# HIGH VACUUM AND ELECTRODELESS DISCHARGE TECHNIQUE

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Lecture-demonstrations before Demonstrations and Exhibit Division.

1. Molecular bombardment
2. Production of a vacuum by cooled charcoal
3. Electrodeless ring discharge in bulbs containing various gases
4. Electrodeless discharge—the *flash* in the *afterglow* in certain gases
5. Electrodeless discharge—the *afterglow* in nitrogen
6. Electrodeless discharge—measurement of the *gaseous* current by *its inductive* effect

## COMMENT ON THE ABOVE LIST OF DEMONSTRATIONS

**Demonstration 1.** The underlying principle of the mercury vapor pump may be visualized by a molecular bombardment apparatus (original with Knipp) in which the air molecules are replaced by pith balls which in turn are bombarded and held suspended by the mercury molecules issuing from the heated mercury. The tube is about 1 meter in length and 70 mm in diameter. It contains about 20 cc of mercury, and 2 dozen pith balls. It is thoroughly pumped out and then sealed off. The tube is mounted in a vertical position and the lower end is heated either electrically or by a small Bunsen flame. As the mercury vapor is given off the balls begin to be agitated and with increased heating may be lifted free of the mercury surface and ultimately held dancing in any part of the tube that may be desired. The condensed mercury vapor trickles down the walls of the tube.

**Demonstration 2.** The absorption of air by cooled cocoanut charcoal is shown simultaneously by an electrodeless discharge in a 500 cc bulb and by the height to which mercury is raised in an attached tube forming a barometric column. This experiment simply illustrates in a striking way what is common knowledge to chemists and physicists—the wonderful absorption and adsorption of gases by cooled charcoal.

**Demonstration 3.** Electrodeless discharges are not new. Sir J. J. Thomson studied them as far back as 1891. The successful operation of these discharges requires that the bulb (which has no electrodes) be exhausted to a pressure of about .1 mm of mercury. The bulb may be sealed off from the pump. To produce the discharge a high-potential high-frequency generating outfit is necessary. This may be obtained from a 110 volt A.C. lighting circuit by using a transformer and kenotrons; or by a transformer, capacity and a spark-gap. The latter is used in these demonstrations. Bulbs containing various gases (helium, argon,

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hydrogen, neon, etc.) are made to glow giving out their characteristic color by inserting the bulb in the energizing coil.

**Demonstration 4.** A few gases have the property of glowing for some moments after the energizing current is removed. This afterglow seems to be due in part to a molecular rearrangement. The glow dies off exponentially with time. Under certain conditions depending on the kind of gas (argon works best), the moisture and impurities present, there appears early in the decay of the afterglow a sudden flash (new, just recently observed by Knipp) of the illumination that is visible throughout the room. The experiment is striking.

**Demonstration 5.** It has been known for some time that an electric discharge in nitrogent causes an afterglow to be set up which persists for some time after the exciting coil is removed. Afterglows lasting 15 to 20 minutes have been reported. In this particular bulb the glow lasts for some 35 minutes. A nitrogen bulb that glowed for 187 minutes was reported by Knipp (abstract No. 21) at the recent (Nov., 1931) Chicago meeting of the American Physical Society. The active nitrogen afterglow is a beautiful lemon color.

**Demonstration 6.** The induced gaseous current in an electrodeless ring discharge may rise to a high value. The magnitude of this current was measured recently by its inductive effect. In the ordinary form of bulb this could not be done by reason of the larger inductive effect of the current in the energizing coil. This was overcome by piping, as it were, the gaseous current aside to a position where this disturbing effect is zero, and then utilizing the *inductive effect* of the *gaseous current* on a metallic secondary connected to a radio-frequency ammeter. See Physical Review, Vol. 38, No. 5, Sept. 1931.