conserved or broken; that is, worth in the sense of highest attainment in functional grade and in the approach to mentality.

CHARLES SCHUCHERT

SPECIAL ARTICLES

A SIMPLE MICRO-INJECTION APPARATUS MADE OF STEEL

FOR injection and suction purposes in the field of the compound microscope two very good methods are in existence. One is Barber's[1] mercury pipette. This consists of a glass tube completely filled with mercury. One end is bent into several loops and sealed at the tip. The other end is drawn out into a capillary with a microscopic aperture at its tip. The pipette is held in Barber's pipette holder which is clamped to the stage of the microscope. For injection and suction purposes Barber depends on the expansion and contraction of the mercury by varying the temperature of the loops of the pipette. This method gives excellent results but the pipette is rather difficult to make, it is easily broken and the driving force of the mercury can not be instantly controlled.

A more recent method is that of Taylor's,[2] which also consists of a mercury-filled pipette, but which depends upon a minute plunger to regulate the pressure of the mercury. The plunger method gives the operator a better control of the pressure in the pipette but has the disadvantage of possible leakage around the plunger. This generally occurs after the plunger has been used several times. A great deal of time tends to be wasted in keeping the apparatus in a working condition.

The apparatus described here is very simple to set up and, excepting for the few inches of capillary pipette which can be inserted into the apparatus within a few minutes, it is permanently ready for use. The apparatus depends upon leverage clamps to regulate the mercury pressure which can be controlled at any instant. Consisting entirely of steel and heavy glass it is practically unbreakable, a consideration of great importance for easy manipulation.

As in Barber's and Taylor's instruments, mercury is used to procure the necessary pressure. The apparatus consists of a thin-walled, (.028 inch or less thick), straight, one half inch, steel tube about six inches long (see figure). Into one end of this is sealed an

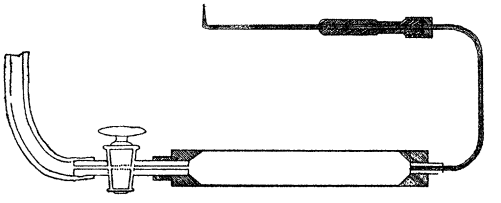

FIG. 1.

accurately fitting steel or glass stopcock. The other end leads into a small steel tube fine enough to be flexible, viz., about 3/32 of an inch in outside diameter. The small tube is bent into a twisted S shape, so that, when at rest, its tip lies on a pipette carrier on the stage of the microscope. The tip of this thin tube is furnished with a screw joint by means of which it may be attached to a hollow steel rod two inches long which carries the glass micro-pipette. The outer end of the stopcock is connected with a rubber tube about four inches long. The steel tube is placed in a special clamping device which is secured to the table beside the microscope. This clamping device consists of three leverage clamps, one of which presses on the steel tube in a direction at right angles to that of the other two.

The apparatus is first filled with clean mercury through a glass funnel inserted into the rubber tube upon which the stopcock is closed. The glass pipette is made according to Barber's method[3] and is sealed with wax into the hollow steel rod.

[1] Barber, M. A., 1911, "A technic for the inoculation of bacteria and other substances into the cavity of the living cell," *Jour. Inf. Dis.*, VIII., 348; 1914, "The pipette method," etc., *The Philip. Jour. Sc.*, Sec. B, Trop. Med., IX., 307.

[2] Taylor, C. V., 1920, "An accurately controllable micropipette," SCIENCE, N. S., LI., 617.

[3] See footnote 2, also Chambers, R., 1918, "The microvivisection method," *Biol. Bull.*, XXXIV., 121.

The rod is then screwed to the end of the tube of the injection apparatus by means of the screw point in which is a fiber washer to make the joint tight. The rod is then clamped in a mechanical pipette holder, either that of Barber or one described in an article already printed. The next step is to fill the pipette with mercury. To do this open the stopcock and see that the rubber tubing connected with the stopcock is full of mercury. With a strong clamp close the tubing about four inches from the stopcock. Along this four inches place several screw clamps which, on being screwed down, will produce sufficient pressure to drive mercury almost to the tip of the pipette. The stopcock is then to be securely shut off.

We are now ready for action. Squeezing the metal tubes by one or other of the leverage clamps will drive mercury through a pipette having an aperture of only one micron (.001 mm.) in diameter. Move the pipette by means of the pipette holder till its tip projects into a hanging drop of the solution to be injected. Release pressure on the steel tube and some of the solution will be drawn into the pipette. Now lower the pipette and move the moist chamber till the cell to be injected is brought into view. The pipette is now raised until it punctures the cell. On applying pressure to the steel tube the solution is readily injected. The apparatus may also be used to withdraw materials from the cell.

The apparatus is extraordinarily sensitive. The meniscus of the mercury in the pipette responds instantly to the pressure of the leverage clamps. A comparative estimation of the quantity of injection material used may be made by focusing, first, on the mercury meniscus, then on the tip of the pipette and measuring the distance of the two focal points by means of the fine adjustment screw of the microscope.

A more complete description of this apparatus will shortly be published.

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ON THE EMISSION AND ABSORPTION OF OXYGEN AND AIR IN THE EXTREME ULTRA-VIOLET

UP to this time very little has been known of the spectrum of oxygen in the region of wave-lengths shorter than λ2000. Some previous investigators were unable to obtain a spectrum in this region. "No lines or bands," says Lyman, "were observed between λ2000 and 1230."[1] Schumann, however, had succeeded in photographing some continuous maxima of which the most refrangible has a wave-length of about 1850 Ångstroms. Moreover, Lyman had observed that the great absorption band of oxygen diminishes in intensity as it approaches λ1230, but he thinks that another absorption band exists "lying in the region shut out by the absorption of fluorite." This preliminary investigation was undertaken, therefore, to test the emission and absorption of oxygen and air in the region of wave-lengths shorter than those transmitted by fluorite.

The apparatus used consisted of a vacuum grating spectrograph, containing a Rowland concave grating of 50 centimeters focus, about 15,000 lines per inch, and a ruled surface of approximately 2 inches. A discharge tube of internal capillary, end-on type and with aluminum electrodes was employed. The tube was also provided with a quartz window for Hg comparison spectrum and opened through a slit directly into the receiver. A method has been developed of making Schumann films, and these were used for the spectrograms. Commercial oxygen, dried with phosphorus pentoxide, filled the receiver and connected discharge tube to a pressure of about 0.4 mm. When the spectrum of air was obtained, this gas was likewise dried and filled the receiver to about the above pressure. The time of exposure varied from 20 minutes to 2 hours for the gas spectra, while an exposure of 3 minutes was found to be sufficient for the Hg-arc comparison spectrum. The apparatus was so arranged that both the first and second orders of the Lyman region

[1] Lyman, "The Spectroscopy of the Extreme Ultra-violet," p. 82.