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ELECTRIC EXPLOSION OF A MERCURY JET

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Electrically exploded wires are used extensively for various purposes - to obtain intense molecular beams [1], shock waves [2], powerful radio pulses [3,4], as laser pumps [5], to initiate chemical reactions [6], etc. The difficulty of replacing the wire limits the application of this method. We have therefore deemed it desirable to investigate the possibility of replacing the wire with a jet of liquid metal, so as to produce repeated electric explosions in a simple manner. The working medium used was mercury, but other liquid metals can also be employed. The mercury jet was made to explode both under atmospheric pressure and in vacuum.

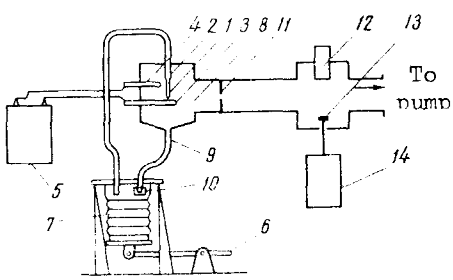

Fig. 1. Schematic diagram of setup.


Fig 2. Oscillogram of collector current.

The setup (Fig. 1) consisted of a system simulating a mercury jet ("mercury wire"), electrodes with which to apply voltage from a capacitor to the jet, and measuring apparatus. The mercury jet (1) escaped under pressure from a glass capillary (2) and struck an electrode (3). The diameter of the mercury jet was determined by the capillary. In our case the capillary diameter was 0.15 - 0.30 mm. The jet length was 25 mm. The "mercury wire" was grounded, and neither electrode was connected directly to the ground. Voltage (3 - 4 kV) was applied to these electrodes from a capacitor (5) rated 18 μF. The mercury pressure in the capillary was produced by pressing on the lever (6) of a bellows (7). The mercury jet flowed through the capillary to electrode 3. The electric explosion of the jet took place when the gap between the jet and moving electrode 4 broke down. This breakdown could occur only when the jet reached electrode 3. The gap was set at the minimum value. We have tried earlier variants without a movable electrode, using the mercury in the capillary as one of the electrodes. It turned out then that at the instant of the mercury-jet explosion a glass capillary was shattered, the the diameter of a steel capillary approximately doubled after two or three shots.

When the pressure on the lever was released, the mercury flowed from the lower part of the chamber (8) through a tube (9) into the bellows. The tube had a rubber valve (10) which prevented the mercury from entering the interelectrode space from below. The working space was pumped out with a mercury diffusion pump and cooled with liquid nitrogen to -50°C. To determine what happens during the electric explosion of the mercury jet - whether it travels broken up into droplets or in the form of a molecular beam - the jet-explosion products were sounded with an electron beam. They passed first through a diaphragm (11) and then crossed the electron beam from a gun (12) at a distance 23 cm from the place of the explosion. This scattered the electrons and changed the current to the collector (13). This current was recorded with an oscilloscope (14). A typical oscillogram of the collector current is shown in Fig. 2. It is seen from this oscillogram that explosion of the mercury jet produces a molecular beam which contains no individual droplets (there are no gaps in the oscillogram). The velocity of the leading front of the molecular mercury beam is 2.5×10^6 cm/sec, and its total duration at a distance 23 cm from the point of explosion is 600 μsec. The sweep duration was 1.2 msec.

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A NOTE ON C-ODD MULTIPOLES

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In discussing the possibility of charge-parity nonconservation in electromagnetic interactions, Bernstein, Feinberg, and Lee [1] emphasized that for particles with spin $I \leq 1/2$ there are no C-odd terms in the vertex part of photon emission even if the electromagnetic current contains a C-even component [1)]. This is connected with the fact that when $I \leq 1/2$