Biochemical Studies On Nutrition Under Special Environment : I. An Apparatus Capable Of Keeping The Reduced Pressure Constant

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BIOCHEMICAL STUDIES ON NUTRITION UNDER SPECIAL ENVIRONMENT

I. AN APPARATUS CAPABLE OF KEEPING THE REDUCED PRESSURE CONSTANT*

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For purposes of examining the effects of reduced pressure upon nutrition, it is prerequisite to have an apparatus enabling us to maintain the experimental animal under a constant reduced pressure. An attempt has been made, accordingly, to set up an appropriate apparatus by using the usual laboratory facilities. Experiments have also been carried out to examine several factors governing the efficiency in automatic control of reduced pressure.

1. THE DESCRIPTION AND MANIPULATION OF THE APPARATUS

A. Description of the Apparatus

Fig. 1 shows a diagram of the apparatus. FM is a flow-meter, F_1 and F_2 are equipments used for calibration of the flow-meter and ordinarily not connected with FM. D is a desiccator of about 10 litre capacity, having one thermometer and two tubes, one for the inlet of air, the other for evacuation. E_1 and E_2 are suction flasks, E_1 is provided with a manometer M, for the measurement of pressure in D. E_2 is connected, on the one hand, with a regulator of reduced pressure, MR and, on the other, with a magnetic valve, B. The magnetic valve can be operated by a 10 volt accumulator and a magnet having a resistance of 600 ohm. MR

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has a movable terminal of platinum wire Pt, which can be adjusted at any required reading of the manometer. C_0 is a large stop-cock, installed with a dial enabling us to regulate the passage of air through the cock. C_1 is an ordinary stop-cock connected with a water suction.

B. Technique of Manipulation of the Apparatus

1) Preliminary adjustment: Fix a platinum wire Pt at particular reading of reduced pressure needed for the experiment. Measure the rate of air flow by the flow-meter FM. The flow-meter may be calibrated by a following procedure. Use is made

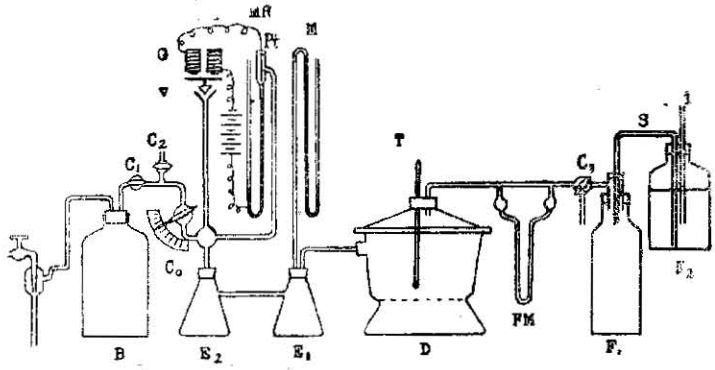

Fig. 1. Diagram of the Apparatus

of a special equipment F_1F_2, being connected to FM in case of the calibration. By sucking the air in F_1 through C_3, the water in F_2 will flow down and fill siphon S. Since the bottom level of siphon S in F_1 is adjusted so as to be at the same level of the lower end of tube i, water will not drip into F_2, if no leakage exists in F_2. Then, on connecting F_1 with FM through C_3, a a certain quantity of water equivalent to the volume of air being sucked into D through FM will drip into F_1 from F_2. Hence, several measurements of the volume of water at various degrees of reduced pressure in vessel D will give the calibration for readings of the flow-meter.

2) Manipulation: Put experimental animal on the wire gauze in D. After closing stop-cock C_2, open C_1, and gradually open regulating stop-cock C_0, observing the rate of rise in the

mercury column in M. If the pressure is reduced to a required degree, the mercury surface in MR will make contact with the platinum wire, fixed at the required reading; electrical circuit will close, making magnet B work so as to open valve V. When the pressure in D rises mercury surface in MR will move down, breaking the electric circuit and stopping the valve V. Thus in repeating the electrical contact, automatic control of the pressure can be carried out without any difficulty within the variation of ± 1 mm. mercury. To release the reduced pressure, first close both C_0 and C_1, and open C_2, then gradually open C_0, care being taken in the rate of pressure-rise by observing the mercury surface in M.

2. Examination of Factors Governing the Accuracy of Automatic Regulation of Reduced Pressure

Fine regulation of the reduced pressure can be obtained by finding an ideal condition which affords a minimum frequency as well as a minimum magnitude of up-and-down movement in the manometer, provided that the magnet and the regulating valve work without clogginess.

Two examples of the observations are shown in Table 1. It will be seen from Table 1 that the reduction in number of contacts between platinum wire and mercury in the manometer can be achieved by either reducing evacuation capacity of pump or inserting several reservoirs of air between the suction and the regulator. Experiments, on the other hand, show that minimizing the number of contacts is always followed with an increase in magnitude of a sudden change in the manometer-reading after the contact. Hence, it is a difficult task to realize the above-mentioned ideal condition required for the fine regulation of reduced pressure.

It will be noticed in Table 1, however, that the magnitude of change in manometer-reading shows values less than 0.7 mm. mercury, if the number of contact be over about thirty per 20 minutes. The frequent contacts between the platinum wire and the mercury causes an oxidation film on the contcat surface by the electric spark, unless the vacuum tube relay is not used. Therefore, it is recommended that the number of contacts be kept

Table 1. Number of contacts in 20 minutes and magnitude of change of pressure.

Insertion of bottles shown in Fig. 2 / Range of deviation in mm. Hg.	Atmospheric pressure corresponding to 7,000 m.								Atmospheric press. corresponding to 9,000 m. (two suctions applied)			
	abcde		abce		abe		ae	e	abcde	abe	ae	be
0.00–0.50	0	8	35	56	48	96	95	166	0	100	213	76
0.51–1.00	0	24	5	0	7	0	3	7	12	12	0	39
1.01–1.50	0	0	0	0	0	0	0	0	7	0	0	0
2.51–3.00	3	0	0	0	0	0	0	0	0	0	0	0
3.01–3.50	5	0	0	0	0	0	0	0	0	0	0	0
Total number of contact	8	32	40	56	55	96	98	173	19	112	213	115

to about thiry to fifty per 20 minutes, by either regulating the evacuating capacity of the pump or by inserting air reservoirs between the suction and the regulator.

So far as the number of air reservoirs are concerned, the insertion of a bottle B shown in Fig. 2 is indispensable if the

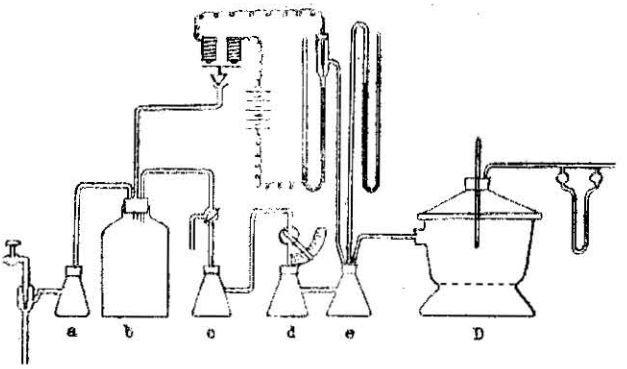

Fig. 2. Arrangement of Air Reservoirs

reduction of pressure in the vessel within a short time-interval be required, because a sharp evacuation requires having a vacuum chamber sufficient to reduce the pressure in D within a few minutes. If it is wished, however, to eliminate a bottle B, a

rotary pump of high evacuating capacity should be used instead of water suction.

It is further noticed that, when the regulating manometer is separated from the magnetic valve by the regulating stop-cock shown in Fig. 2, lag is always observed in the response of the manometer to the inlet of air. Hence, it is necessary to have the magnetic valve located quite close to the pressure-regulator.

3. Summary

1. The description has been made of an apparatus capable of of keeping the reduced pressure constant for quite some duration.

2. Observations of factors governing the control of constant reduced pressure have shown that the variation of reduced pressure can be maintained within 0.7 mm. mercury by controlling the number of contacts in the regulation of manometer to over 30 per 20 minutes.

3. Experiments have shown that locating the magnetic valve close to the pressure-regulator and minimizing the number of air reservoirs are important for the accurate regulation of reduced pressure.

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