A SPRAYER FOR APPLYING HERBICIDES TO HIGHWAY PAVEMENTS

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Weeds and grasses growing in asphalt shoulders, paved medians, and other places along highway rights-of-way shorten the life of the pavement and increase the cost of maintenance. A number of chemicals (herbicides) have been used by various districts of the Texas Highway Department in their maintenance programs. Even wider use can be expected in the future as additional experience and research information are accumulated. Many of the newer herbicides are effective at much lower rates than the older, more familiar materials. These newer, more potent herbicides require precise methods of application to insure that the prescribed amount of material is used to treat a given area.

A pilot model sprayer which can be adapted to operate in conjunction with existing maintenance equipment was built at Camp Hubbard during the winter of 1960. This pilot model has been used successfully to make experimental applications of herbicides for controlling vegetation growing in paved shoulders during the current season. The functional components of a sprayer are described, and the performance of the pilot model is reviewed. Suggestions are offered for efficient use of spray equipment in a highway maintenance program.

A good cover of vegetation on the unpaved portion of a highway right-of-way is highly desirable for erosion control, but some of the more aggressive plants such as Johnsongrass and Bermudagrass often invade and shorten the life of asphalt pavements (Figure 1). Paved shoulders which carry a relatively light load of traffic as well as paved medians are particularly susceptible to invasion by these and other plants. A number of chemicals (herbicides) have been developed over the past several years for controlling specific weeds in agricultural land. Many of these herbicides have been used by various districts of the Texas Highway Department in their maintenance programs. Even wider use of herbicides in maintenance operations is indicated as additional experience and research information are developed in the chemical control of unwanted vegetation.

Many of the newer herbicides are effective in much smaller quantities than were needed with older chemicals to control the invading vegetation. This means that these newer herbicides should be applied uniformly, both across and along the swath. Equipment which can be obtained or constructed with a minimum investment and which will give uniform coverage will insure maximum benefit from the herbicide applied. This report will describe and discuss a sprayer constructed at Camp Hubbard by the Texas Highway Department and used to make experimental applications of herbicides to paved shoulders during 1961.[1]

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[1] The layout for this pilot model sprayer was planned by the Landscape Architects in the Maintenance Division, Texas Highway Department.

Figure 1. Paved shoulders which carry little or no traffic are often invaded by Johnsongrass, Bermudagrass, and other vegetation.

Components of a Sprayer

A sprayer for use in highway maintenance should have the following characteristics:

1. It should be simple in design for easy cleaning and maintenance.

2. It should be easy to fill.

3. It should deliver a uniform coverage.

4. The pressure should be easy to regulate and maintain.

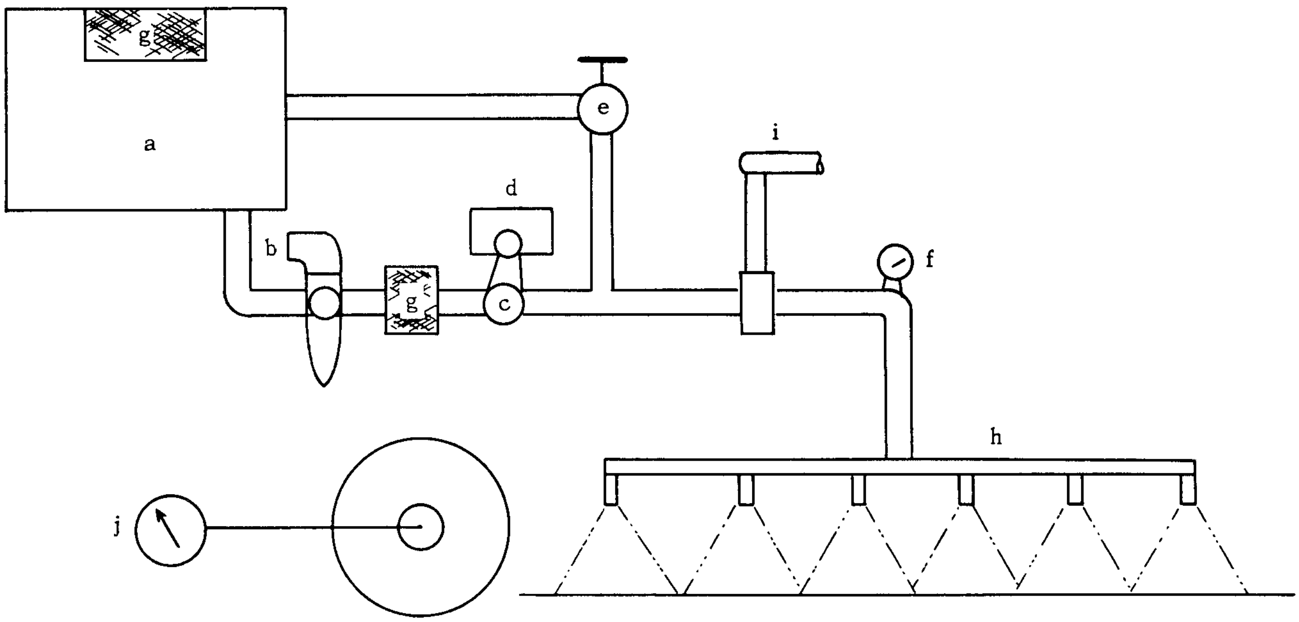
A sprayer can be divided into storage, pressurizing, and distribution components. The storage component consists of a tank with suitable strainers and intake hoses. The pressurizing component consists of a pump, a motor or other power to drive the pump, a pressure regulator, a pressure gauge, and a line strainer. The distributing component consists of a boom (spraybar) or a hand gun, a suitable cut-off, and a speedometer (Figure 2).

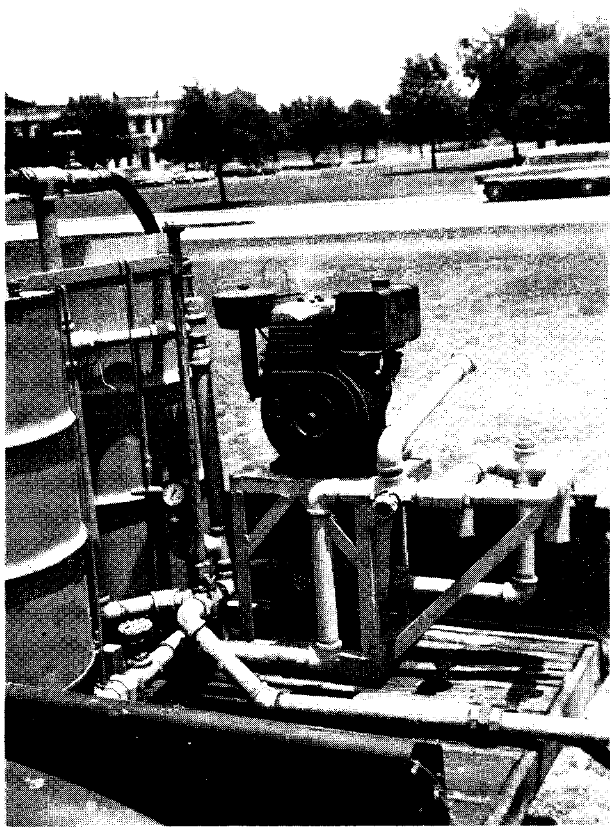
Open-top barrels have been used as tanks on the experimental model, but the tank of a water turck would function equally as well. Agitation from the bypass return is considered sufficient for materials which go into solution. So-called wettable powders in which the particles are suspended rather than dissolved require mechanical agitation. Three-way valves, as used on the intake line of the experimental sprayer, simplify spraying operations.

The pressurizing component is basic to the performance of the sprayer. The experimental unit has a nylon-roller pump, capable of delivering approximately 25 gallons per minute. Pumps having a smaller delivery rate may not have sufficient capacity to treat wide shoulders if the volume to the applied is relatively large.

The pump is driven with a 5 hp, 4-cycle gasoline engine fitted with a centrifugal clutch. The centrifugal clutch permits the operator to idle the engine when the pump is not in use.

A pressure regulator should be located between the pump and the spray nozzle. Its purpose is to maintain a constant delivery pressure at the nozzle. A commom pressure regulator consists of a spring-loaded bypass valve with a screw or handle to change the spring tension, which in turn alters the pressure at the spray nozzle. In operation, this valve allows the excess pump output to bypass the nozzle and return to the supply tank. In addition to controlling the pressure at which the spraying is done, the regulator serves as a relief valve and allows all of the pump discharge to return to the supply tank when the spray nozzles are cut off. The pressure is regulated by reading a pressure gauge installed in the line between the spraybar and the shutoff valve with the nozzles spraying.





Storage

a. Tank

b. Intake with three-way valve

Pressurizing

c. Pump

d. Motor

e. Pressure regulator and bypass

f. Pressure gauge

g. Strainer

Distributing

h. Boom

i. Cutoff

j. Speedometer

Figure 2. The component parts of a sprayer compared with the pilot model as assembled at Camp Hubbard.

A strainer, not smaller than 50-mesh, should be installed in the line ahead of the pump. This strainer will prevent sand or rust particles which might damage the nylon rollers or casting from entering the pump. All materials entering the tank should be strained, either in this line or at the entrance to the tank.

The spray solution is distributed through a spraybar fitted with nozzles or by a hand gun. Uniform spacing of the nozzles along the spraybar is necessary for uniform coverage. The number and size of nozzles are determined by the volume of application desired and the width of the strip to be treated. Either the spraybar or the hand gun should be fitted with a positive cutoff. The speed of travel for all applications with the spraybar should be measured with a speedometer accurate at slow speeds and similar to those used on asphalt distributors.

Field Performance

The sprayer designed and built in the state shops performed very well using volumes of application ranging from 18 to 80 gallons per foot-mile.[2] Travel speeds ranged from 300 to 1200 feet per minute. Spray output also was regulated by varying the number of nozzles employed.

A wire throttle control was improvised which permitted setting the engine speed to activate the centrifugal clutch (Figure 3). For mixing, or at other times when the pump was not needed, this throttle could be disengaged and the engine returned to idling speed.

Although a dual line strainer was installed in the experimental sprayer, a single large strainer should be sufficient. Regular servicing will prevent the strainer from restricting the rate of flow of liquid to the pump. Strainers should be cleaned at least once daily. Asphalt tanks should not be used for spraying sodium trichloroacetate (TCA), as flakes of asphalt are loosened by the TCA and soon clog up a filter.

Using the Sprayer

A sprayer operator should be designated and made responsible for the operation and maintenance of each unit. Many of the procedures in the operation and care of asphalt distributors and similar equipment will be applicable to these sprayers as well.

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[2] Foot-miles X 8.25 = Acres.

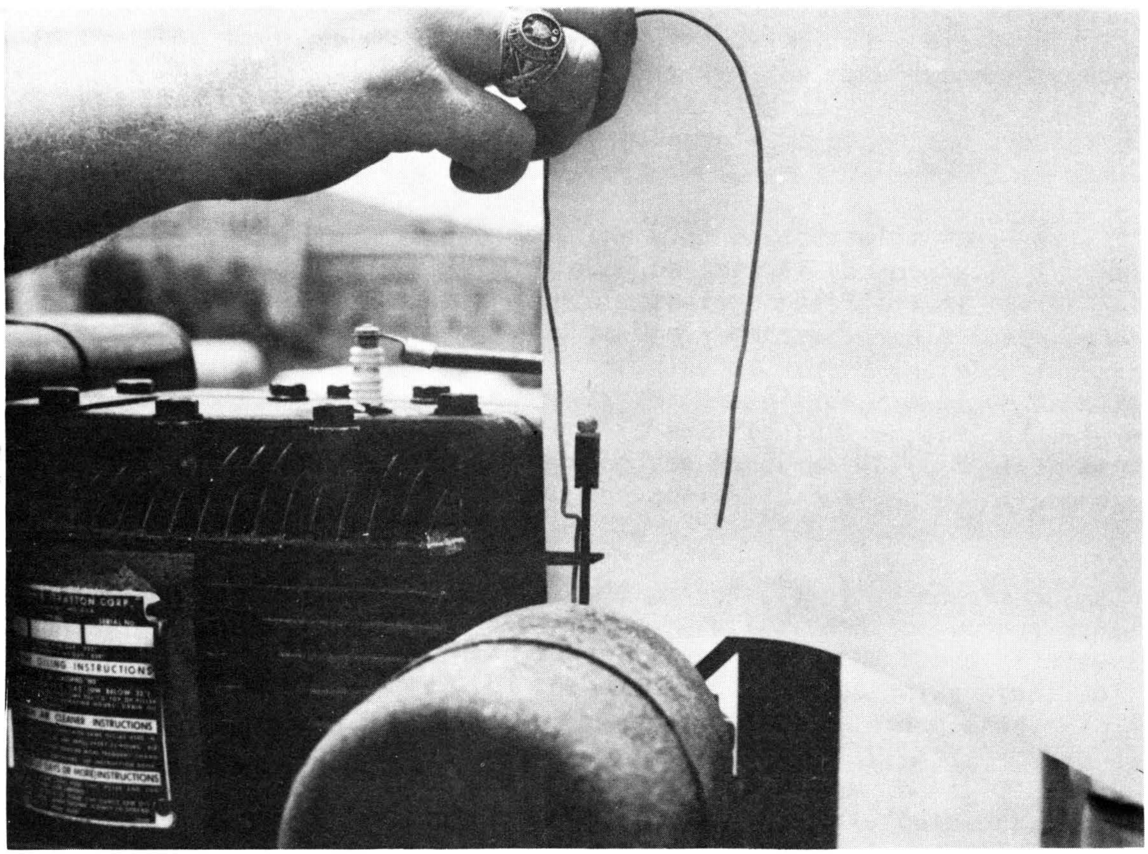

Figure 3. A wire throttle was improvised to operate off the same bracket as the governor control. To activate the automatic clutch, the wire throttle was raised until the wire loop was seated on the metal bracket.

The sprayer built at Camp Hubbard could be mounted on a standard watering truck for most highway maintenance operations. However, open-top 55-gallon drums could serve as a tank for patching or treating other small areas. Care should be taken in assembling the fluid lines so that the pipe size either is not changed or is reduced progressively from the pump to the spraybar. A section of small pipe anywhere in the line will restrict the flow to the capacity of the smaller pipe. Valves having relatively large openings should be used in the line.

The nylon-roller type pump requires very little maintenance. Rollers should be replaced if the pump will not maintain the operating pressure or if the pressure fluctuates during application. Running the pump dry or pumping abrasive materials will increase the wear on the rollers. Normally, a set of rollers should last at least one season if the pump is cleaned and lubricated with diesel or other light oil after each use.

The pressures at which most applications will be made will range from 25 to 40 psi. Most nozzles will not give a good pattern if the pressure is lower than 20 psi, and the spray is atomized into more fine particles as the pressure is increased. These sprayers may be used to apply materials on a swath using a boom or spraybar fitted with a number of nozzles or around individual posts by attaching a hose and hand gun. The spray to be applied in a swath is mixed so that a given amount of active ingredient is applied in a prescribed volume per foot-mile. The spray to be applied using the hand gun will be mixed on the basis of concentration, and the strength usually is designated as pounds of active ingredient per 100 gallons of mix.

Normally the applications made with hand guns are applied to the point of runoff or drip. The swath treatment is more precise, and the output depends upon the pressure at which the sprayer is being operated, the speed of travel and the size of the nozzles, together with the number of nozzles being used. Of these factors, usually only the speed of travel needs to be calculated.

Generally, the speed of travel should range between 350 and 1,100 feet per minute. Slower speeds are difficult to maintain in most equipment. Speeds greater than 1,100 feet per minute result in excessive swirling and loss of spray material, particularly when traveling into a wind.

The volume to be applied will be specified in the treatment recommendation. The output for a given size nozzle over a wide range of operating pressures is available in tables furnished by the manufacturer. The amount of material being applied should be checked periodically, particularly when new nozzles are installed or when the spray mixture is changed from one material to another. The estimated speed of travel can be calculated using the following formula, but it should be checked by measuring the volume applied over a measured distance.

$$\text{Speed of Travel (Feet per minute)} = \frac{5280 \times \text{number of nozzles} \times \text{nozzle capacity (gal. per min.)}}{\underset{\text{(Feet)}}{\text{Width of shoulder}} \times \underset{\text{(Gallons per foot-mile)}}{\text{Volume to be applied}}}$$

Example: Determine the estimated speed of travel using a spraybar fitted with 14 nozzles, operating at 30 psi, applying 40 gallons of spray per foot-mile to a shoulder 4 feet wide.

Nozzle capacity is listed at 1.30 gallons per minute in manufacturer's tables.

$$\text{Speed (feet/minute)} = \frac{5280 \times 14 \times 1.30}{4 \times 40}$$

$$\text{Estimated speed} = 600.6 \text{ feet/minute}$$

Set the speed of travel at 600 feet per minute and adjust if subsequent spraying operations show any appreciable deviations in volume of application.

A number of nozzle types are available. Generally, the fan-type nozzle is preferred over the cone-type for making applications to pavements (Figure 4). For high volumes of application the use of nozzles with a larger output, such as some asphalt nozzles, should be investigated. For varying the volume of application, nozzles are available with removable tips so that a blank or a tip with another size opening may be substituted. Nozzles having an opening larger than the screen mesh in the line strainer should not require a nozzle screen.

The volume of spray solution to be applied will vary with the herbicide being used. The exact volume to be used for a particular herbicide has not been established at this time. For example, dalapon is extremely soluble and can be applied in five gallons or less of solution per foot-mile. On the other hand, TCA and many other materials are much less soluble and may require one-half to one gallon of water per pound of material. An application rate of approximately 25 pounds per foot-mile is indicated for TCA, and as much as 25 gallons of solution per foot-mile may be required for the application of this material.

Swirling of the spray and blowing of the spray by the wind may produce an uneven or spotty spray pattern. Strips or spots which receive a light application may remain green or recover from the treatment in a very short time. The effect of wind on the spray pattern can be overcome to some degree by adjusting the spraybar to a height of six to ten inches above the pavement.

Some Possible Future Refinements

The basic sprayer can be adapted to a wide variety of spray applications. Two possible uses of the present sprayer are the broadcast or swath applications as to paved shoulders, or the treatment of local areas as around guard posts or sign posts using a hand gun.

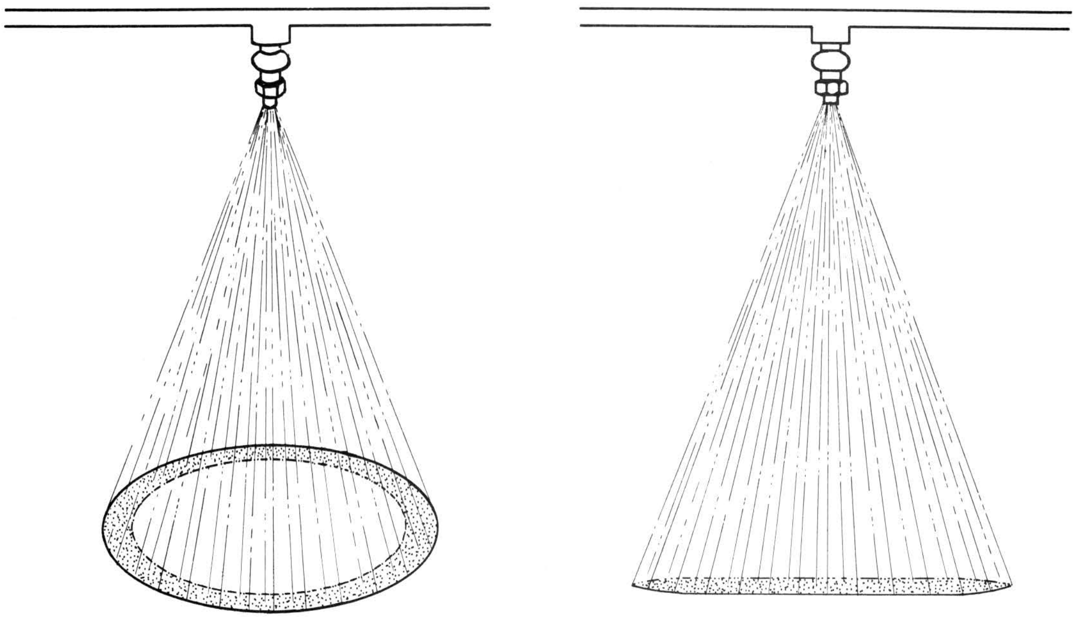

Figure 4. (Above) The spray pattern from the fan type nozzle is easier to use than either the hollow cone (shown above) or the solid cone. In practice the fan nozzle tip can be turned so that the spray from one nozzle does not interfere with spray from the next nozzle on the spraybar. Also, the nozzle tips which produce the fan pattern can be set at whatever angle to the direction of travel is needed to give a uniform coverage across the swath (below).

Bermudagrass often forms an irregular pattern on the shoulder pavement (Figure 1). In some places it may extend completely across the shoulder pavement to the edge of the trafficway, while in other places it does not extend too far from the outside edge of the shoulder pavement. For this type of infestation considerable spray material could be saved by organizing the spraybar into gangs of one-foot segments, each gang having its own cutoff. This would enable the spray operator to treat only that portion of the pavement which is infested with grass.

A second innovation, which is used by some state highway departments in the eastern United States, is an applicator on an adjustable arm which sprays behind guard rails on bridge approaches. A nozzle on each of two arms, set to oppose each other, could be used to spray around the base of individual sign posts and guard posts. This type of application could then be applied from a moving vehicle in the same manner as a broadcast spray and eliminate the necessity of specifying two or more herbicide mixtures.