begins to flow into the 13-mm. bulb at *E*, the mercury level is pushed up at *C*, so that a new drop is forced into the horizontal tube, trapping a new segment of the gas stream. This drop then moves to the right and the cycle is repeated.

Thus, each cycle represents the flow of a definite volume of gas and the time between cycles is a measure of the flow rate. For low flow rates the time required for movement of the drop between two fixed points may be a more convenient measure of the rate.

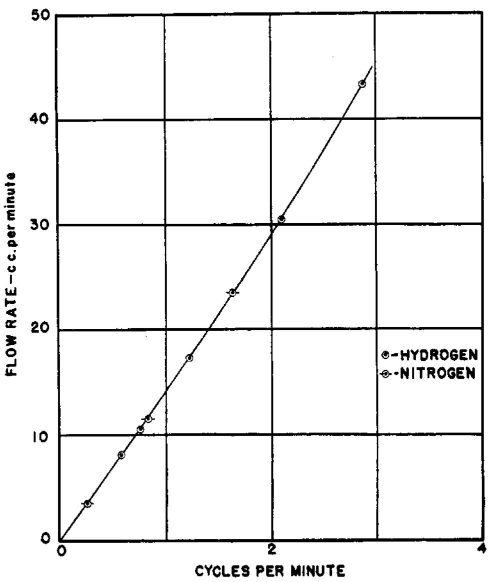

FIGURE 2

Figure 2 shows a calibration curve obtained with hydrogen and with nitrogen, when gas volumes were measured by collection over water in suitable burets. The points for the gases are seen to fall accurately on the same line. The use of mercury as a displacement fluid eliminates the difficulties caused by use of water or organic liquids in the usual wet-test meters.

Some details of the construction and operation of the flowmeter need further discussion. The glass spirals permit small adjustments in the tilt of the tube, which controls the size of the drop. Since there is a lag between the time at which the drop begins to flow into the bulb at *E* and the time at which the mercury rises at *C*, the drop must be of sufficient length to ensure that mercury will enter the horizontal tube at *C* before the drop at the right is entirely discharged from the tube. If this condition is not met, a jet of gas will flow through the tube during a part of each cycle. The amount of gas will be a function of the gas viscosity and the calibration curve will then be found to depend on the kind of gas.

The requirement that there must be a drop of mercury in the horizontal tube at every part of the cycle suggests the use of a tube of relatively large diameter and as short as possible for the mercury piston, in order to reduce the time lag. However, in such a tube the mercury level tends to oscillate for some time after a drop is discharged at *E*, thereby producing a series of drops at the left instead of one. The constriction in the vertical tube at *F* reduces these oscillations; the long zigzag horizontal tube, shown in the top view, ensures complete damping of the oscillations of one cycle before the second begins and minimizes possible errors from fluctuations in the size of the mercury drops. In the authors' instrument 2 drops are formed at the beginning of every cycle when the flow rate becomes greater than 15 cc. per minute and as this rate is approached there will be 1 drop one cycle and 2 the next. However, the total volume of mercury remains very nearly constant, as the calibration curve proves. Above 35 cc. per minute 3 drops are formed. The tungsten contacts shown in the top view actuate a counter through a relay, so that the instrument may be used to record total flow as well as to measure the rate.

The surface of the tubing through which the gas and mercury droplets flow should be free of any oil or water film or dust particles, and the mercury should be pure; otherwise there will be small fluctuations in the rate of gas flow which may give pressure variations as high as 1 or 2 mm. of mercury. This effect can be eliminated in any case, however, by having a surge chamber in the line following the meter.

Since the volume displacement per cycle does not depend on the pressure or temperature of the gas, the instrument may be used at subatmospheric pressures. During any particular run, however, the temperature and pressure should have constant values; otherwise it would be difficult to convert the gas volumes to standard conditions. The meter could also be adapted for use at superatmospheric pressures by using metal parts or suitable plastic tubing and connections.

Acknowledgment

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Forceps with Platinum-Covered Tips

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THE usual platinum-tipped forceps commercially available have each platinum tip fastened to nickel-plated steel by means of two rivets in a simple scarf joint. During the past five years, three or four of these expensive tools have failed here, always owing to corrosion or oxidation where the two metals join. Even moderate attack of the steel soon renders the forceps unfit for use because the platinum alone is too weak to withstand the flexing that occurs at the rivet holes.

Forceps that are stronger, cheaper, and more durable than those just described have been made in this laboratory by covering the tips of ordinary steel forceps with 5-mil platinum foil. The tips of the steel forceps were filed to the shape desired and a piece of foil (0.8 $\times$ 2.5 cm.) was fitted to each, so that the seam would fall outside. A close fit was obtained by slitting the lower edge of the foil so that it could be folded around the end of the tip; excess foil was then carefully trimmed away. Spot-welding to form a practically continuous seam completed the assembly. The welding operation is simple with the proper equipment. In this case, a low inertia bench welder with synchronous thyratron control was used under the following conditions: 350 amperes for 6 cycles, or 0.1 second; electrode pressure, 20 pounds; flat copper electrodes of diameters $^3/_{16}$ inch (lower) and $^3/_{32}$ inch (upper).

The forceps thus constructed have been used constantly during the last six months and have given satisfactory service without deteriorating noticeably. There is no reason why the tips of a wide variety of tongs and forceps could not be covered with platinum foil to great advantage. The implements to be covered should preferably be made of stainless alloys.