to neutralize any undesirable cold drafts or radiation effects set up by a concentration of the heating or cooling load. The problem can be divided into *natural loads* due to outside weather and *internal heat loads*.

In winter the natural or primary heating load is caused by exposed walls, windows and skylights. Heat is lost primarily through convection to these exposed surfaces. The convection currents or cold drafts drop down the exposed surfaces and seriously impair the comfort conditions in the room, particularly at the floor level near the exposed surfaces. The outlets should be located to counteract these down drafts. Methods which may be employed are:

a. Direct counteraction of convection currents from cold surfaces can be obtained by locating the outlets to blow upward from beneath windows or exposed walls or to blow across the exposed wall. This method is desirable in small offices or bedrooms, or any location where people are seated or working near exposed surfaces. In northern climates, where the outside temperature may be constantly below 40 F, and the construction consists of uninsulated walls and single glass, this method of distribution is particularly useful for the maintenance of comfort requirements.

b. High induction by ceiling or wall outlets may be employed to nullify the convection currents from exposed surfaces. If outside temperatures are consistently below 40 F, and the exposed surfaces are not well insulated, the induction effort required for neutralization of the downdrafts is so great that the air motion in the room may exceed comfort limits unless care is taken in selection and location of the outlet. Where comfort conditions are not critical as in factories for heavy manufacturing, warehouses, etc., satisfactory results can be obtained even in cold climates. For uninsulated walls and glass areas some supplementary heating is often valuable. Wall diffusers, direct radiation or warm panels will satisfy these requirements for supplementary heating.

c. The location of exhaust or recirculated air openings at the base of large areas of glass is sometimes effective in reducing cold downdraft into the occupied space.

If a *concentrated source of heat* creating an *internal heat load* is located at the occupancy level of the room, the heating effect may be counteracted by blowing the supply air toward the heat source or by locating an exhaust or return grille adjacent to the heat source. The latter method will prove more economical, as heat will be withdrawn at its source rather than be dissipated into the conditioned space. Where a lighting load is particularly heavy (five watts per square foot) and located high in a conditioned space, it may be economically desirable to locate the outlets below the lighting load. Warm air from the lights will stratify near the ceiling and can be removed by an exhaust or return fan, the former being advisable if the wet-bulb temperature of the air is above the outside temperature, and the latter being preferable if the wet-bulb temperature is below that of the outside air. Either method reduces the requirements for supply air. If the lamps are exposed, less saving can be realized than if enclosed, as a considerable portion of the total energy is radiant.

4. *Outlet Performance*. The laws of air distribution, previously discussed, will be found to exercise an important influence upon the design of an acceptable distribution system. This applies particularly to such features as throw, drop, capacity and room air motion.

Procedure for Outlet Location and Selection

In determining outlet location and selecting the type of outlets it is customary to proceed as follows:

1. Study the plan of the building and note the amount of air to be supplied to each enclosure.

2. Select number of outlets for each enclosure considering air quantity required and distance available for throw or as radius of diffusion. The same factors, as well as distance from floor level available as mounting height, structural characteristics of the space and frequently consideration of appearance will determine the type of outlet used.

3. Arrange location of outlets in space. Usually the outlets will be evenly spaced to distribute air uniformly throughout the enclosure. Sometimes, however, more air should be supplied and directed towards zones of exceptional heating or cooling loads. An important point to consider is the combination of proper outlet location and efficient duct design (see Chapter 41). Consult manufacturers' tables for recommended location and spacing of outlets.

4. Select size of outlets according to air quantity handled, permissible throat or discharge velocities or effective throw, taking into consideration other factors such

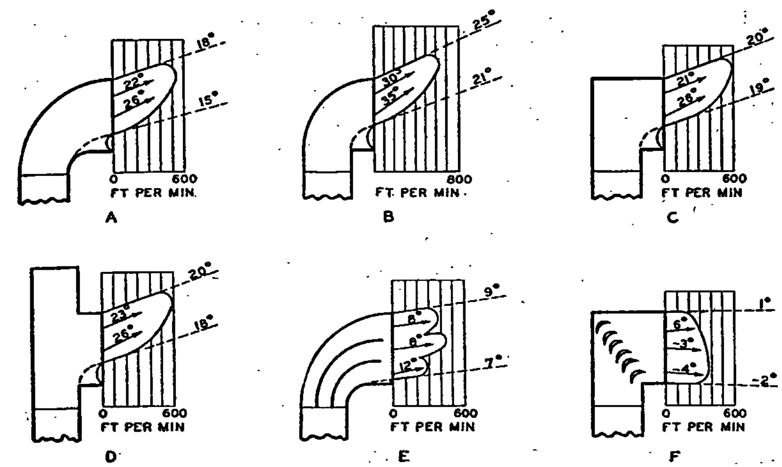

Fig. 6. Outlet Velocity and Air Direction Diagrams for Stack Heads with Expanding Outlets

Stack 14 in. x 6 in. Outlets 14 in. x 9 in. Stack Velocity 500 fpm

A. Rounded Throat and Round Back. D. Square Throat and Cushion Chamber.
B. Square Throat and Round Back. E. Rounded Throat and Back and 2 Splitters.
C. Square Throat and Back. F. Square Throat and Back and 6 Guide Vanes.

as noise level, static pressure resistance, etc. It will be generally found that most selection tables for grille type outlets are based on capacity and throw, whereas data for ceiling or wall diffusers are usually based upon capacity and permissible outlet velocity. Choice and arrangement of either type of outlet should however satisfy the requirements of all aspects of air distribution. Therefore, type, location and size of any outlet should be checked against manufacturers' ratings to determine whether the selection made would satisfy the requirements of the job. The most important questions to be considered are:

a. Can drafts occur because of divergence between rated throw (radius of diffusion) and distance between outlet and nearest obstacle of air stream (wall, beam, pillar, ledge, etc.)?

b. Can drafts occur because of excessive cooling temperature differential and too low mounting height of the outlet?

c. Can drafts occur because of too low velocity causing a drop in cooling installations?

d. Will the outlet operate at too high a velocity and thereby cause an excessive increase in noise level?

e. Will the outlet operate against an excessive static pressure resistance?