

Balancing the System

In designing an air conditioning system it should be the aim of the engineer to size ducts and outlets in such a manner that proper distribution of supply air takes place. In practice, however, this is almost impossible and therefore additional means for regulating air distribution are required to *balance* the system. Some of these means are:

1. Reducing the effective area of some supply openings by blank-offs.
2. Placing dampers in the supply and return (exhaust) openings.
3. Placing dampers in the supply and return (exhaust) ducts.
4. Using combinations of dampers in both supply and return (exhaust) ducts.

In selecting the desired type of damper or balancing method the following points should be kept in mind:

1. Unfavorable effect on air stream and noise level should be avoided. This will often eliminate blank-offs and dampers installed in the supply and return (exhaust) openings, unless such dampers are of special design.
2. It should be possible to alter the volume control setting and measure the amount

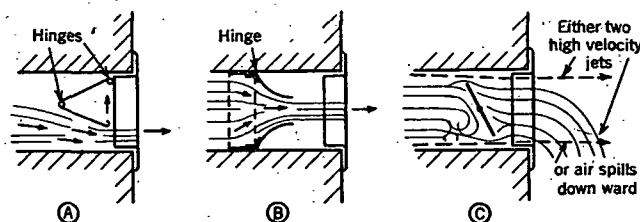


FIG. 7. EFFECT OF VARIOUS DAMPER ARRANGEMENTS DESIGNED FOR STRAIGHT BLOW

of air handled without difficulty. This will be particularly difficult to achieve in the case of blank-offs.

Generally speaking, it is most satisfactory to install dampers in the supply duct at some distance back of the outlets, so as to avoid disturbing the air flow. Dampers in both supply and return air ducts form the most flexible means of controlling supply of air to the room and static pressure within the room. Means of volume and directional control are discussed in detail in a following section of this chapter. Many types of air distribution control devices are now commercially available.

DIRECTIONAL AND VOLUME CONTROL

Duct Approaches to Outlets

In order to obtain proper direction of flow and distribution of air from outlets it is necessary that the air stream approaching the outlet be of uniform velocity over the entire connection to duct and perpendicular to the face.

Grilles and directional outlets cannot compensate for improper approach. Any attempt to secure a low face velocity and a high duct velocity by constructing an expanding chamber directly behind the grille is likely to be unsuccessful because the enlargement angle in even a straight duct cannot be

TABLE 1. RECOMMENDED RETURN INTAKE FACE VELOCITIES

INTAKE LOCATION	VELOCITY OVER CROSS AREA FPM
Above occupied zone.....	800 up
Within occupied zone, not near seats.....	600-800
Within occupied zone, near seats.....	400-600
Door or wall louvers.....	500-700
Undercutting of doors (through undercut area).....	600

greater than 7 deg at each side if the stream is to fill the outlet without turbulence.

In elbow outlets or stack heads at the top of vertical stacks it is necessary to provide splitters or guide vanes in the elbows regardless of the shape of the elbows whether of rounded, square or expanding types. Cushion chambers at the top of the stack heads have no beneficial effect. The direction of flow, distribution and velocity (measured 12 in. from outlet) of the air, based on tests⁵, are shown in Fig. 6 for various types of stack heads expanding from a 14 in. x 6 in. stack to 14 in. x 9 in. outlets, without grilles. The air velocity for each was 500 fpm in the stack below the elbow, but the direction of flow and the distribution patterns are generally indicative of performance obtainable with non-expanding elbows of similar shapes for a range of velocities 200 to 1400 fpm. Some of the conclusions drawn from the tests were:

1. Experiments with various elbow outlets on the 14 in. x 6 in. vertical stack⁵ with stack air velocities of 200 to 1400 fpm indicated that enlargement of the outlet area, whether used in connection with square or rounded elbows, would not reduce either the angle of discharge (which was 20 to 30 deg above the horizontal) or the outlet velocity. The effect of the enlargement of the outlet was mainly to increase the reverse flow area in the lower part of the outlet, but in each case enlargement of the outlet reduced the static pressure in the duct below the elbow.
2. Splitters in the elbows had the effect of dividing the air stream into a number of streams flowing through rounded elbows and therefore lowered the angle of discharge, reduced or eliminated the reverse flow area, and made the outlet velocity quite uniform.
3. Turning vanes having 2 in. inner and 1 in. outer radii located in the center of the elbow were found most effective in improving performance in regard to angle of discharge, outlet velocity, and elimination of reverse flow area.
4. Pressure loss through stack heads may be reduced by use of splitters or turning vanes or by increasing the inner radius of an elbow. Considering the sum of the velocity and static pressure as a measure of the energy required to change the direction of the air stream and to deliver the air into the atmosphere, and considering the energy required for a plain fitting as 100 per cent, it was found that *turning vanes* dropped the energy requirement of square type stack heads to 45 per cent. Splitters

TABLE 2. APPROXIMATE PRESSURE DROPS FOR LATTICE RETURN INTAKES
Inches Water Gage—Standard Air

PER CENT FREE AREA	FACE VELOCITY, FPM						
	400	500	600	700	800	900	1000
50	0.06	0.09	0.13	0.17	0.22	0.28	0.35
60	0.04	0.06	0.09	0.12	0.16	0.20	0.24
70	0.03	0.05	0.07	0.09	0.12	0.15	0.18
80	0.02	0.03	0.05	0.07	0.09	0.11	0.14