outlets are attached either directly to the bottom of horizontal ducts or to special vertical take-off ducts which connect the outlet with the horizontal duct. In all these cases, special devices for directing and equalizing the air flow are necessary to obtain proper direction and distribution of the air.

The influence of the duct approach on outlet performance has been investigated for vertical stack heads with plain openings[12] or equipped with grilles[13] and for side outlets on horizontal ducts.[14] In the tests conducted with the stack heads it was found that it is necessary to provide splitters or guide vanes in the elbows at the top of the vertical stacks 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. Fig. 13 shows the direction of flow, distribution and velocity (measured 12 in. from opening) of the air for various types of stack heads tested, expanding from a 14 x 6 in. stack to a 14 x 9 in. opening, without grille. The air velocity for each was 500 fpm in the stack below the elbow, but the direction of flow and the distribution pattern are generally indicative of performance obtainable with nonexpanding elbows of similar shapes for a range of velocities 200 to 1400 fpm.

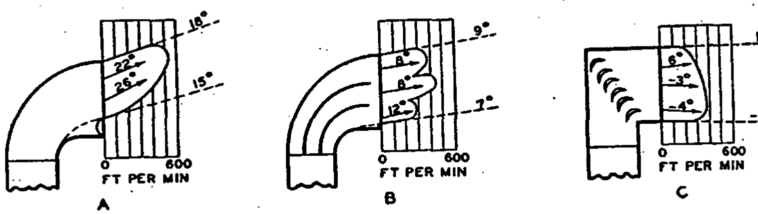

Fig. 13. Outlet Velocity and Air Direction Diagrams for Stack Heads with Expanding Outlets

Stack 14 in. x 6 in. Outlets 14 in. x 9 in. Stack Velocity 500 fpm
A. Rounded Throat and Rounded Back.
B. Rounded Throat and Back and 2 Splitters.
C. Square Throat and Back and 6 Guide Vanes.

In tests conducted with 3 x 10 in., 4 x 9 in., and 6 x 6 in. side outlets in a 6 x 20 in. horizontal duct at duct velocities of 200 to 1400 fpm (in the 6 x 20 in. section) it was found that multiple curved deflectors produced the best flow characteristics. Vertical guide strips in the outlet were not so effective as curved deflectors. A single scoop type deflector at the outlet did not improve the flow pattern obtained from a plain outlet, and was therefore not found to be desirable.

Directional Control

Many devices for directing and equalizing air flow in side wall and ceiling outlets are now commercially available, and should be used whenever necessary. They are indispensable for all side outlets in horizontal ducts and for most ceiling outlets.

Ceiling outlets are usually installed below horizontal supply ducts so that the supply air has to make a 90-deg turn before entering the outlet itself. The shorter the connection between bottom of duct and outlet, the greater is the need for directive devices to obtain uniformity of flow. Generally speaking, conditions and remedy in such cases strongly resemble those for side outlets in horizontal air ducts. Ceiling ducts often have a rectangular cross-section, while the connections to the ceiling outlets are circular. It will then be quite difficult to install turning vanes successfully, particularly if the ducts are shallow and the connection areas are comparatively large. This will be the case when more than one outlet is installed on one duct run, and restrictions of duct areas must be avoided. In such cases good results have been obtained by using a series of vertical guide strips, installed at right angles to the direction of air approach in the outlet connection where it leaves the horizontal air duct.

Volume Control

Various methods are used to regulate volume of supply and return (exhaust) air. Some of these accomplish only minor changes in volume; most of them however permit a range of adjustment from maximum air supply to complete shut-off.

When selecting type and location of such dampers, the following points must be considered, especially when the volume control feature is to be located near the air outlet itself: (1) deflection of air stream by the damper; (2) need and feasibility of directional control; (3) increase of noise level due to irregular and localized high air velocities caused by damper operation.

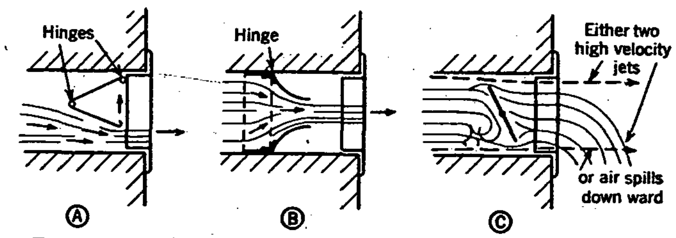

Fig. 14. Effect of Various Damper Arrangements Designed for Straight Blow

The following types of volume control are most frequently encountered:

1. *Slide Damper*. A single plate which can be pushed across the duct. Since its operation changes the free area of air passage in a one-sided manner, it should not be located near any air outlet, and its use is practicable only where no intermediate setting between full open and closed is required.

2. *Hit-and-Miss Damper*. Two slotted plates or discs, closely adjacent; by moving one of the two plates the respective slots may be opened or closed. This type of volume control may be installed close to an air outlet and it is easy to operate, but its main disadvantage is that even in the open position the air passage area is blocked by at least 50 percent. This requires oversizing of the air outlet in order to avoid excessive increase of noise level.

3. *Splitter Damper*. A single blade sheet metal plate hinged at one edge, usually located at the branch connection of a duct or outlet. It is easy to operate, but often causes irregular air flow in the duct. When used in connection with, and near an outlet, additional directional control is required.

4. *Butterfly Damper*. A single blade sheet metal plate hinged in the middle, usually located in a straight duct run. It is easier to handle than a splitter damper, since only half the motion is necessary to change its setting. However, if located too close to an air outlet, it is objectionable because its operation frequently results in a condition whereby two high velocity jets are created along the sides of the duct, or the air spills immediately downward into the occupied zone (see C Fig. 14).

5. *Louver Dampers*. Numerous designs have been developed incorporating a series of splitter or butterfly dampers across the duct or air outlet. Their main advantage consists in retaining greater uniformity of air flow, and in requiring less depth for installation. Some designs provide for louver blades moving in opposite directions, and while decreasing free air passage area, retain a constant air flow direction along the axis of the duct air outlet connection (see A and B in Fig. 14).