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FOREST RESEARCH REPORT

No. 54 February, 1995

Use of a "Flow Control Plate" to Modify a Maruyama® Backpack Air Blast Spreader for the Application of Pronone 10G® Granular Herbicide

Introduction

Pronone 10G is a granular form of the soil active herbicide hexazinone. In Nova Scotia it is registered for ground application and is used by the Christmas tree, blueberry, and forest industries to selectively control a wide range of weeds including grasses and raspberries. One of the main factors limiting its use, is the lack of appropriate equipment designed for low volume applications (10 to 20 kg/ha) in rugged terrain. Most of the available equipment is designed for the agricultural application of fertilizer at delivery rates of 200 to 300 kg/ha (McLaughlan, 1992).

The purpose of this report is to describe the use of a "flow control plate" installed in a Maruyama Model MD150DX backpack air blast spreader to regulate Pronone application rates. The "plate" enables precise adjustment of flow at the low rates required. The equipment typically produces an **18m (60 foot) swath** at an impressive coverage rate of **4 ha (10 acres) per productive hour.**

This report details the construction and installation of a flow control plate and describes proper application technique as well as methods for calibrating flow and determining swath width.

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® Maruyama U.S., Inc., Redmond, WA
® E.I. Du Pont de Nemours & Co. (Inc.), Wilmington, DE

Canada
Nova Scotia

Flow Control Plate Installation

This method of applying Pronone 10G requires a modification to the Maruyama sprayer to provide greater control over the chemical flow rates. The modification consists of the construction and installation of a "flow control plate", and replacement of the original "shutter rod" with a custom made "shutter rod" (Construction details on page 10). The installation is illustrated in Figure 1, and written instructions follow.

The task will take approximately 30 minutes to complete. Before proceeding, ensure that the tank is clean and well rinsed.

Tools Required:

- 10 mm Wrench
- Needle Nose Pliers
- Flat Screwdriver
- Phillips Screwdriver

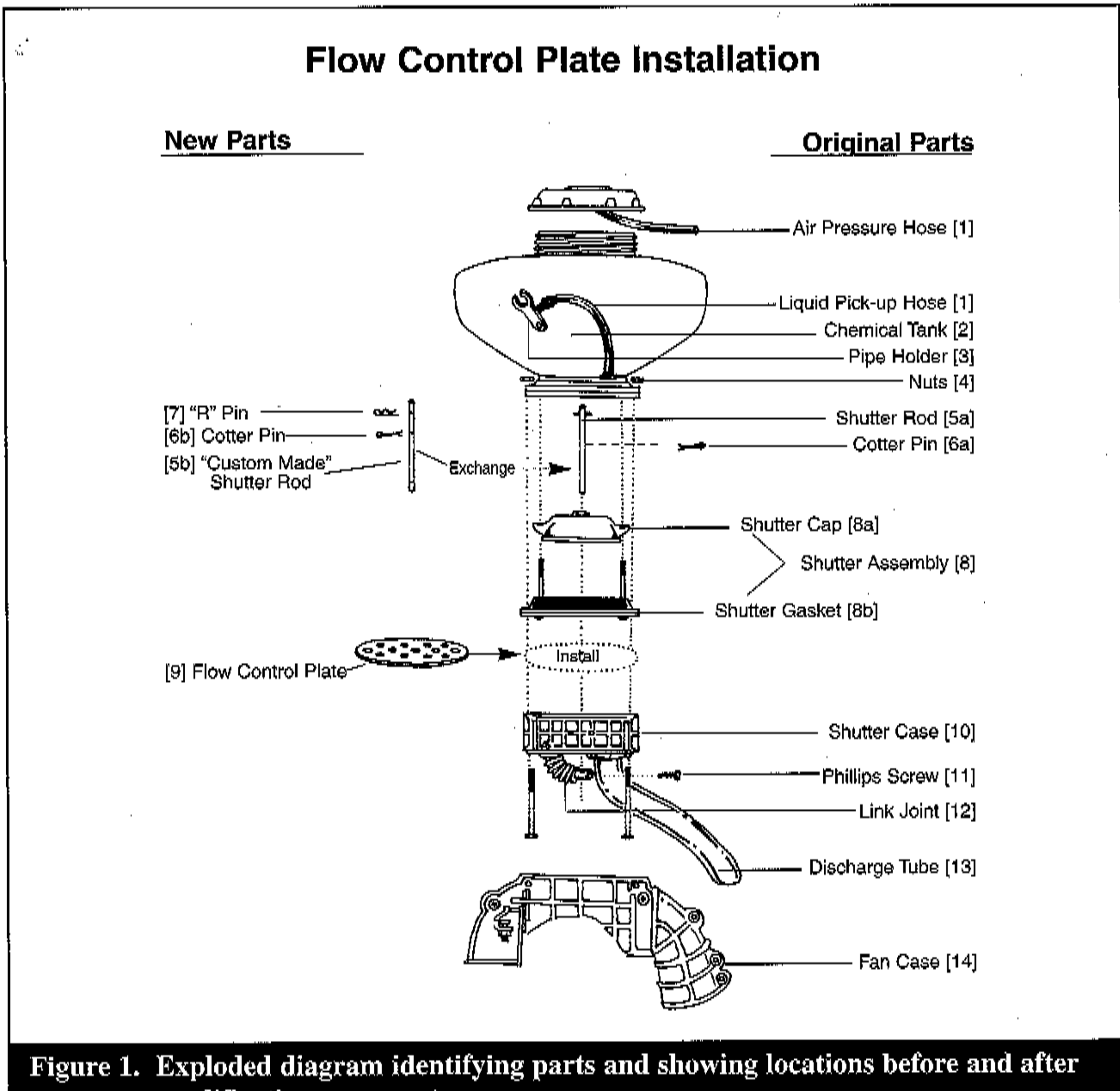


Figure 1. Exploded diagram identifying parts and showing locations before and after modification.

Detailed Instructions (Figure 1 & 2)

Dismantle:

1. Disconnect the two **Hoses [1]** inside the chemical tank from the white plastic **Pipe Holder [3]**. (may need flat screwdriver for pry).
2. Remove four **Nuts [4]** at base of **Chemical Tank [2]** and lift off tank (10 mm Wrench).
3. Disconnect **Joint Rod [17]** from **Link Arm [16]** by removing **"R" Pin [15]** (Pliers)(Figure 2 on page 4).
4. Lift off orange plastic **Shutter Case [10]** with attached **Shutter Assembly [8]**. (note: shutter assembly consists of 2 parts, the white plastic shutter cap [8a], and black rubber shutter gasket [8b]).
5. Loosen **Phillips Screw [11]** from **Link Joint [12]** to release "Original" Shutter Rod [5a]. This may require removal of white plastic **Discharge Tube [13]** to access phillips screw (Phillips Screwdriver).
6. Remove **"Original" Shutter Rod [5a]** from **Shutter Case [10]**.
7. Remove **Cotter Pin [6a]** from **"Original" Shutter Rod [5a]** and slide shutter rod out of **Shutter Assembly [8]**

Reassemble:

8. Slide new **"Custom Made" Shutter Rod [5b]** (see "Shutter Rod Construction") through the **Shutter Case [10]**.
9. Secure to **Link Joint [12]** by replacing previously removed **Phillips Screw [11]** through bottom hole (3/16 inch) in shutter rod. Re-attach **Discharge Tube [13]** if previously removed.
10. Return **Shutter Case [10]** to original position on top of **Fan Case [14]**
11. Reconnect **Joint Rod [17]** to **Link Arm [16]**. Position joint rod in "-" labelled hole at top, and ensure that it is also attached to outer hole in **Lever Arm [19]** (Figure 2). Test operation of **Shutter Lever [18]** to verify that shutter control is working (shutter rod moves up and down). If not, check **Link Joint [12]** (Remove black rubber cover to view joint).
12. Slide centre hole in **FLOW CONTROL PLATE** [9] onto **Shutter Rod [5b]** to cover discharge opening in **Shutter Case [10]**.
13. Place a **Cotter Pin [6b]** through middle hole (1/8 inch) in **Shutter Rod [5b]** and bend to lock.
14. Slide **Shutter Assembly [8]** back onto **Shutter Rod [5b]**.
15. Slide white plastic **Pipe Holder [3]** back onto **Shutter Rod [5b]**.
16. If necessary for tightness, fit a washer or two over rod.
17. Secure assembly with an **"R" Pin [7]** or cotter pin through top hole (1/8 inch) in shutter rod.
18. Replace **Chemical Tank [2]** and secure with **4 Nuts [4]**.
19. Reconnect **Hoses [1]**, placing the hose from the cap over the **Shutter Rod [5b]**, and the hose for liquid discharge over the nipple on the plastic **Pipe Holder [3]**.
20. Holes in the **FLOW CONTROL PLATE [9]** can now be accessed for flow adjustments by removing **"R" Pin [7]** (step 17) and sliding off **Shutter Cap [8a]**.

Note: Equipment must be operated with the **shutter cap** installed in order to get proper flow. The **hose** from tank lid must be connected to the hollow shutter rod to keep the tank pressurized.

Application Technique

The following application techniques are recommended for consistent results. Although complex at first glance, they are quickly mastered with practice. These methods typically produce an average swath width of 60 feet (18 m) at a production rate of 120 square feet per second (10 acres per productive hour). Prior to use, applicators should measure their swath width using the methods described on page 8.

1. **Machine Setting:** Fully open throttle and shutter during application. Position Joint Rod in "-" position in the Link Arm, and "outer" position in the Lever Arm (Figure 2).
2. **Walking Speed:** Walk 2 feet per second. Establish a pace of 1 step per second with a stride of 2 feet. This requires small steps of 4 to 5 inches from toe to heel, and provides a comfortable walk in moderately rugged terrain.
3. **Throw Tube Angle:** Hold throw tube at an upward angle of 45 to 55 degrees from horizontal. This influences swath width and pellet distribution.
4. **Sweep Arc:** Sweep throw tube back and forth 45 degrees to the right and left of centre. Excessive sweep will result in streaks of over application to each side. Insufficient

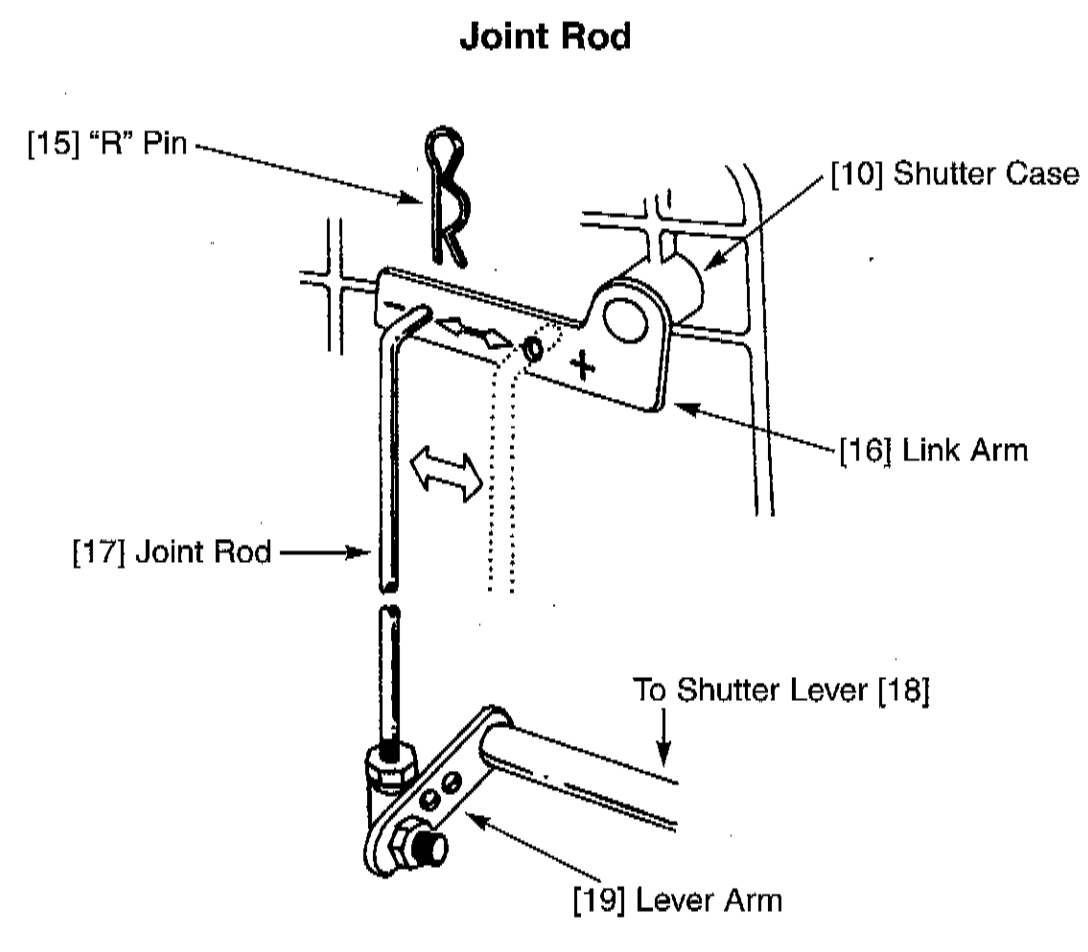


Figure 2. Illustration showing positioning of Joint Rod in Link and Lever Arm.

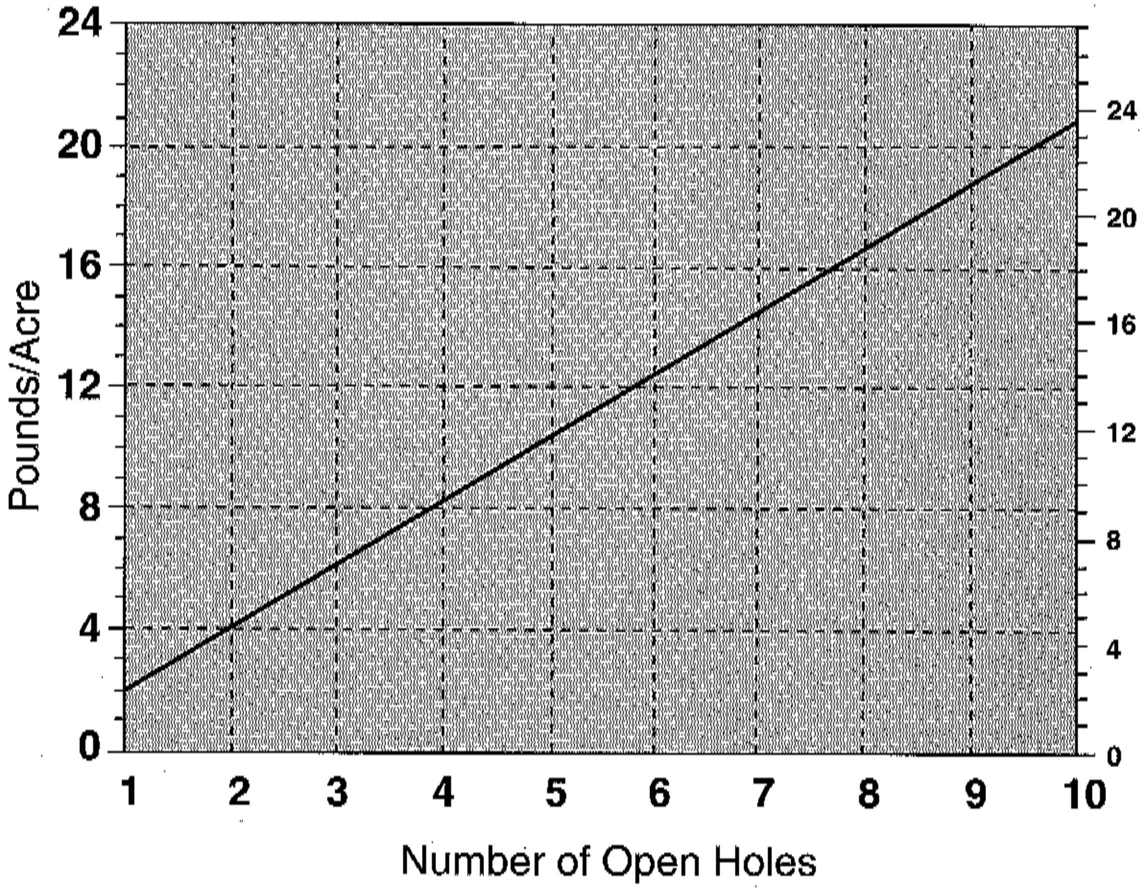
sweep will reduce swath width. It is useful to have someone observe the sweep arc and pellet distribution to assist in making necessary adjustments. The observer often has a better perspective.

5. **Sweep Pace:** Make one sweep each second, keeping time with the walking pace, and **Do Not** pause at the end of each sweep. This will help keep walking speed constant, and ensure that the granules are evenly applied and not banded in an "S" pattern. One sweep consists of a pass from one side to the other *without a return*.
6. **Swath Width:** The application rates and flow plate settings in this report are based on a 60 foot swath. The prescribed application technique should produce a swath width of 60 feet, however actual swath widths may vary with different operators and should be measured using the methods described in "Swath Width Calculation" (page 8).
7. **Swath Marking:** Swaths are normally marked using range poles, one at each end of the swath. These should be 12 feet long (3.6 m), for use in measuring the 60 foot (18 m) distance to the next swath (5 lengths of the pole). Measurements between swaths must be made *perpendicular to the swath direction*. Often a site must be broken into treatment strips (with flagging tape or traverse string) so that the range poles remain visible over the entire length of the swath. If unfamiliar with range poles, visit a N.S. Dept. of Natural Resources office for instruction.
8. **Practice:** Practice is essential to achieve consistent results, and is particularly important for developing a 1 second operating rhythm. Mark off a 40 foot (12 m) strip and practice covering this distance in 20 seconds while performing the application technique. Adjust travel speed by increasing or decreasing stride length. Do not use active chemical during this exercise. If available, load the tank with **blanks** and make swath width measurements at the same time (see Swath Width Calculation). Blanks consist of inactive "pronone" pellets that do not contain live chemical. They are useful for practice and should be available upon request from the Pronone supplier.

Application Rates —Calibration

Application rates are regulated by covering one or more open holes in the **flow control plate** with tape. Figure 3 provides a quick reference guide to help determine the number of open holes required. The rate calculations are based on a coverage rate of 120 ft^2/second (60 ft. swath X 2 ft/sec travel speed). If actual swath widths are not equal to 60 feet (see Swath Width Calculation) adjust the rate calculation using step 7. Research indicates that the flow per hole is consistent regardless of the number of open holes and averages 0.092 ounces per second. ***However:*** Flow rates may vary with different machines and product formulations. They are also very sensitive to slight variations in hole diameters in the **flow control plate**. To obtain precise application rates individual calibrations should be made at several settings (# of open holes) using the following method:

1. Load chemical tank half full with the specific Pronone formulation intended for use. **DO NOT** use blanks, they yield very different flow rates.
2. At normal operating settings (see Application Technique), blow chemical into a collecting bag for specific time period (e.g. 60 seconds). A cloth bag attached to a sona tube is suggested for this purpose. DO NOT obstruct air flow thereby creating back pressure in the throw tube, nor use a highly porous bag such as burlap.



Note: This graph assumes a 60 foot swath width, a 2 ft/sec travel speed (120 sq.ft./sec coverage rate), and a flow rate of 0.092 oz/sec/hole. Since these factors may vary, calibrations should be made using the methods described in "Application Rates - Calibration".

Figure 3. Application Rate by Number of Open Holes.

3. Weigh total output in ounces (grams) and divide by the number of seconds to determine flow rate in ounces/second (grams/sec).
4. Repeat at least 3 times to obtain average.
5. Be aware that pellets may lodge in the shutter assembly and prevent full closure of the shutter. This allows pellets to accumulate in the discharge tube after shutoff. Be sure that the tube is empty prior to beginning each new calibration run (and also when starting up during actual field applications).
6. Calculate application rate by applying appropriate formula:

A) Pounds per Acre = ounces/second x 22.7

B) Kilograms per Hectare = grams/second x 0.90

EXAMPLE

Eight open holes are tested 3 times for 60 seconds/time. The following outputs are measured:

1) 42.9 ounces, 2) 44.1 ounces 44.7 ounces

The application rate is caculated as follows:

AVERAGE OUTPUT $= \frac{42.9\text{ oz} + 44.1\text{ oz} + 44.7\text{ oz}}{3\text{ trials}} = 43.9$ ounces

OUTPUT PER SECOND $= \frac{\text{average output (ounces)}}{60\text{ seconds}} = \frac{43.9}{60} = 0.73$ ounces/second

POUNDS PER ACRE = 0.73 ounces/second **X** 22.7 = 16.6 pounds/acre

7. The above calculations are accurate for a 60 foot swath (120 ft^2/sec). However, if the measured swath width (see Swath Width Calculation) differs significantly from the prescribed 60 feet, adjust the application rate as follows:

Adjusted Application Rate = Calculated Application Rate X $\frac{\textbf{60 (ft)}}{\textbf{swath width (ft)}}$

8. Although less accurate, measuring cups are often more convenient than weight scales. If using a measuring cup, the following formulas can be used to determine application rates from output volumes, instead of the weight based formulas presented in step 6. The calculations are based on an <u>average</u> "Product" density of 38 pounds per cubic foot as reported in the Material Safety Data Sheet for Pronone.

A) Pounds per Acre = "Imperial Fluid" Ounces/Second x 13.8
B) Kilograms per Hectare = Millilitres/Second x .55

Swath Width Calculation (Figure 4)

Field tests using the recommended application technique commonly produced a 60 foot (18 m) swath. **HOWEVER**, swath widths vary for different operators and should be measured. If, after practising and adjusting application technique, a swath width of 60 feet is not attained, the application rates should be adjusted using step 7 in the "Application Rate - Calibration" section.

The following instructions provide an accurate method for determining swath width, with allowance made for overlap at the edges. Avoid windy conditions when testing. They may affect the distribution pattern.

Materials: 17 cardboard boxes of equal size (for pellet collection) measuring approximately 1.5 feet deep by 2 feet wide. Large buckets (2 ft diam eter) may substituted. Beware of pellets bouncing out.

1. Set up pellet collection boxes across (perpendicular to) the line of travel as follows:
   - place one box at centre (on line of travel), and the others spread out and located at 7, 14, 21, 26, 28, 30, 32, and 34 feet to each side of centre (Figure 4).

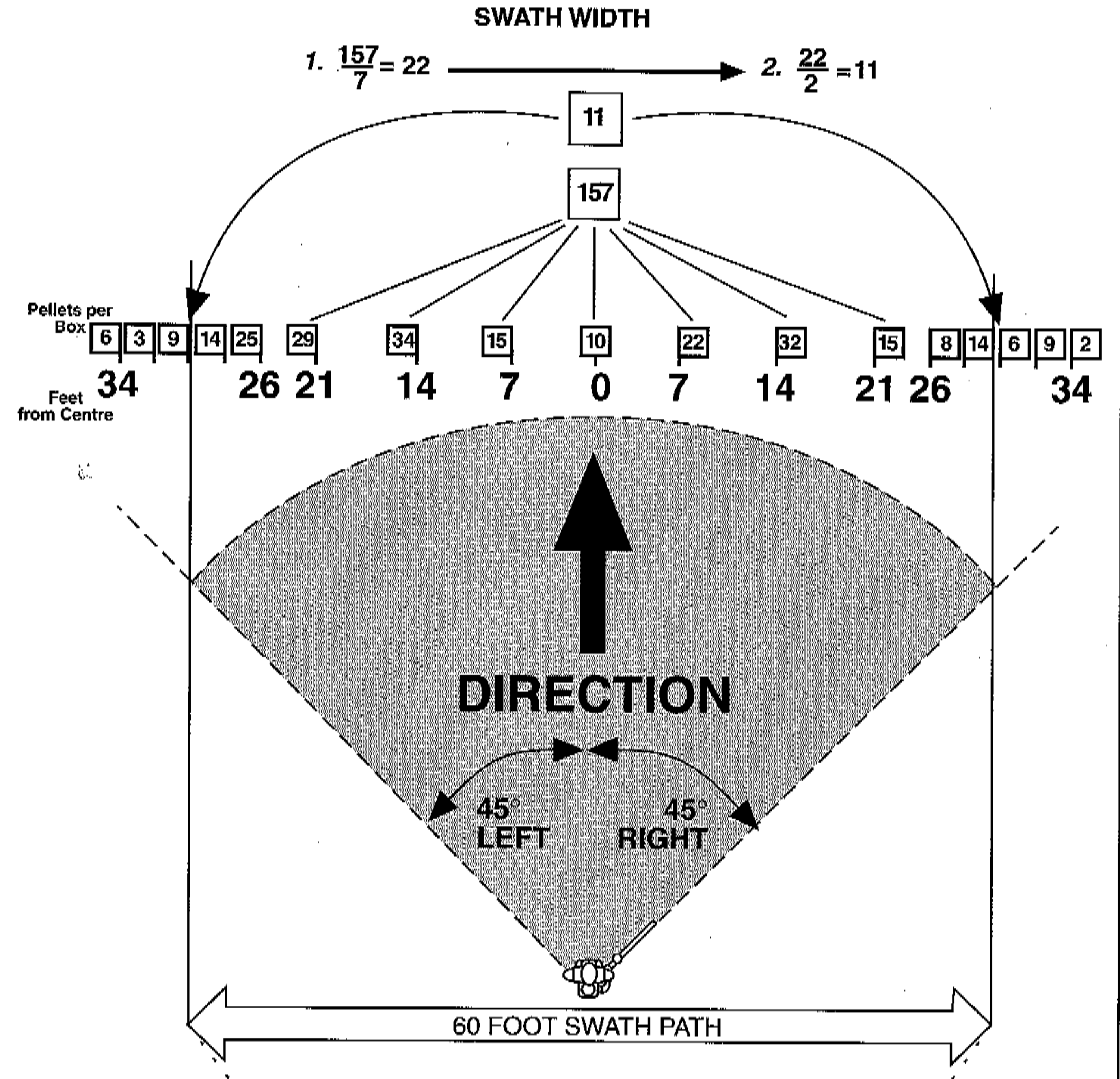
2. Beginning approximately 50 feet in front of boxes, make a pass through the collection box setup, applying pellets using the recommended "Application Technique".

3. Count the number of pellets landing in the 7 central boxes (those located at 0, 7, 14, and 21 feet to each side of centre). Calculate the average of the central boxes by summing these 7 individual box counts and dividing the sum by 7.

4. Count the pellets in each of the outer boxes (those located at 26, 28, 30, 32, and 34 feet). The number of pellets landing in these boxes will decrease as the distance from centre increases. The swath edge is located at the edge (closest to centre) of the box where the pellet counts decrease, *and remain*, **below *half* of the *average* obtained from the *central* boxes.** Measure the distance between the swath edges to obtain the swath width.

5. Repeat this procedure several times to get the average result, always travelling in the same direction during testing. Adjust application technique until a swath width of 60 feet is being consistently attained and the swath width is well centred.

If available use blanks (Pronone pellets without herbicide - available from supplier), they will allow repeated testing at the same location. Use of live chemical will require repositioning the setup for each pass.



Pellets Per Box | Center Box

Run Number																	
Example	6	3	9	14	25	29	34	15	10	22	32	15	8	14	6	9	2
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
Total																	
Average																	

Figure 4. Method for using collection boxes to determine effective swath width. (sample tally sheet at bottom)

Shutter Rod Construction (Figure 5)

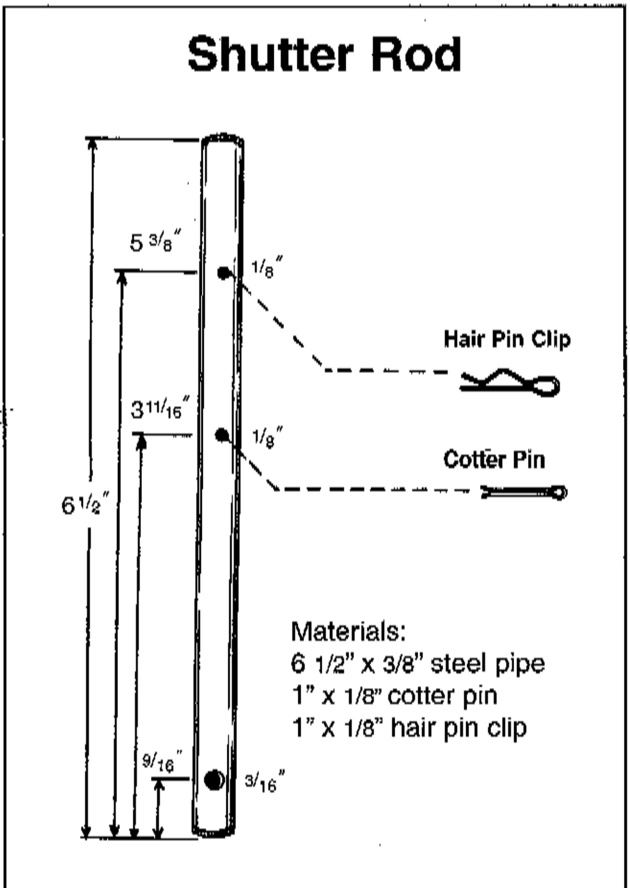


Figure 5. Guide for construction of "custom made" shutter rod.

Material:
- 6 1/2 inch long X 3/8 inch (out side diameter) sturdy hollow steel pipe (approx. 1/16 inch walls)
- 1 cotter pin - 1 inch X 1/8 inch
- 1 "R" pin - 1 inch X 1/8 inch (if unavailable use cotter pin)

Tools:
- Drill
- 2 drill bits: 3/16 inch, and 1/8 inch

Method:

1. Measuring from one end of tube (bottom) mark for drilling at 9/16 inch, 3 11/16 inch, and 5 3/8 inch.
2. Use 3/16 inch bit to drill bottom hole through tube, and 1/8 inch bit to drill centre and top holes. It is not necessary to align holes.
3. Install according to directions in "Flow Control Plate Installation".

Flow Control Plate Construction (Figure 6)

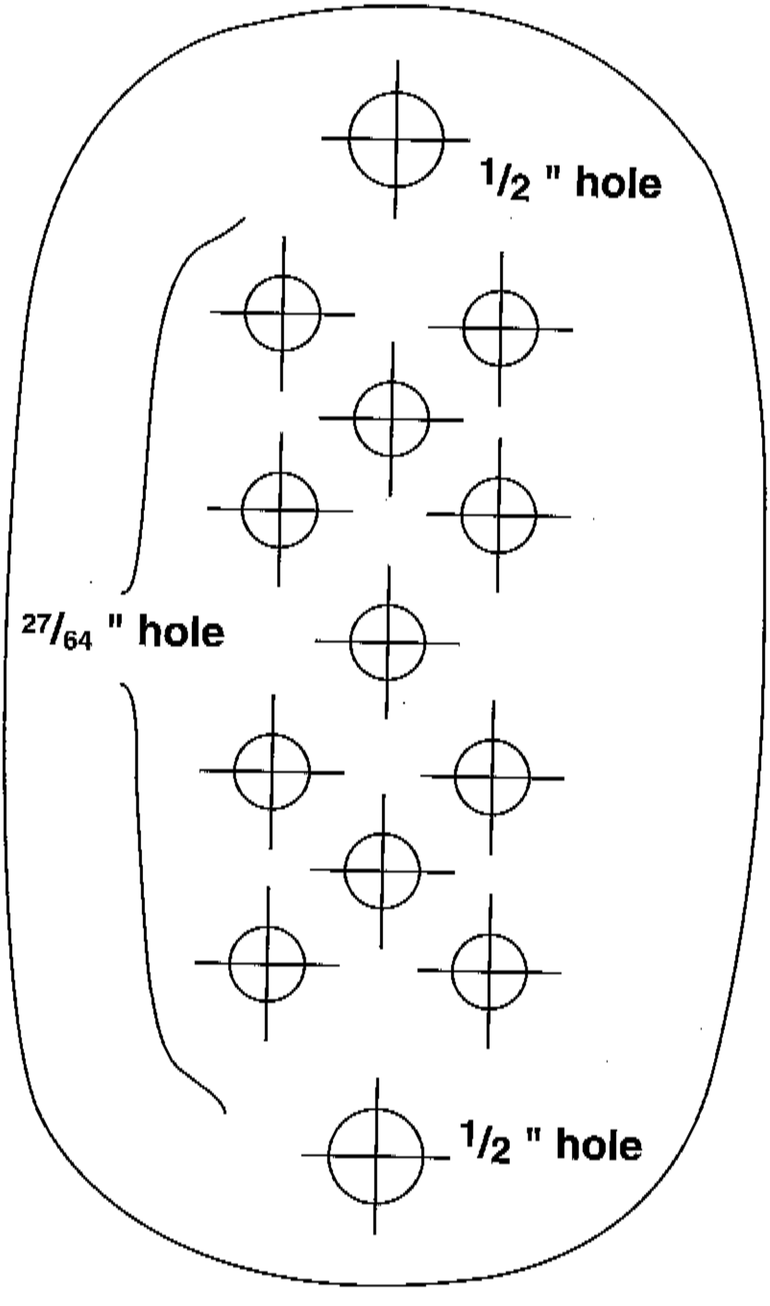
Material:
- 4 X 8 inch sheet metal - 20 to 24 gauge, preferably rust resistant

Tools:
- drill, preferably drill press
- 2 drill bits: 1/2 inch, and 27/64 inch
- centre punch
- metal shears
- tape
- file

Method:

1. Tape template guide to metal sheet
2. Mark hole location centres with centre punch
3. Drill holes as indicated on guide. Hole size and location are critical - work with precision.
4. Cut out flow plate with shears, following edge of template guide.
5. File off burrs.
6. Install according to directions in "Flow Control Plate Installation".

FLOW CONTROL TEMPLATE (TO SCALE)



Material:
20 to 24 Gauge Sheet Metal
Preferably Aluminum, Galvanized or Stainless Steel

Figure 6. Template Guide for construction of flow plate.

Disclaimer

Mention of trade names of equipment or herbicides is for reader convenience and does not constitute endorsement of a particular product by the N.S. Dept. of Natural Resources to the exclusion of any other suitable product.

Literature Cited

McLaughlan, M.S. 1992. *Hexazinone and granular herbicide applicators: a review of the herbicide and available application equipment.* Thunder Bay: Ont. Min. Nat. Res. Northwest Region Science and Technology Technical Report No. 71, 65 pp.

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