Weed Spraying Equipment
Michigan State University Extension Service
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WEED SPRAYING EQUIPMENT

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Weed Spraying Equipment

By C. M. Hansen, B. H. Grigsby and B. R. Churchill[1]

Modern science has given us the key to weed control, but the effectiveness of chemicals depends upon many factors—the proper choice of chemical, the rate and time of application, and the prevailing temperature and moisture conditions. The application equipment is equally important. This bulletin discusses the advantages and disadvantages of the various sprayers. Such things as selection, care and maintenance, including calibration, are covered in detail.

TYPES OF SPRAYERS

Compressed Air

The capacity of a compressed air sprayer tank ranges from 1½ to 5 gallons. The tank is usually cylindrical in shape of 30 gauge galvanized iron or brass made to withstand a pressure of 80 pounds per square inch (psi). A hand air pump fits into the top, or into the filler cap which in turn locks into one end of the tank. Compressed air forces the liquid from the bottom of the tank through an internal tube to the top. A valve at the end of a short length of hose controls the flow of liquid. A metal extension tube fitted to a nozzle is part of the discharge mechanism.

The tank is filled from ⅔ to ¾ full, leaving room for an air space. Frequent stops are needed to recharge the tank with air to maintain pressure within working range. (Fig. 1)

Knapsack

The pressure knapsack sprayer is fitted with a plunger pump which the user operates constantly while spraying. As its name implies, this portable sprayer is designed to strap on the operator's back. A number of models have a shield which keeps the tank from coming in direct contact with the back of the user. The containers are usually made of a light gauge stainless steel, copper or brass. An air chamber is built into the pump system to cut down the effect of pulsations. The tank capacity ranges from 4 to 6 gallons. (Fig. 2.)

[1]Agricultural Engineering, Botany and Plant Pathology, and Farm Crops Departments, respectively.

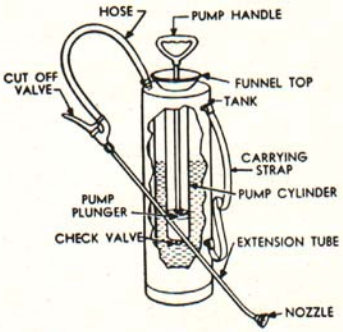

Fig. 1. – Compressed air hand sprayer.

Fig. 2. – Knapsack weed sprayer.

Garden and Wheelbarrow Sprayers

These sprayers may be either hand or engine powered. The hand operated wheelbarrow sprayer utilizes a plunger pump and can be

Fig. 3. – Gas engine powered garden sprayer.

operated by one or two men. The capacity of the tank usually ranges between 10 and 25 gallons.

The small portable power sprayers have capacities up to 30 gallons and are usually mounted on two wheels. They are powered by a small gasoline engine. (Fig. 3.)

Tractor-Mounted Weed Sprayer

The tractor-mounted weed sprayer is good for applying herbicides to row crops, as well as to pastures and grain crops. The pump is usually driven by the power take-off. Tanks may be either factory built or of good quality discarded oil drums. They may be carried at

Fig. 4. – Tractor-mounted weed sprayer.

the rear of the tractor or on brackets next to the engine. The boom or nozzle-cluster can be mounted at the front or rear of the tractor. (Fig. 4). Many prefer the front mounted distribution system because it is easier to see its operation. The tractor mounted rig is less desirable because too much time is usually required in attaching and detaching the equipment.

Trailer-Mounted Sprayer

The trailer weed sprayer has the component parts mounted on a two-wheel, adjustable-tread trailer. The pump is attached to the power take-off or can be driven by an auxiliary engine. Controls are either mounted on the tongue of the trailer in easy reach of the opera-

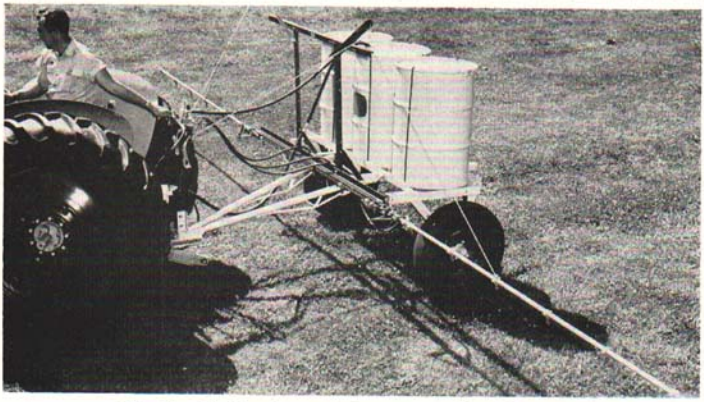

Fig. 5. — Trailing type weed sprayer with PTO pump.

tor or can be attached to the tractor fender. The boom or nozzle cluster is mounted at the front or rear of the trailer. (Fig. 5). One advantage of this sprayer over the tractor-mounted unit is that it can be readily hitched to the tractor. It is also possible to use larger capacity tanks in this case.

PUMPS

Piston

The reciprocating pump, piston or plunger, was first used in the early power sprayers. It is the most expensive type but can be used for many jobs around the farm. Piston pumps can apply both corrosive and abrasive materials. They usually have a stainless steel piston and a leather, rubber or plastic packing gland. (Fig. 7) In the most durable pump of this type, the cylinder walls may be lined with ceramic materials or made entirely of ceramic. Less expensive piston pumps are constructed principally of steel.

Manufacturers report a trend toward using the piston type pump on weed sprayers. They find that farmers are replacing their other type pump unit with the piston pump. This change will make their weed sprayer usable for other purposes such as applying white-wash to the interiors of dairy barns and the cleaning of farm implements where high pressures are desirable.

Gear

Many of the early manufacturers of power weed sprayers used a commercially available gear pump. Such a pump can apply herbicides successfully where no abrasive materials are involved. Oil suspensions, emulsions, or water will sufficiently lubricate the gears which mesh with one another. The sprayer used exclusively for herbicides can also use the gear pump; hence it can be economically replaced when it no longer produces working pressure. Most manufacturers of this type of pump are using bronze housings and gears with a stainless steel shaft. One manufacturer employs a relief valve which is built directly into the pump cover. This type of construction is quite acceptable when hydraulic agitation of the spray material is not required. (Fig. 8.)

A gear pump can be driven by a direct coupling to the power-take-off or through a system of belts or roller chains. Roller chain is preferable. In many cases it is quite desirable to increase the speed

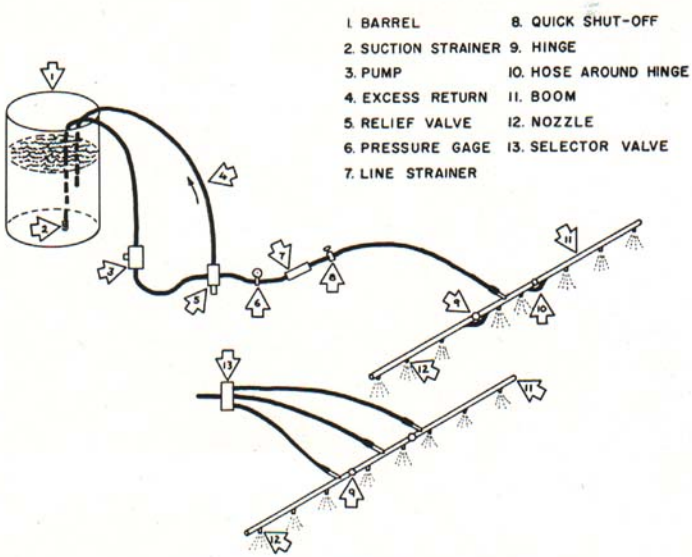

Fig. 6. — Layout of a boom weed sprayer.

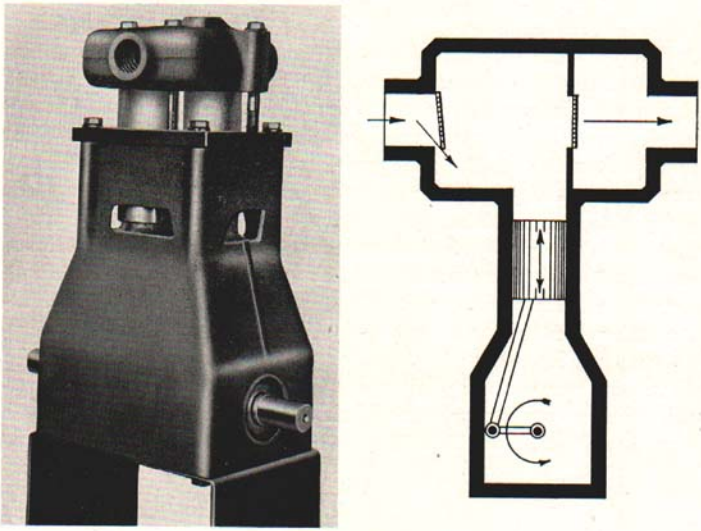

Fig. 7. – Piston pump.

of rotation above that of the power-take-off speed to compensate for the loss in pressure due to wear.

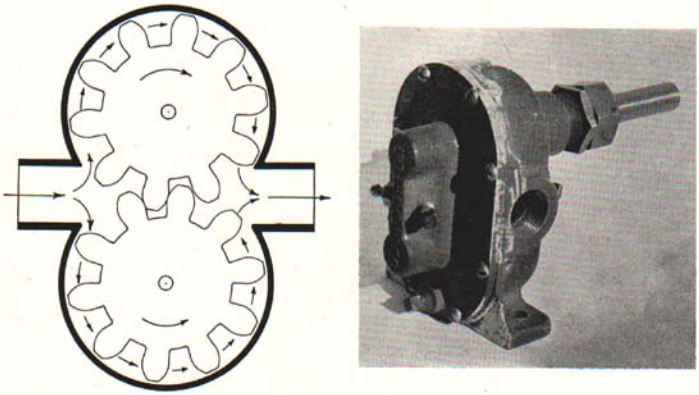

Fig. 8. – Gear pump.

Flexible Impeller

The flexible impeller pump has a series of rubber "paddles" attached to a hub. The pump housing is designed to deflect or "squeeze" the paddles, causing the pumping action. This type of pump has a "built-in" relief system, for the paddles will not return to the radial position when the pressure becomes excessive. (Fig. 9.)

It will handle mildly abrasive materials as well as a number of other chemicals which will not scratch the housing or cause the impeller to deteriorate. Do *not* operate this pump without liquid!

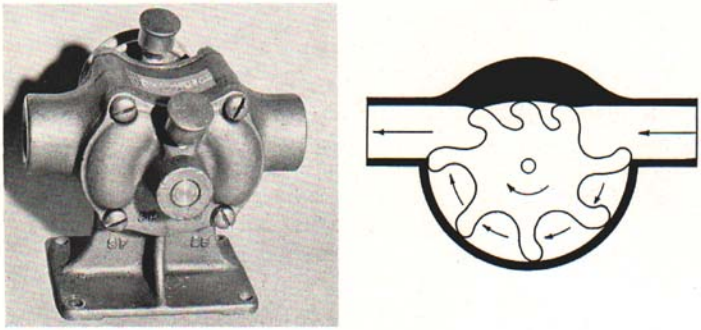

Fig. 9. – Flexible impeller pump.

Roller Impeller

The "rollers" of a roller impeller pump are fitted into slots of the rotating impeller. The slots allow rollers to follow the housing which is eccentric to the shaft causing the pumping action. This type of pump can be designed to function under a wide range of conditions. Nylon-covered rollers are used with a cast nickel iron alloy housing to handle the non-abrasives. Manufacturers recommend that copper compounds not be used with this type of pump for the copper will build up on the nickel cast housing. (Fig. 10.) Rubber rollers are used to handle the more abrasive type materials such as the wettable powders.

Special techniques are required to disassemble and assemble this pump, and it can be operated over a wide range of speeds.

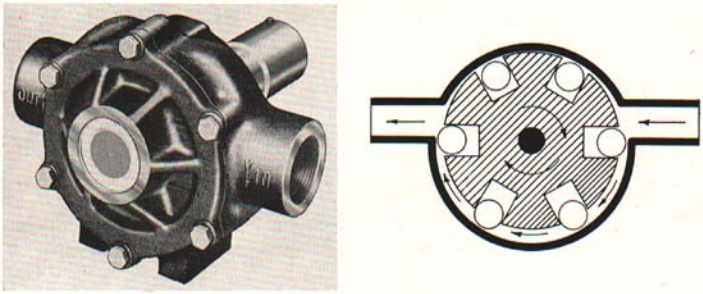

Fig. 10. — Roller impeller pump.

Sliding Vane Impeller

This type of pump has moving parts which function like the roller impeller pump. In place of the rollers, spring loaded vanes or slides are used. The vanes may be made of carbon, stainless steel, plastics, or materials impregnated with a lubricant such as graphite. (Fig. 11.) The pump can be successfully used to handle materials which have some lubricating value.

Diaphragm Pump

The diaphragm pump is constructed with either one or two diaphragms. The more popular is the single diaphragm, largely due to the lower cost. (Fig. 21.) The pumping action is caused by the move-

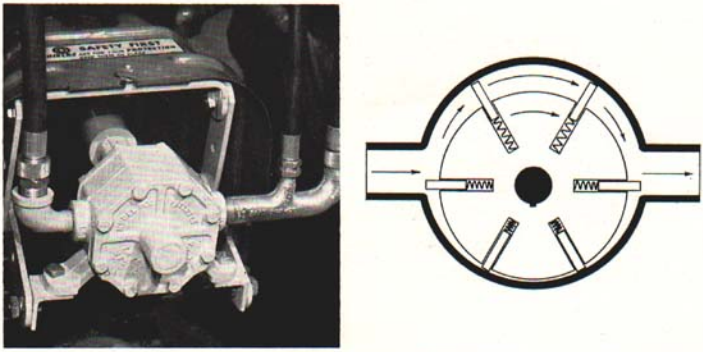

Fig. 11. — Sliding vane impeller pump.

ment of the diaphragm. The liquid is drawn into the chamber by the downward stroke and forced out by the upward stroke. The valves are usually made of neoprene and are spring loaded. The effects of the stroke pulsations are lessened by a small air chamber.

This pump will operate for a long period of time provided *(1)* the material in the diaphragm will not be deteriorated by the chemical being pumped, and *(2)* the bearings are of the roller type. It is a relatively high priced unit and has a working pressure of about 100 psi.

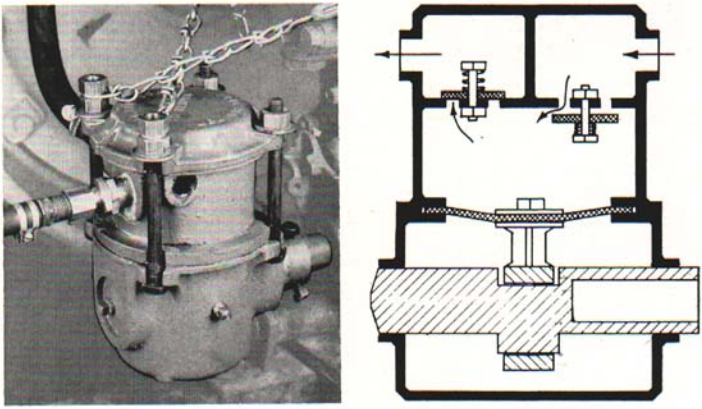

Fig. 12. – Diaphragm pump.

Internal Idle Gear Pump

The pumping action of this pump is caused by the internal meshing of teeth between an idle gear and a drive gear. (Fig. 13.) The liquid is moved from the intake with the unmeshed teeth to the exhaust and forced out by the meshing of the teeth between the two gears. This pump is not designed to handle abrasive materials. Usually it is constructed of cast or nickel cast iron, designed to attach directly to the power-take-off of the tractor.

DISTRIBUTION SYSTEMS

Nozzles

A nozzle used for applying herbicide is classified by the delivery pattern. These patterns are: *(a)* fan, *(b)* solid cone, *(c)* hollow cone. (Fig. 14.) The three types of nozzles may have the same number of

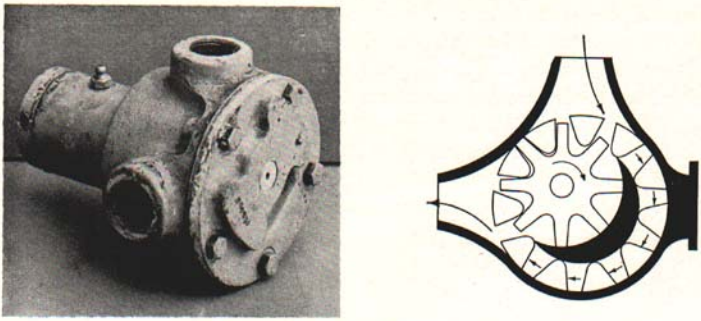

Fig. 13. – Internal idle gear pump.

parts but the shape of the opening differs to give the desired spray pattern. A strainer is usually incorporated into the body of the nozzle with the tip held in place by a screw cap.

The fan nozzle is recommended for herbicides because it gives an even distribution throughout the spray pattern. (Fig. 15.) Nozzles

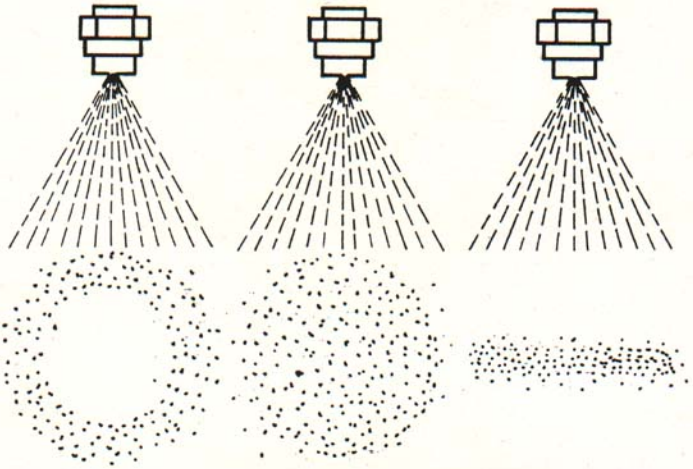

Fig. 14. – Three common boom type nozzle spray patterns – L to R – Hollow cone, solid cone, fan.

can be arranged on a boom to give overlap for complete ground or crop coverage.

The solid cone nozzle and the hollow cone nozzle are the least desirable, for they cannot be readily arranged on the boom for uniform application of material. The solid cone nozzle deposits material in a circular area while the hollow cone deposits it only on the outer edge of a circle.

The angle of the spray as it leaves the nozzle is pre-determined by the manufacturer. It varies from 60 to 90 degrees. This angle determines the height at which the nozzle is placed above the ground or crop and the spacing on the boom. Wide angle nozzles allow the

Fig. 15. – Fan type nozzle.

boom to be held closer to the ground, thus reducing interference by wind.

The size of the opening (orifice) which determines the application rate is calculated by the manufacturer. He can provide charts which show pressure, delivery rate in gallons per minute, speed of travel, and nozzle spacing.

Booms

Weed sprayer booms are usually made of ¾ inch galvanized iron or aluminum pipe, mounted at the front or rear of the tractor-mounted sprayer or on the rear of the trailer rig. The pressure drop to the end nozzles of a 20-foot-¾-inch pipe boom while applying 69 gallons per

acre traveling at the rate of 5 mph will be less than 0.4 psi. The height is adjustable and in most cases the nozzle spacing is fixed at 20 inches along the boom. A few manufacturers have devised systems employing clamps to hold the nozzles in place, connecting them with a short piece of hose. This latter system enables the user to space the nozzles on the boom at will. Popular lengths of booms range between 16 and 24 feet.

The booms are hinged for various reasons. If they are hinged at the center of the rear tractor-mounted and the trailer rigs, the user can adjust the spacing by bringing the outside ends of the booms back. Three-piece booms usually employ a center section which is about equal to the width of the tractor or spray rig. The operator can control both types of booms from the tractor seat and can raise them for road travel or swing forward or back to pass through gates. Safety devices are incorporated in the hinges to allow the booms to swing back in case they hit an obstacle.

Drop Pipes

After corn is 12 to 18 inches tall, herbicides should not be directed into the folded leaves of the corn. Drop pipes will prevent the spray from reaching the center of the corn plants. Two adjustable nozzle heads are attached to a 2 foot length of tubing and fitted into every other nozzle spacing on the boom. (Figs. 16 and 17.) The nozzle openings between the drop pipes are then plugged. This arrangement allows

Fig. 16. — Drop pipes for corn herbicide application.

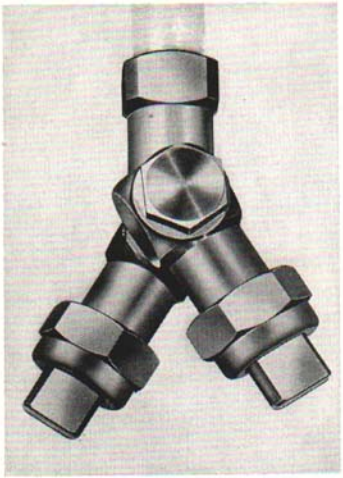

Fig. 17. – Adjustable head for drop pipe.

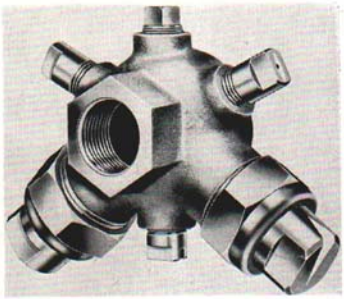

Fig. 18. – Nozzle cluster or "boomless nozzles."

the operator to direct the herbicide toward the base of the corn. Several types of devices limit the danger of breaking off the corn drops. They are usually spring or metal reinforced rubber hoses about 3 inches in length fitted at the top end of the drop and into the boom. Such devices permit the drop to swing backwards but not from side to side.

Cluster Nozzle

Several makes of nozzles do not require a boom. They are referred to as "boomless nozzles". (Fig. 18.) The chemical is sprayed from a nozzle or nozzle cluster mounted at the rear of the tractor, in the case of a tractor-mounted rig, or at the rear of a trailer-mounted rig. They usually cover a swath 20 to 30 feet wide. (Fig. 19.)

Many farmers prefer this type of distribution unit over the boom type system for the following reasons:

- Lower initial cost
- Easier to handle
- No trouble with plugging
- Affected less on rough ground
- It can be more readily used along fence rows or ditch banks

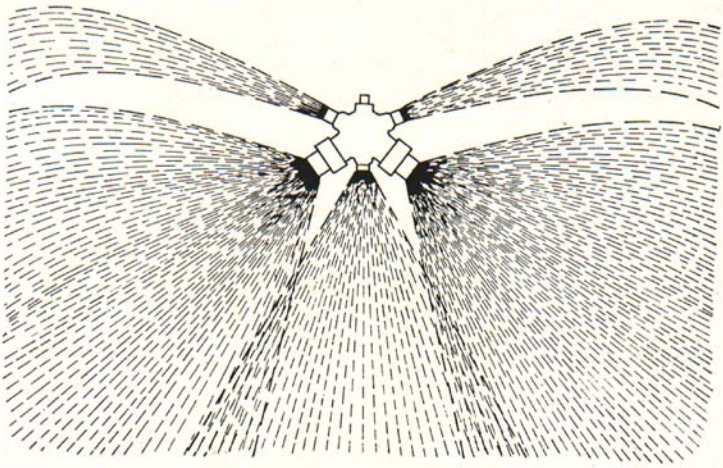

Fig. 19. – Spray pattern from a nozzle cluster.

There are, however, reasons why one should use great care in choosing this distribution unit. Tests have shown that even a very light wind will upset the spray pattern causing skips in a field where areas are not covered. There is a marked separation of droplet sizes, particularly when directed into the wind. The larger droplets will be carried farther from the nozzle and the smaller ones may be blown away.

AGITATION

The need for agitation is greater with the emulsifiable and wettable powder materials which do not go into solution but remain in suspension. Weed spraying equipment usually employs one or two methods of agitation. One method of keeping the chemical completely stirred at all times is called jet agitation, which results from an excess flow from the pump through the relief valve. This flow is discharged through small openings into the spray tank. It is important to use a pump having sufficient capacity to supply the nozzles while returning sufficient quantity of the spray materials to the tank to maintain the desired agitation. In jet agitation, the orifices should be so located

that the jet streams pass through at least 14 inches of liquid before striking the tank walls.

It is rather difficult to secure *mechanical* agitation in the tractor- or trailer-mounted rigs which use the power-take-off to operate the pumps. Mechanical agitation is usually built into the weed sprayers which employ an auxiliary engine. This vigorous type of agitation is more desirable for the suspension sprays.

CONTROL VALVES

Valves used to maintain a given pressure in a weed sprayer system are called *relief valves.* The less expensive relief valves use a stainless steel ball pressurized by a spring under a screw which can be turned to vary the pressure. (Fig. 20.) The more expensive relief valves employ two springs with a ground valve and seat. The springs are of different sizes and the heavier spring comes into play only for the high pressures. Such an arrangement enables the relief valve to function satisfactorily under a wide range of pressures.

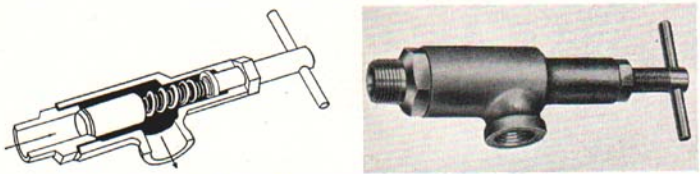

Fig. 20. – Two spring loaded pressure relief valve.

Selector valves are usually mounted within easy reach of the operator to permit sending the spray material to any one, two, or all three sections of the boom (Fig. 21.) The solution comes from the pump to the selector valve and then to the individual boom sections or hand gun by separate hoses.

STRAINERS

Strainers can be found at 3 points on a sprayer. *(1)* The *suction* strainer, on the end of the suction hose in the tank. *(2)* The *line* strainer, at one of 3 points; before the pressure regulator, after the pressure regulator, or near the boom. (Figs. 22, 23.) *(3)* Other strainers are found in the nozzles. The openings in the strainers need not be any smaller than the orifices in the nozzles. The number 50 mesh

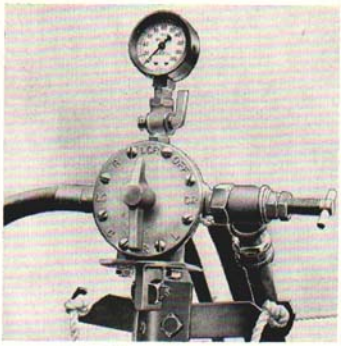

Fig. 21. – Selector valve.

Fig. 22. – Suction line strainer.

screen is generally fine enough, particularly where rates per acre exceed 20 gallons. The strainers should be easily accessible for cleaning. The screens are made of brass or a stainless steel, cloth or felt. Cloth or felt strainers will not function satisfactorily with suspensions or wettable powders because the solids quickly coat the surface of the strainer.

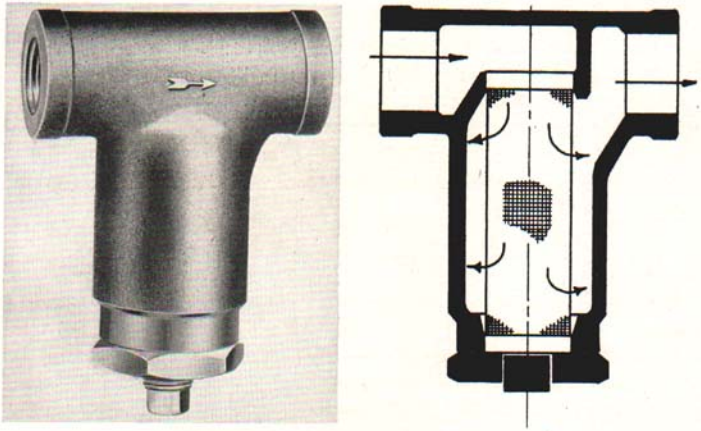

Fig. 23. – One type of line strainer.

HAND GUNS

The use of the weed sprayer is expanded if a *hand gun* can be attached. A tee can be put into the line leading to the boom. A shut-off valve can stop flow to the boom when the hand gun is in use. A second shut-off valve in the gun line will stop the flow to the gun while the boom is in use. Fence rows, fence corners, ditch banks, and areas near the farm buildings which cannot be covered with a boom can be treated with a hand gun.

TANKS

Several weed sprayer manufacturers offer tanks coated to withstand corrosion or made of corrosion resistant materials. This type of tank can be used to apply fertilizers provided the rest of the sprayer is made of coated or corrosion resistant materials.

A good quality oil drum is a very serviceable tank for the weed sprayer provided openings are made large enough for internal inspection.

CALIBRATION

Determining the accuracy in rate of application is an important procedure in making the machine ready for the field. Many herbicides must be applied within very close limits.

Calibration curves or tables furnished by the manufacturer of a sprayer will give the operator some clue as to the speed of travel, nozzle opening size and pressures for a given rate of application. This information will be accurate while the equipment is new, but will not be reliable when the orifices wear or the pressure gage no longer gives a true reading. The more careful operator will use some system to check his rig, such as one of the techniques discussed below. We shall first assume that we are working with a boom sprayer and the nozzles are spaced 20 inches on the boom. The calibration of a sprayer boom having a deviation from this nozzle spacing will also be explained.

1. Large Area Method

(a) Fill tank on sprayer full of water.

(b) Measure and stake off one acre (43,560 sq. ft.) in the field to be treated.

(c) Adjust sprayer as to pressure and orifice size and apply water at the prescribed rate of speed over the acre as indicated by manufacturer's instructions.

(d) The amount of water to refill tank is equal to gallons per acre applied. For further reference, let's assume it required 15 gallons.

Alternate System Starting with Step (b)

(b) Using manufacturer's information, adjust sprayer pressure, use proper orifice size and speed to apply at the desired rate.

(c) Spray swath across field. Let us say that it is a square 40 acre field. The distance will be ¼ mile or 1,320 feet. If a boom 20 feet long was used the area will equal 1,320 x 20 divided by 43,560 or ⅔ acre.

$$\frac{1{,}320 \times 20}{43{,}560} = \frac{2}{3} \text{ acre}$$

(d) Refill tank. Let us assume it required 10 gallons.

10 gallons x 3/2 = 15 gallons per acre.

Note—In the event we wanted to apply 10 gallons per acre, it would be necesasry to readjust the sprayer by increasing the speed of travel, decreasing the pressure or by using smaller orifices. A higher rate would require the opposite adjustments.

(e) Divide the number of gallons per acre (in our case 15) into the number of gallons the spray tank holds. Let's assume this to be 100.

$$\frac{100}{15} = 6.66$$—the number of acres which the sprayer will cover with one filling.

(f) Multiply the number of acres the sprayer will cover with one filling (in our case 6.66) by the number of pounds of active ingredient to apply per acre. (2,4-D is often applied at the rate of 2 pounds per acre) which will give the number of pounds to put in tank, thus:

2 x 6.66 = 13.32 pounds of 2,4-D to be put in the tank.

2. Short Course Method

(a) Measure off a course of 163⅓ feet in a driveway or lane near source of water. Place stakes at each end of course.

(b) Using information furnished by manufacturers, adjust tractor speed, select recommended orifice size for nozzles and pressure.

(c) Select a gear to give the tractor sufficient power so it can maintain a constant speed. A speed of about 4 miles an hour is desirable. For tractors which do not have speedometers, the operator can start the tractor going in the field, drop a stone, begin clocking off 30 seconds and drop a second stone. The distance between these two stones in feet divided by 44 will equal the speed of the tractor in miles per hour.

(d) Line up the equipment 10 to 20 feet ahead of the measured course, check the pressure, see that the nozzles are working. The tractor throttle adjustment should be approximately ¾ open. When the equipment is set in motion a second person catches the discharge of one nozzle throughout the length of the measured course of 163.3 feet. (Caution—use only a standard kitchen measuring cup to measure the discharge.) The quantity of **discharged measured cups** from one nozzle throughout the length of the course multiplied by 10 equals the gallons per acre. Assume that 2½ cups are caught in a container. The amount which the sprayer will apply on one acre will be 2½ x 10 = 25 gallons.

If the nozzles are not spaced 20 inches apart on the boom, use the following method of calculating gallons per acre:

$$\text{Number of cups} \times \frac{200}{\text{Nozzle spacing in inches}} = \text{gallons per acre.}$$

(e) Now it is possible to use the method of calculating as described in (1.) e, and (1.) f.

Note—This method can be used even though the spray tank is charged with the herbicides.

3. Small Area Method of Calibration

(a) Fill tank.
(b) Using manufacturer's recommendations, adjust sprayer and tractor speed.
(c) Spray a strip 330 feet long.
(d) Record number of gallons to refill tank.
(e) Number of gallons to refill tank multiplied by 132, divided by swath width in feet equals gallons per acre, (Calculate amounts of chemical to put in tank as in (1) e and f.

4. Graduate Container Method

A graduated quart glass jar to calibrate a sprayer is available at sprayer dealers, with instructions printed on the jar. Follow the same technique as described in the short course method 2. The only exception is the gallons per acre read directly on the jar. Four columns of graduations read in gallons per acre for four nozzle spacings. They are 14, 16, 18 and 20 inch. Once the rate per acre is determined, follow the calculations as previously described.

SPRAY EQUIPMENT FOR PLANTERS

Many farmers have found it best to mount spray nozzles at the rear of the planter. This "pre emergence" type of spray application is particularly well suited when the minimum tillage method of seed bed preparation is employed. Nozzles can be mounted to spray either over the row or to cover the entire area. (Fig. 24.)

Fig. 24. – Corn planter with herbicide applicator.

The tank may be mounted on the planter or on the tractor, driving the pump from the power-take-off. Controls are mounted either on the tractor or on a post attached to the planter.

It is desirable to attach the nozzle for "over-the-row" application to the planter press wheel frame. This nozzle can be raised to 18 inches and another can be mounted to the main frame of the planter for over-all coverage.

Give the same care and maintenance to this type of spray equipment as to the regular farm weed sprayer.

Calibration of the Planter Mounted Sprayer

- *Overall application.* The technique described in the calibration of a weed sprayer can be used to accurately determine the application rate for a planter mounted sprayer which covers the entire surface of the soil.
- *For band applicator.* Use the "short course method of calibration" with the following exception to check the rate of application. The formula—Cups x 10 = gallons per acre should be changed to read—Cups x 10 x $\frac{\text{row width inches}}{\text{spray band width, inches}}$ = gallons per acre.

  No further changes in calibration method need be made.

CARE AND MAINTENANCE

The sprayer used for applying herbicides should not be used for insecticides or fungicides. It takes only one part per million of certain herbicide to damage sensitive plants such as tomatoes and grapes. However, if it is necessary to use the herbicide sprayer for insecticides, rinse the steel tanks or barrels thoroughly with a solution containing one quart of household ammonia in 25 gallons of water. A cup of trisodium phosphate will do equally as well to render the chemical inactive. Wood tanks cannot be rendered safe. Pump the solution through the weed sprayer and let stand for at least 6 hours. A more thorough cleaning can be made by disassembling all hoses, screens, strainers, and nozzles and putting them into the solution.

The sprayer should be thoroughly flushed out with water before using it as well as after each spray job is finished.

Summary of the various types of pumps used for weed spraying

	FLEXIBLE IMPELLER	PISTON	GEAR	SLIDING VANE ROTARY	CENTRIFUGAL	ROLLER IMPELLER	DIAPHRAGM
1. Adaptability: Handle corrosive or abrasive materials.	Will handle most materials which will not attack case or impeller. Will handle wettable powders, limited abrasive materials.	Wide range of application. Will handle corrosive and abrasive materials.	Oil emulsion, non-abrasive materials. Cannot be used with wettable powders.	Will not handle abrasives. Limited to oils and oil emulsions.	Will handle coarse materials.	Works best with oil emulsions and non-abrasive material. Recommend not using copper compounds. Rubber rollers-slurries wettable powders.	Will handle all chemicals which will not attack diaphragm.
2. Durability	Cannot be operated dry for long periods.	Basic parts have long life.	Limited life under adverse conditions.	Cannot be operated dry for long periods. Must be used with materials which have some lubricating qualities.	Pressure drops with wear.	Pressure drops with wear.	Maintains pressure with wear.
3. Cost	$20.00 to $35.00	$75.00 to $300.00	$25.00 to $50.00	$50.00 to $70.00	$30.00 to $60.00	$35.00 to $75.00	$160.00 to $200.00
4. Serviceability	Impeller readily replaced. Pump usually replaced.	Readily serviced.	Parts not usually replaced. Pump readily replaced.	Parts readily changed.	Certain models can be serviced.	Special technique in servicing. Worn parts can be replaced.	Readily disassembled for service.
5. Construction (critical parts)	Impeller—neoprene.	Cylinders ceramic; stainless steel; bronze.	Bronze gears, stainless steel shaft.	Sliding vanes—stainless steel, graphite. Case—cast iron, nickel.	Case—cast iron. Impeller—bronze, cast iron.	Rollers—nylon or rubber. Case—nickel, cast iron.	Rubber or synthetic diaphragm.
6. Pressure range	0—40 psi	40—1000 psi	40—100 psi	20—125 psi	50 psi	0—150 psi	0—150 psi
7. R.P.M. (operating range)	500 to 1500	500 to 600	500 to 1800	500 to 600	1200 to 3500	300 to 1000	500 to 800
8. Gallons per minute	0—30	3—10	0—65	5—20	0—100	5—50	3—10
9. Required horsepower	½ to 7 HP	2 to 6 HP	⅛ to 4 HP	¼ to 1½ HP	¼ to 3 HP	½ to 5 HP	5 to 3
10. Displacement	Non-positive	Semi-positive	Semi-positive	Semi-positive	Non-positive	Semi-positive	Positive
11. Direction of rotation	Either	Clockwise	Either	Clockwise	Clockwise	Clockwise	Either
12. Bearings— Type: Lubrication:	Bronze or ball Grease	Bronze or ball Grease	Bronze Grease	Bronze Grease	Ball Sealed or Grease	Bronze or ball Sealed or Grease	Ball Grease
13. Type of drive	PTO, Belt or chain	PTO, Belt or chain	PTO, Belt or chain	PTO, Belt or chain	PTO, Belt or chain	PTO, Belt or chain	PTO

NOTES

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