Where ,

X - reading of differential manometer .

S_h – Sp.gravity of the liquid manometer .

S_o – Sp.gravity of the liquid flowing through pipe .

2. Orifice meter :

It is a device used for measuring the rate of flow of a fluid through a pipe. It also works on the same principle as that of venture meter. It consists of a flat circular which has a circular sharp edges hole called orifice , which is concentric with the pipe . The orifice diameter is kept generally 0.5 times the diameter of the pipe (or 0.4 to 0.8 times the pipe diameter) .

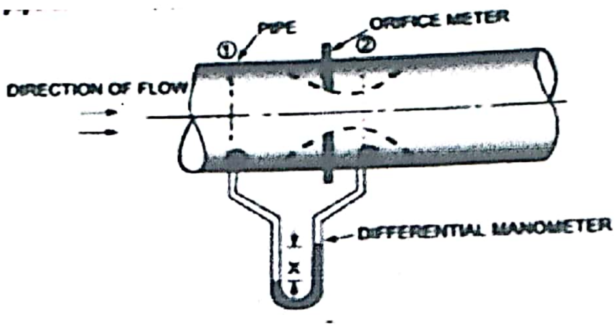

Fig.(5.3)

Applying Bernoulli equation between section 1 & section 2 , we get :

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

As the pipe is horizontal , $Z_1 = Z_2$

$$\frac{P_1}{\rho g} - \frac{P_2}{\rho g} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$$h = \frac{V_2^2 - V_1^2}{2g}$$

$$2g\,h = V_2^2 - V_1^2$$

$$V_2 = \sqrt{2gh + V_1^2} \qquad (5.8)$$

Now , section 2 is at the (vena – contracta) and A_2 represents the area at the (vena – contracta) . If the A_o is the area of orifice , then we have :

$$C_c = \frac{A_2}{A_o}$$

Where , C_c - Coefficient of contraction .

Then , $A_2 = C_c A_o$

From continuity equation , we have , $A_1 V_1 = A_2 V_2$

$$V_1 = \frac{A_2}{A_1} V_2 = \frac{A_o C_c}{A_1} V_2$$

Substituting the value of V_1 in equation (5. 8) :

$$V_2 = \sqrt{2gh + \frac{A_o^2 C_c^2 V_2^2}{A_1^2}}$$

$$V_2 = \frac{\sqrt{2gh}}{\sqrt{1-(\frac{A_o}{A_1})^2 C_c^2}}$$

The discharge $Q = V_2 A_2 = V_2 A_o C_c$

$$Q = \frac{C_d A_o A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_o^2}} \quad (5.9)$$

Where ,

C_d - Coefficient of discharge for orifice meter .

3.Pitot – tube :

It is a device used for measuring the velocity of flow at any point in a pipe or a channel . It is based on the principle that if the velocity of flow at a point becomes zero, the pressure there is increased due to the conversion of the kinetic energy into pressure energy .

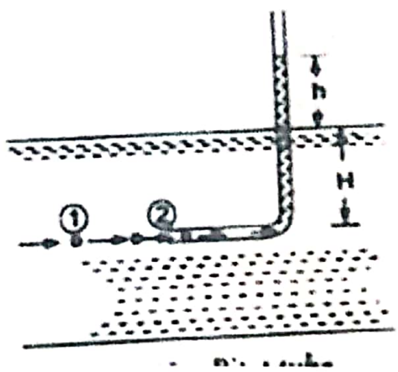

Fig.(5.4)

Applying Bernoulli's between points 1 & 2 , we get :

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$Z_1 = Z_2$, because the points 1 & 2 are on the same line , and $V_2 = 0$.

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g}$$

$$H + \frac{V_1^2}{2g} = (h + H)$$

$$\frac{V_1^2}{2g} = h \quad , \quad V_1 = \sqrt{2gh}$$

In this equation , the velocity V_1 is theoretical velocity , but the actual *velocity is :*

$$(V_1)_{actual} = C_v \sqrt{2gh} \qquad (5.10)$$

<u>There are many arrangements with Pitot – tube (as shown in Figures) :</u>

1 – Pitot- tube along with a vertical piezometer tube , as shown in Fig.(5.5)

2 – Pitot –tube connected with piezometer tube as shown in Fig.(5. 6).

3 – Pitot – tube and vertical piezometer tube connected with a differential U – tube manometer as shown in Fig.(5. 7).

4 – Pitot – tube , which consists of two circular concentric tubes one inside , the other with some annular space in between as shown in Fig. (5.8). The outlet of these two tubes are connected to the differential manometer where the differential of pressure head (h) is measured by knowing the difference of the levels of the manometer liquid , say x , then :

$$h = x \left[\frac{S_m}{S_o} - 1 \right]$$

.16.

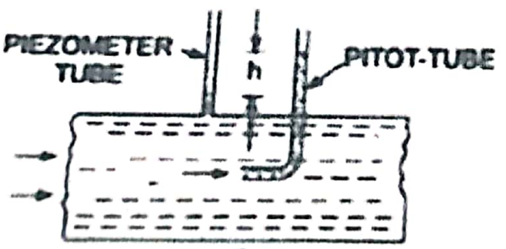

Fig. 5.6

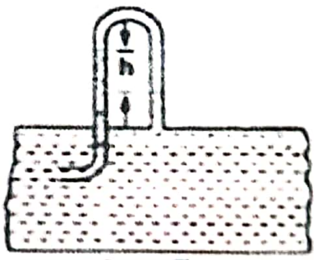

Fig. 5.5

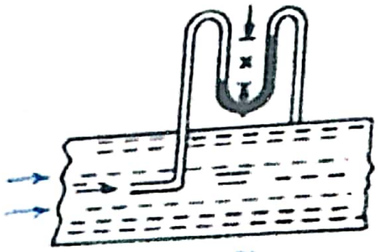

Fig. 5·7

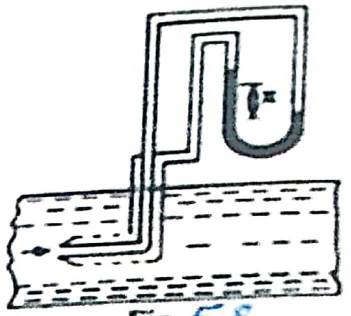

Fig. 5-8