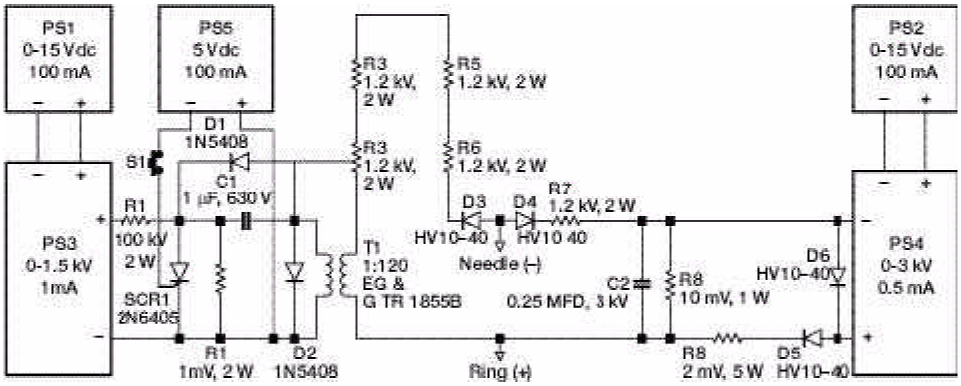
High-Voltage Droplet Dispenser Developed

Various techniques have been applied to deploying individual droplets for many applications, such as the study of the combustion of liquid fuels. Isolated droplet studies are useful in that they allow phenomena to be studied under well-controlled and simplified conditions. A high-voltage droplet dispenser has been developed that is extremely effective in dispensing a wide range of droplets. The dispenser is quite unique in that it utilizes a droplet bias voltage, as well as an ionization pulse, to release the droplet.

The droplet is deployed from the end of a needle. A flat-tipped, stainless steel needle attached to a syringe dispenses a known value of liquid that hangs on the needle tip. Somewhat below the droplet is an annular ring electrode. A bias voltage, followed by a voltage pulse, is applied to attract the droplet sufficiently to pull it off the needle. The droplet and needle are oppositely charged relative to the annular electrode. The needle is negatively charged, and the annular ring is positively charged.

The circuit of the droplet dispenser configuration described here is shown in the diagram. Power supply PS2 energizes DC/DC converter PS4 to produce the desired bias voltage for the droplet. A bias voltage on the order of 3 kV was found to be effective. PS4 charges capacitor C2 through current-limiting resistor R9. Bleed resistor R8 discharges C2 for safety when the circuit is not in use. Diodes D5 and D6 protect PS4 from inductive spikes. The droplet is charged via steering diode D4 and current-limiting resistor R7. Power supply PS1 energizes DC/DC converter PS3 to charge capacitor C1 via current-limiting resistor R1. Charging C1 to 100 V was found to be effective. Bleed resistor R2 discharges C1 for safety when the circuit is not in use. SCR1 conducts when S1 is depressed momentarily to produce a microsecond pulse in the primary winding of transformer T1. Diodes D1 and D2 protect SCR1 from inductive spikes. A pulse of 12 kV is produced at the secondary winding of T1 with C1 charged to 100 V, but the circuit can produce a pulse up to 40 kV. The pulse provides ioni-zation energy to the droplet via steering diode D3 and current-limiting resistors R3, R4, R5, and R6 to release the droplet. Multiple resistors are used to handle the high-voltage pulse.

In use, PS1 and PS2 are set to the minimum voltage levels and are turned on along with PS5. Power supplies PS1 and PS2 are then set to the desired voltage level. Finally, S1 is depressed momentarily to release the droplet. The circuit shown was developed for manual control, but it is readily adaptable to microprocessor-controlled applications.



Electrical circuit diagram of high-voltage droplet dispenser.

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