Charpter III

EXPERIMENTAL INVESTIGATIONS

3.1 Description of apparatus

(a) Models (see Fig. 3-1)

Twenty Cyclones are made of galvanized steel sheet in various sizes (see Table C-1). The inlet nozzle, the discharge pipe, and the suction pipe for a Cyclone are made from copper tubes.

(b) Test stand (see Fig. 3-2)

A test stand is made of U-shaped steel beams. The legs of the stand are provided with 12.7 mm slots in order to adjust the vertical position of the Cyclone, the position of the support bar of a pressure probe, and the position of a set of air-filter and pressure regulator. On the lower part of the stand there is a square thread provided for adjusting the distance between the two legs when a bigger Cyclone is clamped an the stand.

(c) Orifice (see Fig. 3-3)

The orifice is made of brass plate 3.175 mm thick and 25.4 mm in diameter. The brass pipe diameter is 50.8 mm,O.D. (47.25 mm,I.D.). Pressure taps are located radially. Air flow rate through the system is measured by the pressure drop across the orifice which can be calculated by using the formula:

Fig. 3-1 TEST MODELS

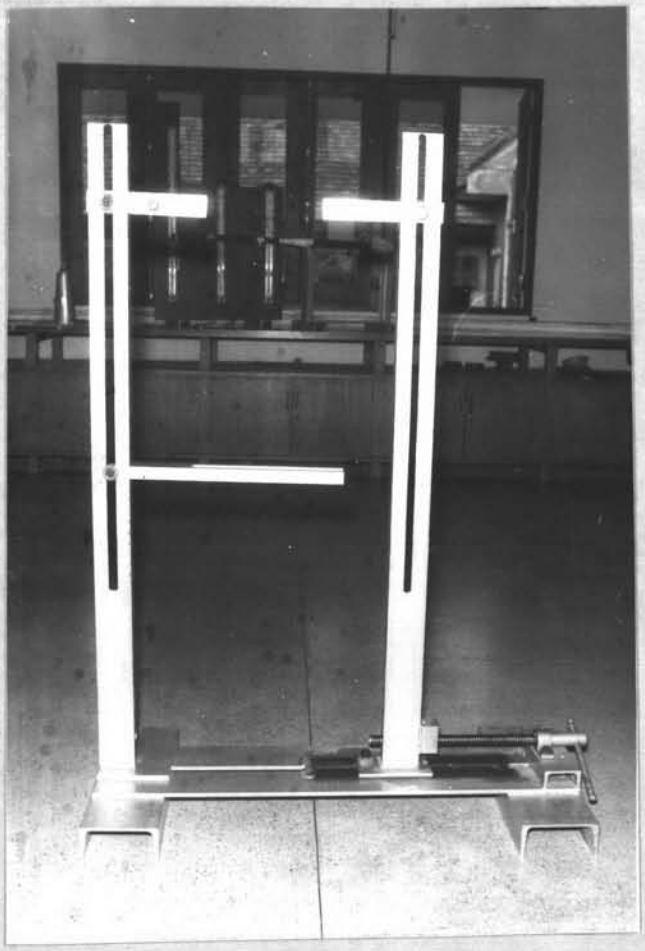

Fig. 3-2 TEST STAND

Fig. 3-3 AN ORIFICE

$$Q = 232.9158\sqrt{h_w} \quad \text{Lit/min,}$$

Where Q = air flow rate, Lit/min.

h_w = pressure drop across the orifice, cm of water.

More details of the orifice can be seen in Appendix A.

(d) Pressure probe (see Fig. 3-4)

The pressure probe is a double copper tube, in which the inner tube is 3.175 mm,O.D., and the outer tube is 4.76 mm,O.D. There are two lock screws to clamp the probe. At the lower part of the clamp there is a lock nut for locking the clamp to a hollow aluminium bar when the probe is adjusted to the center line of the Cyclone. The alumunium bar has a 19.3 mm slot to help adjust the probe in relation to the center of the Cyclone. The bottom end of the probe has a tube leading to a 36-in manometer used to measure the pressure at the center of rotation of the air in the Cyclone. In addition, near this end of the probe there is a pointer showing the position of the other end protruding into the Cyclone. The distance of the probe protruding into the Cyclone is read from a scale.

(e) Manometers (see Fig. 3-5)

Three manometers fixed on the panel are used in this experiment. The first one, a 36-in manometer, is used to measure the vacuum in the Cyclone and the other two, 24-in manometers, are used to measure the discharge pressure and the pressure drop across the orifice. The liquid in the manometers is red

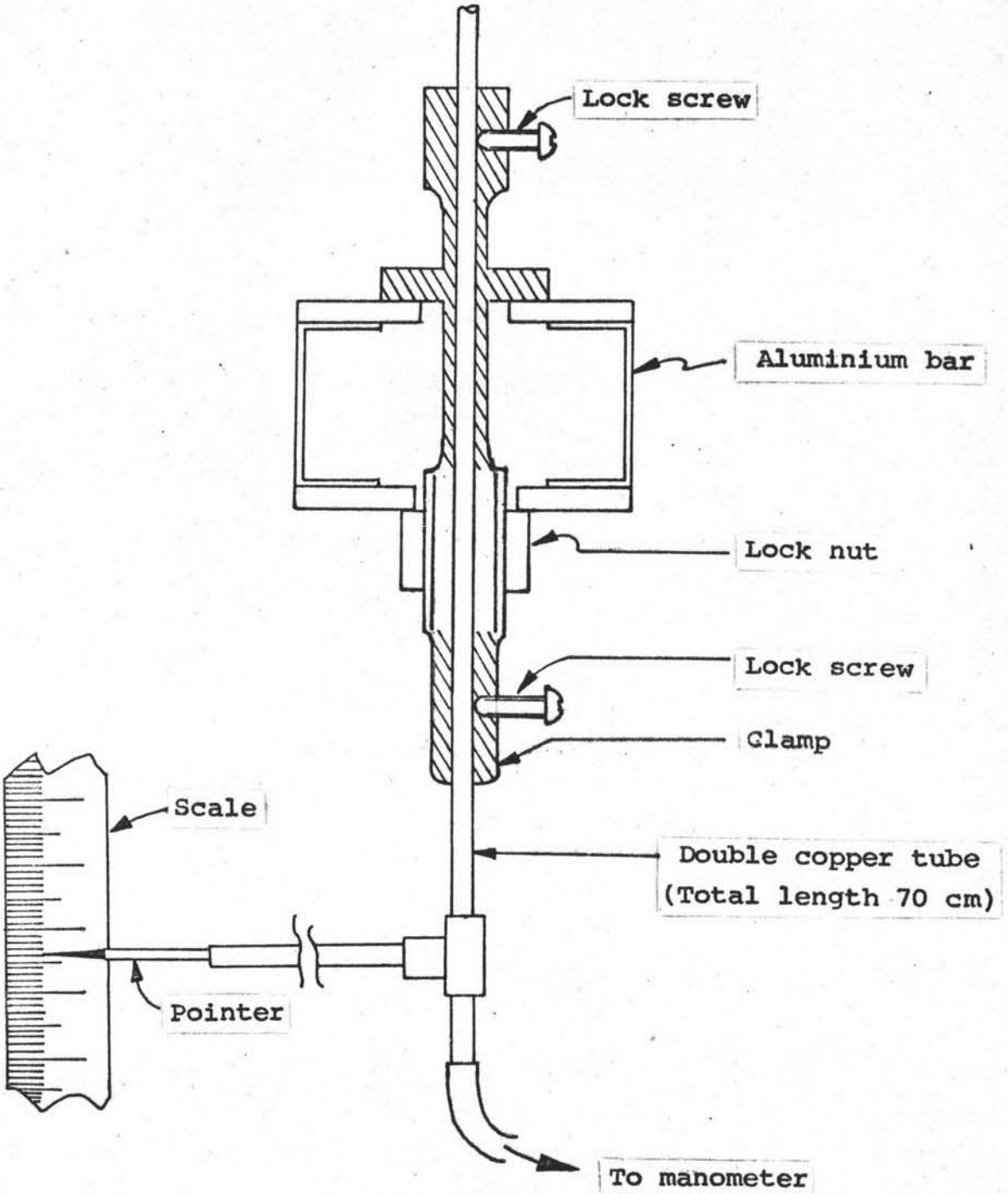

Fig. 3-4 PRESSURE PROBE WITH A SCALE

Fig. 3-5 MANOMETERS

oil with sp gr 0.83 (at 27 C).

(f) Air-filter and pressure regulator (see Fig. 3-6)

A set of air-filter and pressure regulator, SMC Model no.AR400,pipe size 12.7 mm is used. The pressure regulator can be adjusted within a range of 0 - 861.625 kN/m^2(0 - 125 psi). It is used to control the pressure of compressed air supplied to the inlet nozzle or to control the flow rate of compressed air.

(g) Pickup nozzle (see Fig.3-7)

A pickup nozzle made of brass is used to induce material and air into the conveying line. Three lock screws near the top end of the air nozzle are provided for adjusting the clearance between the entry of conveying line and the air nozzle.

(h) Weighing machine

A Berkel weighing machine-capacity 100 kg-is used for measuring the rate of material being conveyed.

(i) Materials

Materials used in this experiment are sand, cane-sugar, and tapioca. The comparision of the grain-size of the materials is shown in Fig.3-8 and their bulk densities are shown in Table 3-1.

Fig. 3-6 A SET OF AIR-FILTER AND PRESSURE REGULATOR

Fig. 3-7 A DESIGNED PICKUP NOZZLE

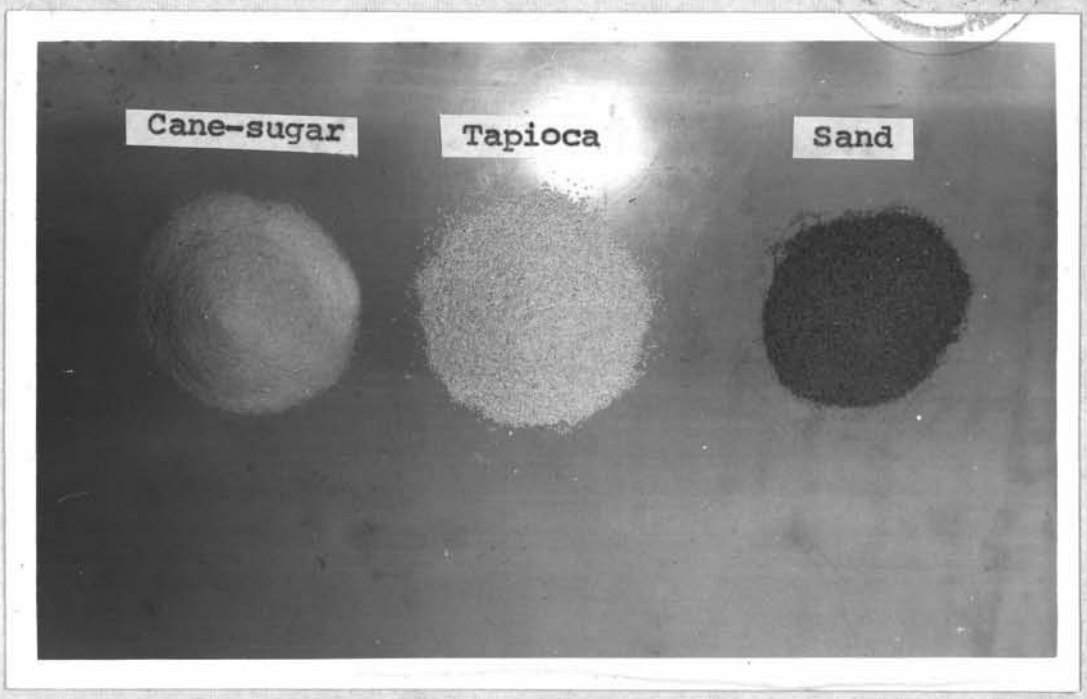

Fig. 3-8 COMPARISION OF THE GRAIN-SIZE OF MATERIALS

TABLE 3-1 BULK DENSITY OF MATERIALS

Material	Bulk density (ton/m^3)	Remark
Sand(dry)	1.430	All size passed seive # 16
Tapioca	0.692	Small size type
Cane-sugar	0.884	All size passed seive # 16

3.2 Test Procedure

At first the calibration of the orifice is made (see details in Appendix A), in order to allow the determination of air flow rate from pressure drop directly. The calibration curve is shown in Fig. 4-1. Next the experiment is divided into two parts.

3.2.1 Test without conveying of material

The schematic diagram for this test is shown in Fig. 3-9. Twenty Cyclones are tested in this part. The precedure of the test for each Cyclone is :

(a) Set up the apparatus as shown in Fig. 3-10. One end of the pressure probe is at the bottom of the Cyclone.

(b) Adjust the pressure regulator beginning with 5 psig by increasing 5 psi for each step.

(c) At a pressure setting in (b),record the vacuum

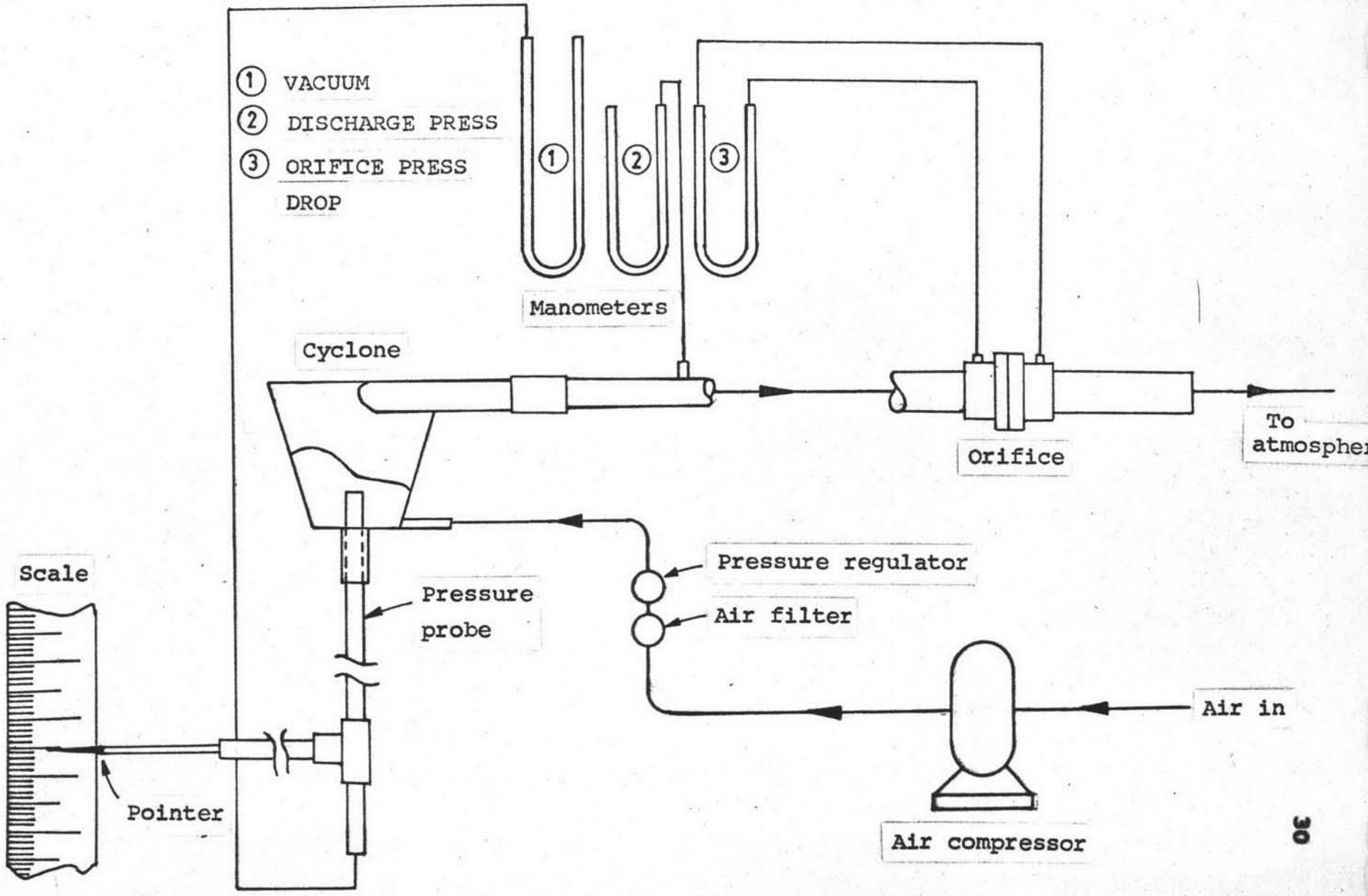

Fig. 3-9 SCHEMATIC DIAGRAM OF MEASUREMENT OF VACUUM IN CYCLONE

Fig. 3-10 ARRANGEMENT OF APPARATUS FOR TEST WITHOUT CONVEYING MATERIALS

produced, discharge pressure, and pressure drop across the orifice from the three manometers.

(d) Adjust one end of the pressure probe to a height of 10 per cent of the Cyclone height above the bottom of the Cyclone, and then follow (b) and (c).

(e) Repeat (d) but adjust the probe to 20,30,and 40 per cent of the Cyclone height respectively.

The data and results are shown in Appendix B.

3.2.2 Test with conveying of material

The schematic diagram for this test is shown in Fig. 3-11.

From the results of the test in Sec. 3.2.1, the Cyclones no. 3,7,12 and 17 are selected to test in this part because these Cyclones create vacuum almost the same as the maximum vacuum for each Cyclone height. The procdure of the test for each Cyclone is :

(a) Set up the apparatus as shown in Fig. 3-12. Sand is used as conveyed material.

(b) Adjust the pressure regulator to the point at which material begins to be induced into the conveying system. The rate of conveying of material is convenient to measure at 15 psig for 7.5 cm and 15 cm or 25 psig for 30 cm and 45 cm of Cyclone height. Then proceed by increasing 5 psi for each step.

(e) At a pressure setting in (b), record time and weight of material conveyed.

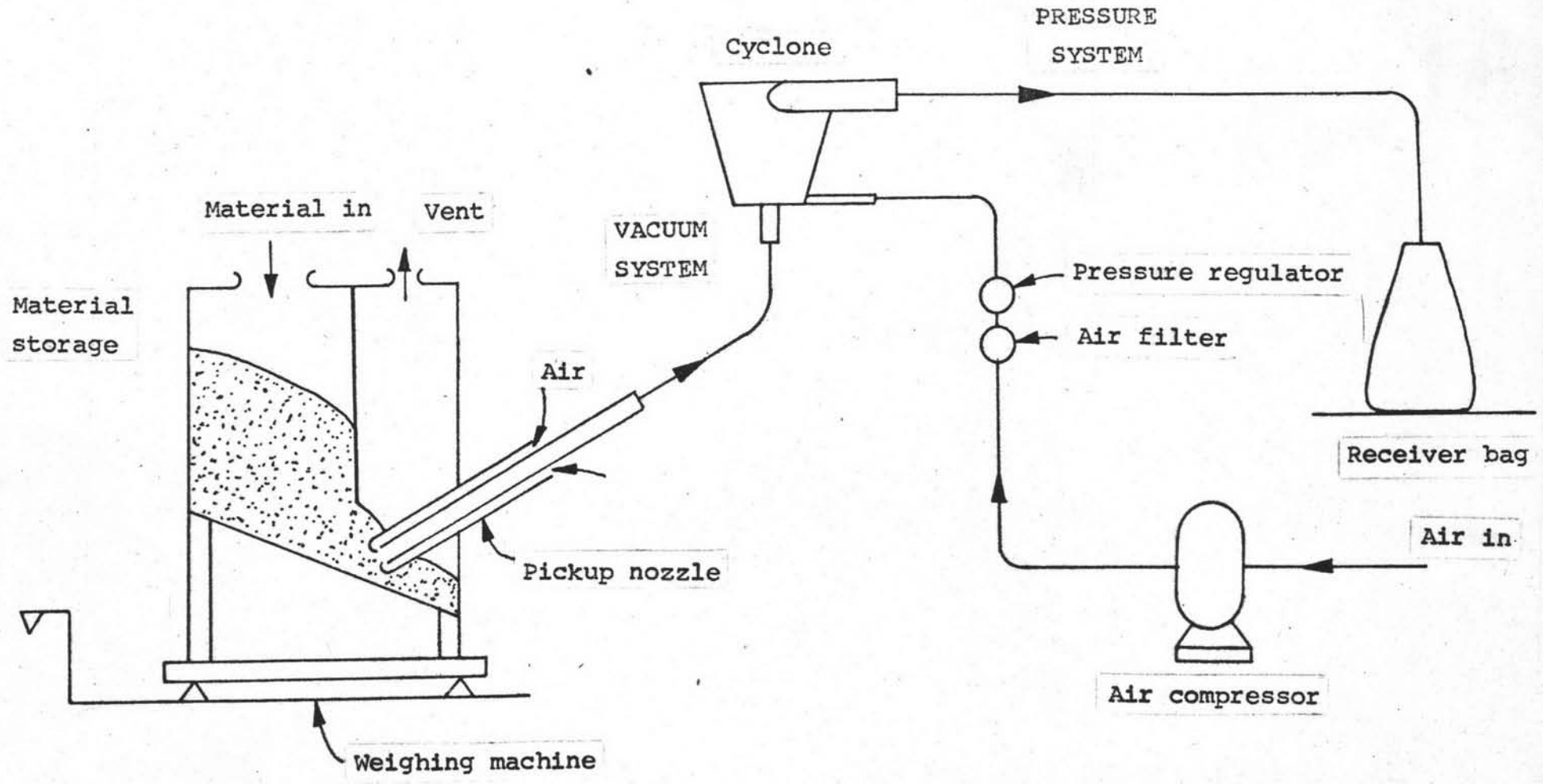

Fig. 3-11 SCHEMATIC DIAGRAM OF CONVEYING OF MATERIAL TEST

(d) Repeat the test from (a) to (c), but the conveyed materials are cane-sugar and tapioca respectively.

The data and results are shown in Appendix B.

Fig. 3-12 ARRANGEMENT OF TEST APPARATUS FOR CONVEYING MATERIALS