

# New Air Powered Hand Duster

use of compressed air to fluidize dusts permits treatment of 7,000 square-foot-capacity glasshouse in less than half hour

Norman B. Akesson and R. H. Sciaroni

**Designed** for applying insecticidal and fungicidal dusts to indoor ornamental crops—but practical elsewhere—a new power duster is efficient in glass, plastic, cloth, and lath houses where narrow walkways are customary.

There are no particularly critical parts in the construction of the duster. Well-tinned sheet metal—so-called bright tin—appears to withstand the corrosive action of various dust materials.

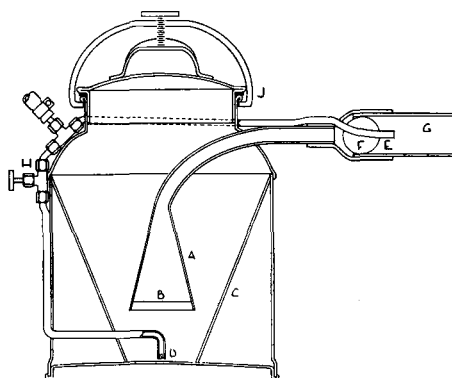
Two sizes of dusters have been made from one-gallon and two-gallon size milk pails. The one-gallon size holds about four pounds of clay base dust; the two-gallon size about 10 pounds. A lever-operated valve controls the air flow, and a small adjustable valve further regulates the air stream within the duster. Experience with given dusts indicates where the regulating valve should be set. The main lever valve then operates the entire machine.

The mobility of the duster is determined by the length of the hose connecting it to the air supply. Where a given fixed area is to be dusted many times, quick couplers for the duster hose attached to an air line can extend the range of the duster to any point desired.

Two of the new compressed air hand dusters are in use in San Mateo County. A rose grower with 90,000 square feet of glasshouse space has permanent air lines. Quick air couplers located at each glasshouse and about 200' of rubber hose allow operators to reach plants in any section. Dusting a 7,000 square-foot house requires about 20 minutes as compared to over one hour for liquid spray applications.

A carnation grower in Redwood City with 65,000 square feet of indoor growing area has satisfactorily used a compressed air hand duster for the past year.

The compressed air duster uses a fluidizing principle to control and maintain accurate dust discharge. The diagram in the next column shows the construction of the duster. The two cones *C* and *A* are made from tin funnels. The maximum diameter of the fluidizing—small—cone should be the same or slightly larger than the bottom or small end of the hopper cone. This should be about 2" for the rate of feed of 10 to 20 grams per second. A safety feature is incorporated at the lid by a sponge rubber



Section drawing of compressed air powered hand duster.

gasket *J* of  $\frac{1}{4}$ " thickness. Even though the screw cap is forced down tightly, this gasket will blow out if the feed tube or screen at *B* should plug. Because of the chances of plugging this tube, all materials to be put through the duster should be free of lint and lumps or else screened through a 12-to-16 mesh fly screen.

Fluidizing is accomplished in the compressed air duster by the controlled—valve *H*—flow of air through the tube *D* to the bottom of the hopper *C*. There the air is directed through four  $\frac{1}{16}$ " holes evenly spaced around the end of the tube, which is soldered shut so no air escapes through the end. This air fluidizes the portion of dust directly above it which in turn is forced into the inverted cone collector *A* and out the  $\frac{1}{2}$ " diameter discharge tube to the mixing venturi *G*. A 10-to-16 mesh fly screen *B* in the inverted cone prevents rapid or slugging flow of the dust. To provide more screen area, this screen can be formed into another cone inside cone *A*.

The air directed to the sides of the hopper cone *C* also has an important effect of agitating the dust. This aids in keeping the dust falling uniformly to the bottom. Air tube *D* can be brought into the bottom of the hopper rather than through the side if clearances at the bottom permit. The large cone *C* reduces the capacity of the milk pail considerably. Flow rates can be altered by increasing the pressure of air on tube *D*, but a rate of 10 to 20 grams per second appears to be suited to the usual dusting operation.

The air tube *E* discharges air at line

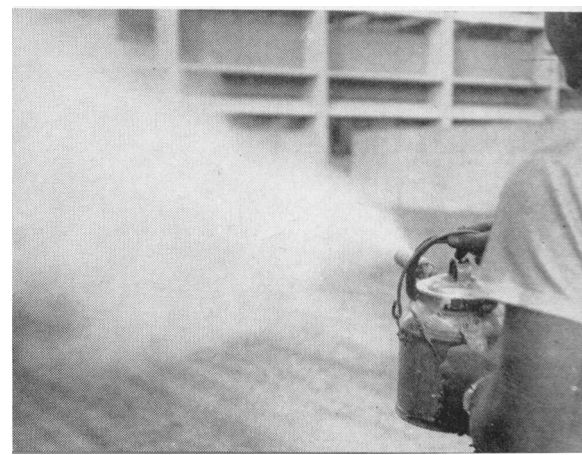
pressure to the venturi chamber *G*. Due to the action of the venturi, a large quantity of air is drawn through the two ports *F* and carried into the chamber *G* and discharged. The two ports, one on each side at *F*, were made the same diameter as the discharge opening at *G* or  $1\frac{1}{4}$ ". With an air tube *E* of  $\frac{1}{8}$ " inside diameter—so-called  $\frac{3}{16}$ " tube, which is the outside diameter—the total air discharged from *G* at 80 psi—pounds per square inch—line pressure is about 135 cfm—cubic feet per minute. Of this, 17 cfm comes from the compressed air tube and the remainder or about 118 cfm are drawn in through the ports. This quantity of air is many times over that which can be obtained from the usual hand powered duster.

When dusting materials are taken from the package, they feel hard and dense. But with a small amount of agitation, the energy for which may be supplied mechanically or by bubbling compressed air through the dust, the dust may be fluidized—entrain and hold air—which makes the dust behave much as a fluid. This fluidizing reduces the density by  $\frac{1}{3}$  to  $\frac{1}{2}$  depending on the particle size of the dust. The finer the dust is ground, the greater is the density reduction. Fluidizing thus is a means whereby a very fine particulate material may be expanded with air and made to behave physically as a liquid. Density is reduced and viscosity or internal shear becomes greatly lessened and more nearly constant. Under these conditions, it becomes possible to move the dust, mix, and discharge in an air stream at a chosen nearly fixed rate.

The graph to the left on the next page

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Duster in operation showing expanding dust cone. With 80 pounds jet pressure the cone is about six feet in diameter at 15' downstream.



# DUSTER

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indicates the nature of the air discharge pattern as obtained at various pressures. Both air discharge and velocity are increased by increasing pressure on the air tube. Increasing the air discharge alone by using a larger air tube will increase the distance the dust is carried also but not so rapidly as for the pressure increase.

The first table below shows the air

Tube Nominal OD*	ID**	Pressure on tube	Discharge in cfm***
1/8"	0.065" or #51 drill	20	1.2
		40	1.7
		60	2.3
		80	3.0
3/16"	1/8" drill	20	5.7
		40	9.5
		60	13.0
		80	17.0
1/4"	0.19" or #11 drill	20	12.7
		40	20.7
		60	29.0
		80	36.0
Fluidizing tube 4-1/16" holes. Radially in 3/16 tube.		10	2.5
		15	3.25
		20	4.0
		25	4.6
		30	5.25

\* Outside diameter. \*\* Inside diameter.  
\*\*\* Cubic feet per minute.

Hose ID	Pressure at start	Free air (cfm) through 25' hose plus couplings					
		5	10	15	20	25	30
1/4"	25	9.7					
	25	1.0	4.5	8.1			
	25	.42	1.6	3.5	6.0	9.2	13.0
3/8"	50	5.0	20.0				
	50	.5	2.1	4.5	7.8	12.0	17.0
	50	.22	.86	2.0	3.3	5.0	7.0
1/2"	75	4.5	15.0	35.0			
	75	.45	1.6	3.5	6.0	9.4	13.0
	75	.19	.66	1.5	2.8	4.0	5.5
3/8"	100	2.6	10.0	22.0	40.0		
	100	.3	1.2	2.5	4.3	7.0	10.0
	100	.1	.5	1.0	1.7	2.5	4.0

Values above are approximate and are for 25' of hose.

discharge in cfm from three sizes of copper tubing 6" long and at various pressures on the tube. When hose is used to carry the air from the compressor to the duster, the inside diameter of the hose must be kept consistent with and large enough to keep the pressure up at the duster. The lower table in the first column shows the pressure drop which will occur when different-size hoses are used to carry various volumes of air.

The horsepower to operate a compressor at these pressures and discharges is shown in the table in this column. A three horsepower electric motor would handle the job—17 cfm at 80 psi—but if a gasoline engine is used, at least 25% additional capacity should be provided to insure long engine life.

The table to the right lists the various formulations of dusts and wettable powders that were tested in the duster. The densities indicated in pounds per cubic foot are bulk or bagged density. The microphotograph in the next column is one taken to determine, if possible, the reason for the variation in flow rates found with different materials.

Friarite clay diluent flowed the easiest of any of the materials, while the flowers of sulfur and the vermiculite diluent were the hardest to make flow. Part of this can be attributed to the density of the clay Friarite which evidently increases its flowability over the vermiculite. However, the structure or shape of the materials and their relative sticki-

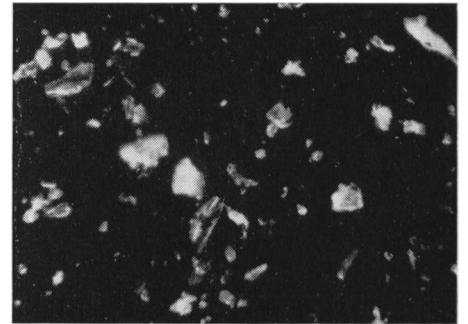
Horsepower Required to Compress Air at Volume Rate (cfm) and Pressure (psi) Indicated. Compressor Efficiency of 82% Assumed

Discharged cfm psi pressure	10	15	20	25	30
	25	1	1.5	2	2
50	1.5	2	3	5	5
75	2	3	5	5	5
100	2	3	5	5	7.5

Electric motor size indicated. For gasoline engine, approximately 25% greater horsepower is needed.

ness seem to be of great importance. The flowers of sulfur are not as finely ground as the others which also might alter the flow rate. However, the tendency of the flowers of sulfur to cling together is probably the greatest single cause for its poor flowability.

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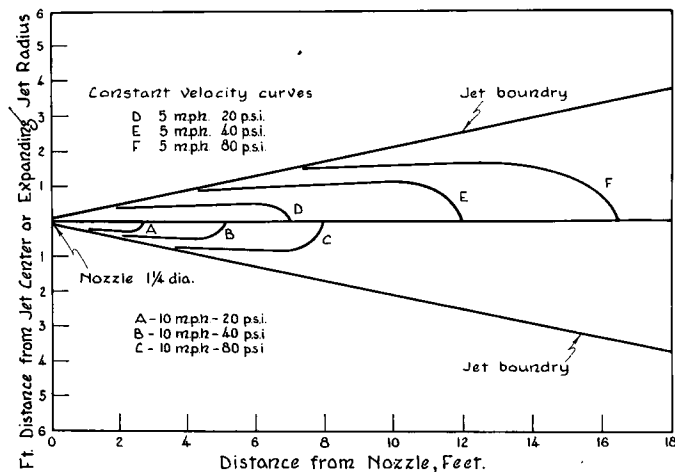


Photomicrograph of a 5% chlordane dust. Note the table below.

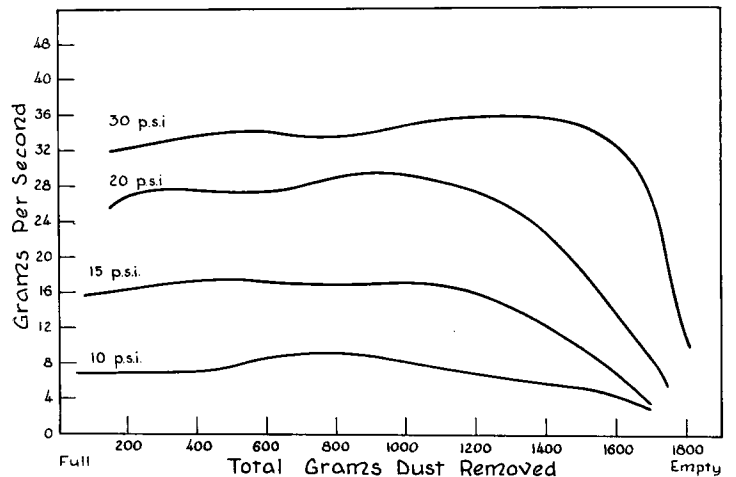
Physical Characteristics of Certain Typical Agricultural Dusts and Wettable Powders

Material	Density lbs/cu. ft.	Approx. particle size (microns)			Particle shape
		Max.	Min.	Ave.	
Friarite clay	63	60	2	5	Short, sharp crystal
Special dust 40% less than 40 microns	60	20	.01	2	Short crystal
Vermiculite 325 mesh	16	40	.1	8	Platelike crystal
5% chlordane	55	40	.1	5	Short crystal
Sublimed flowers of sulfur	40	15	2	10	Round balls stick together
10% DDT 50% sulfur	43	50	2	5	Short crystal
95% wettable sulfur 3 brands	52	40	.1	5	Short crystal

Air Discharge Pattern and Velocities. The lines show the pattern of the expanding jet and the curves the velocities for three jet pressures downstream from the nozzle.



Dust Discharge vs. Quantity of Dust in the Hopper. This indicates the relative uniformity of a clay dust flow, from full to empty hopper.



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## DUSTER

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The most commonly used diluent is the clays. These have bulk densities of 50 to 60 pounds per cubic foot. They are finely ground to an average of five microns particle diameter. Their crystalline structure makes them very abrasive to equipment—the vermiculite seems to have a lubricating quality. The amount

of active chemicals as DDT, chlordane, or other applied to the clays seems to alter the flowability also; the heavier the concentration the more sticky was the dust. No difference was observed between wettable powders and dusting materials as regards flowability. The tendency to use higher concentrated materials on wettables may cause trouble in some cases.

Wetting agents were not noticeable, probably because very small amounts are actually present in any formulation. Because wettable powders may have higher concentrations of active chemical, it is well to be sure this higher amount will not cause damage to the plants being treated.

In actual commercial practice, it has been found that the wettable powder

insecticides and acaricides—25% malathion, 25% diazinon, 50% DDT, and 15% aramite—were not injurious to common varieties of glasshouse carnations. The wettable powders of the fungicides Captan and Zineb also were applied to carnations with no harmful effects. With glasshouse roses, the 50% wettable powder of the insecticide DDD produced no injury on the varieties Red Delight, Happiness, Rome Glory, Better Times, and other commercial types. In all cases, the same total amount of actual chemical was used on plants in a given area that formerly was applied in a water spray.

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Germain's, Inc.	9 lbs. grass seed
For turfgrass culture research	

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For turfgrass culture research	
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For turfgrass culture research	
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