1937

COMPARISON OF SPRAY NOZZLES FOR EFFECTIVE SPRAYING OF HOPS FOR DOWNY MILDEW.

by

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Agent, U.S.D.A.

Under Legislative Funds 1937

Hop Pests and Agronomy

A Special Oregon State Legislative Project

Introduction

There are between 750 and 800 hop growers in Oregon with a total of 22,500 acres under cultivation in Benton, Clackamas, Douglas, Jackson, Josephine, Lane, Linn, Marion, Polk, Umatilla, Washington and Yamhill counties. Gross production in 1937 is estimated at 24,530,000 pounds. The actual poundage harvested (dry weight) is estimated at 22,000,000 pounds or 980 pounds per acre. The average cost of production per pound (1934-1936) was 18.6 cents. In general the cost of production decreases as the yield increases. The cost of production has been increasing annually. Agronomic practices and the practices employed for the control of hop pests and diseases play an important role in profitable hop production.

A cooperative Federal-Oregon State Hop Disease Investigations Project has been in progress since 1931. While headquarters have been maintained at Corvallis the field of operations has included British Columbia, California, New York and Washington. The activities of those connected with the project have of necessity been confined largely to field control and selection and breeding for disease resistance.

Since 1934 Purnell projects Nos. 68, 69 and 70 - "Artificial Drying of Hops," "Improvement and Application of Chemical Methods in Hop Evaluation for Brewing Purposes," and "Hop Cost Studies," respectively, have been in progress at the Oregon Experiment Station. In order to expand the coordinated hops program funds were made available for the conduct of the State project under immediate consideration.

Five hundred of the fifteen thousand dollars appropriated was assigned to the Botany Department for the conduct of a sub-project, "Spraying for Hop Mildew," and placed at the disposal of G. R. Hoerner, Agent, U. S. Department of Agriculture, Bureau of Plant Industry, Division of Drug and Related Plants. A more accurate statement of the nature and scope of the problem under investigation would be, "special chemical and physical studies of fungicides, spreaders, stickers and wetters as related to liquid sprays and dusts to be used in the control of diseases of hops, with particular reference to downy mildew."

The immediate problem was to secure more or less empirical information of a practical nature which might be of use to growers rather than fundamental scientific data.

Downy mildew is found in every hop-growing county in the state except Umatilla and constitutes an annual menace to profitable production. There are no commercial hop varieties which are immune. All parts of the .

plants may become infected. Under favorable environmental conditions the disease spreads with extreme rapidity and actual crop losses range, in individual yards, as high as 100 per cent. Entire plants are sometimes killed. Until such time as immune or highly-resistant commercially-valuable varieties can be offered growers, field control practices are of major importance.

Tentative budgets have been submitted providing for an expenditure of $ 100.00 for equipment and supplies and $ 150.00 for labor in each of the two years of the biennium. As of February 1, 1938 expenditures for equipment and supplies have amounted to $ 176.18 and for labor, $ 137.20 leaving balances of $ 23.82 and $ 162.80 respectively.

In all probability the unexpended balances will suffice to conclude the work on the sub-project as planned. If additional funds in like amounts are made available in future, however, the investigational work can be extended to good advantage.

By way of augmenting trials of spraying and dusting equipment and materials, which have been made each year since the Hop Disease Investigations project was inaugurated in 1931, more detailed information was desired.

Experimental Spraying

The primary objective was to compare the relative merits of various spray nozzles obtainable through trade sources by determining: (1) the mechanical relation between pump in-take and out-put in gallons per minute; out-put being limited by nozzle openings, pressure being constant, (2) the spray pattern as to type, size, shape, and size of spray particle and (3) the most effective distance from nozzle to object being sprayed.

A 4-4-50 Bordeaux mixture was pumped through a motor-driven Hardie Estate pump of three gallon per minute capacity. See figure 1. The various nozzles were tried with varying disc appertures; the spray being directed at a back-board. Using the back-board as a gauge, the type, size and shape of the spray patterns were determined.

The size of the particles of spray was estimated by eye, four classifications being used: fine, medium-fine, medium and coarse.

The most effective distance was considered as that point at which, in the case of a hollow cone, where the cone of spray converged; in the case of a flat spray, where the pattern was widest.

The output in gallons per minute was determined by measuring a one-minute discharge collected in a covered container. This process was repeated three times. The average of the three trials was recorded. Details are presented in the following tables.

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TABLE 1. - GUN

Nozzle	Disc	Pressure	Spray Pattern	Spray type	Eff. Dist.	Gal/Min.
Hardie Orchard Gun Model "E"	No. 2	300 lb.	Hollow cone 1 ft. dia.	Fine	* a. 8 ft. b. 15 ft.	0.325 1.005
	No. 3	300 lb.	Hollow cone 1-1/2 ft. dia.	Fine	a. 7 ft. b. 15 ft.	0.500 1.500
	No. 4	300 lb.	Hollow cone 2 ft. dia.	Med.-fine	a. 6 ft. b. 15 ft.	0.750 1.800
	No. 5	280 lb.	Hollow cone 3 ft. dia.	Medium	a. 5 ft. b. 15 ft.	1.825 2.300

N.B. The pump would not develop pressure above 150 lbs. with a disc larger than a No. 5.
* a. indicates results with gun one half open.
b. indicates results with gun full open.

TABLE 2. - NOZZLES WITHOUT DISCS

Nozzle	Disc	Pressure	Spray Pattern	Spray type	Eff. Dist.	Gal/Min.
Bean Best	x	300 lb.	Solid cone 1 ft. dia.	Fine	10 ft.	0.900
Hardie Blizzard	1/4 open	300 lb.	Solid stream	Med.-fine	3 ft.	0.315
	1/2 open	300 lb.	Flat, 90° spread	Med.-fine	5 ft.	2.050
	Full open	290 lb.	Flat, 180° spread	Coarse	4 ft.	2.500

(continued)

TABLE 2. - NOZZLES WITHOUT DISCS (CONT.)

Nozzle	Disc	Pressure	Spray Pattern	Spray type	Eff. Dist.	Gal/Min.
Bean Bordeaux	1/4 open	300 lb.	45° flat spread	Med.-fine	5 ft.	0.500
	1/2 open	300 lb.	120° flat spread	Medium	6 ft.	2.005
	Full open	285 lb.	Solid stream	Coarse	15 ft.	2.250
Bean Clipper	1/4 open	300 lb.	60° flat spread	Fine	5 ft.	0.500
	1/2 open	300 lb.	120° flat spread	Medium	6 ft.	1.815
	Full open	285 lb.	Solid stream	Coarse	15 ft.	2.250
Vermoral	x	300 lb.	Hollow cone 2 ft. dia.	Med.-fine	5 ft.	1.000
Weed	x	300 lb.	Hollow cone 1-1/2 ft.dia.	Fine	4 ft.	1.100

TABLE 3. - NOZZLES WITH DISCS

Nozzle	Disc	Pressure	Spray Pattern	Spray type	Eff. Dist.	Gal/Min.
Hardie Adjustable						
Open	No. 2	300 lb.	Solid cone 3" dia.	Fine	5 ft.	0.750
Closed	No. 2	300 lb.	Hollow cone 1 ft. dia.	Fine	4 ft.	0.500
**						
Open	No. 4	300 lb.	Solid cone 6" dia.	Med.-fine	6 ft.	1.375
Closed	No. 4	300 lb.	Hollow cone 1-1/2 ft.dia.	Fine	4 ft.	1.000
Open	No. 5	285 lb.	Solid cone 10" dia.	Medium	8 ft.	2.375
Closed	No. 5	300 lb.	Hollow cone 2 ft. dia.	Med.-fine	3 ft.	1.500
Open	No. 6	250 lb.	Solid cone 1 ft. dia.	Medium	9 ft.	2.500
Closed	No. 6	300 lb.	Hollow cone 2-1/2 ft.dia.	Med.-fine	3 ft.	1.875
***						
Closed	No. 7	285 lb.	Hollow cone 3-1/2 ft.dia.	Med.-fine	3 ft.	2.125
Maidstone						
Open	No. 5	300 lb.	Semi-hollow cone 3 ft. dia.	Fine	4-1/2 ft.	2.125
Closed	No. 5	300 lb.	Solid cone 1 ft. dia.	Med.-fine	10 ft.	2.250
Noblox						
Open	No. 5	300 lb.	Hollow cone 1-1/2 ft.dia.	Fine	5 ft.	1.750
Closed	No. 5	300 lb.	Hollow cone 2 ft. dia.	Med.-fine	4 ft.	1.500
Hardie Vapo - 2 Straight nozzles on Straight Y	No. 2	300 lb.	Double Hollow cone, each cone 2 ft. dia. 8" overlap	Fine	3-1/2 ft.	0.750
	No. 3	300 lb.	Double hollow cone, each cone 2-1/2 ft.dia. 10" overlap	Med.-fine	4 ft.	0.935
	No. 4	300 lb.	Double hollow cone, each cone 3 ft. dia. 12" overlap.	Med.fine	5 ft.	1.125

(continued)

TABLE 3. - NOZZLES WITH DISCS (CONT.)

Nozzle	Disc	Pressure	Spray Pattern	Spray type	Eff. Dist.	Gal/Min.
Hardie Vapo ****	No. 3w*	300 lb.	Flat 3 ft. x 3" rt. angle to welt.	Fine	5 ft.	0.505
	No. 4w*	300 lb.	Flat oval hollow 3-1/2 ft. x 6" rt. angle to welt.	Med.-fine	4 ft.	0.850
	No. 5w*	300 lb.	Flat oval hollow 4 ft. x 10" rt. angle to welt.	Medium	4 ft.	1.000
	No. 2	300 lb.	Hollow cone 2 ft. dia.	Fine	3-1/2 ft.	0.300
	No. 3	300 lb.	Hollow cone 2-1/2 ft. dia.	Fine	4 ft.	0.415
	No. 4	300 lb.	Hollow cone 3 ft. dia.	Med.-fine	5 ft.	0.600
	No. 5	300 lb.	Hollow cone 3-1/2 ft. dia.	Med.-fine	5 ft.	0.800
	No. 6	300 lb.	Hollow cone 4 ft. dia.	Med.-fine	4 ft.	0.950
	No. 7	290 lb.	Hollow cone 5 ft. dia.	Coarse	4 ft.	1.010

* (w) is used to indicate the welted disc. In the trials the welt was to the outside.
** No. 3 disc for the Hardie adjustable nozzle was not available.
*** Pump capacity not great enough to hold pressur e with a No. 7 disc and the gun full open.
**** The same results were obtained with both the straight and angle Vapo nozzle.

Summary

1. In view of the general grower tendency to employ automatic sprayers in preference to orchard type sprayers with either rods or guns, emphasis has been placed on a study of the relative merits of nozzles only.

2. Nozzles with discs are preferred to those without discs.

3. Nozzles which deliver a cone-shaped spray are considered preferable to those which deliver a flat spray pattern.

4. In general welted discs are not advised. Discs which deliver a type of spray classed as fine or medium-fine are to be preferred over those which deliver the material in coarser particles.

5. Of the nozzles tried the Hardie Vapo, straight with No. 4 regular disc, appears most desirable and will be used in all further experimental work on the sub-project.

G. R. Hoerner, Agent.
February 1, 1938.

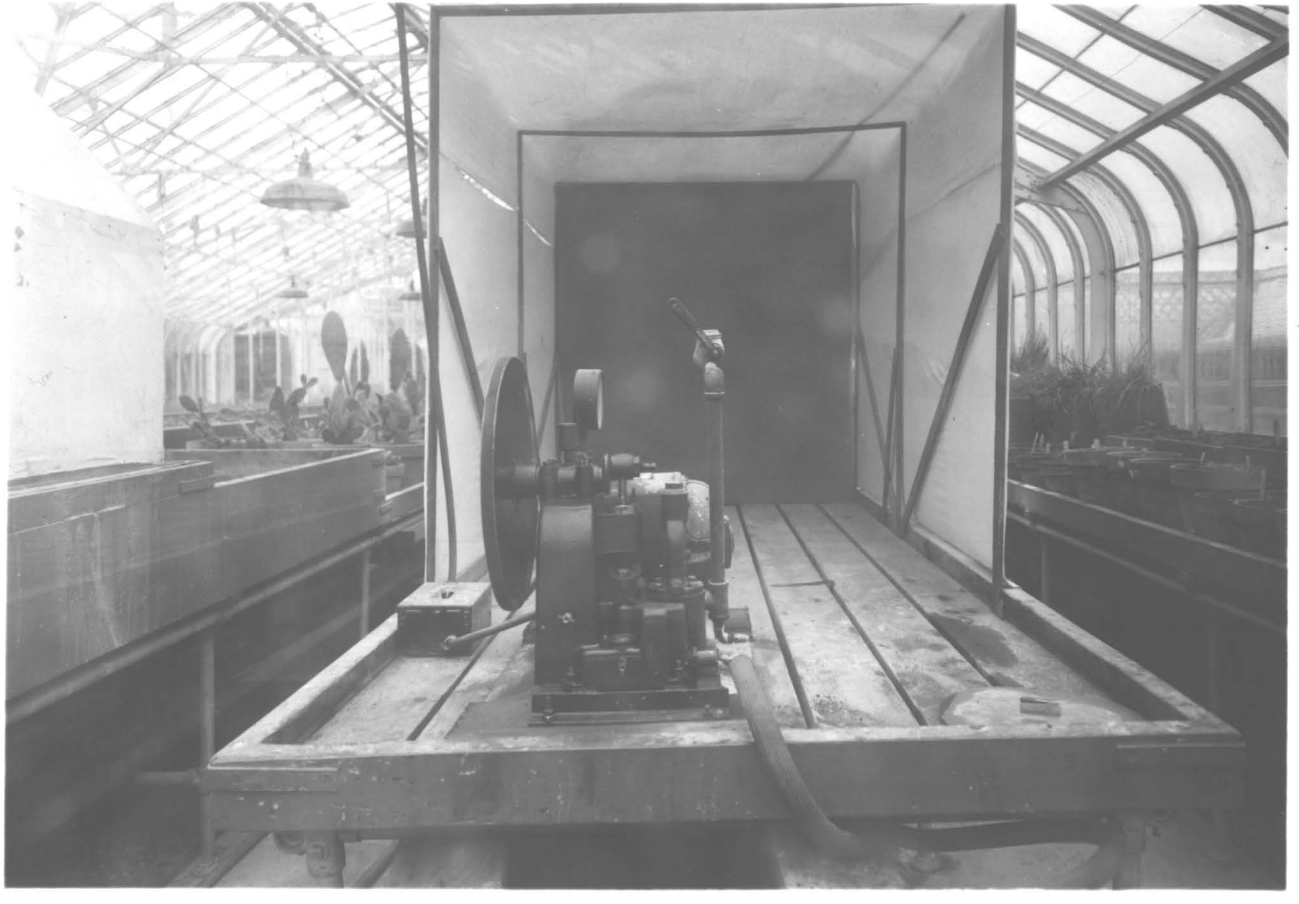
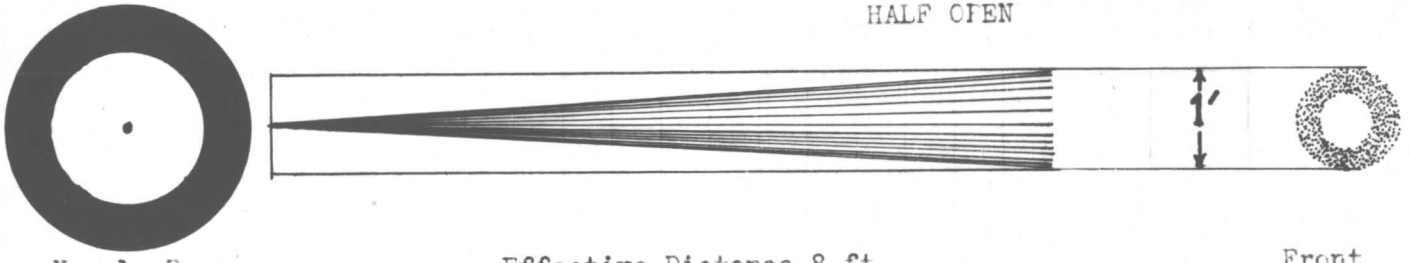


Fig. 1 -- Experimental Spraying Equipment

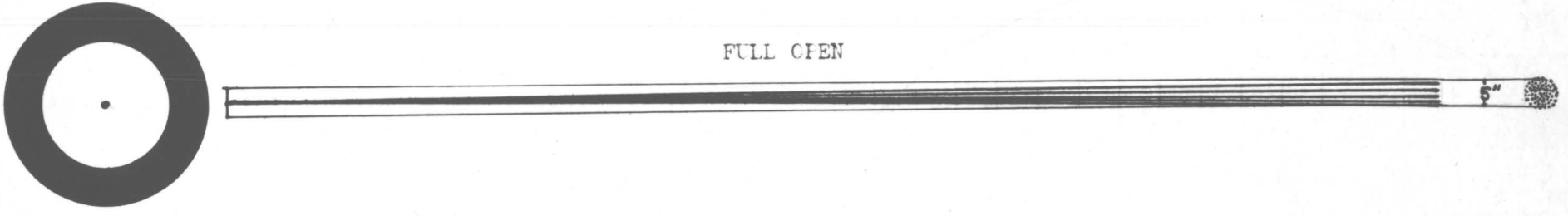
HARDIE ORCHARD GUN MODEL "E"
(No. 2 disc)

HALF OPEN



Nozzle Face Effective Distance 8 ft. Front

FULL OPEN

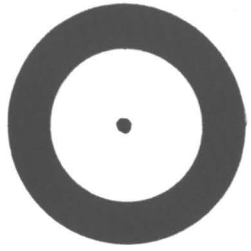


Nozzle Face Effective Distance 15 ft. Front

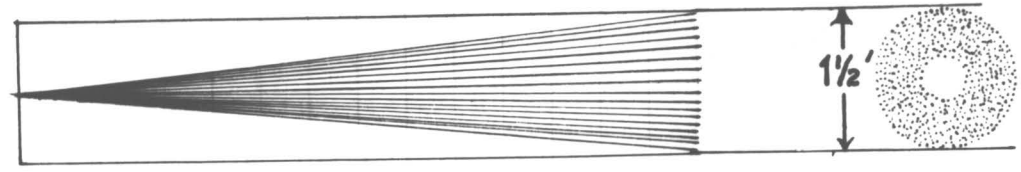
Scale 1/2" = 1'

HARDIE ORCHARD GUN MODEL "E"
(No. 3 disc)

HALF OPEN



Nozzle Face

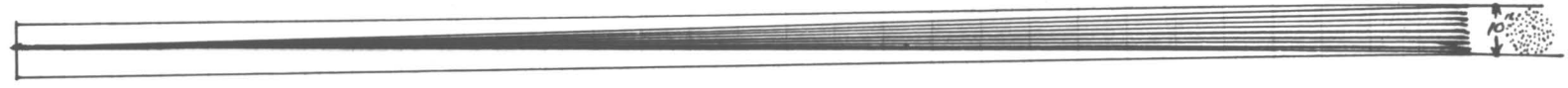


Effective Distance 7 ft.

Front

FULL OPEN

Nozzle Face



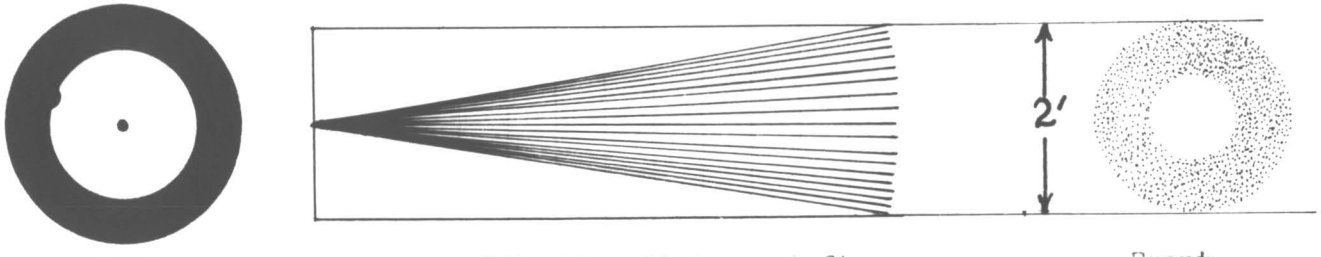
Effective Distance 15 ft.

Front

Scale 1/2" = 1'

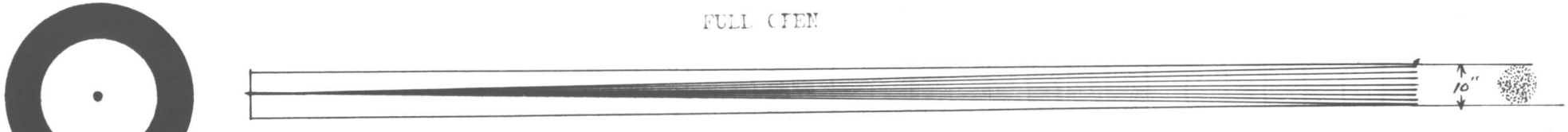
HARDIE (PEERLESS) GUN MODEL "F"
(No. 4 disc)

HALF CIRCLE



Nozzle Face — Effective Distance 4 Ft. — Front

FULL CIRCLE

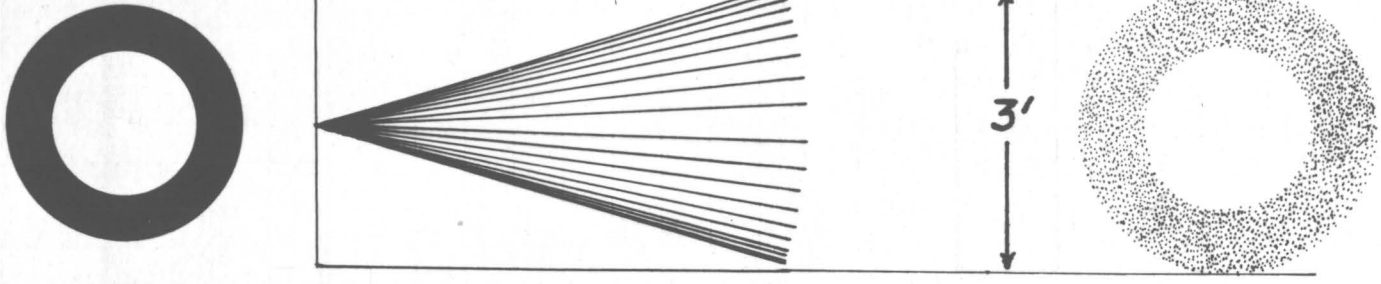


Nozzle Face — Effective Distance 15 Ft. — Front

Scale 1/2" = 1'

HARDIE ORCHARD GUN MODEL "E"
(No. 5 disc)

HALF OPEN

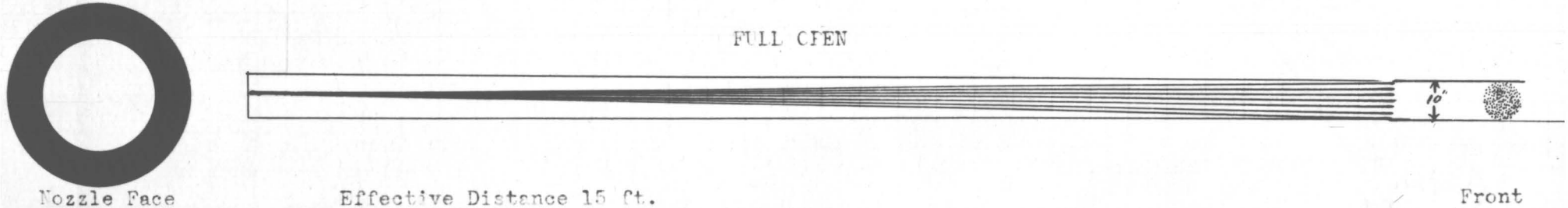


Nozzle Face

Effective Distance 5 ft.

Front

FULL OPEN



Nozzle Face

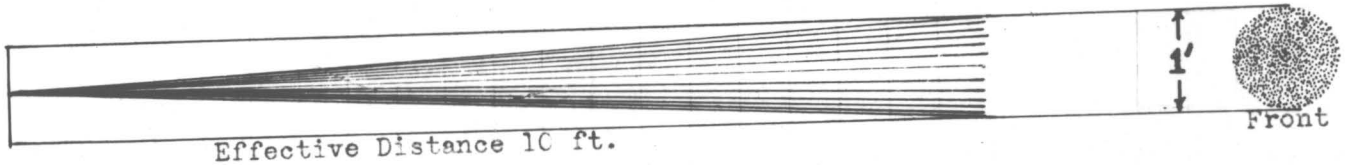
Effective Distance 15 ft.

Front

Scale 1/2" = 1'

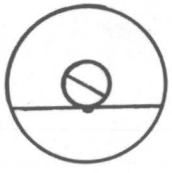
BEAN BEST

Nozzle Face
(Full size)

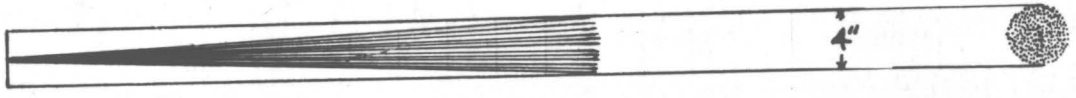


Scale 1/2" = 1'

HARDIE BLIZZARD
(1/4 open)



Nozzle Face



Effective Distance 3 ft.

Front.

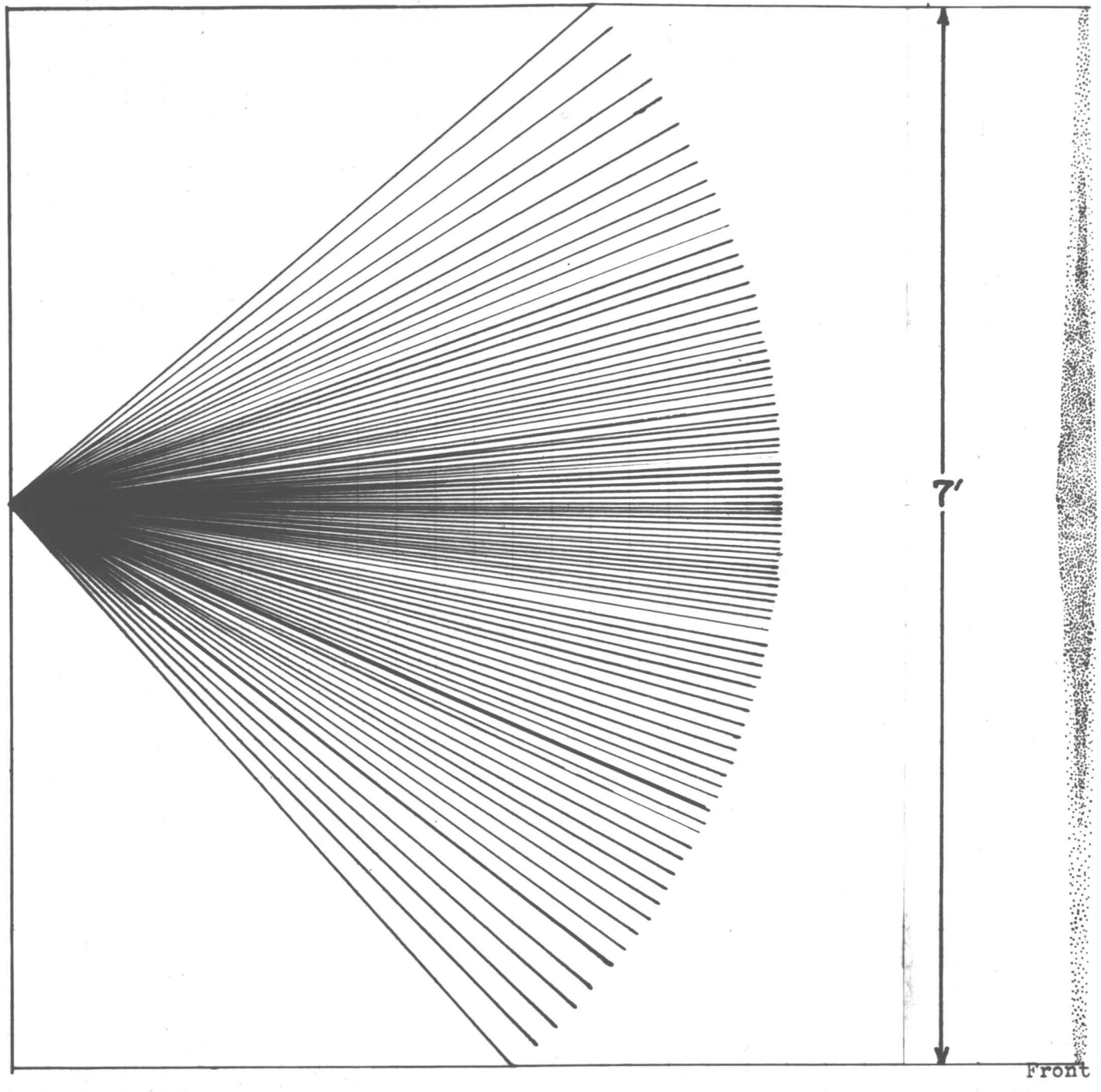
Scale 1" = 1'

HARDIE BLIZZARD
(1/2 open)

Nozzle face.

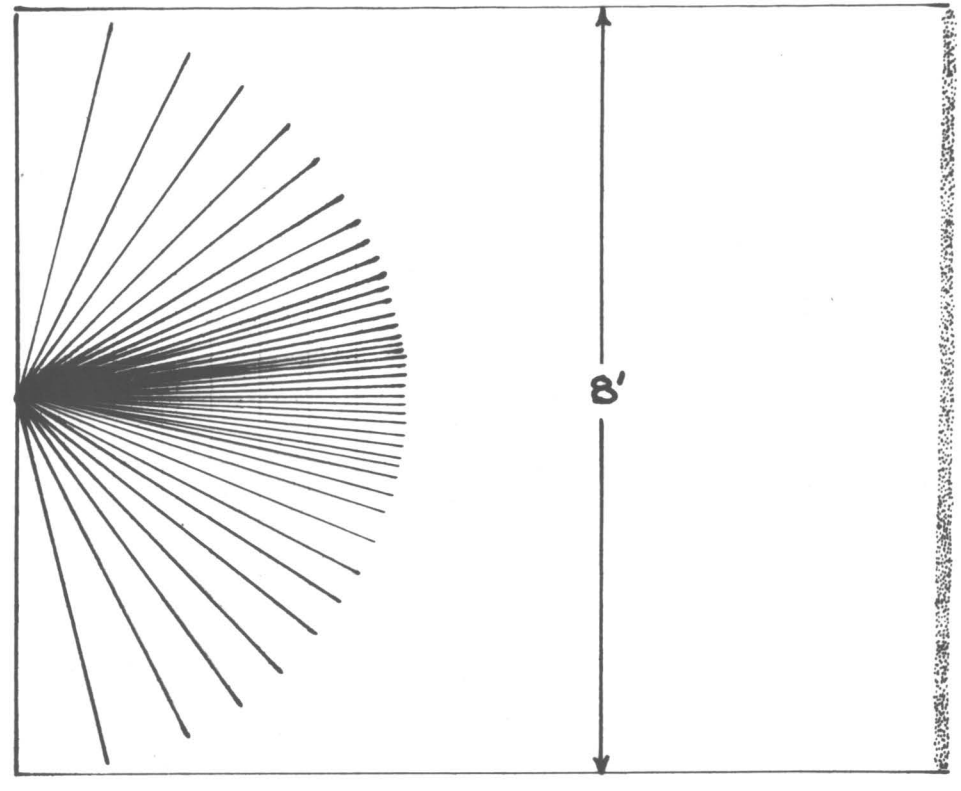
Effective Distance 5 ft.
90° spread

Scale 1" = 1'



HARDIE BLIZZARD
(full open)

Nozzle Face

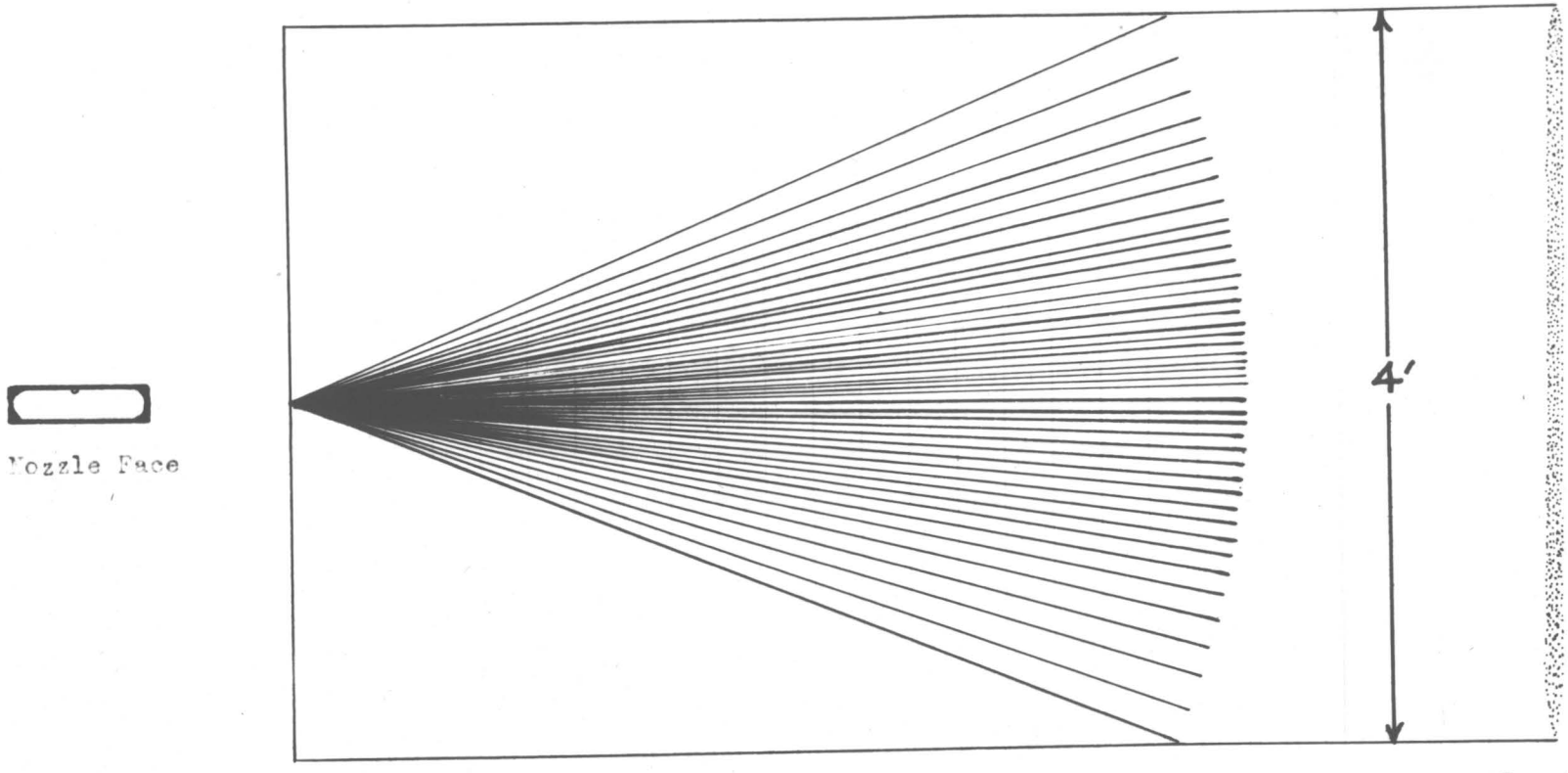


Effective Distance 4 ft.

Front

Scale 1/2" = 1'

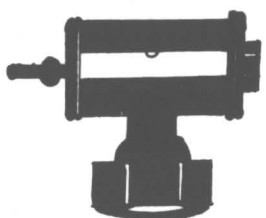
BEAN BORDEAUX
(1/4 open)



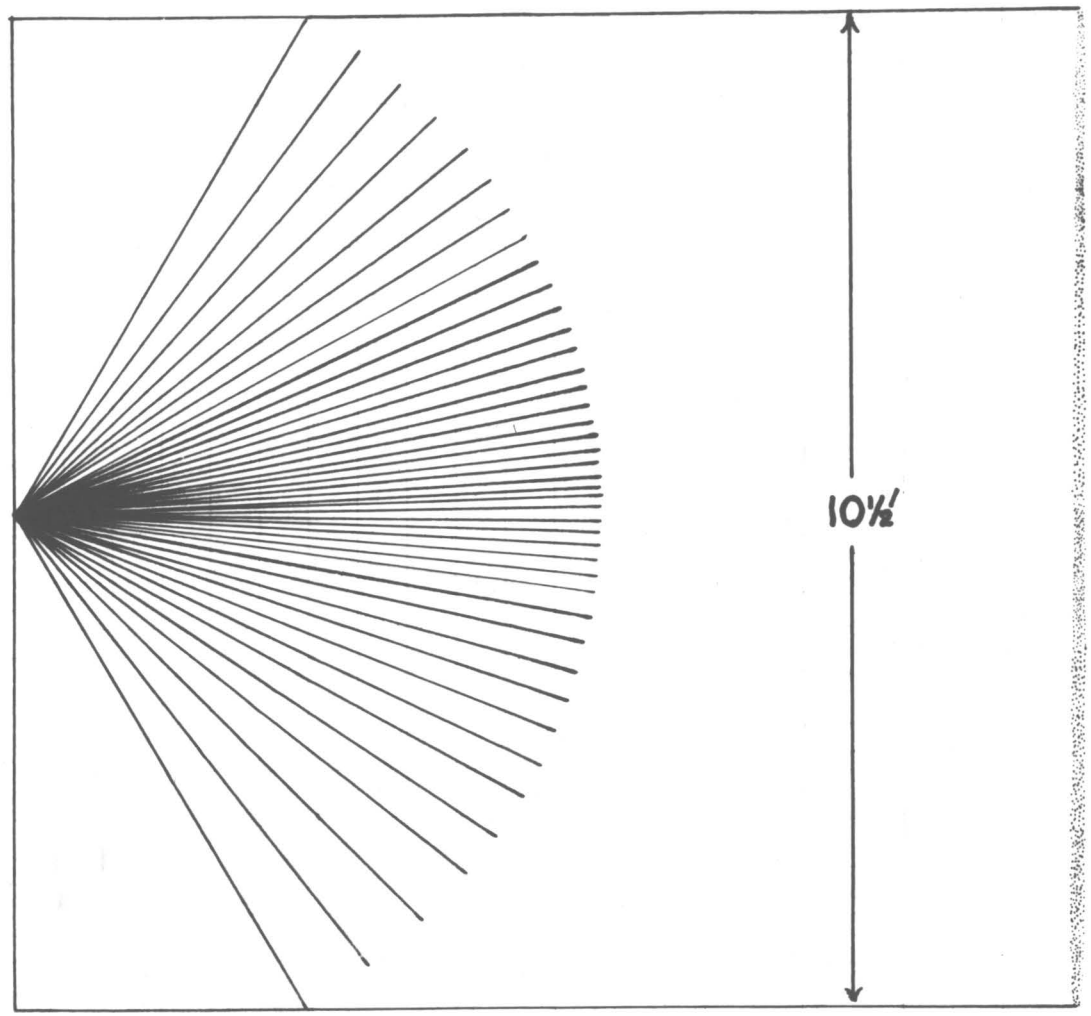
Effective Distance 5 ft.

Scale 1" = 1'

BEAN BORDEAUX
(1/2 Open)



Nozzle Face

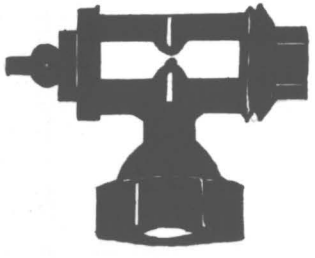


Effective Distance 6 ft.

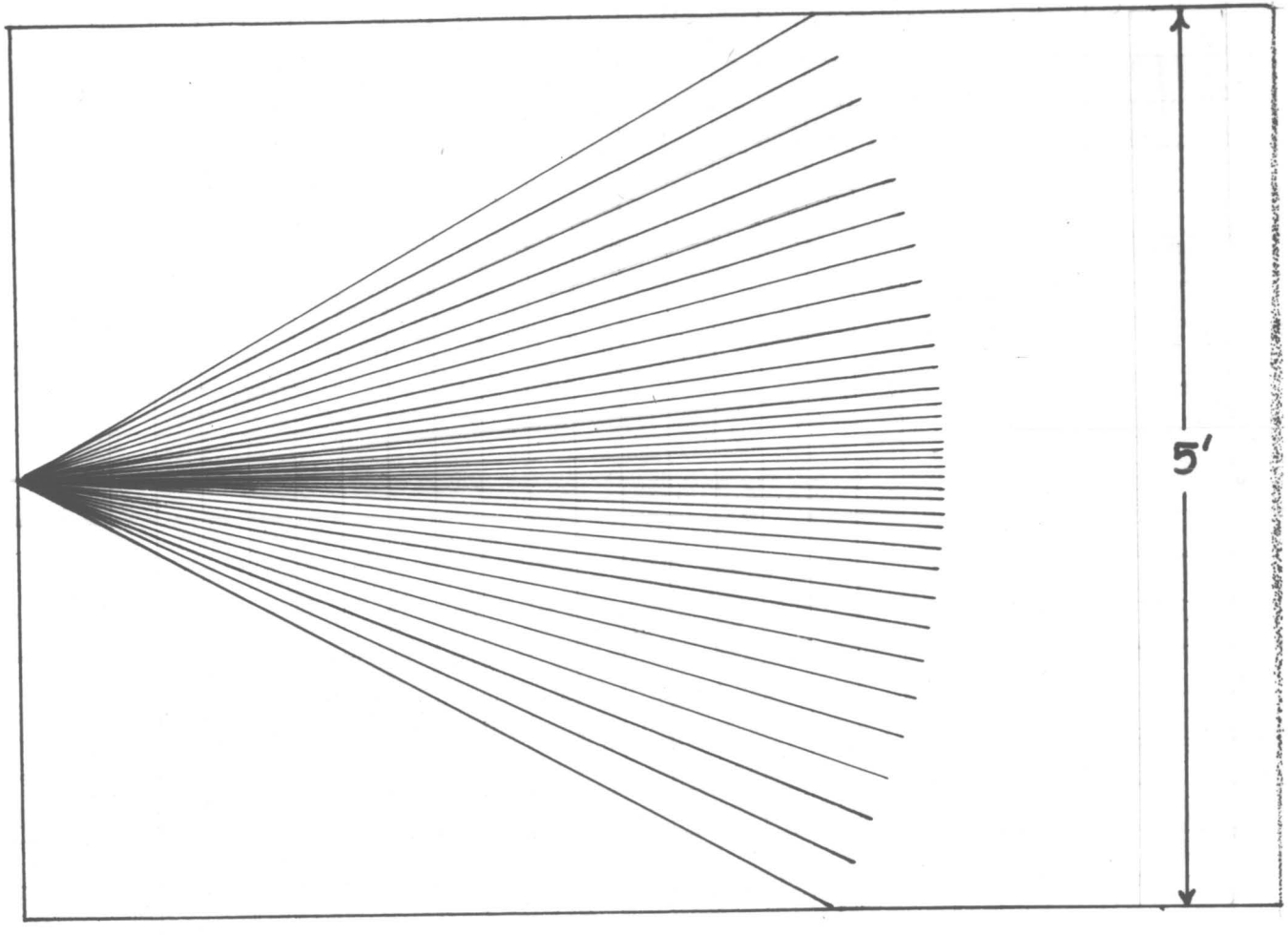
Front

Scale 1/2" = 1'

BEAN CLIPPER
(1/4 open)



Nozzle Face



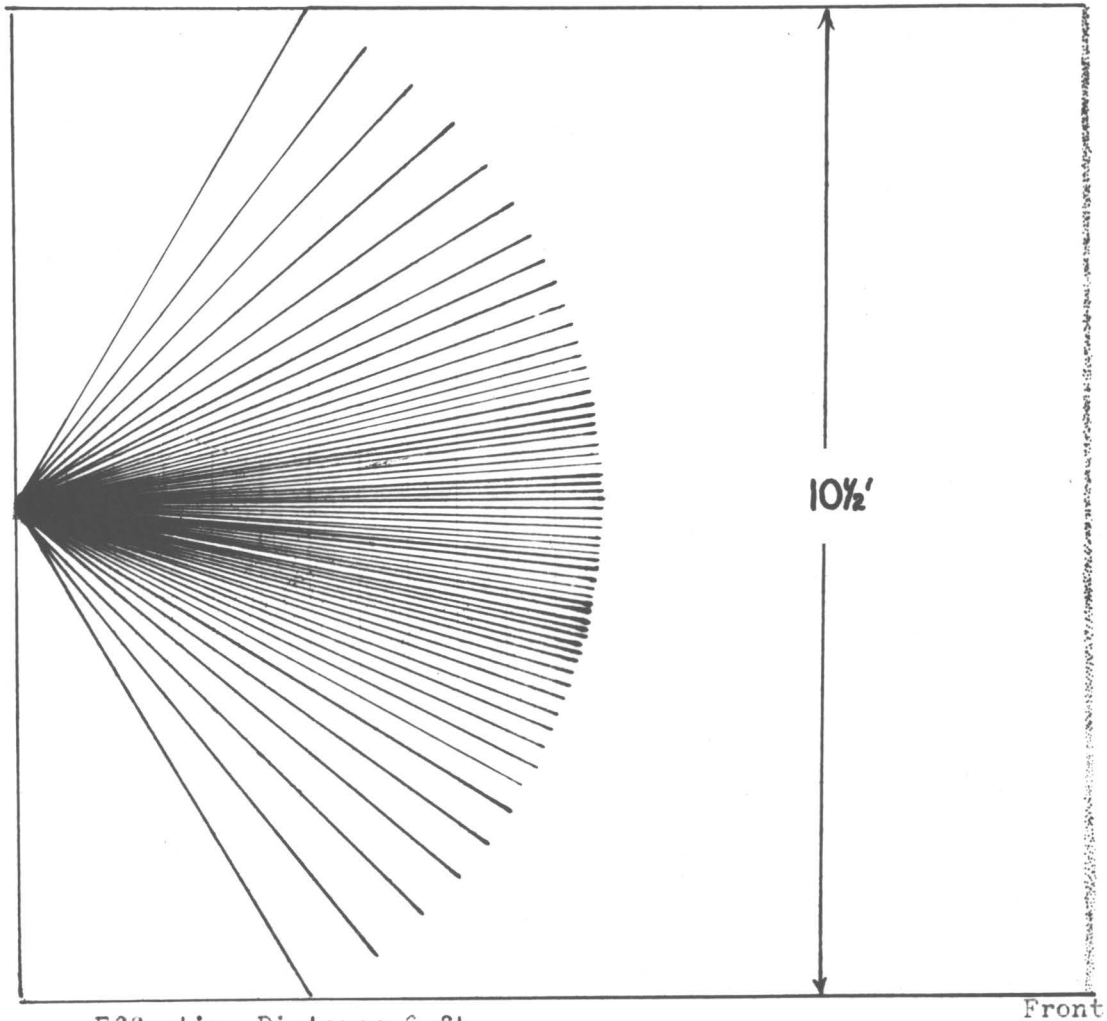
Scale 1"= 1'

Effective Distance 5 ft.

Front

BEAN CLIPPER
(1/2 open)

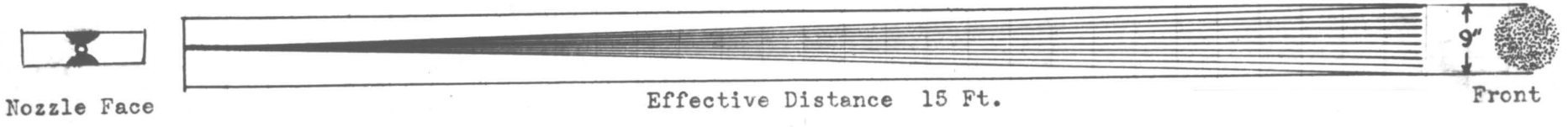
Nozzle Face



Effective Distance C ft.

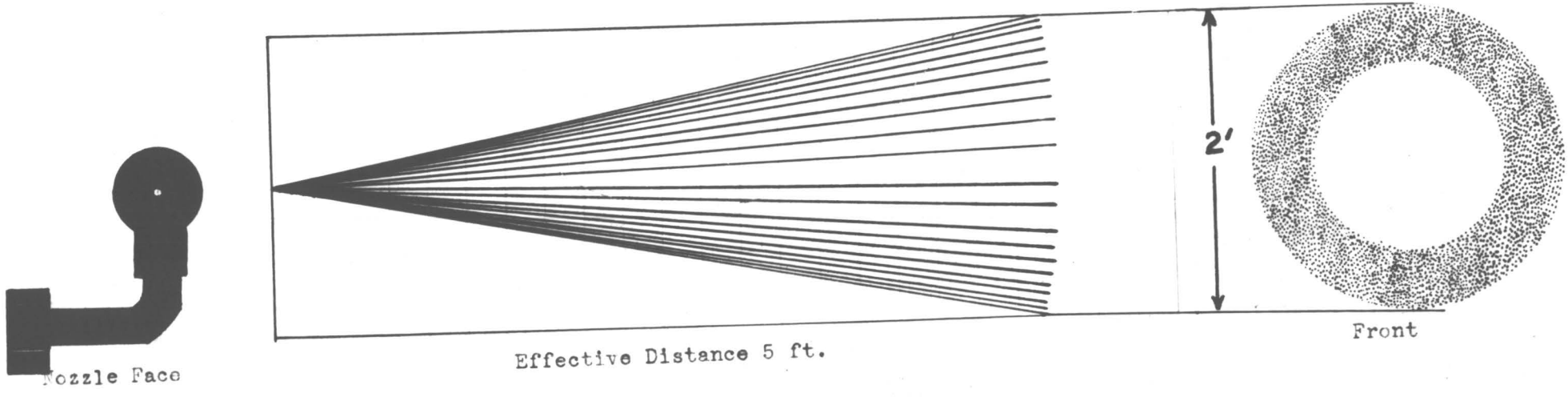
Scale 1/2" =1'

BEAN CLIPPER
(Full Open)



Scale 1/2" = 1'

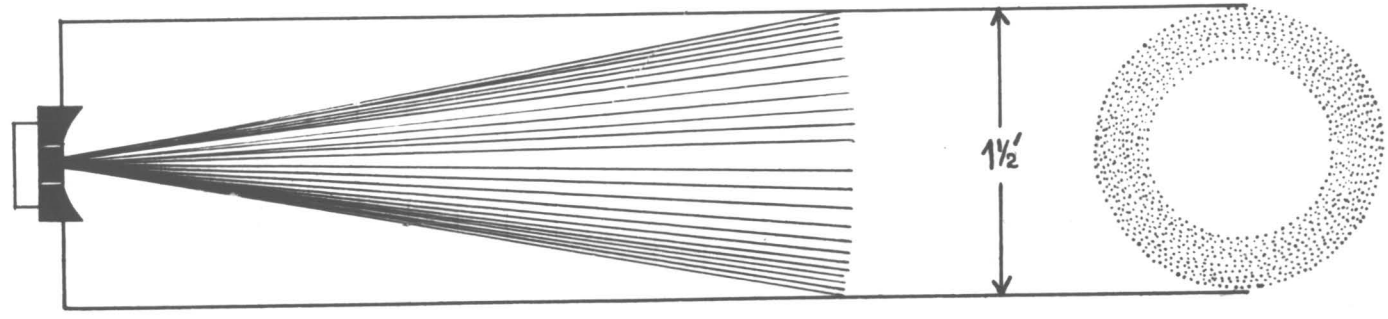
VERMORAL
(No. 4 disc)



Scale 1"= 1'

WEED NOZZLE

Nozzle Face



Effective Distance 4 ft.

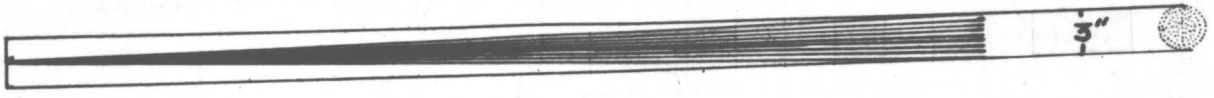
Front

Scale 1" = 1'

Hardie Adjustable
(No. 2 disc)

Nozzle Face

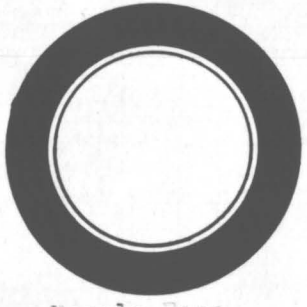
OPEN



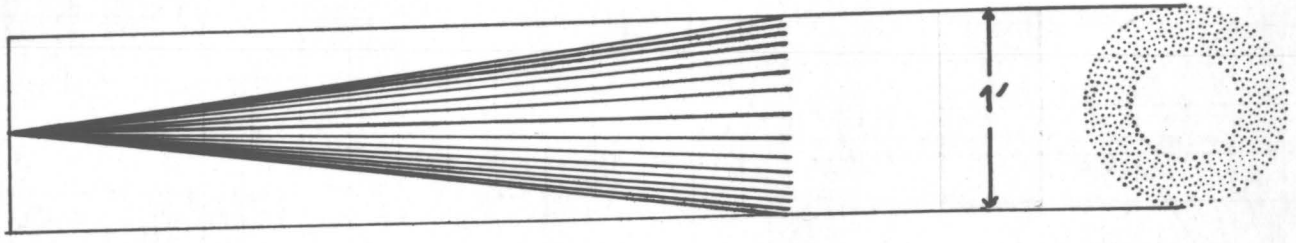
Effective Distance 5 ft.

Front

CLOSED



Nozzle Face

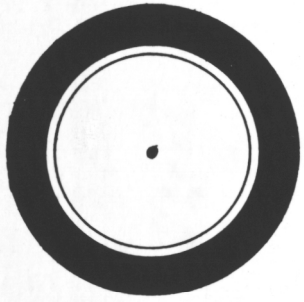


Effective Distance 4 ft.

Front

Scale 1" = 1'

MAYOR ADJUSTABLE
(No. 4 disc)



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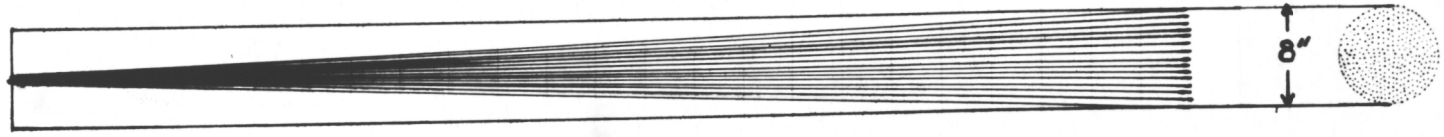
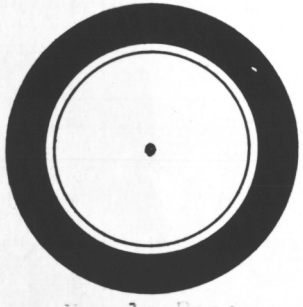


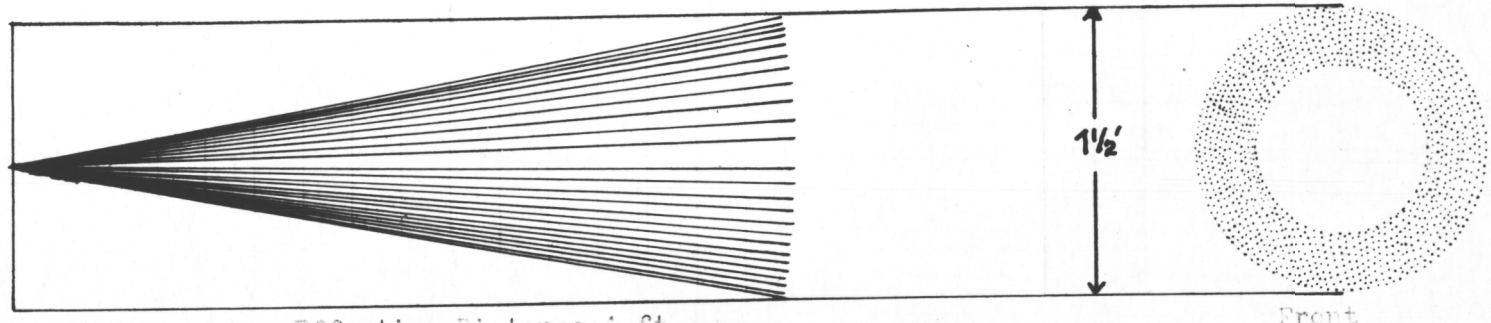
Effective Distance 6 ft.

Front

Nozzle Face

CLOSED





Nozzle Face

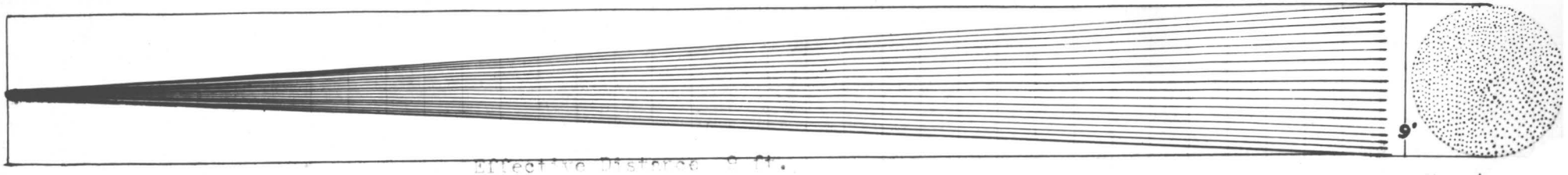
Effective Distance 4 ft.

Front

Scale 1" = 1'

NOZZLE ADJUSTABLE
(No. 6 disc)

OPEN

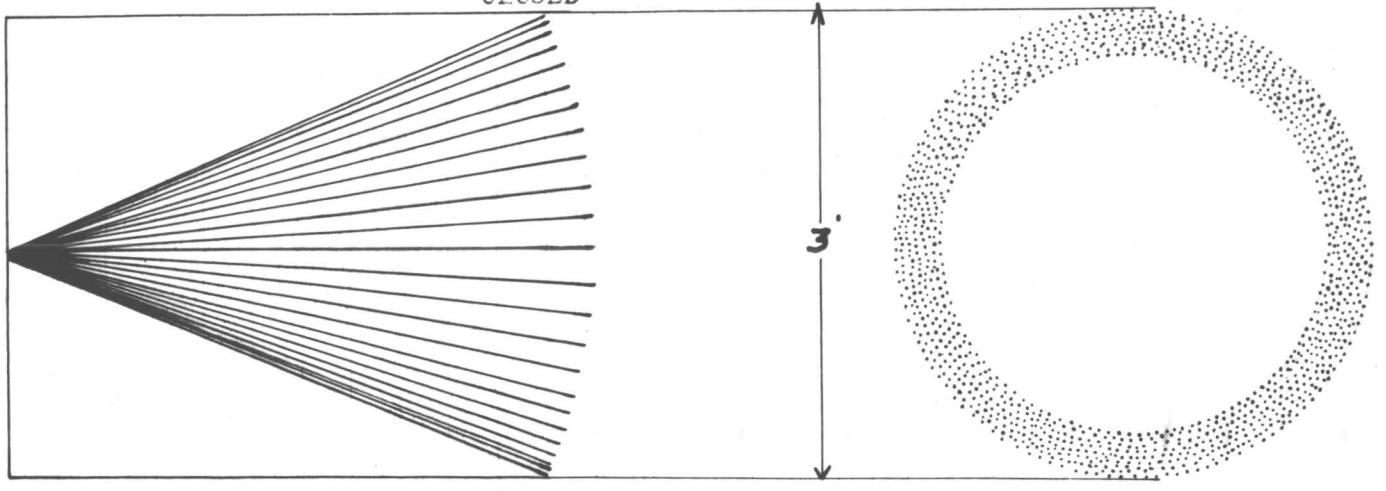


Effective Distance 9 Ft.

Front

CLOSED

Nozzle Face



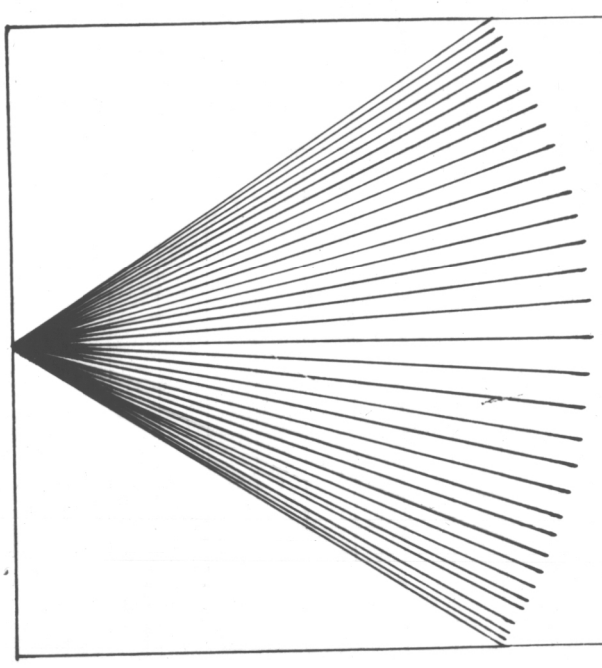
Effective Distance 3 Ft.

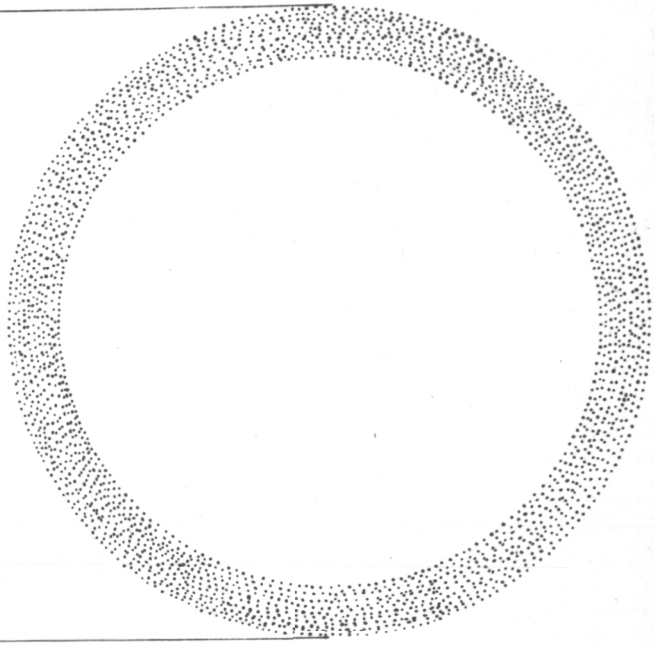
Front

Scale 1" = 1'

HARDIE ADJUSTABLE
(No. 7 disc)

Nozzle Face



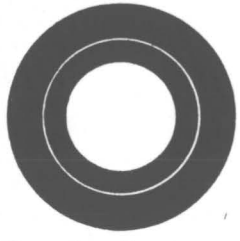


Effective Distance 3 ft.

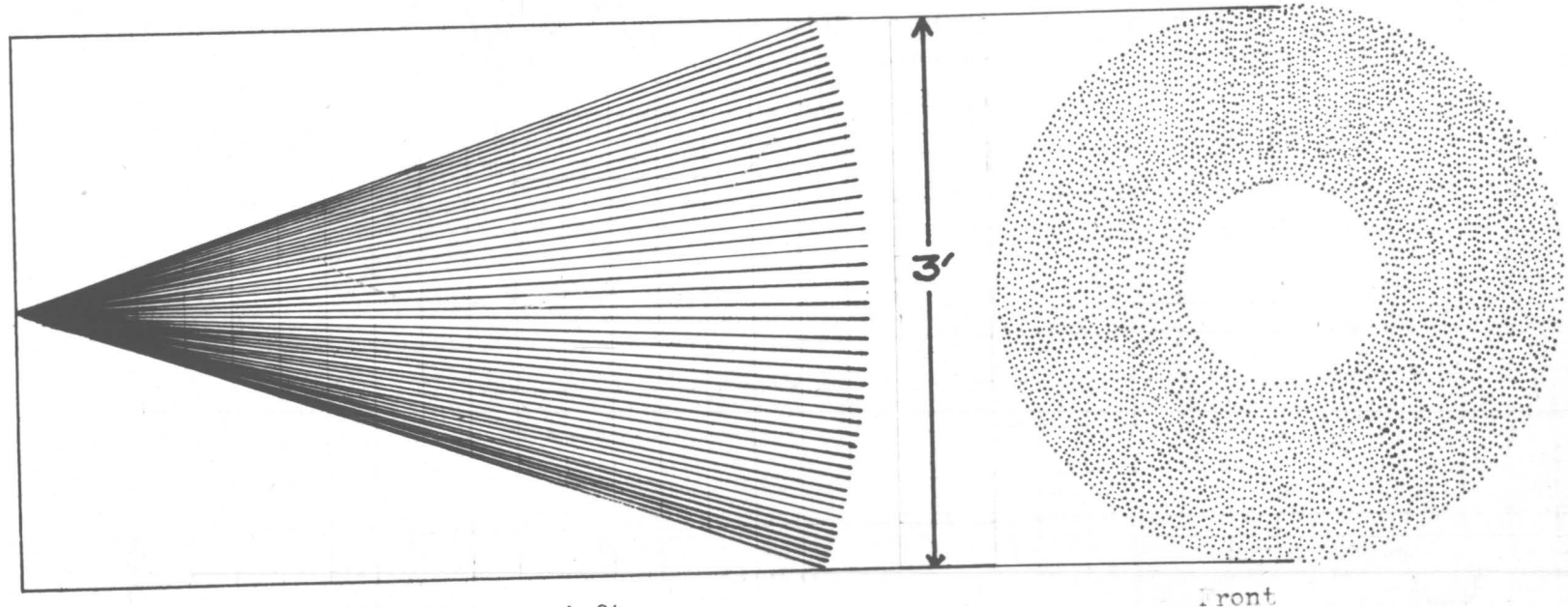
Front

Scale 1" = 1'

MAIDSTONE
(open)



Nozzle Face

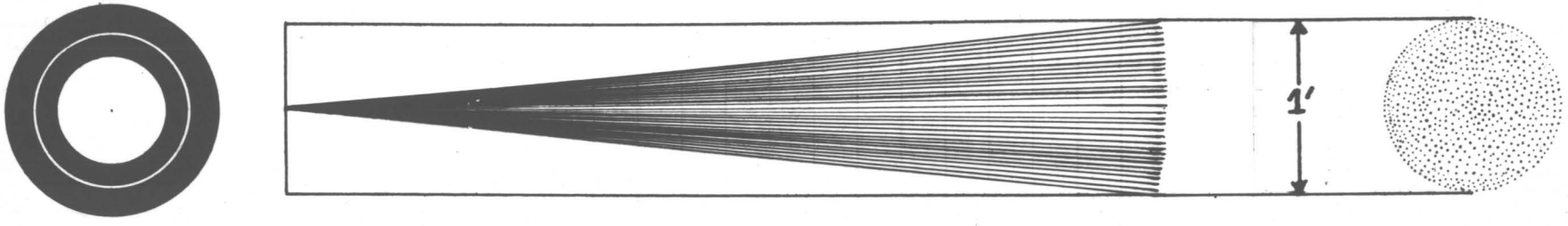


Front

Effective Distance 4 ft.

Scale 1" = 1'

MAIDSTONE
(closed)



Nozzle Face

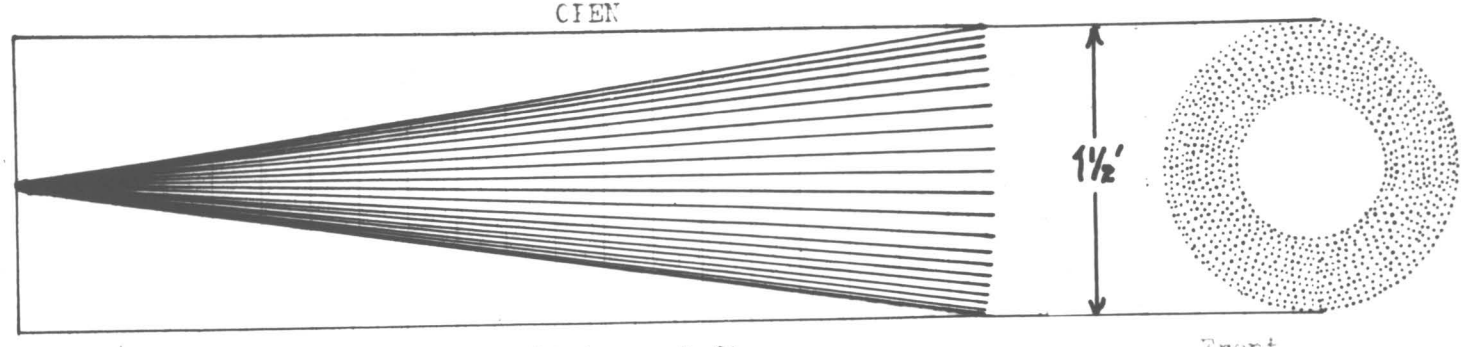
Effective Distance 10 ft.

Front

Scale 1" = 1'

NOBLOX

OPEN

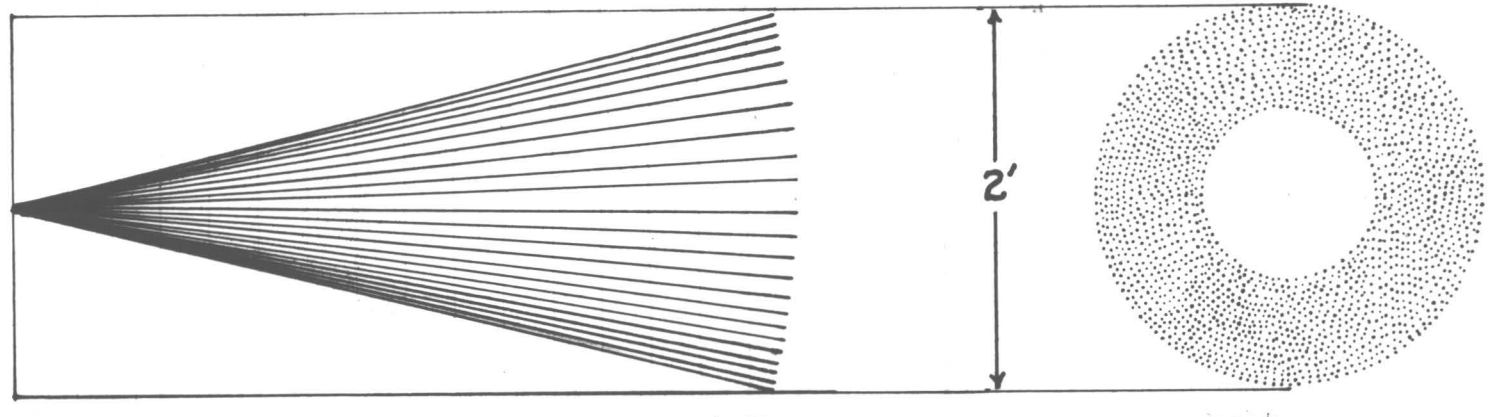


Nozzle Face

Effective Distance 5 ft.

Front

CLOSED



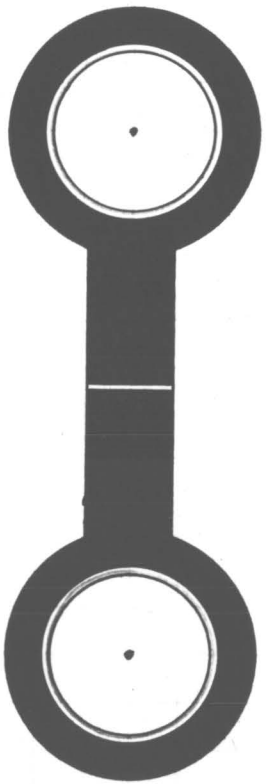
Nozzle Face

Effective Distance 4 ft.

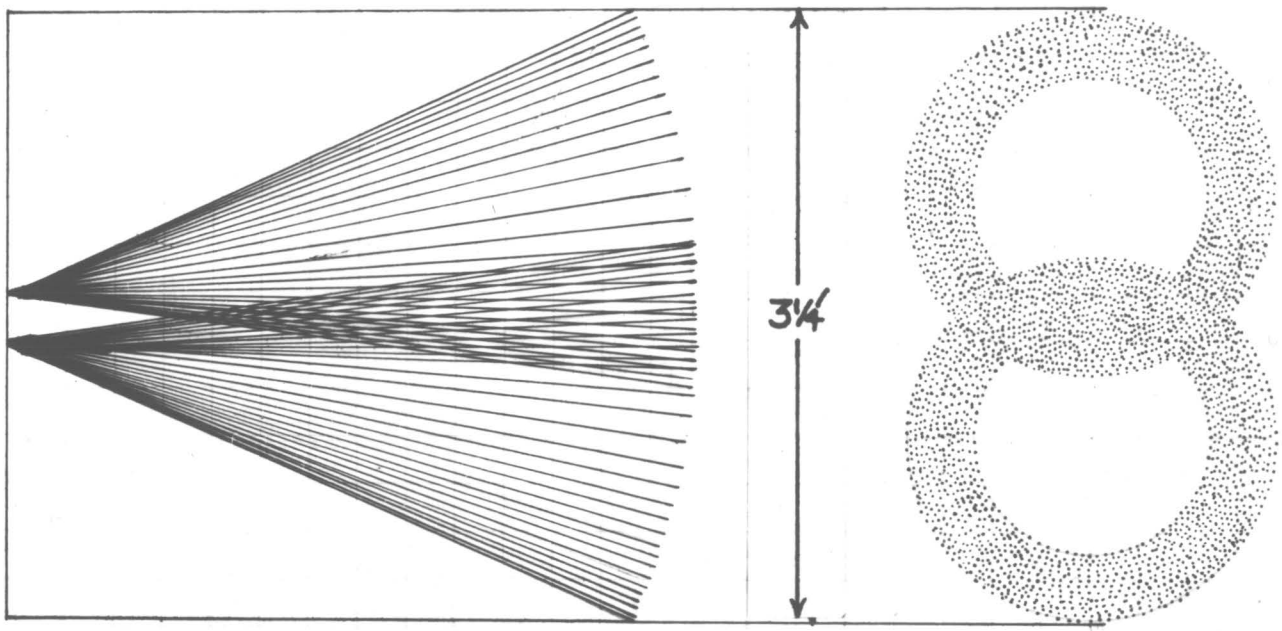
Front

Scale 1" = 1'

STRAIGHT VAIC NOZZLES ON STRAIGHT "Y"
(No. 2 disc)



Nozzle Face



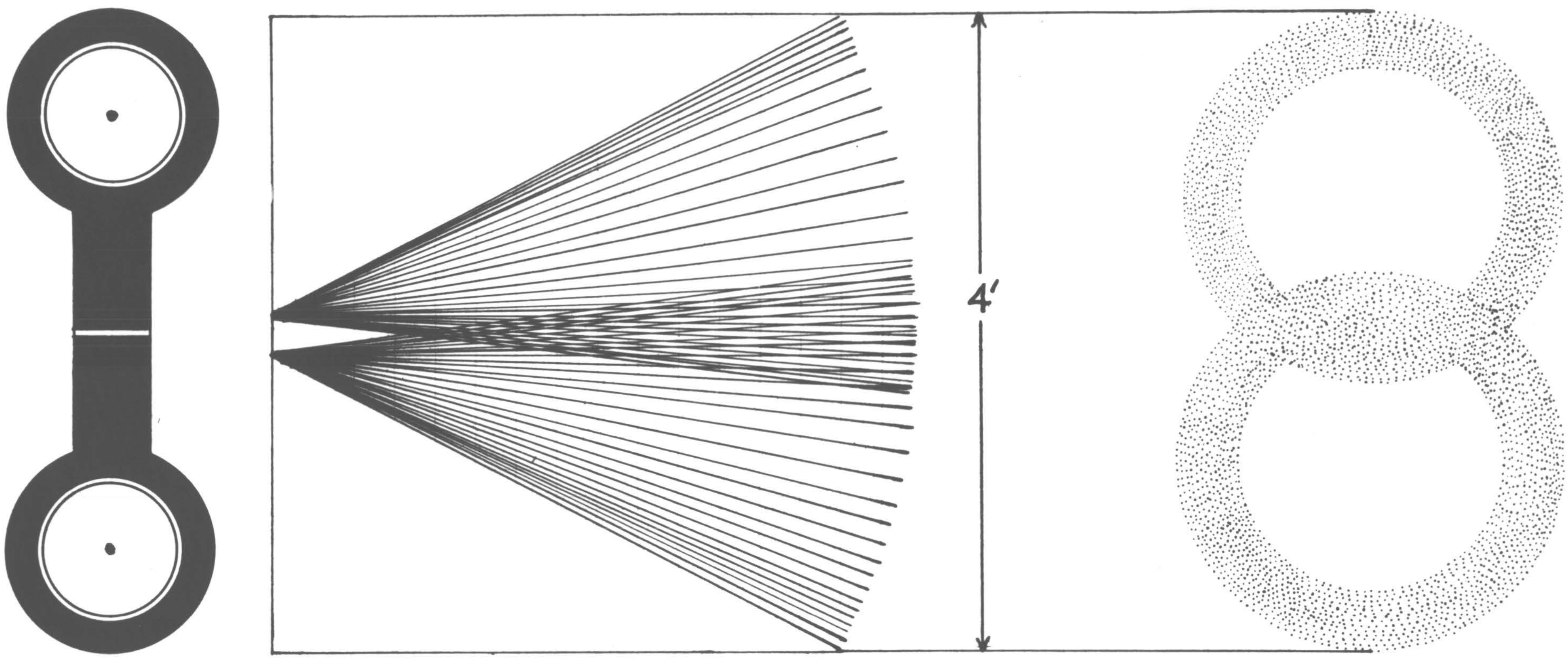
Effective Distance 3 1/2 ft.

Front

Scale 1" = 1'

STRAIGHT VEIC NOZZLES ON STRAIGHT "Y"

(No. 3 disc)



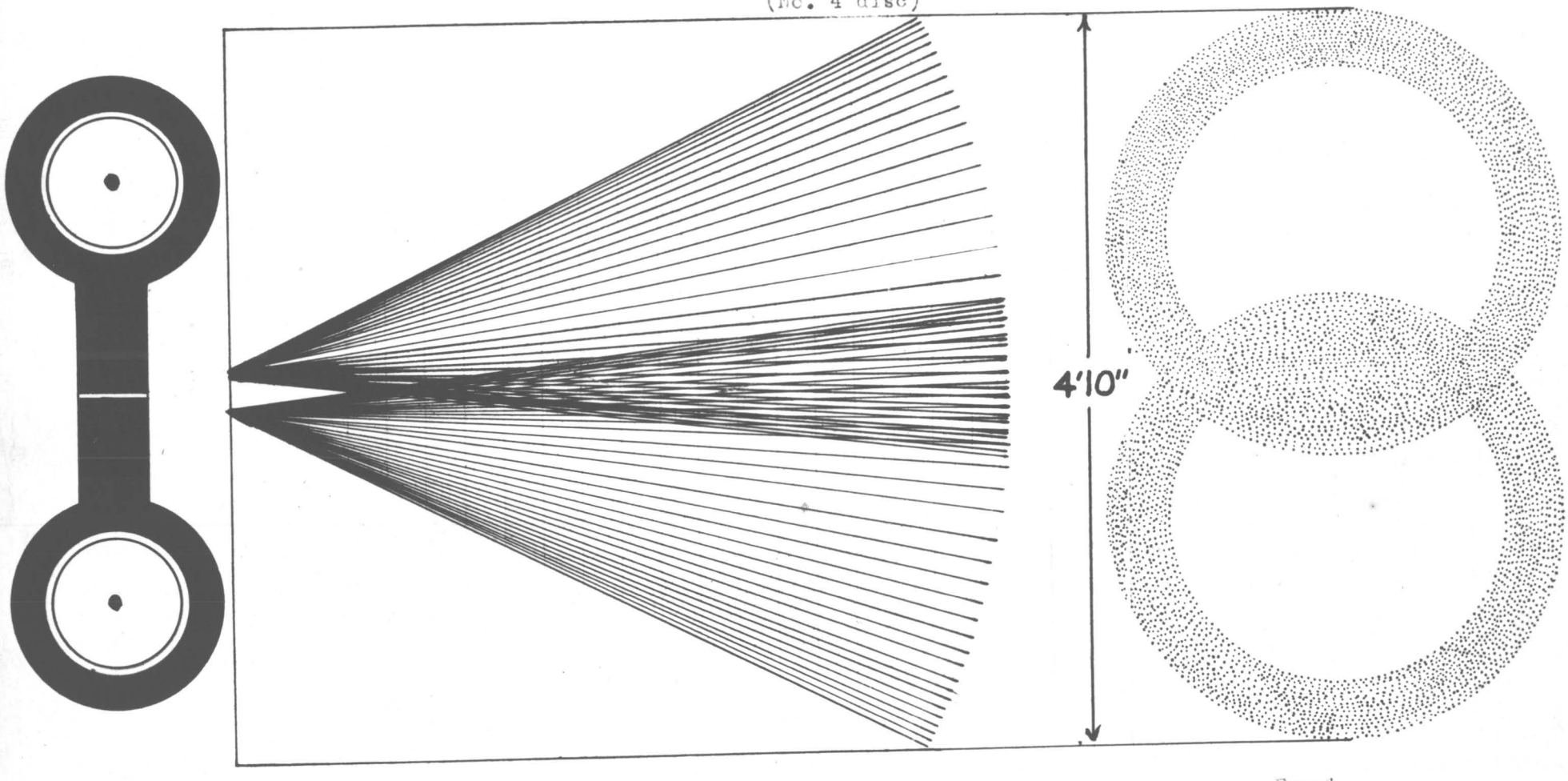
Nozzle Face

Effective Distance 4 ft.

Front

Scale 1" = 1'

(No. 4 disc)



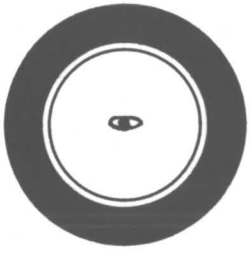
Nozzle Face

Effective Distance 5 Ft.

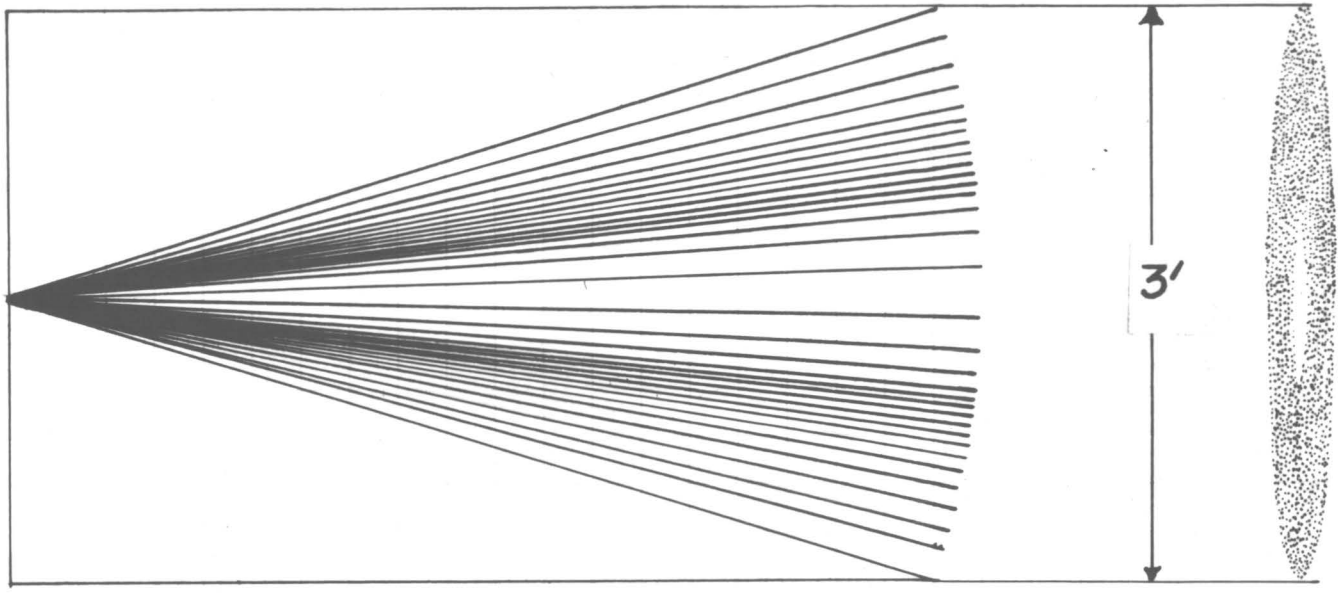
Front

Scale 1" = 1'

VAPO
(No. 3 welted disc)



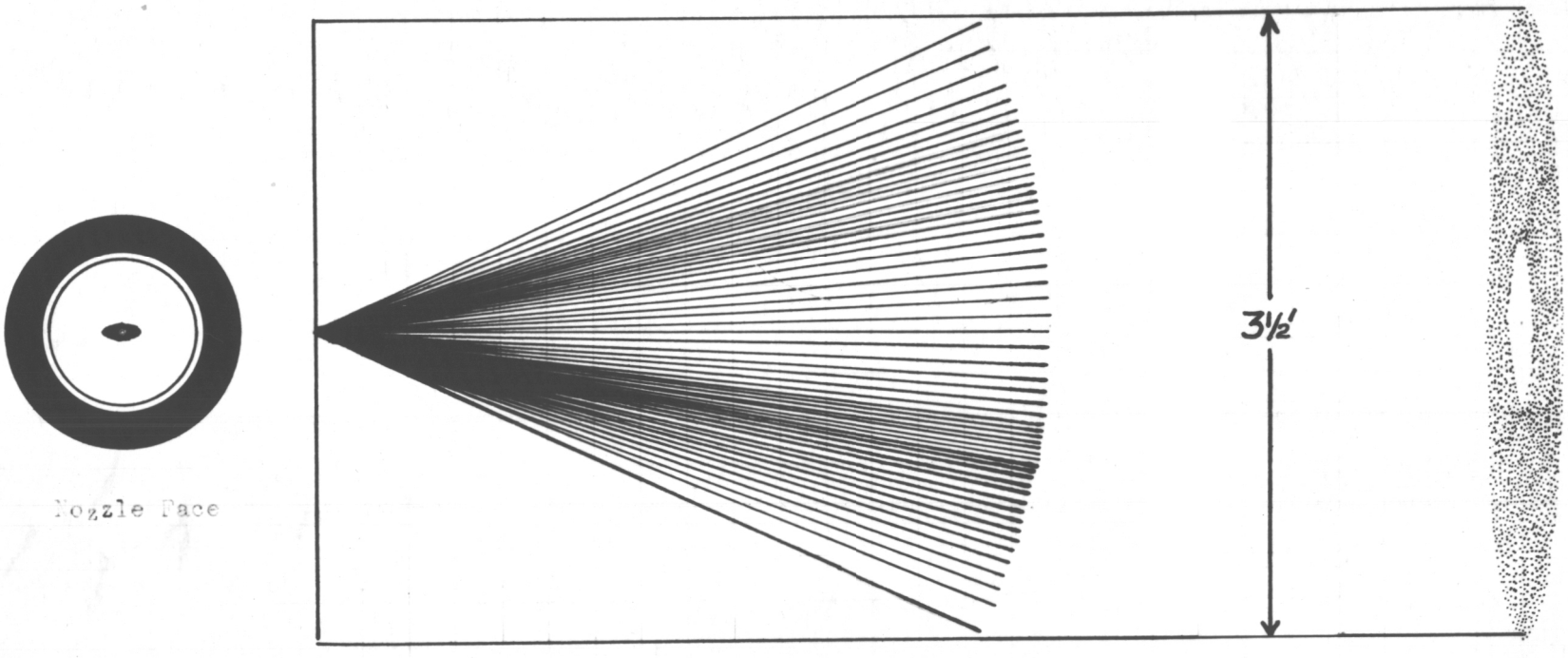
Nozzle Face



Effective Distance 5 ft.

Scale 1" = 1'

VAFC
(No. 4 welted disc)



Nozzle Face

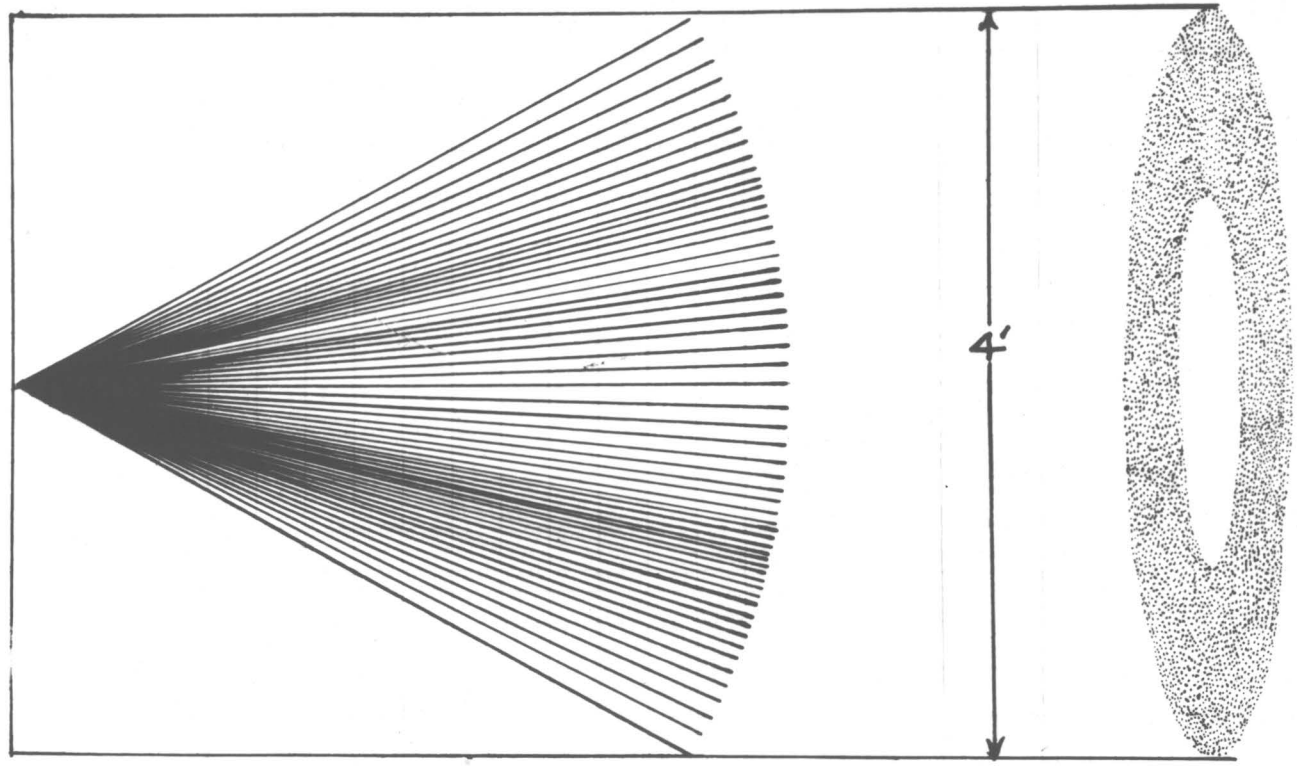
Effective Distance 4 ft.

Front

Scale 1" = 1'

VAFC
(No. 5 welted disc)

Nozzle Face

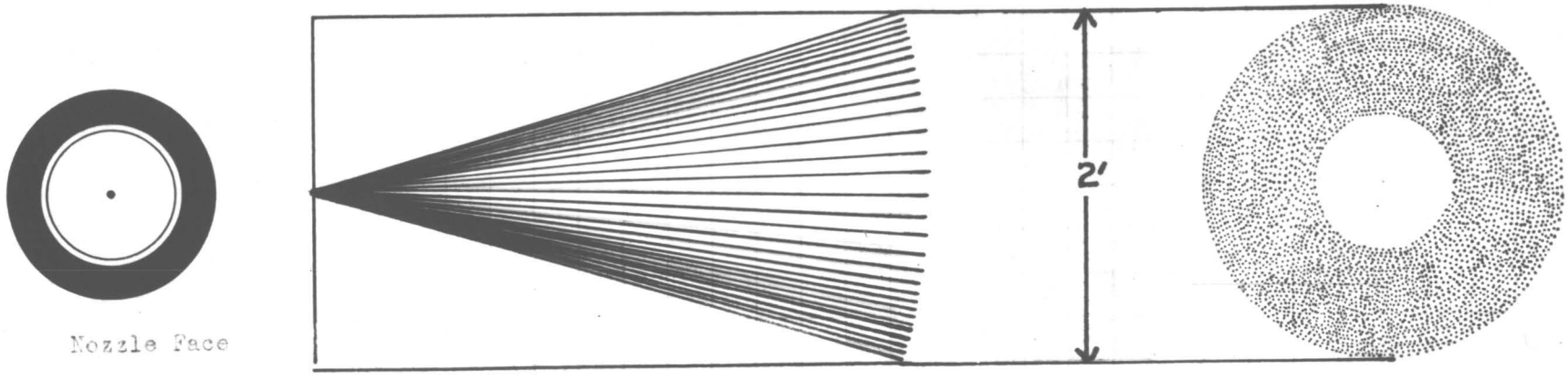


Effective Distance 4 ft.

Front

Scale 1" = 1'

VAPO
(No. 2 disc)

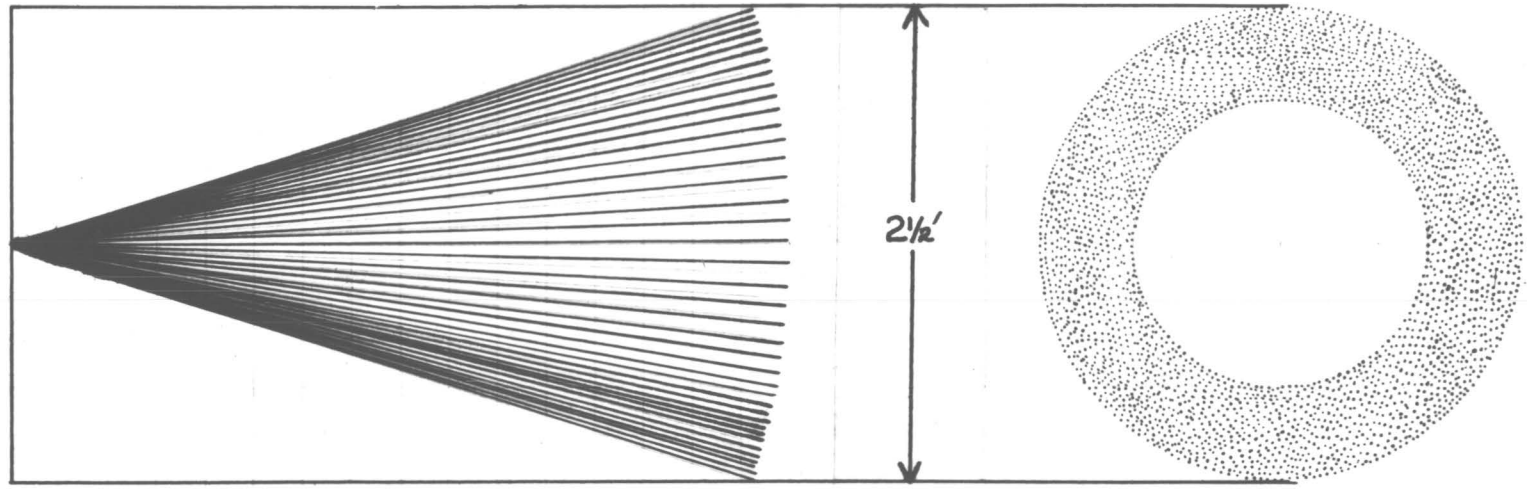


Effective Distance 3-1/2 ft.

Scale 1" = 1'

VAFC
(No. 4 disc)

Nozzle Face

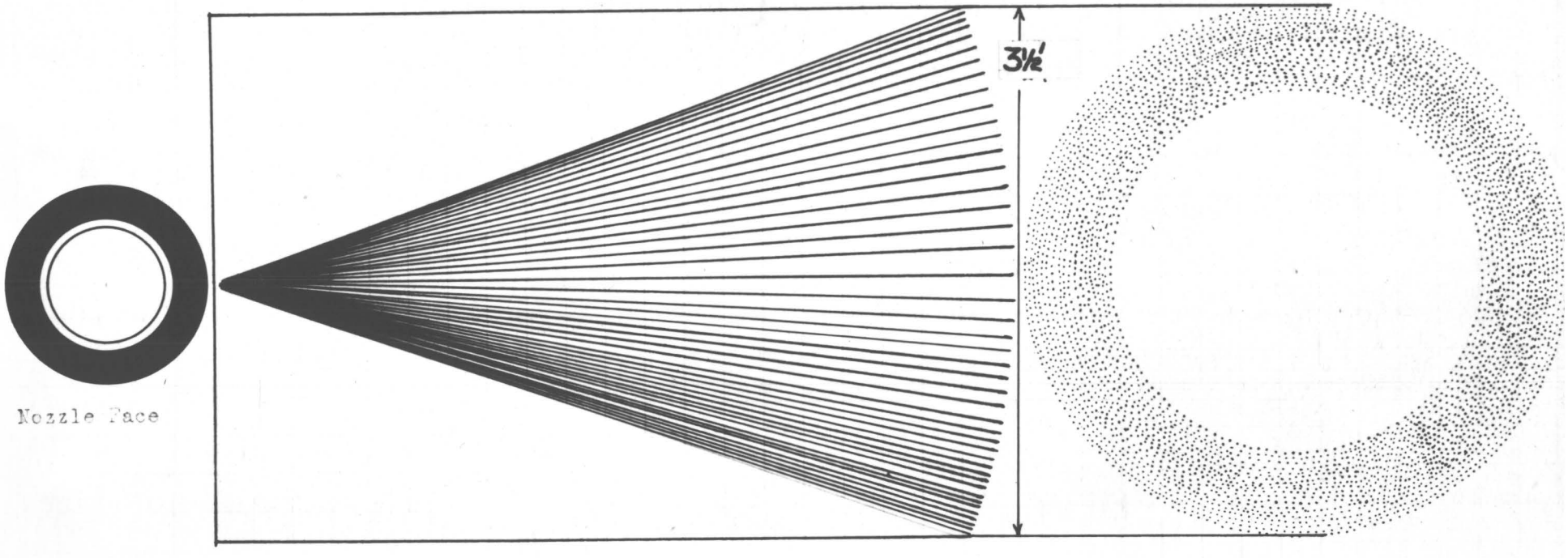


Effective Distance 4 ft.

Front

Scale 1" = 1'

VAPO
(No. 5 disc)

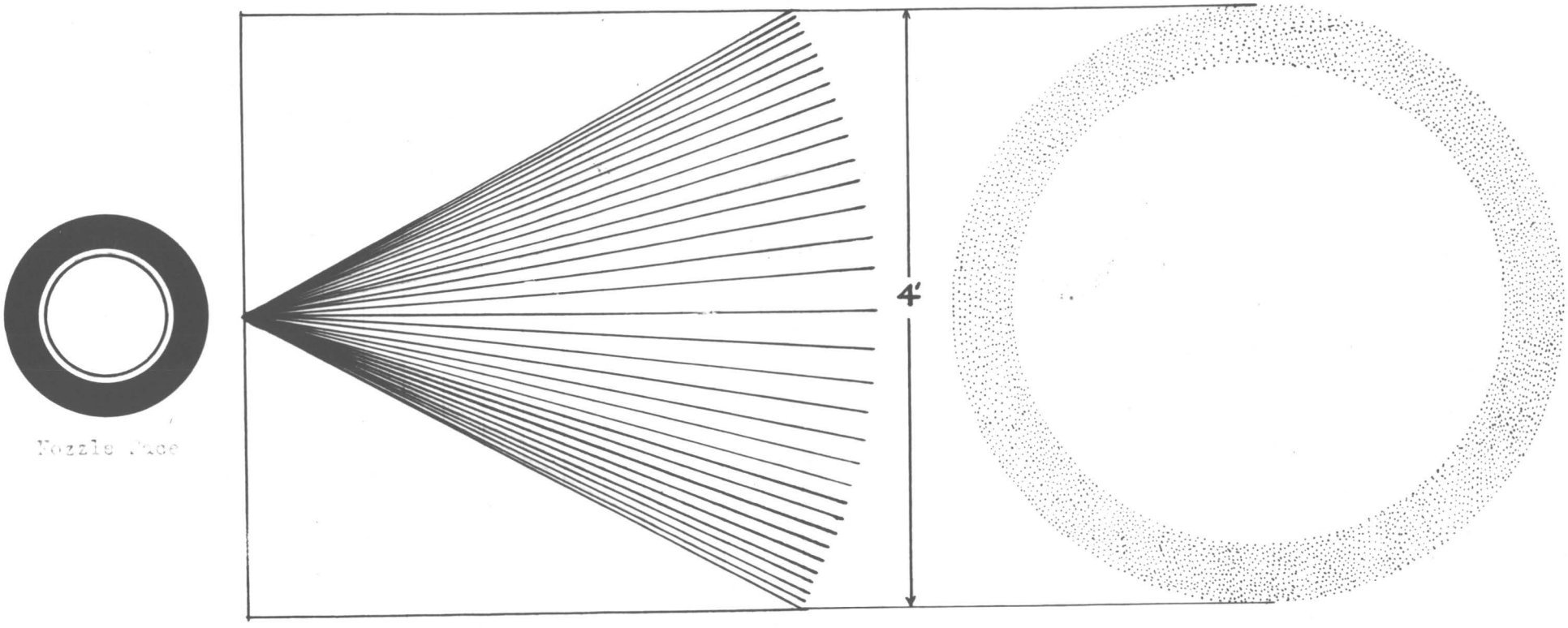


Effective Distance 5 ft.

Front

Scale 1" = 1'

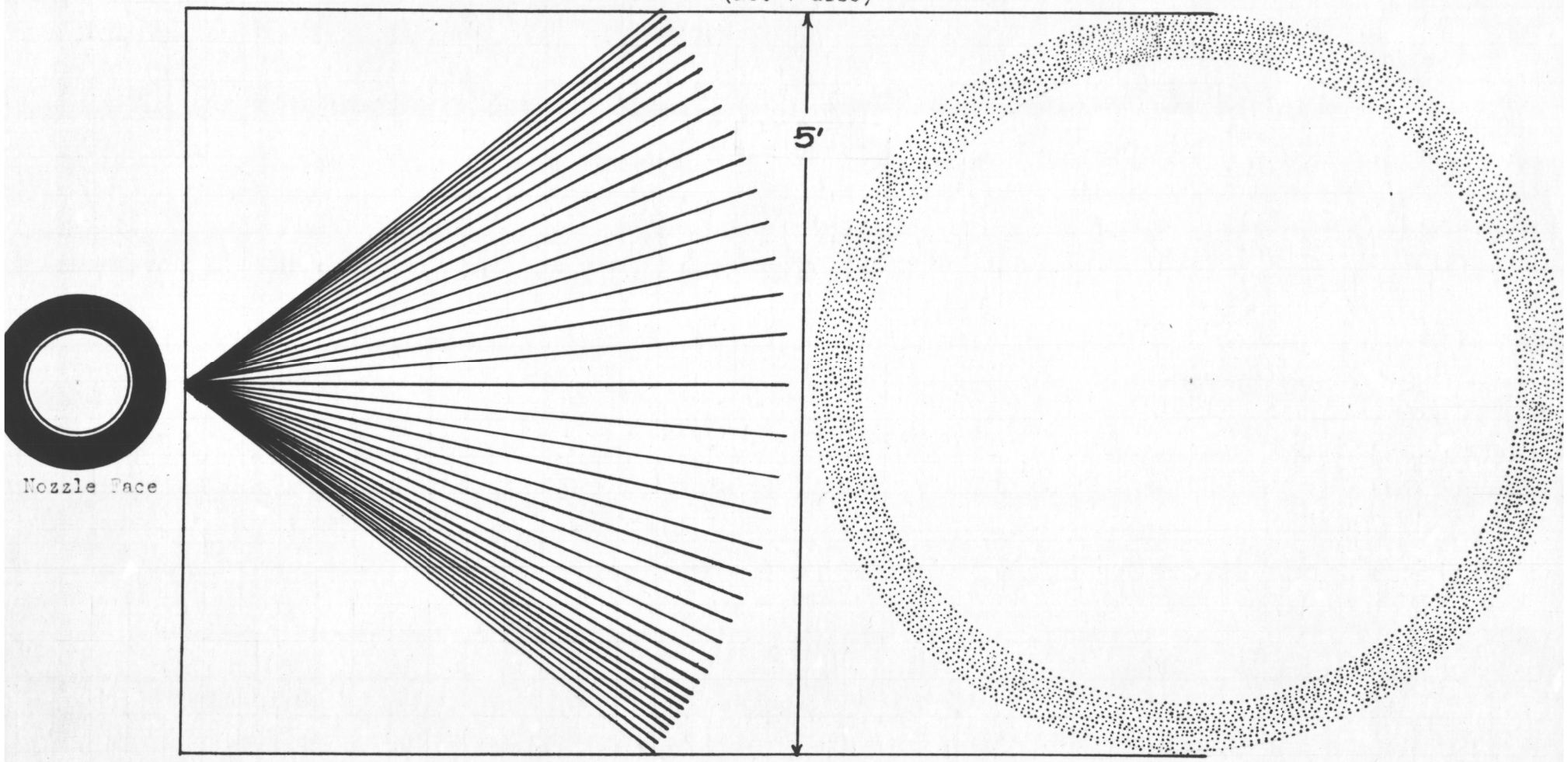
VAIC
(No. 6 disc)



Effective Distance 4 ft.

Scale 1" = 1'

VAFC
(No. 7 disc)



Scale 1" = 1'