sectional area of this stream is equal to the outlet wall area less the stream area and the area obstructed by furnishings. Equation 5 gives the average room velocity in the occupied zone as a function of the air volume supplied per square foot of outlet wall area and the outlet velocity.

$$V_r = \frac{Q_3}{AZ} \tag{5}$$

where

V_r = average room velocity, feet per minute.
A = outlet wall area, square feet.
Z = 0.6 (reduction factor to allow for supply air stream 20 per cent, furniture obstruction 20 per cent, at point where supply air stream occupies 20 per cent of the room cross-section).

Since $Q_3 = Q_1 r$ by definition, and $r = \frac{V_1}{V_3}$ from Equation 2, and V_3 is assumed to be about 200 fpm for total induction in actual practice, then Equation 5 results in:

$$V_r = \frac{Q_1}{A} \times \frac{V_1}{V_3} \times \frac{1}{Z} = \frac{FV_1}{120}$$

or

$$F = \frac{120\,V_r}{V_1} \tag{6}$$

where F is the room circulation factor expressed in cubic feet per minute per square foot of outlet wall area. Thus room air motion is directly a function of outlet velocity and air volume per square foot of outlet wall area. Hence Equation 6 and Table 1 can be used to determine the probable acceptability of a particular installation from the standpoint of proposed air volume, outlet wall area, and outlet velocity.

Vertical Drop and Rise

The vertical distance the lower edge of an air stream moves between the outlet and the end of the blow is termed the drop or rise (H). This drop or rise is influenced by the difference in density between the air stream and the room air, resulting from the temperature difference and the spread of the air stream. For air emerging at room temperature, the drop or rise will be a function of the spread only and will be equal to:

$$H = L \times \tan\left(\frac{\text{Spread Angle}}{2}\right) \tag{7}$$

where

H = drop due to spread, feet.
L = throw, feet.

Table 1. Values of Room Circulation Factor (F) in Equation 6

Outlet Velocity Fpm V_1	Average Room Velocity Fpm, V_r					Outlet Velocity Fpm V_1	Average Room Velocity Fpm, V_r				
	10	20	30	40	50		10	20	30	40	50
200	6.0	12.0	18.0	24.0	30.0	900	1.3	2.7	4.0	5.3	6.7
300	4.0	8.0	12.0	16.0	20.0	1000	1.2	2.4	3.6	4.8	6.0
400	3.0	6.0	9.0	12.0	15.0	1200	1.0	2.0	3.0	4.0	5.0
500	2.4	4.8	7.2	9.6	12.0	1400	0.9	1.7	2.6	3.4	4.3
600	2.0	4.0	6.0	8.0	10.0	1600	0.8	1.5	2.3	3.0	3.8
700	1.7	3.4	5.1	6.8	8.5	1800	0.7	1.4	2.0	2.7	3.4
800	1.5	3.0	4.5	6.0	7.5	2000	0.6	1.2	1.8	2.4	3.0

When there is a temperature difference between the air stream and the room, the additional drop or rise is approximately given by Equation 8:

$$H = \frac{n_1\,(t_r - t_{as})\,L\,n_2}{V_1} \tag{8}$$

where

n_1 and n_2 = constants (tentative suggested values $n_1 = 5$, $n_2 = 1.2$).
t_r = room temperature, degrees Fahrenheit.
t_{as} = supply air temperature, degrees Fahrenheit.

For cooling application H is subtracted from the outlet height, for heating H is added.

Duct Approaches to Outlets

Assuming that proper supply openings for a given installation have been selected, unsatisfactory performance may still result due to the construction of the duct work immediately back of the supply openings. Performance data on the grilles and registers of various manufacturers are based upon results obtained with the air approaching the grille perpendicularly and at uniform velocity over the entire duct cross-section. Where this condition does not exist in practice, performance predictions based on published data cannot be realized. Every precaution should be taken to secure as nearly ideal conditions in the approaching air stream as are possible.

In addition to disturbances due to the construction of the duct work itself are those which may be created by dampers immediately behind the grille. Where either multiple louver or single blade dampers are used for throttling, considerable deflection of the air stream may result. This is particularly true when the fins of the register core are perpendicular to the damper blades. If the core has sufficient depth and the fins are parallel to the blades, there is a marked tendency to straighten the air stream, although some deflection may still result.

Any attempt to secure a low face velocity and high duct velocity by the construction of any expanding chamber immediately behind the grille is likely to be unsuccessful. In order to expand from a small duct to a larger one, and have the air stream fill the duct at the end of the diverging section without turbulence, angle A in Fig. 2 should be about 7 deg. From this it is apparent that an attempt to secure equivalent results with a short connection would be futile. What actually happens when this is attempted is illustrated by the arrows in Fig. 2. When localized high velocities through the supply opening exist from this cause or any other, the noise produced will naturally exceed that which would be expected

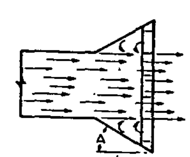

Fig. 2. Effects of Expanding Duct

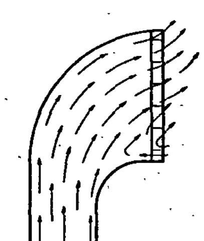

Fig. 3. Unequal Face Velocities

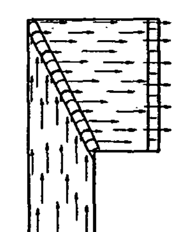

Fig. 4. Effect of Turning Member