Then, since liquids are generally measured in gallons instead of cubic feet, and since there are 7.4805 gal in 1 cu ft,

$$Q_w = 334.86\, K D_2^2 \sqrt{h_w \left(\frac{1}{\rho_f} - 0.00118\right)} \qquad (65)$$

in which Q_w is the discharge or rate of flow, in gallons per hour.

Since liquids, for practical purposes, are incompressible, no expansion factor is necessary. If circumstances demand, the factor P for the expansion of the orifice may be applied. Also, if it is necessary to correct the volumetric discharge to a base temperature, application of the known expansion characteristics of the liquid will enable the conversion to be made. Values of K again are obtainable from Figs. 7, 8, and 9, according to the type of pressure tap.

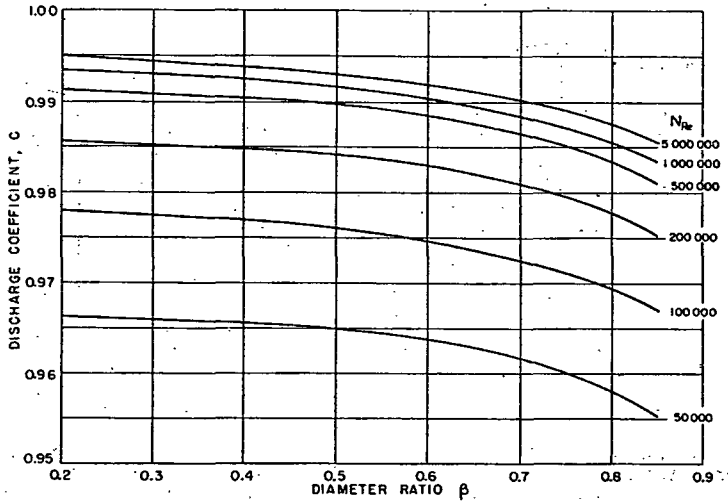

FIG. 16. RELATION OF NOZZLE DISCHARGE COEFFICIENT, C, FOR 2-INCH PIPE, TO DIAMETER RATIO AND REYNOLDS NUMBER

NOZZLE COEFFICIENTS AND EXPANSION FACTORS

Nozzles differ from orifices in that the flow is guided to the throat in such a way that contraction of the jet is suppressed, or, in other words, there is no vena contracta. Because of this fact, the coefficients are different from those of orifices, and are very close to unity before the velocity of approach factor is added. Also, the expansion factor may be deduced rationally, rather than empirically, as with orifices.

Two shapes of nozzles that have been under investigation by the *A.S.M.E.* for some time are shown in Figs. 14 and 15. They are referred to as long-radius nozzles. Their contour is that of a semi-ellipse, and the contracting portion is followed by a cylindrical section of the same area as the throat. The shape shown in Fig. 14 is designed for use with ratios of throat to pipe diameter of 0.53 or less, that of Fig. 15 for ratios of 0.4 to 0.7. The most usual location of pressure taps is 1 pipe diameter up-

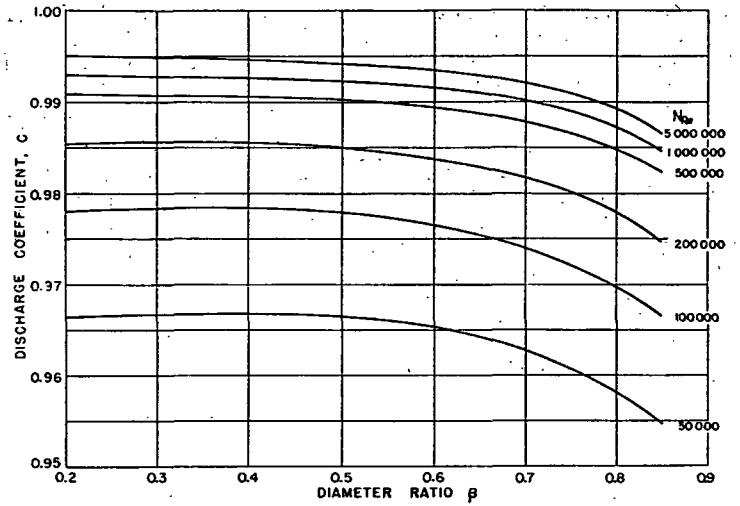

FIG. 17. RELATION OF NOZZLE DISCHARGE COEFFICIENT, C, FOR 6-INCH PIPE, TO DIAMETER RATIO AND REYNOLDS NUMBER

stream and ½ diameter downstream, both measured from the plane of the nozzle inlet. In addition, the *International Standards Association* has adopted still another shape of nozzle, which has a somewhat sharper approach than the *A.S.M.E.* nozzles, and which uses corner taps. Very little use of this nozzle has been made in this country.

The formulas already given for orifices apply equally to nozzles except for discharge coefficients, and for the expansion factor, when it is applied.

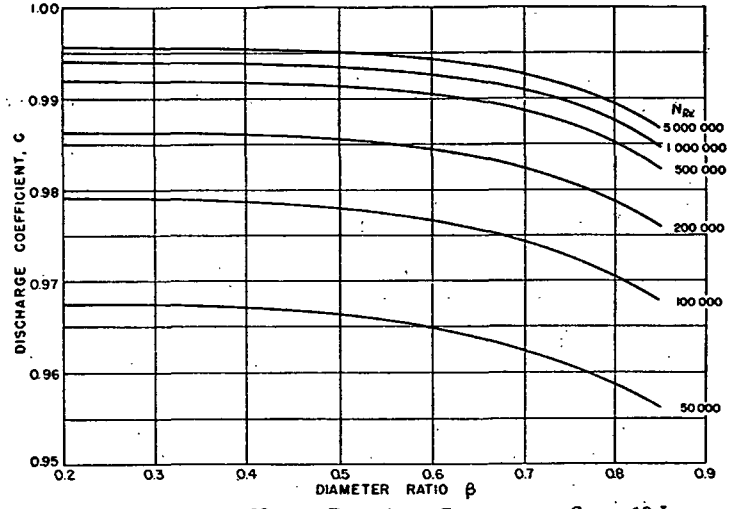

FIG. 18. RELATION OF NOZZLE DISCHARGE COEFFICIENT, C, FOR 10-INCH PIPE, TO DIAMETER RATIO AND REYNOLDS NUMBER