insecticide supply. The nature of the mist (whether heavy or light) is thus controlled by adjustment of the liquid and air valves.

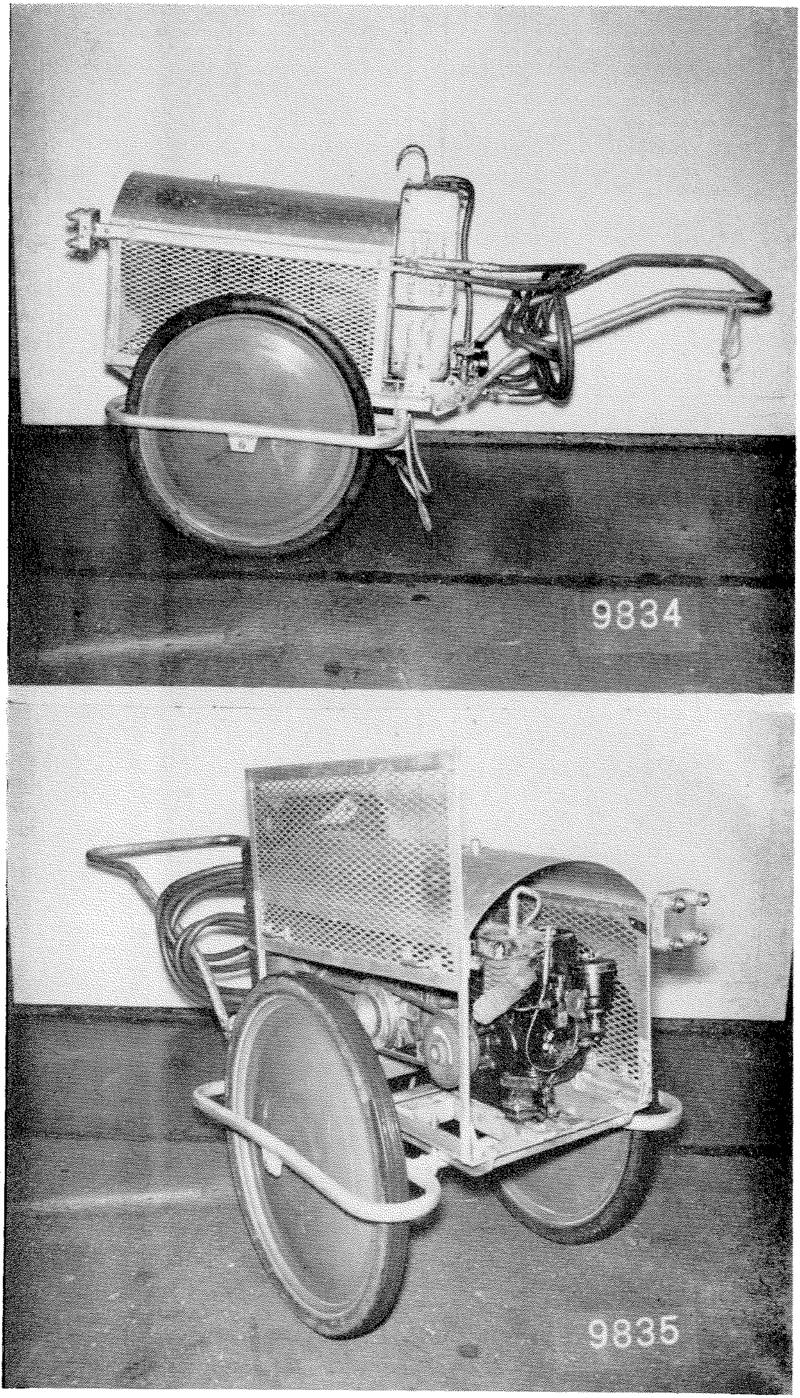

FIG. 1.—Final model of sprayer.

The insecticide line in the wand handle is also provided with a hand operated trigger valve for complete stoppage of the spray by the operator.

By keeping the air pressure constant and adjusting the quantity of liquid pumped, the characteristics of the spray are controlled. By opening the liquid valve or increasing the quantity of insecticide a heavy mist with large particles is obtained; conversely, by closing the valve or decreasing the liquid flow, a light mist is produced. For example, with the air pressure constant at 25 psi and a change in the liquid from 30 gph to 25 gph the mass median diameter of the spray particles decreased from 48 microns to 28 microns.

Combination air-liquid nozzles of various sizes were used in the spray head to find nozzles which would produce spray particles between 30 and 60 microns in diameter and preferably with a mean diameter of approximately 50 microns when using 5 percent DDT in kerosene. Magnesium or dryfilm coated microscope slides were located at intervals of 50, 100, and 150 feet downwind from the sprayer to collect the insecticide particles that would impinge on the slides. The slides were examined under a microscope with an eyepiece micrometer and the sizes of the insecticide particles determined. At 50 feet the median diameter was 55 microns; at 100 feet it dropped to 50 microns, and at 150 feet it dropped to 45 microns. An average of the three distances shows that the median diameter is 50 microns and that 72 percent of all the particles fall within the range between 30 and 60 microns.

Other tests were conducted to determine the amounts of DDT deposited at 50, 100, 150, and 200 feet from the machine. Six-inch glass plates were placed at these distances and chemical analyses of the DDT collected on them were made after they had been exposed to the spray. The amount of DDT deposited varied inversely with the distance of the collecting point from the machine. For example, analyses showed 1.6 pounds per acre at 50 feet and 0.2 pound per acre at 200 feet. The effects of the DDT on mosquito larvae were also determined by bioassay tests. Sterile petri dishes later filled with distilled water and a small quantity of ground dog food were exposed at the same distances from the sprayer. Active fourth instar larvae of either *Culex quinquefasciatus* or *Aedes aegypti* were placed in the dishes and examined 24 and 48 hours later to determine their mortality. Controls were run concurrently in the laboratory by placing larvae, dog food, and water in unexposed petri dishes. Mortalities varied from 100 percent at 50 feet and 20 percent at 200 feet in 24 hours, to 100 percent at 50 feet and 80 percent at 200 feet in 48 hours.

To improve the versatility of the sprayer for field use several accessories were added to permit dispersal of insecticide dust and indoor liquid residual spraying. A standard dusting gun developed by the Quartermaster Corps for use with a personnel delousing unit was adapted for quick connection to the compressed air line of the unit. Also a spray bottle assembly consisting of a one-quart plastic bottle, nozzles, and trigger valve was developed for similar connection. This small hand-operated spraying attachment is used in small restricted places in mess halls and kitchens the same as the dust gun for fly, roach, and ant control. A manifold installed on the compressed air line of the sprayer permits connection of either the dust gun or the spray bottle. Sufficient hose is provided to permit leaving the sprayer with its gasoline engine operating outside the building while the accessories are used on the inside.

Ten working models of this sprayer were shipped to test agencies of the Army Corps of Engineers, Army Medical Service, Navy Preventive Medical Units, Navy Bureau of Yards and Docks and the U. S. Department of Agriculture for operation and field evaluation. With the exception of the units in Korea and France, each agency was visited by a member of the Sanitary Engineering Branch of the Engineer Research and Development Laboratories while the field tests were being made and the performance of each machine was observed. Personnel performing tests on the sprayer consisted of army, navy, and civilian engineers and entomologists who were experienced with insect and rodent control programs both in the field and at permanent installations. While the entomologist was primarily interested in what percentage kill he could get at various distances from the machine with different pounds per acre of insecticide, the engineer was more interested in the operation of the machine and the sizes of insecticide particles it produced. It was felt therefore that the two complemented each other in their work.

The real test of insecticide dispersal equipment is its efficacy in insect control operations. In June 1954, at Fort Churchill, Canada, the sprayer was used for control measures at the Engineer Test Team Camp. Good control was accomplished by space and residual spraying of 5 percent DDT in kerosene both inside and outside of buildings at the camp maintaining a zero landing count of mosquitoes. There was a very dense mosquito population away from the camp in the tundra, where landing counts of approximately 165 mosquitoes per minute on a person's back were recorded. A single spray application of 5 percent DDT in kerosene over a five acre plot of this tundra produced zero landing counts for three days until mosquitoes from the outside area gradually were blown back into the treated area.

The field reports confirmed established requirements for this type equipment, and standardization of the test item with minor modifications was recommended. The sprayer is described by Corps of Engineers drawings and a military specification. These documents cover one complete sprayer and the spray bottle assembly, so that regardless of manufacture they should be similar in design and operating procedure.

Besides being useful to Preventive Medicine Companies, Medical Service Organizations, and Post Engineer personnel in normal insect control operations, the sprayer is also of use in a civilian capacity because of its dual purpose of adult insect control and residual application. It can be used for quick knock-down of flying insects at open air theatres and other such gatherings as well as around dairy barns, stockyards, garbage dumps, sewage plants and summer camps. It is concluded that the sprayer is suitable for classification as standard type equipment for use by all segments of the Department of Defense.