small glass holder which has (i) a sealed-in wire electrode passing up inside the needle to make contact with the liquid, and (ii) a small side arm for supplying pneumatic pressure to the needle from a hand-operated hypodermic syringe via a length of fine rubber tubing. A source of d.c. voltage variable between 0 and 5 kV. is required, and it is convenient to apply this to the micropipette by means of a bell-push operated relay. For mounting the micropipette in its operating position, Goldacre's arrangement[2] is convenient because of its simplicity, universal adjustment and high insulation.

When forming droplets, the procedure is to apply pneumatic pressure to the micropipette, observing the drop in a microscope fitted with a calibrated scale in the eyepiece. As the drop is formed, it tends to run back up the shaft of the pipette so that the liquid usually cannot be sucked back if the required size is exceeded; however, evaporation will quickly reduce the drop to the required diameter, with most liquids. When the drop is exactly the required size, the bell-push is operated, the drop flies off and, by trial and error setting of the micropipette, may be aimed with considerable accuracy over a distance of several centimetres. The trajectory of the charged droplet is of course strongly influenced by electrostatic fields. A 100-megohm leak to earth from the electrode ensures discharge of the holder before the next drop is formed.

A study was made of the minimum firing voltage, tip diameter and drop size for various liquids with the view of establishing a relationship between the relevant parameters; but there was too much unexplained variability in the results for this to be done. It is possible that such factors as the cleanliness of the outside of the pipette and the shape and taper of the tip may have an overriding effect. The results showed a general correlation between a slow increase in minimum firing voltage and increasing tip diameter, the former being practically independent of size of drop from a given tip. In practice, it is convenient to work at a voltage of about twice the minimum firing voltage to ensure immediate firing of the drop. There is a considerable range above the minimum firing voltage which can be used; but at too high a figure the drop is disrupted and spraying commences. Observed minimum firing voltages for various tips are: $< 10\,\mu$, 0·6–1·3 kV.; 10–20 μ, 0·8–1·4 kV.; 20–50 μ, 1·0–1·8 kV.; 50–100 μ, 1·5–3·0 kV. These figures cover all liquids, from conductors such as aqueous salt solutions to insulators such as paraffin oil. The minimum firing voltages for water may be reduced considerably below these values by coating the outer surface of the pipette with a thin film of paraffin wax.

The rule-of-thumb for pipette size is that the tip should not exceed one-third of the required droplet diameter. Micropipettes down to 1–2 μ are easily made, though blockage from foreign substances in the liquid naturally becomes a problem with such fine tubes. To minimize the tendency of the droplet to run back up the micropipette, the taper on the latter should be as small as possible. With a little practice in the control of heating, traction and position of the tube when forming the pipette in the microforge, almost parallel-sided tubes can be made.

Apart from our own requirements, other uses for individually produced droplets may be found in, for example, fuel combustion studies, applying minute quantities of toxic substances such as insecticides to specific areas on insects, the calibration of droplet detectors, etc.

It should be possible to produce droplets continuously by means of a steady liquid flow and controlled frequency voltage pulse.

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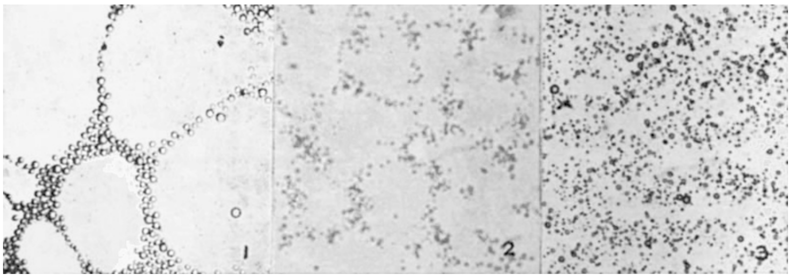
Structure of Breath Deposits on Dielectric Oils

It is possible, by low-power microscopic observation of water droplets deposited by breathing upon the surface of dielectric oils, to detect their degree of alteration by ageing.



With unused oil, the breath figures are identical with those obtained with a neutral paraffin oil containing some foreign molecules with hydrophilic groups[1]: moisture condenses on their surface as very small, randomly disposed droplets (about 10 μ in diameter). After some seconds these droplets join up, forming chains, and finally coalesce as bigger droplets located at the intersection points of former chains (Fig. 1).

With dielectric oils artificially aged (by heating for 10 hr. in contact with copper, at 120° C. or higher) droplets deposited by breathing join up as more-or-less elongated groups (Fig. 2); but they do not readily coalesce to form bigger drops.

With dielectric oil aged by being in use for a long time, the droplets do not join up at all and have the appearance shown in Fig. 3.

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