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Spinning-top homogeneous aerosol generator with shockproof mounting

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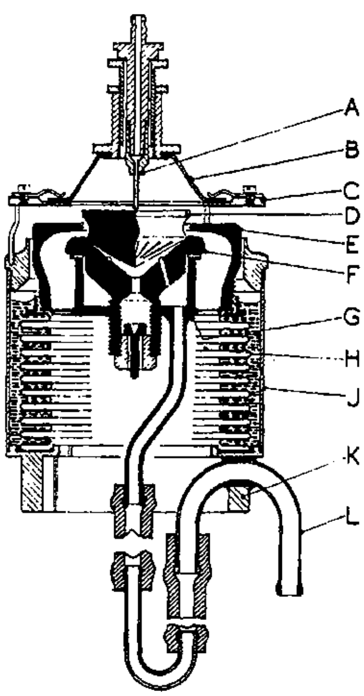
Abstract. Great operational stability is given to the air driven, air supported, high speed 'spinning-top' spray device by including an oil-damped flexible metal bellows as a stator-mounting and by reducing the sprung weight to a minimum. The available range of uniform droplets covers about 10–200 μm diameter.

Droplets of nearly uniform size are projected from the rim of a spinning disk when an even film of liquid is allowed to flow continuously over the disk, as first described by Walton and Prewett (1949). The simplest way of obtaining the high rotational speed (up to 2500 rev sec^{-1}) necessary to produce small droplets is by an adaption of the air driven, air supported 'spinning top' (Beams 1937) as used by Walton and Prewett and developed by May (1949). A single compressed-air line with quite modest air consumption keeps the 'top' spinning indefinitely at a constant speed with no wear, as the only moving part has no contact with any solid. The principles of the system and methods of operation are fully described in the original papers.

Some workers have subsequently preferred to use mechanically operated disk systems, accepting the greater complexity and wear and vibration problems because they found the 'spinning top' unstable and unreliable. Such faults are undoubtedly mainly due to incorrect machining and mounting,



but to eliminate such criticism the new system described here has been developed.

In the diagram, the parts lined in black consist of the one-inch diameter rotor or spinning top D, the stator F with four driving jets in its cup and lifting valve in the stem, the light-alloy dome E and the compressed air supply housing G. These are not essentially different from their counterparts previously described (May 1949) except that, apart from the rotor, they have been reduced to the smallest possible size and weight. They are supported by the bronze bellows H which has thin and very flexible walls (0·004 in.), with ten convolutions, 1·6 in. inner diameter and 2·25 in. outer diameter. The bellows is soldered to the base ring K, as is the outer cylindrical wall J. The gap between the bellows and J is filled with a viscous damping fluid of 500–1000 cP which should not be exceeded if the system is to have the correct damping properties. Silicone fluid or lubricating oils may be used but a 15% w/w solution of polystyrene moulding chips in dibutyl phthalate is particularly good. This is heavier than water and so is not displaced by drops which might collect on its surface when water is sprayed.

The black components, of light weight and low centre of gravity, are in this way mounted to produce a lightly sprung, well damped system which is so impervious to vibration and shock that vigorous blows on the outer casing will not disturb the smooth running of the rotor. No precautions need be taken in turning the compressed air supply on or off. Smooth acceleration of the rotor is obtained however quickly the pressure is applied and after an instantaneous cut-off of the air the rotor coasts smoothly to rest. It will run smoothly from a few revolutions per second (drops 100–200 μm diam.) to, say, 2500 rev sec^{-1} at 40 lb in^{-2} (drops $\sim$ 10 μm diam.) which is near the useful limit of the apparatus.

External compressed air connection is made to the bent pipe L which is soldered through the base-ring K. Internally the rubber tubing connection to G hangs down in two lengths of about 4 inches in the manner shown in the diagram. This arrangement exerts very little mechanical restraint on the flexibly-mounted black parts. Also, as pressure is supplied, the down-tubing expands longitudinally as much as the up-tubing so that the same parts are not pushed upwards. It is very important however that the tube connections should be made without any twist in the rubber, or the black parts will be displaced sideways. The rubber tube must be no thicker than is needed to withstand the maximum pressure. Tubing of $\frac{3}{32}$ in. bore × $\frac{5}{16}$ in. outer diameter has been selected.

The base ring K embodies a socket which may be pushed over an upright tube of any convenient length (not shown in the diagram), serving both as a stand for the spray head and as a duct for the exhaust air. The exhaust consists of air supplied to drive the rotor and of air which has been automatically sucked into the annular gap between C and E by a combination of ejector and Coanda effects acting in the narrow gap between E and F (May 1949). This in-flow of air around the rotor draws back with it the unwanted 'satellite' droplets, separating them from the much larger, uniform, parent drops which escape from the spray head through the annular gap by virtue of their greater inertia.

The exhaust air flows down through the inside of the bellows to the stand tube, from which there must be no restriction to its free escape or the satellite removal system will not function. Suction may be applied to the exhaust system if it is desired to incorporate a filter.

The upper parts of the apparatus are essentially unchanged from the original except that they are attached to the rigid outer casing. They comprise the ring C, with three legs which are a push fit into the guard ring which screws into the top of J, the coned sight-glass B which can be centred over the rotor and the hypodermic needle for liquid supply A (0·25–1·0 ml. min^{-1}) with its mounting for fine adjustment for height. Annulus-extending rings for use with large droplets and a spider needle-mount for small droplets are required as before (May 1949).

This type of mounting has been in regular use in this establishment for many years. Aerosols of solid particles of any size up to about 30 μm have been generated by spraying solutions of the appropriate concentration and allowing the solvent to evaporate from the droplets. The system from D to L is a simple and reliable way of obtaining continuous high rotational speeds for such other purposes as the rotation of a mirror or as a small ultracentrifuge.

The mounting is the subject of British Patent Application No. 6106/66 and the whole apparatus may be obtained from Research Engineers Ltd., Orsman Road, London, N.1.

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Replicating selected areas for electron microscopy

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Abstract. A simple technique for the replication of optically selected details is described. The electron microscope grid is located on the sample, rather than on an intermediate replica, reducing the number of handling operations and time necessary.

Present techniques used in the replication of selected areas of metallurgical specimens for electron microscope examination involve the positioning of an electron microscope grid on the selected area of an intermediate replica. The grid must be held in position by a suitable glue which is dissolved at a later stage (Kay 1965, p. 159, Koehler and Mattern 1965, Watt 1964). It is possible for the grid to move relative to the replica when dissolution of the glue is taking place, thus rendering repetition of the process necessary.

It has been found that the gluing and replicating processes can be combined to reduce this hazard, the number of handling operations involved and the time necessary for replication. The apparatus consists of a simple metallurgical microscope with movable stage and a mounted needle on a laboratory stand.

The selected area is placed in the centre of the field of view of the optical microscope and a supporting grid located approximately over this area. The microscope stage is lowered and the clamped needle placed below a low power objective lens so that the tip of the needle is in focus near the edge of the field of view. The stage is then raised until the sample is in focus, when the needle will be lightly holding the grid. Provided the sample is held firmly on the microscope stage, the grid will move relative to the sample surface when the stage traverses are used. The selected area can then be positioned accurately with reference to the grid. Use of an aperture adjacent to a centre marked grid eases location in the electron microscope.

A few drops of replicating plastic dissolved in a suitable solvent are placed on the grid by a dropper so as to form a continuous film extending a few millimetres from the grid. A 5% solution of cellulose acetate in acetone has been found to be satisfactory. The sample is then left to dry, forming a film that contains the grid and replicates the surface. When the replica is dry, the end of a small piece of adhesive tape is pressed on to the surplus replicating material around the grid. The replica and grid can then be removed with the adhesive tape. Preliminary scoring of the replica will assist in this removal.

The preliminary replica is then ready for any required treatment prior to examination in the electron microscope, for example metal shadowing and carbon replicating. Note that the support grid does not interfere with these subsequent treatments. Many methods of dissolving the preliminary replica exist (Kay 1965, p. 69). The method adopted by this laboratory was that of placing the grid, replica side up, on a sloping wire screen and allowing fresh solvent to flow down the screen.

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