

CALIFORNIA GROUND THERMAL AEROSOL GENERATOR

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Photographs and Drawing by ROBERT F. PORTMAN

Mosquito control in California by mosquito abatement district has experienced a rapid expansion during and subsequent to World War II. Several thousand additional square miles of area, much of it sparsely populated, have become part of new districts or have been annexed to existing districts. In some cases, the limited local tax revenue has restricted the size of the organization needed successfully to accomplish the control requirements of the districts. This has caused Managers of several districts some considerable consternation. The use of conventional spray methods under these expanded conditions, even with the employment of DDT, was found to be inadequate for keeping under control continuously irrigated lands characteristic of certain regions in the Central Valley of California.

Such was the challenge which confronted certain California mosquito abatement districts, and the following deals with how this challenge was met and neutralized. Scene of this paper is the irrigated region in Sutter and Yuba Counties in California, which began mosquito control as an organized district in the spring of 1946, directing efforts against the hordes of mosquitoes which have occurred there year after year. Many of the residents of these counties passed judgment upon the undertaking as a misuse of public funds, because of the vast irrigated acreage and standing water, and they questioned the wisdom of even try-

ing to accomplish this seemingly futile task. For a while during the early period of the district's operations, when the emergence of *Aedes dorsalis*, *Aedes nigromaculis*, *Aedes vexans* and *Aedes lateralis* became widespread, the district personnel were also made to wonder if they possessed the wherewithal to get the upper hand on the mosquito population. It was this urgent situation which provided for necessity to mother invention and thus give rise to what has since been referred to in California as the "plumber's nightmare".

In early 1946 two commercial agencies, (the TIFA and Bes-Kil), had already demonstrated their ground aerosol units in California, but as has been previously mentioned, the budget limitations of the Sutter-Yuba Mosquito Abatement District, as well as other districts, didn't permit purchase of more than one such unit in view of their list price. One unit would have been helpful, but the outstanding need was that of complete treatment of approximately 350 square miles of prolific breeding area simultaneously.

Hence it was, that with the venturing principle for obtaining thermal aerosol in mind, improvising began on a ground exhaust aerosol generator, using galvanized pipe and pipe fittings to fashion the device. Since the district was using a fleet of seven War Assets Administration surplus Dodge 4x4, one-half ton trucks in its operations, one of these was dedicated to the cause of experimental research. By trial and error, the generator described in this paper was developed and used extensively on all of the district vehicles, with very gratifying results. Easily installed and inexpensive to operate, it made a very welcome addition to our equipment. Working with the generators, not as a

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cure-all, but as an aid in killing adult mosquitoes and mosquito larvae, the control crews made a good many people happy. Installed as part of the vehicle, crews could work with it any time of the day or night as occasion demanded.

After experimenting with several types of thermal aerosol generators, the "plumber's nightmare" was installed on all trucks operated by the district. The average cost for the complete unit, including tank, was thirty-five dollars. Any of the men could operate the unit with very little danger of burning vegetation, injury to the operator or damage to domestic or wild life. Pastured stock seemed to enjoy being "fogged" and would drift toward the area being treated. At first a little trouble was experienced in making U turns down wind but by executing a full circle turn across the next "swath" to be fogged, the operator avoided turning into his own smoke. Very little difficulty was encountered by operating the generator from the windward side of the truck. The forward speed of the vehicle, 5 to 8 miles an hour, allowed the aerosol to flow behind the vehicle with very little loss in efficiency. An effort was made to operate the generator from the lee side of the truck whenever heavy vegetation was encountered, particularly along ditches and sloughs.

The most spectacular result from the generator was, of course, the almost immediate adult kill obtained. Better public relations were developed by fogging than by all other control measures combined. Field laborers, fruit workers, warehousemen, urban residents and hunters were loud in their praise of the "mosquito smoking." Irrigators in the large pastures swore that the district did more good in half an hour with the fog machine than had been done in weeks by conventional spraying. Orchards, large truck crop areas and duck clubs were freed from all existing adult mosquitoes shortly after fogging. Two cities in the district were treated in the early evening and everyone seemed to feel the district was doing some-

thing worthwhile. Buildings could be treated very quickly with complete penetration to all cracks and covered places. A pipe extension was used to allow the operator to treat under houses, basements, and buildings not located conveniently with respect to the truck. The small amount of material discharged, approximately 10 gallons an hour, caused no damage to any of the building area. By using the extension pipe the possibility of depositing too much oil near the mouth of the venturi was reduced. Many other pest insects other than mosquitoes were killed as well. No evidence was encountered of injury to honey bees or other beneficial insects.

For practical mosquito control the exhaust venturi offers a tool that in many ways is superior to pressure spray equipment. Any mosquito source that can be reached with a truck can be covered more thoroughly by the aerosol than by hand operated spray nozzles. Crews are more apt to miss spots with the spray guns than they are with the aerosol. A nearly complete larval kill, up to fifty feet, was obtained by the exhaust aerosol at any time of the day. "Swaths" of fifty feet were found to be effective in controlling larvae in irrigated pasture lands. Temperature and wind velocity, up to fifteen miles an hour, did not materially affect the range of kill. A brisk wind actually increased the distance covered, even though the visual smoke dissipated rapidly. Vegetation did not seem to decrease the efficiency of the generator. Under favorable conditions such as early evening when a light wind was blowing, good larval kill was obtained up to 400 feet. In areas where the four wheel drive trucks can "swath," one operator can cover several hundred acres in one day. This method of control kills not only larvae but existing adults as well, thereby reducing the potential egg and larvae crop. No damage to field or pasture crops was observed.

Possible harm to the truck motors did not materialize. No excessive heating was observed and a loss in power did not slow the truck enough to be noticeable.



FIG. 1. The "Plumber's Nightmare" in closeup. The DDT solution is introduced by gravity feed from a tank in the rear of the truck through a copper fuel line into the throat of the venturi. Note solution dripping over the edge of the reservoir cap when exhaust pressure from motor stops.



FIG. 2. The "fog" begins to appear as the vehicle sets out to control this over-irrigated pasture. Such aerosol type control can be accomplished in one-fifth the time required for power spraying, thus resulting in a corresponding economy of operations while obtaining both larval and adult mosquito control.



FIG. 3. Full volume aerosol output is here being accomplished, which means death to larvae within fifty to one hundred feet and complete control of adult mosquitoes from within one hundred yards up to one-half mile. A valve controlling the DDT solution is within reach of the driver, which makes for uninterrupted travel and use of the aerosol only when needed.



FIG. 4. This Jeep is successfully negotiating a flooded pasture. As long as the "Plumber's Nightmare" remains above water, its mosquitocidal action continues. The aerosol under conditions of low relative humidity and moderate wind is inclined to rise somewhat, but in the presence of ponds it drops to hug the water surface.

Practically all the work in the field was done with the truck operating in compound low gear. This low gear driving will perhaps shorten the life of a motor, but the saving in manpower and the increased efficiency of control will more than offset the cost of even a new motor each year. The valves on the two trucks that had been "fogging" for the longest period of time were inspected and no damage was observed.

The descriptive diagram shows the wide latitude possible in the position of the venturi throat by a simple shifting of pipe nipples. This position of the throat, when the material is introduced, to the truck manifold is very important. The particle size of the aerosol can be regulated by the distance of the first reducer from the engine manifold. If the aerosol is too fine (dry fog) very poor results on larvae kill will be obtained. A dry fog will not drift for as long a distance when field adultciding is attempted. The long nipple with the reducer cap acts as a reservoir, holding excess material until the exhaust heat and velocity is able to break it up. Some dripping will occur if the generator is too cold or if the motor speed is too slow. A control valve on the feed line will regulate the flow of material. The reservoir helps to prevent foliage burning at the mouth of the gen-

erator, especially when the truck slows to turn or cross a ridge. A jet type feed line, centered in the throat of the venturi will fill with carbon very quickly and must be removed and cleaned often. The material is carried to the generator by gravity.

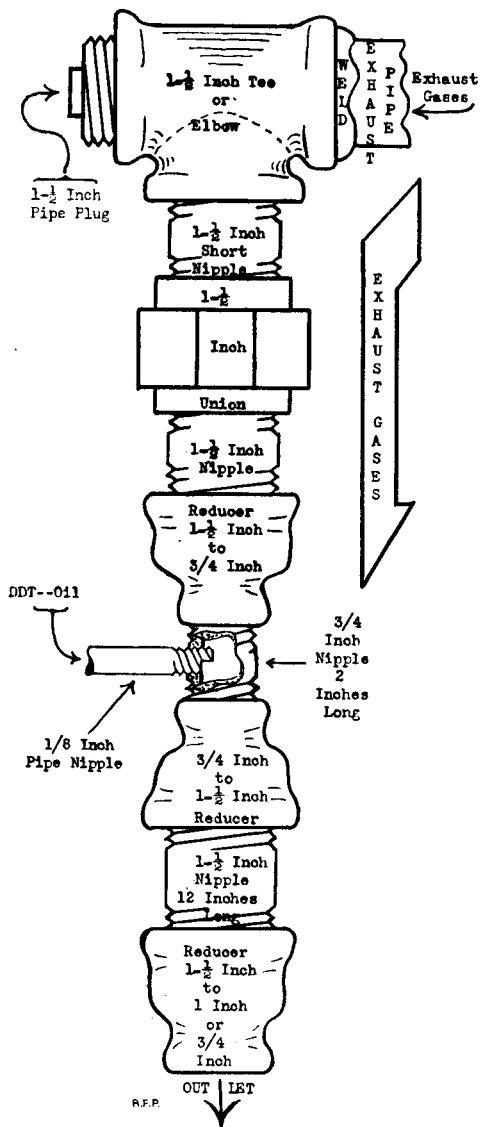


FIG. 5. CALIFORNIA GROUND THERMAL AEROSOL GENERATOR. Originated by Sutter-Yuba Mosquito Abatement District, Theodore G. Raley, Manager.

This vehicle exhaust venturi is welded to a short piece of exhaust pipe and coupled by the usual fitting to the exhaust manifold. It extends horizontally under the vehicle frame, and under the fender, back of the front wheel.

For "fogging" buildings, a number of lengths of two inch sheet iron drain or flue pipe may be used as an extension, by slipping it over the end of the venturi.

When not used for "fogging," the venturi acts as an exhaust muffler.

The specifications given in this diagram are for use in constructing a venturi to be used with a vehicle engine of approximately 90 horsepower.

The material used in this aerosol generator is equivalent to that used for airplane thermal aerosol work. Any DDT solvent capable of dissolving over 5% DDT and possessing a viscosity somewhat heavier than diesel oil is suitable. The addition of a spreading agent such as B 1956, in the amount of approximately 12 to 16 ounces per 100 gallons of material, is particularly desirable for larvicidal work. The formula commonly used in California consists of one-third 25% DDT xylene concentrate, one-third diesel oil and one-third strained crankcase flushings. This produces a DDT concentration of approximately 8 and $\frac{1}{3}\%$. A DDT percentage somewhat higher than this will most likely prove even more effective for larval kill.

During the latter part of 1946, the civilian $\frac{1}{4}$ ton Jeep became a basic unit in California mosquito control, particularly in the expanded area of the Central Valley. Nearly all of the Jeeps are equipped with a light power sprayer and an aerosol generator patterned after the device described for the larger vehicle and shown in the accompanying diagram. The Jeep aerosol generator varies from the accompanying diagram in that $1\frac{1}{4}$ inch pipe and fittings are used along with $\frac{1}{2}$ inch venturi throat and cap reducer. The generator is installed on the Jeep by cutting the exhaust pipe close to the manifold and welding on an elbow. Experience with this Jeep aerosol generator has shown that when a venturi throat of $\frac{1}{2}$ inch is used, carbonization of the orifice of the feed line will occur. This may be eliminated by draining the feed line through the installation of an air intake into the feed line. Frequent comments have been made concerning the possible back pressure exerted upon the motor by the aerosol generator and other possible injurious effects likely to result from this installation. In order to answer these questions,

exhaustive tests were performed by a Willys Corporation Factory Representative on a Jeep equipped with a "plumber's nightmare", which revealed no deleterious effects upon the motor. Their tachometer indicated a reading of 2600 RPM at normal operating range producing ample discharge pressure. 3500 RPM would be considered racing. The manifold pressure gauge indicated only a 20 lb. per square inch pressure, which is normal. The increased pressure developed when a vehicle starts was also found to be normal. A slight increase in motor temperature was noted, which the Factory Representative indicated was not objectionable, but rather was desirable for better motor efficiency.

Thus far, results on the performance of the "plumber's nightmare" have not been completely measured. One of the objects of the California State Department of Public Health, Mosquito Control Section, in co-operation with local mosquito abatement districts, during 1947 will be to attempt to determine the effective control range of this aerosol generator for both larval and adult mosquitoes under specified meteorological conditions. Observations, thus far, indicate that atmospheric conditions are of great significance in affecting the range of efficient use of this aerosol generator. We, in California, are confident however, that this aerosol principle, properly used, will result in considerable saving of time, trouble, and expense under most atmospheric conditions. Refinement of this technique of ground thermal aerosol application should enable it to play a large part in the larval and adult control work, both in California and elsewhere. Well over half of the 37 mosquito abatement districts in California have already installed these units and it can be safely predicted that they will utilize them as an important part of their operations in the 1947 mosquito season.