A MERCURY PUMP FOR MAKING AND SUPPLYING A UNIFORM MIXTURE OF GASES

IN a study of the influence of gas storage upon the keeping quality of apples, the writers wished to subject small lots of fruit in five-gallon closed containers to various synthetic atmospheres; these atmospheres, varying in their percentages of oxygen and of carbon dioxide, to be supplied to the fruit at a uniform rate of flow and of concentration over any given period of time. In this experiment, where different artificial atmospheres were supplied to fruit samples without interruption over a six-month period, it was desirable to reduce the consumption of the various gases to a minimum consistent with the maintenance of uniform atmospheric conditions in the containers. The different atmospheres, containing 5, 10 and 15 per cent. of carbon dioxide and a corresponding reduction in the percentage of oxygen, were therefore supplied the containers at the rate of 100 cc each minute or only in sufficient quantity to give a complete change of air once in about six hours. This rate of exchange, which under a holding temperature of 42° F. proved sufficiently rapid to prevent the concentration of carbon dioxide in any of the containers from increasing at any time more than 0.3 per cent., required such small quantities of "air" that accurate measurement of the different gases by the use of a flow-meter presented difficulties. Thus, rather than employ this indirect method of determining volume by the measurement of differences in gas pressure, a motor-driven mercury pump was devised which accurately measured the volume of the different gases directly and supplied the resulting mixture in proper proportions to the different chambers. A diagrammatic sketch of this equipment is shown in Fig. 1.

Gas tanks, containing CO_2 and N, and the compressed air line, supplying the necessary O_2, were each fitted with the ordinary high and low pressure gauges. The latter were regulated from time to time to deliver each gas to a second regulator, a Murrill pressure controller, (a) at a pressure of from 1 to 2 pounds. After passing through this regulator, the gas flows under a 1¼ inch water pressure, as recorded by the manometer (b) to a specially designed pyrex glass pipette valve (c). In passing through the inlet valve the above pressure nearly equalizes the resistance of the mercury in the bottom of the valve; hence by the time the gas reaches the measuring bulb (d) it is at approximately atmospheric pressure.

The measuring bulbs are alternately filled with gas and mercury by the action of a 6-inch cam (e) lowering and raising a leveling bulb of mercury (f). This pumping action of the mercury is set in motion and maintained by a 1,125 r.p.m. motor equipped with a 2,200 to 1 reduction. Under these conditions one complete stroke is made and one charge of gas delivered each 2 minutes.

The measuring bulbs, also of pyrex glass, were constructed 3 inches in height and of various diameters. The bottom stem of the bulbs was of 6 mm bore and the top stem of 2 mm bore. Approximately one inch of each stem was included in the volume of each bulb. With each stroke of the pump the mercury traveled 5 inches, filling the lower stem one inch as the air was drawn into the bulb and filling the upper stem one inch as the charge was expelled. By slightly raising or lowering the level of each bulb in relation to the height of the mercury in the leveling bulb, the difference in the bore of the upper and lower stem permitted any small adjustment in volume necessary to

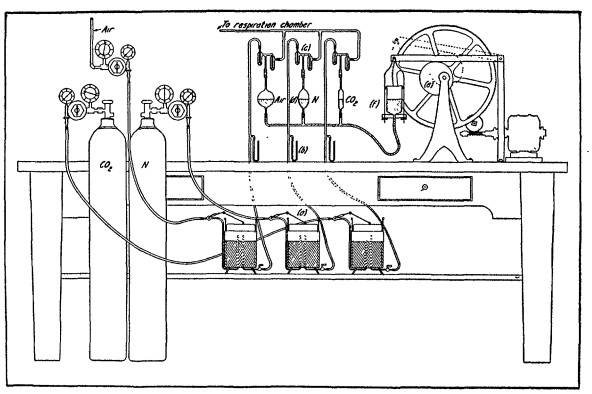

FIG. 1. Schematic diagram of mercury pump for furnishing a constant supply and a uniform mixture of gases to respiration chambers.

overcome the slight resistance encountered by the gas passing through the mercury in the bottom of the outlet valve. Before connecting the outlet valves to the small pipe line leading to the fruit chambers, which were in a 45° F. storage room some 15 feet distance from the pumping equipment, the correct volume of the bulbs was finally calibrated by displacing water in a burette. To secure a 200 cc charge of an atmosphere containing 5 per cent. CO_2 and 15 per cent. O_2, the capacity of the bulbs were CO_2 10 cc, N. 46 cc and air 144 cc.

By duplicating the cams and the series of bulbs and valves, as was actually done, any set of conditions may be duplicated. By varying the relative proportions of the bulbs measuring each gas, several different atmospheres may likewise be obtained. Changes in the gear ratio and in the actual size of the equipment make possible its adaptation to a wide range of conditions.

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