LEYBOLD DIDACTIC GMBH

9/88 — ös — Sf —

Instruction Sheet 371 57

Boyle's Law Apparatus after Kröncke

The apparatus is used to investigate the relationship between the pressure p and the volume V of a quantity of air enclosed in a glass tube sealed off by a ball. The length l of the air column is a measure for the volume V. Different pressures p acting on this air column are generated by means of a diaphragm vacuum and pressure pump or by a syringe. The apparatus has the advantage of being permanently ready for use, and works without mercury; but it is not a precision instrument.

1 Technical Data

Length:	55 cm
Width:	13 cm
Height:	25 cm
Length of the tube:	39 cm
Length of the rule:	30 cm
(1 cm ≙ 0.79 cm^3)	
Manometer dial:	16 cm dia.
Measuring range:	0 to 2 bar
Weight:	3.12 kg

2 Description

A precision glass tube 39 cm long and closed at one end is linked via a knob to a dosing valve. The whole is mounted on a sheet-metal chassis, approx. 50 cm x 10 cm in size.

The glass tube contains an exactly matching but movable steel ball which seals off nearly completely an air quantity. The volume can be read on a coloured rule of 30 cm length and mounted behind the tube. The length of the space sealed off by the ball serves to measure the air volume. It is measured up to the half of the ball and can easily be estimated. The error produced by this reading and which is equivalent to the half of the ball has been compensated by a corresponding cavity in the metal stopper on the right of the tube.

Between the tube and the dosing valve there is a filter to prevent dust particles to be blown into the tube. The tube can be taken out and then opened at the end closed by the metal stopper.

The dosing valve has apart from the connection to the glass tube a connection to a manometer as well as to a hose nozzle. In operation using a pump, the desired pressure within the glass tube can be adjusted by means of the knob ⑨.

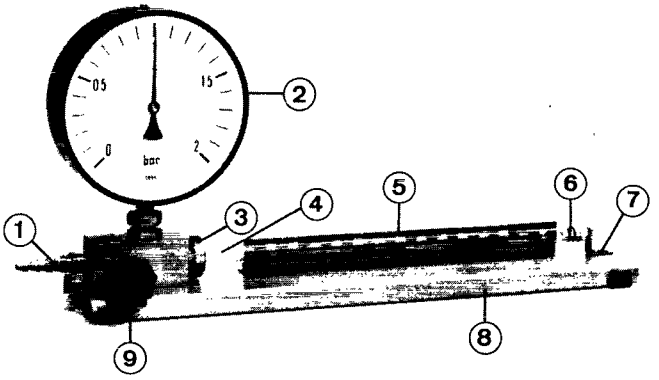

Fig. 1

① Hoze nozzle
② Manometer
③ Clamping screw
④ Glass tube
⑤ Rule
⑥ Metal stopper
⑦ Cross-head screws
⑧ Base plate
⑨ Knob to operate the dosing valve

The manometer is provided with a dial of approx. 160 mm diam. and indicates the absolute pressure from 0 to 2 bar (1 bar ≙ 10^5 Pa = 10^5 N/m^2). Due to the easy mobility of the ball the pressure is identical on both sides of the ball so that the pressure reading applies to both sides.

3 Use

3.1 General notes for experimentation

Equipment for the generation of high and low pressure:

Syringe, e. g. from 361 27

Pump which can also be used as compressor (for pressures ≥ 2 bar) e. g.

Diaphragm vacuum and pressure pump 375 57

If the apparatus is held in inclined or vertical position the ball sinks slowly as the air gap between the ball and the tube wall is only 0.01 mm wide. Prior to the experiment the ball is made running up to any appropriate point of the rule, about up to 15 cm and then the apparatus is placed in the horizontal position. The manometer indicates 1 bar.

3.2 Operation using a syringe (see Fig. 2)

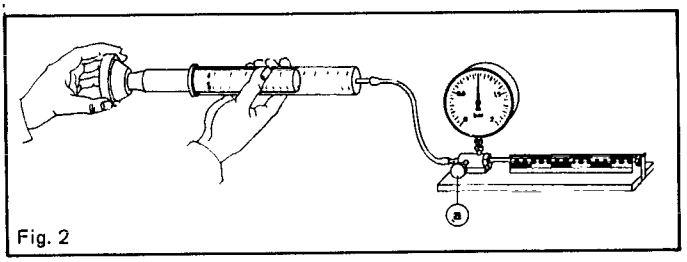

Fig. 2

Bring the syringe in mid position (see Fig. 2), first with the dosing valve ⓐ open, then close the valve completely. Produce different pressures p between 0.5 bar and 1.5 bar by drawing out and pressing in the piston. Read off the corresponding lengths l of the air column from the scale.

3.3 Operation using the diaphragm vacuum and pressure pump (see Fig. 3)

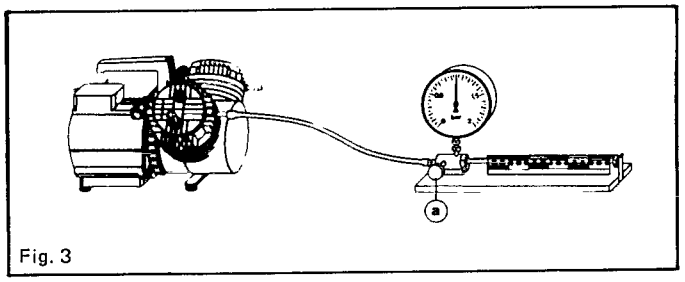

Fig. 3

To begin with the dosing valve is completely opened. When the pump is then set working with closed pressure side, the pressure increases insignificantly and the ball moves a little to the right. If now the opening is closed more and more by turning the knob of the valve, the manometer indicates an increasing pressure and the air volume sealed off by the ball becomes steadily smaller.

In a corresponding manner the law can be proved at pressures inferior to 1 bar.

4 Maintenance

1. Loosen the clamping screw ③
2. Loosen the cross-head screws ⑦
3. Take out the tube
4. Remove the sealing ring and the clamping screw ③
5. Pull out the metal stopper ⑥ of the tube
6. Draw a linen cloth moistened with alcohol or acetone through the tube using a thread
7. Let dry the tube during some minutes. Clean in the meantime the ball with the same cloth
8. Let run the ball into the tube
9. Set the metal stopper ⑥ to the right hand side
10. Reset the clamping screw ③ and the sealing ring
11. Reinsert the tube and tighten it by means of the cross-head screws ⑦ and the clamping screw ③

Care must be taken that the filter has the correct position within the valve (white lamella). A possibly untight seal on the right hand side may be perceptible by the fact that the ball creeps continuously to the right at overpressure and to the left at low pressure.

5 Trouble shooting

During prolonged experiment series, in particular in very slowly running pressure variations, deviations of the volume indication from the correct value may occur because the air seal by the ball is not complete. Better results are obtained when, after preparation of the experiment, the pressure of 1 bar is reset by switching off the pump, the position of the ball is corrected by inclining the instrument and the pump works again. Moreover, care must be taken that the apparatus is in horizontal position.

Before the beginning of the measurement the ball must run once through the total length of the tube held vertically. It is easily perceived whether or not its running is completely accurate and the movement without hindrance. When the movement of the ball is retarded anywhere a dust particle is probably the cause. In general such troubles do not occur so that the apparatus is always ready for demonstration.

It is recommended not to blow with the mouth into the apparatus as the ball may then eventually get rosty.

If the tube is broken a spare glass tube with ball may be ordered under Ref. No. 4360 4 101. The replacement is made as described in 4 (Maintenance).

6 Measuring Example

(Boyle's Law; Carrying out the experiment by means of a syringe)

Pressure p	bar	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
Length l of the gas volume	cm	28.8	24.0	21.0	18.5	16.6	15.0	13.5	12.0	11.1	10.5	9.6
$p \cdot l$	bar cm	14.4	14.4	14.7	14.8	14.9	15.0	14.9	14.4	14.4	14.7	14.4

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