may affect the static pressure reading. If the static pressure openings point downstream in any degree, a suction effect is produced to falsify the reading. In instruments having the static pressure opening pointed downstream, the coefficient may be as low as 0.86. Consequently, for accurate work, Pitot tubes should be calibrated, and the pertinent coefficient should be applied to Equation 68. In a sense, this coefficient is advantageous, since it results in a higher differential reading, which, in turn, enables more accurate readings at low flows.

In using Pitot tubes, it is generally necessary to make a traverse of the pipe or duct to determine the course of the velocity pattern. In a pipe, for instance, one of the profiles shown in Fig. 5 would be obtained. Near a valve or fitting, however, the profile might be quite distorted, a fact which would be revealed by the traverse. If the pipe or duct is

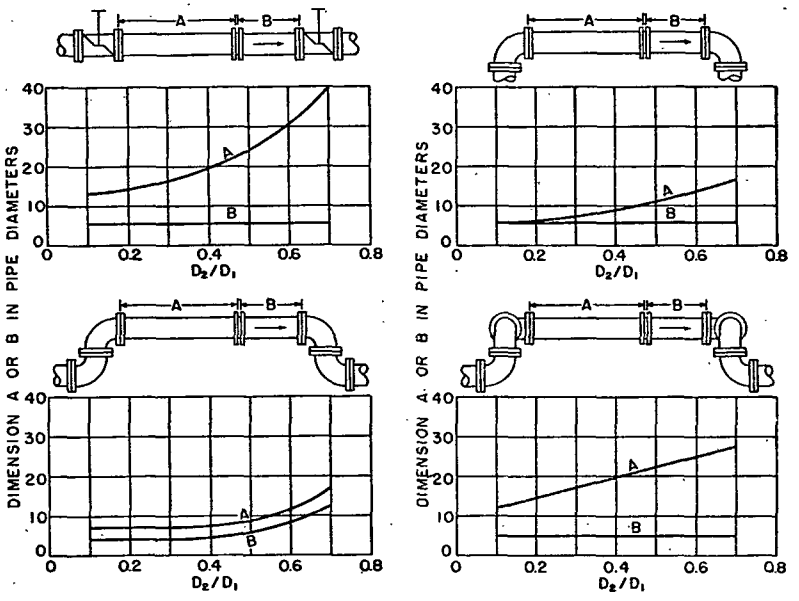

FIG. 21. MINIMUM CONDITIONS TO BE OBSERVED WHEN INSTALLING ORIFICES AND NOZZLES BETWEEN FITTINGS AND VALVES

divided into equal areas, and a determination of h_{aw} is made for each, the average velocity would be obtained by using the average of the square roots of h_{aw} in Equation 69.

INSTALLATION OF NOZZLES AND ORIFICES

A final note should be made of the installation of orifices and nozzles. Generally speaking, the orifice or nozzle, together with a holding arrangement, including pressure taps, is available from the manufacturer. In making the installation, the user should make certain that the flow approaching the nozzle or orifice is steady and evenly distributed, *i.e.*, with velocity profiles similar to those shown in Fig. 5. Fittings and valves,

which tend to direct the flow to one side and which in some cases cause it to rotate as it advances, must be far enough upstream from the orifice or nozzle to permit the disturbed stream to straighten out to the even form before reaching the meter. Minimum conditions in the installation for avoiding trouble from fittings and valves are shown in Fig. 21. If necessary, straightening vanes may be used upstream from the orifice or nozzle at a distance of not less than 8 pipe diameters.

LETTER SYMBOLS USED IN CHAPTER 4

β = ratio, throat or orifice diameter to pipe diameter.
μ = absolute viscosity in pounds per foot second.
μ/ρ = kinematic viscosity in square feet per second.
ρ = density of flowing fluid in pounds per cubic foot.
ρ_w = density of water at 60 F, (62.37 lb per cubic foot).
ρ_f = density of fluid over mercury in a manometer.
φ = expansion factor for nozzles.
A = cross-sectional area of flow, in square feet.
C = correction factor (coefficient of discharge) for flow through orifice, nozzle or Venturi.
c_p = specific heat of gas at constant pressure.
c_v = specific heat of gas at constant volume.
D = diameter of fluid stream in feet.
d = internal diameter of pipe in feet.
E = mechanical work in foot pounds per pound of fluid flowing.
e = absolute roughness of pipe surface, in feet.
f = dimensionless friction coefficient.
g = acceleration due to gravity = 32.17 ft per (second) (second).
G = specific gravity of gas referred to air.
h = enthalpy, Btu per pound of fluid.
h_{aw} = loss of head in inches of water.
h_f = loss of head in feet of fluid.
h_t = total head in feet of fluid.
h_w = differential pressure in inches of water.
J = mechanical equivalent of heat = 778 foot pounds per Btu.
K = flow coefficient (correction factor), including velocity of approach correction factor, for flow through orifice, nozzle or Venturi.
k = ratio of specific heat at constant pressure to specific heat at constant volume.
L = perpendicular distance from axis of pipe in feet.
l = length of pipe in feet.
N_{Re} = Reynolds number.
P = correction factor for expansion of orifice plate with temperature.
p = pressure in pounds per square foot.
p_c = critical pressure.
P_b = standard pressure to which correction is to be made, pounds per square inch, absolute.
P_f = pressure of gas flowing, pounds per square inch, absolute.
Q_b = rate of flow in cubic feet per hour under standard conditions of pressure and temperature.
Q_f = rate of flow in cubic feet per hour.
Q_s = discharge rate in cubic feet per second.
Q_w = rate of flow in gallons per hour.
q = heat transferred to the fluid per pound of fluid flowing.
R = gas constant.
R_H = hydraulic radius = ratio of area of cross-section to wetted perimeter of cross-section.
r = radius of pipe in feet.