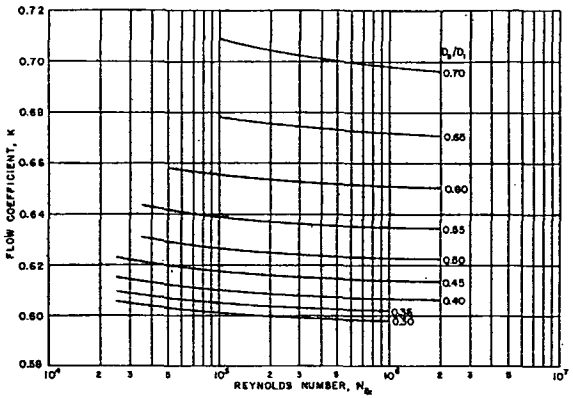

FIG. 9. FLOW COEFFICIENTS, K, FOR SQUARE-EDGED ORIFICE PLATES AND VENA CONTRACTA TAPS, IN SMOOTH PIPE
NOTE: From Table 7, Bibliography [H].

Reynolds number referred to the diameter of the orifice or throat of the nozzle, in feet.

Pressure Taps—Location and Types

The different sets of pressure taps are called flange taps, radius taps, vena contracta taps, and pipe or full-flow taps. The relative locations of the first three of these are shown in Fig. 10, and the need for different coefficients for the different taps is indicated by the course of the change in pressure of the flowing fluid shown in the lower part of the figure. Pipe taps are located 2½ pipe diameters upstream and 8 pipe diameters downstream, both measured from the upstream face of the orifice plate,

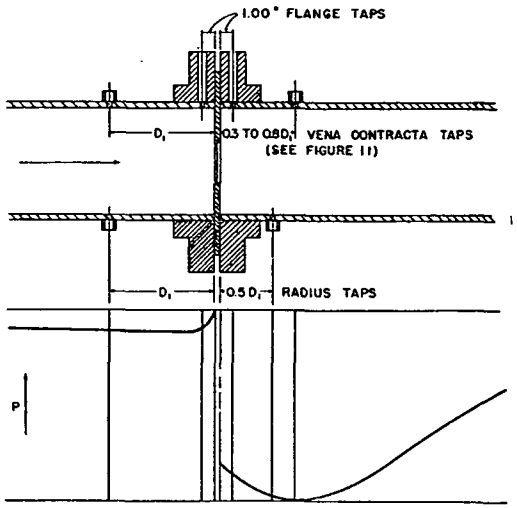

FIG. 10. RELATIVE LOCATION OF FLANGE, RADIUS AND VENA CONTRACTA TAPS

or in other words, before the orifice plate has had any effect on the flow, and after the recovery in pressure has been completed. The use of pipe or full-flow taps has been limited to the metering of natural fuel gas in certain areas. As they are not suited to use in heating and ventilating work no data for them are given in this chapter.

Still another type of pressure tap, the corner tap, is used in European practice. Pressures are taken from recesses in the flange connected to annular slits in the corners formed by the pipe wall and the orifice plate. Coefficients for these taps have been adopted by the *International Standards Association*, but are not used commercially in America.

It will be noted that the location of the downstream pressure tap of the vena contracta arrangement is variable. Vena contracta is the term applied to the minimum cross-section of the jet from the orifice, where the static pressure is at a minimum. Its location, and the location of the downstream vena contracta tap, vary with the ratio of orifice to pipe diameter, and with rate of flow, as shown in Fig. 11; the tap is generally located in accordance with the mean curve in the figure.

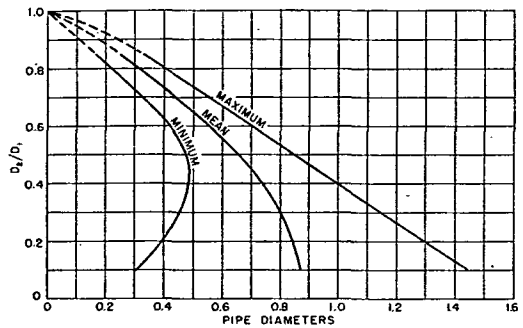

FIG. 11. LOCATION OF VENA CONTRACTA IN RELATION TO RATIO OF ORIFICE TO PIPE DIAMETER AND TO RATE OF FLOW

Expansion Factor for Gases

The expansion factor, Y, for gases (for liquids, $Y = 1$) is found from the empirical formula

$$Y = 1 - (0.41 + 0.35\beta^4)\left(\frac{p_1 - p_2}{p_1}/k\right) \qquad (59)$$

This is applicable to flange, radius, and vena contracta taps.

Values of Y for air, computed from these equations, are given in Fig. 12.

Computing Orifice Discharge

With this information it is possible to compute the discharge from an orifice if the Reynolds number is known. Here an odd complication is encountered—when the value of N_{Re} is computed, the rate of flow, which is the unknown quantity, must be used in the computation. However, it will be noted in Figs. 7, 8, and 9 that the orifice coefficient does not change greatly as N_{Re} changes. If, then, an estimate is made of the velocity, using this in computing N_{Re}, and if the corresponding coefficient is used in Equation 58, a value for the rate of flow will be found. Using