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SUFFIELD MEMORANDUM NO. 56/70

A SIMPLE SMALL PARTICLE DISPENSER (U)

by

J.P. Bitz and M.G. Dudley

PROJECT NO. 20-20-32

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ABSTRACT

A device for the continuous emission of small particles is described.

RÉSUMÉ

Un dispositif pour l'émission continue de petites particules est décrit.

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INTRODUCTION

The DRES Meteorological Section has carried out trials on the diffusion of small particles in the atmosphere for a number of years. The particulates used have frequently been glass micro-spheres coated with fluorescent dyes. In various trials spheres of nominal diameters of 25μ 50μ, and 100μ have been used. In previous continuous source trials, with a desired emission of some tens of grams over an emission period of from 10 minutes to a half hour, an endless belt dispenser was used (Fenrick, 1957). This device proved quite satisfactory for 100μ particles but for smaller sizes there was a tendency for the particles to enter the bearings where they behaved like fine sand.

Various types of small particle dispensing devices are available commercially, however many of them have certain disadvantages.

The design and method described in this memorandum employs an entirely different concept and has several advantages over existing devices. These are:

(1) simplicity in design and operation, no moving parts and readily cleaned,

(2) more uniformity and consistency in output,

(3) less danger of malfunction when subjected to adverse climatic conditions.

DESIGN AND CONSTRUCTION

A piece of 100 mm diameter "Pyrex" brand glass tubing was chucked in the headstock of a glassblowing lathe and the outer end was closed off and squared. A small hole was then blown in the centre of the squared tube end and a piece of 10 mm tubing previously placed in the tailstock of the lathe and removed in the final piece was sealed to it. The flame was then repositioned approximately 40 mm back from the squared end and the tubing was expanded to 125 mm. The other side of the tube was then squared off and shaped with a carbon paddle. A ₮ 24/40 joint was then sealed to the unit and the air inlet was fabricated from a piece of 9 mm O.D. tubing as shown. Note the flattened expanded opening at the bottom of the tube. It is most important that the air inlet tube is positioned correctly both for height and centre since this type of construction directs the air at the particles to produce effective agitation. In addition an indentation was placed on the opposite side of the air inlet tube to prevent most of the particles from going directly up into the venturi opening.

The venturi was constructed from a piece of 13 mm O.D. tubing with a 10 mm O.D. side arm and a male ₮ 24/40 joint. This assembly was positioned in the female ₮ 24/40 joint and an air line attached. The air pressure, usually from 1 to 10 psi, and the size of the side arm opening in the venturi will have a direct effect on the output of the unit.

OPERATION

In use a weighed quantity of the material to be dispersed is placed in the flask and the flask is attached to a mast at the emission height desired. Air from a cylinder of compressed air is brought through a reduction valve, giving controllable pressure, to a pipe leading up the mast. The pipe goes to a Y-junction. A tube leads from one arm of the Y-junction to a glass orifice, which acts as a fixed throttle, and thence to the inlet end of the nozzle in the side of the flask (see figure). The flow from the nozzle produces chaotic turbulence inside the flask so that the particulates are kept in suspension. The choice of orifice used determines the emission rate for given particulate and for given pressure head. The tube from the other arm of the Y-junction goes directly to the inlet of the venturi tube; the flow through the venturi draws air from the flask at a constant rate and discharges it to the atmosphere. In operation the pressure is turned on at a given signal, emission proceeds for a specified time, and the air pressure is then turned off to terminate the emission. The residual material in the flask is then weighed, allowing the amount of material dispensed over the emission time to be determined.

It is apparent from the description that the apparatus should, with a given pressure head and given orifice, deliver equal volumes of air in equal times. If the stirring action in the flask is sufficiently vigorous to keep all the material in the flask in suspension, it is to be expected that the rate of emission of the particulates will decrease with time approximately exponentially. To be able to justifiably treat the emission rate as reasonably constant it is necessary to charge the flask with much more material than it is intended to emit, say three times as much. The period of emission will then occupy only a short portion of the rate of emission curve. For example, in a typical diffusion trial the flask would be charged with 100 gms of glass spheres of 25μ mass-mean diameter, and a pressure of 1 psi would be used. This would give an emission of about 25 gms in 15 minutes, a suitable amount for good assessment.

In practice it has been found that there are sometimes problems due to condensation in the tubes. To avoid this it is necessary that the transportation agent be thoroughly dried before compression; to assure this it has been found convenient to use compressed nitrogen instead of air.

TRIAL RUNS

The device was designed with the intention of its being used in the trial series F.E. 590 (Johnson, 1969). It was therefore required that it be put into operation rapidly and, in consequence, there was no attempt to make elaborate tests of the output with various orifices and various pressure heads. The testing done was only sufficient to enable a combination of pressure and orifice sizes to be found which would be satisfactory for the immediate future.

One set of runs, performed in the laboratory, indicates the effect of change of orifice size. For the run, tabulated below, the outflow pressure of the reduction valve was 1 psi with compressed air being the working substance.

Orifice Size (litres/min)	Output of Particulates (gms/20 min)
21	5
27	15
30	15
34	18
36	30
50	42

To check the change in rate of emission with time, one 25-minute run was done under field conditions. The emission was interrupted at the end of each 5-minute period, and the micro-spheres remaining in the flask weighed. Using nitrogen as the working substance, and 1 psi pressure, with a 36 litre/min orifice, the first three periods gave outputs of 8.0 gms each, and the remaining two 7.5 gms, indicating only a slight departure from a constant rate of emission.

If the dispenser is to be used extensively, a more thorough testing could, and should, be made to determine the emission rate with various orifices and pressure settings. Also, longer runs could be made to determine exactly the departures from constancy of emission rate.

CONCLUSIONS

Although the output of this device as a function of air pressure, particle size, size of venturi side arm opening, etc., has not been fully investigated, by using various orifices a wide range of emission rates is available, and for the short emission periods, ∿15 minutes, the emission rate is virtually constant. The dispenser has been used with 25μ glass beads in a number of the trials of the F.E. 590 series and appears to perform satisfactorily.

REFERENCES

W.J. Fenrick, 1957. "A Regulated Micro Glass Sphere Dispenser", Suffield PMMP No. 73, UNCLASSIFIED.

O. Johnson, 1969. "Downwind Travel of Small Particles From Low Level Release Points", Suffield Memorandum No. 46/69, UNCLASSIFIED.

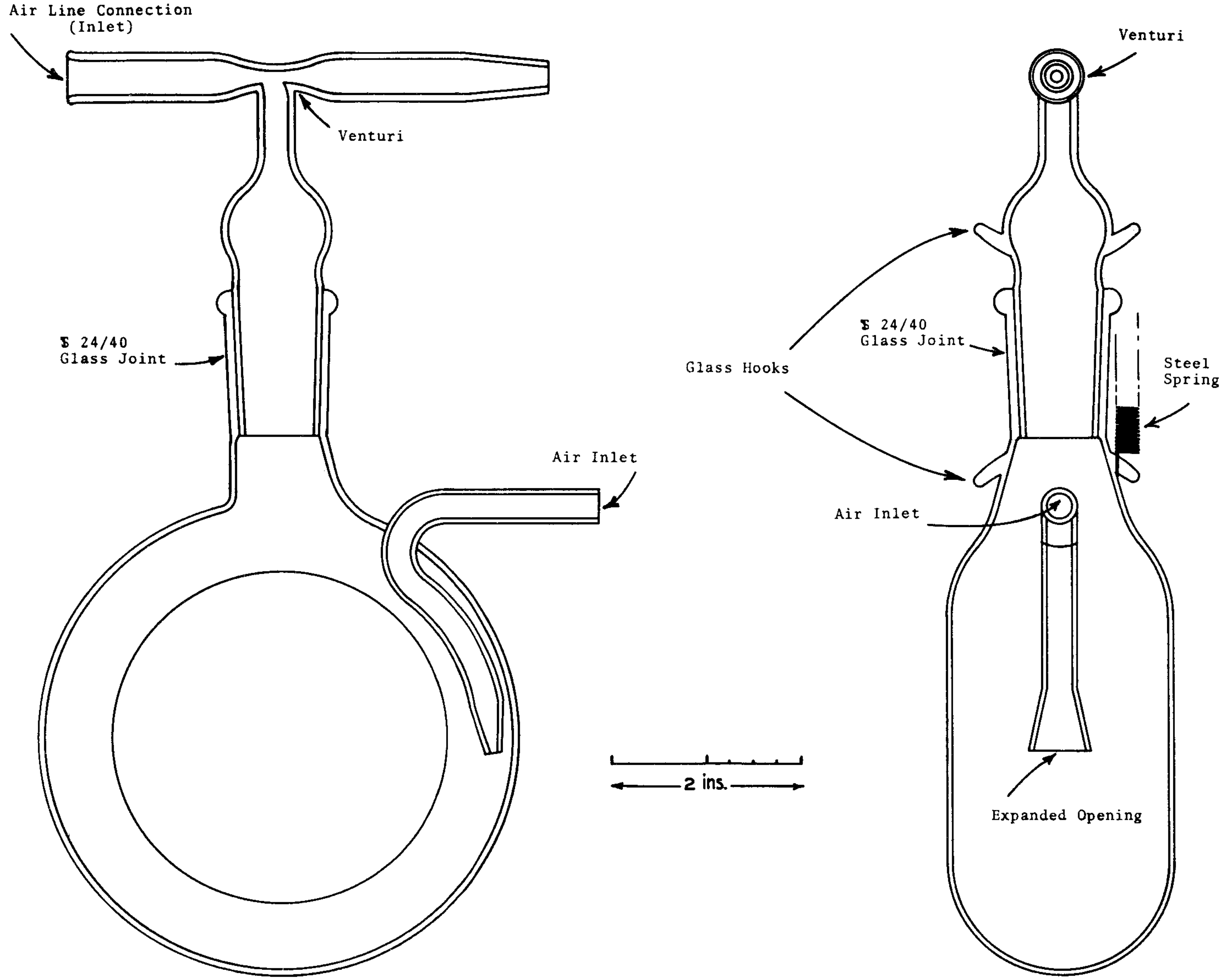

FIG. 1 A SMALL PARTICLE DISPENSER

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