

Modifications of the Wright Dust Feed Mechanism permitting stable dispersion of native ragweed pollen

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Conventional methods have not provided aerosols of suitable constancy. The Wright Dust Feed Mechanism was adapted to provide tractable pollen dispersion.

The continuous liberation of native (i.e., dry and non-defatted) pollens into air streams presents major problems which arise from their high compressibility, surface ornamentation, and lipidic coatings. As a result, conventional "dry dispersion" methods,¹ evolved primarily for use with mineral dusts, have not provided aerosols of suitable constancy.

These difficulties became manifest during efforts to study the effects of atmospheres, having defined physical properties and ragweed pollen levels, upon subjects during normal respiration. For this purpose, a 7 by 8 by 9 foot exposure chamber was constructed; pollen was to be dispensed directly into the intake duct of this test cell. Exhaustive efforts to achieve tractable particle dispersion with the use of liberation from "fluidized" pollen beds or continuous shearing from crudely compacted pollen masses failed completely, however. Among alternative approaches, the use of pollen suspensions² or slurries disseminated by small vortex generators or clinical nebulizers was considered; however, prospects of variable elution of allergens by the subsequently aerosolized liquid media were prohibitive. Similarly, while dilution in materials such as lactose might have vitiated the unfavorable surface properties of pollen, the possibility of respiratory changes due to such "inert" carrier particles was unacceptable.³ Efforts were made, therefore, to adapt an existing dispersion unit, the Wright Dust Feed Mechanism (WDFM),* to our special needs (Fig. 1).

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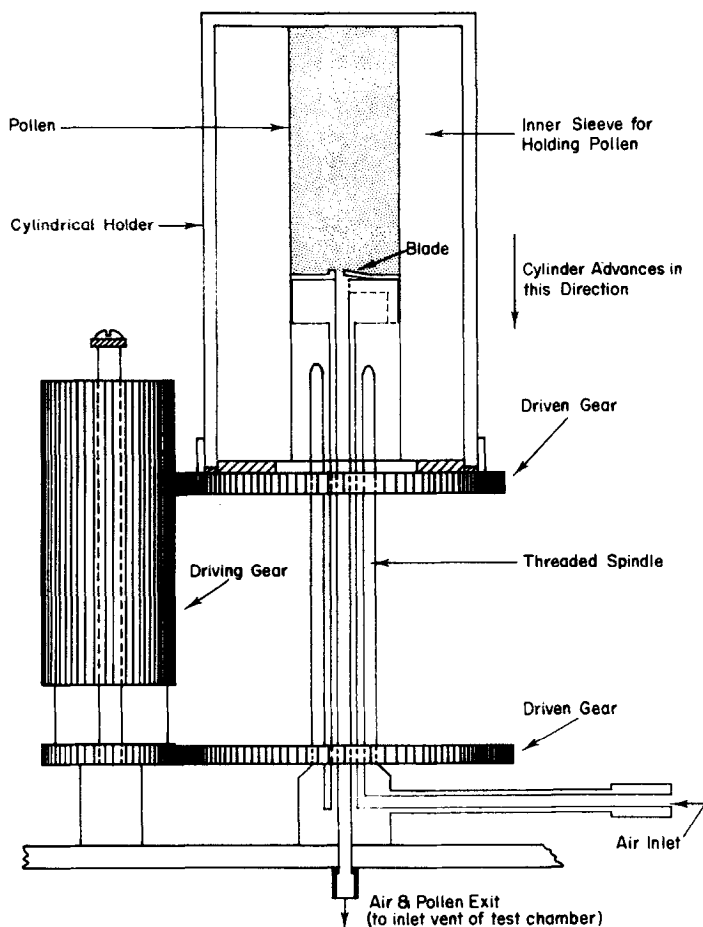


FIG. 1. Components of the Wright Dust Feed Mechanism as supplied by the manufacturer; the unit is shown with a pollen charge (the stippled area).

This device was first described in 1950⁴ as a dispenser for particles below 5 μ . It employs a discoid head bearing a low bar or "blade" to shave sequential layers from a slowly rotating cup of compacted dust. An air stream passing through the interior of the cutting assembly at a recommended rate of 17.5 l/min captures abraded particles and conducts them to an efflux orifice. Under ideal conditions, particle dispersion is controlled by a variable system of reduction gears which determines the rate at which the cylindrical cup of dust is fed down upon the immobile head. Particle packing has been achieved simply by forcing a "dust rammer" down upon the dust aggregate with several sharp hammer blows.

Extensive trials of this device with native, commercially obtained, short ragweed pollen produced erratic fracture and erosion of the compacted particles, resulting in peaks and troughs of dispersion. In response to these failures, a series of empirical modifications of the WDFM were made over a 3-yr span.

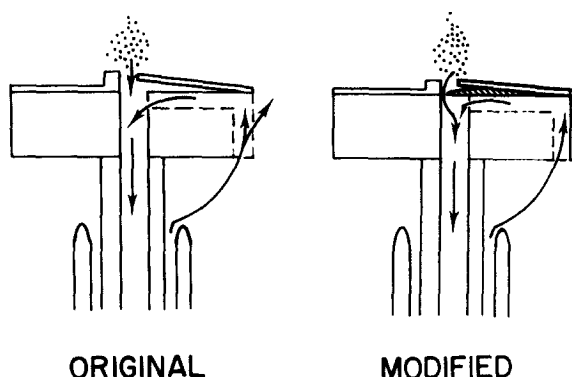


FIG. 2. Modifications of the cutting head of the Wright Dust Feed Mechanism to facilitate dispersion of pollen; the altered cutting assembly is shown at the right. Arrows indicate the flow of air in which pollen is entrained.

The effects of each successive structural alteration upon the level and variability of pollen concentrations within the test chamber were assessed by multiple series of 30-60 min sequential rotohar samples. Tractable pollen dispersion was secured after adopting the following structural and procedural changes.

1. A standard packing procedure was adopted in which a 1.5 gm charge of pollen is compressed to approximately 4.5 cm³. Bench clamps are used both to secure the inner (pollen containing) cylinder and to depress the dust rammer until a predetermined level, measured by calipers, is reached.

2. To reduce pollen erosion at the surface of the compacted bed, the air flow channel in the side of the cutting head was closed laterally (Fig. 2). Segments of transparent tape, if carefully applied, have been adequate temporarily for this purpose.

3. A central pore in the circular face of the cutting head was closed. In addition, a 1 by 0.5 cm deep segment of stainless steel razor blade was inserted beneath the terminal cutting disc and positioned to underlie the radial slot in the face of the cutting head (Fig. 2). These additions served to prevent mobilized pollen grains from merely falling into the effluent air stream, requiring instead that they be insinuated around the insert.

4. The cutting bar or blade was milled down to approximately one half of its original height. Both this modification and the presence of the stainless steel insert, which elevates half of the cutting disc, have tended to decrease the depth of the layer of pollen engaged by the blade.

5. Air flow through the WDFM has been reduced and a level of slightly over 6 l/min found especially satisfactory.

6. Prior to use, all pollen is passed through a 200-mesh sieve to remove plant hairs and other coarse debris that might otherwise occlude portions of the cutting assembly.

Despite these modifications, initial contact between the cutting disc and pollen "cake" is still attended by high and erratic pollen liberation in the first

hour of dispenser operation. After dissipation of this initial cloud, however, the unit may be stopped and subsequently restarted with rapid re-establishment of stable pollen emission.

With maximum available gear ratios, the fully modified WDFM has produced and maintained pollen levels of 800-1,000 grains/m³ in the test chamber for as long as 30 hr of continuous operation. Lower levels are obtained by attaching a flow divider, one limb of which is connected to a variable source of negative pressure, to the dispenser's effluent nozzle.

Direct studies of dispenser output have suggested that, for periods as long as 90 min, ragweed pollen emission values in successive 3-5 min intervals seldom differ from their mean by more than $\pm 30\%$. (Preliminary trials suggest that *Chenopodium album* and *Urtica gracilis* pollens will behave similarly but not pollen of *Pinus strobus* [white pine] or 60 μ spherical glass beads.) These data were obtained by directing the output from the WDFM into a Greenburg-Smith impinger⁵ containing 150-ml portions of 3% Heikol (as an antifoaming agent) and counting aliquots in a hemocytometer. Although this range is relatively narrow, it suggests that a significant mixing volume (in this case, provided by the chamber and its ducting), remains a desirable if not essential factor in obtaining stable pollen levels.

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