De La Rive Operation

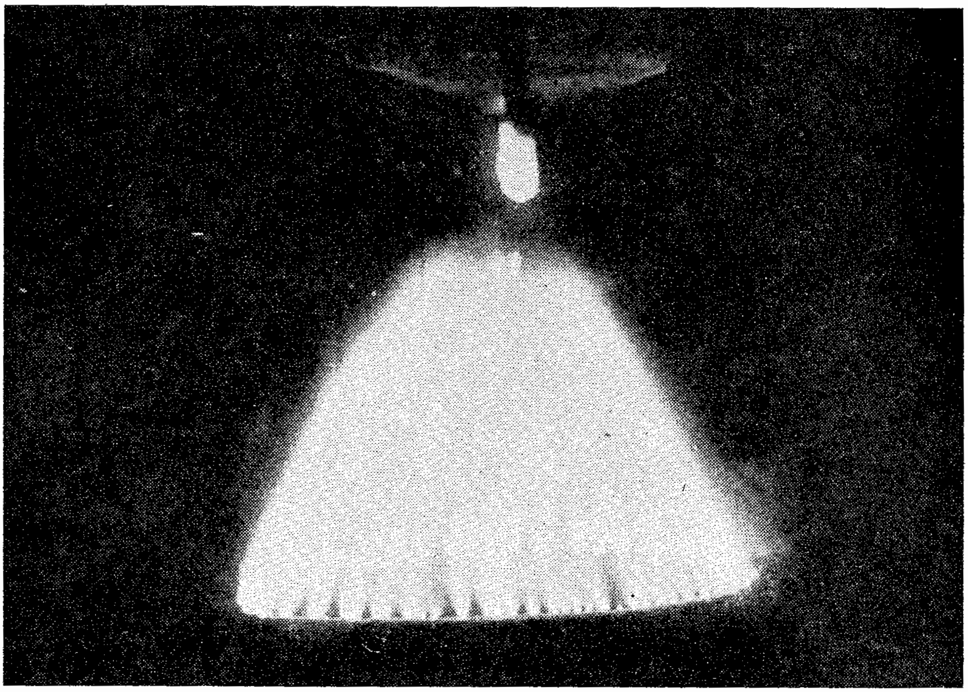

FIG. 10. The photo above is a time exposure of the rotating streamer discharge in the De La Rive tube. The effect is varied according to the tube pressure, as described in the text.

☐ Install the tube in the shield box and attach an 8-in. length of 3⁄16-in.-bore vacuum hose to the copper exhaust tube. Use vacuum grease at this and all other hose connections. Place a pinch clamp on the vacuum hose projecting from the rear panel of the box.

Clip the black lead in the box to the copper tube and the red lead to the lower terminal. In the following, the jack and control designations refer to the power supply detailed. When using an equivalent supply, make connections with polarities as indicated.

Using the 3-ft. HV cables, connect the black cable to the metered negative terminal (jack J3a) and the red cable to the positive terminal of the supply (jack J3c). Plug the remaining ends of the cables into the jacks of corresponding color on the rear panel of the shield box. Ground the negative terminal of the power supply (jack J1c). Connected as such, the tube will be energized with unfiltered half-wave DC.

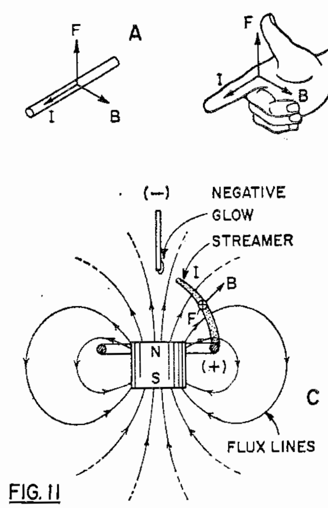

FIG. 11

Evacuate the tube to about 25 or 26 in. vacuum as indicated on a Bourdon type vacuum gauge. Next, increase the applied voltage (by advancing variable transformer T3) until the discharge streamer appears. If the spark gap in the power supply begins to arc over, reduct the applied voltage.

At this pressure, the streamer may rotate erratically. Reduce the tube pressure slowly until the streamer stabilizes and rotates smoothly. With decreasing pressure, the rate of rotation increases and the streamer becomes shorter, broader, and more diffuse. At tube pressures well below 29 in. vacuum, the streamer disappears and the ring electrode is covered with a flickering glow. Fig. 10 shows a time exposure of the tube in operation.

Because the tube is being energized with half-wave DC, the discharge is initiated and extinguished at the line frequency rate of 60 times per second. As a result, and at moderate rates of streamer rotation, a remarkable display showing a number of equally spaced and somewhat diffuse streamers appear in the tube. This apparently multi-streamered display is the combined result of persistence of vision, excitation of the tube by half-wave DC, and the ratio of streamer rotation to line frequency. Actually, there is but one streamer in the tube at any particular instant.

Operate the tube at various electrode spacings and compare results. Some interesting effects are obtained by using upper ring electrode K as shown in Fig. 8. Vary magnet position by using magnet supports of different lengths. When stacking two or more slug magnets for use in the tube, allow the combined magnet to project an equal distance above and below the plane of the ring electrode.

When the magnet projects well above the ring electrode, the streamer may tend to terminate on the magnet. The remedy is to shield the magnet with a close-fitting glass tube. A suitable shield can be made by cutting off the end ofa large test tube.

Operate the tube directly on high-voltage AC (jack J1a and J2a of the power supply). Two streamers will appear in the tube, one from each electrode. The streamers do not meet head-on but tend to parallel each other. The blue cathode glow will appear at both electrodes. Also, the streamers may tend to skip or rotate erratically in one direction. The two streamers do not exist simultaneously in the tube. They are separated in time by 1/120 second and are produced by the alternate positive and negative half cycles of the 60-cycle alternating voltage. Viewing the discharge through a rotating disc stroboscope will verify this fact.

When using this tube in a Science Fair Project, prepare diagrams illustrating and explaining the phenomena demonstrated. The following, supplemented by your own research and modified to fit your particular objective, may be used as a starting point.

First, referring to Fig. 11A, the direction of force F acting on a conductor carrying current I in the presence of magnetic field B is illustrated. B is that component of the magnetic field which is normal to or perpendicular to the conductor. The vector arrows, F, I and B are mutually perpendicular to each other. As a memory aid, Fig. 11B shows the right hand rule relating directions of force, current and magnetic flux.

Next, Fig. 11C shows the arrangement of tube components, a portion of a field map representing the magnetic flux lines of the magnet, and the discharge streamer. By convention, the current I flows from the positive electrode to the negative electrode of the tube although the electrons flow in the opposite direction. Therefore, the current vector I in Fig. 11C points to the negative electrode. Also by convention, the magnetic flux lines emanating from the magnet are directed outwardly from the north pole of the magnet. Therefore, the flux vector B is similarly oriented outwardly.

Applying the right hand rule of Fig. 11B, we find that the force vector F must be directed into the page. This is indicated by the small circle with a cross indicating the tail end of an arrow directed into the page. Therefore, the streamer is urged to rotate in a counterclockwise direction as viewed from the upper electrode of Fig. 11C.

A reversal of the direction of the magnetic field by inverting the magnet will reverse the direction of rotation. Reversing the direction of current flow by changing the polarity of the voltage applied to the tube will also reverse the direction of rotation.

To predict the direction of rotation of the streamer, it is necessary to know which face of the magnet is the north pole. To determine this, suspend the magnet at its midpoint with its pole facing in a horizontal plane using a single strand of fine nylon thread. The pole face which *seeks* the north geographic pole is the north pole and should be labeled as such with a dab of red paint.