3. *High-Pressure or High-Velocity Outlets.* Refer to text in section Wall Outlets.

4. *Perforated Ceilings and Perforated Panels.* These devices discharge air through perforations in the ceiling or part of the ceiling, and share with slotted outlets the advantage of unobtrusive appearance. In addition, sound absorbing materials may be used for the panels, or the panels may provide a luminous ceiling.

Outlet air velocities may be kept low by using large outlet areas, particularly in spaces with high room loads, high ventilating requirements or low ceilings. Some perforated panels have a control plate frame which is inserted in the conventional ceiling duct. Supply air enters the plenum above the distribution plates through an adjustable air valve which can be set for varying air quantities and velocities.

OUTLET LOCATION AND SELECTION

The design of the air conditioning plant for a building depends on the use to which the building is put, on its size, and its construction type; the design of the air transmission and air distribution system is influenced by the same factors. Therefore, these factors must be considered in designing the air transmission system, and in selecting the type and location of the supply outlets. The location and selection of the supply outlets is further influenced by the interior design of the building, local sources of heat gain or loss, and outlet performance and design.

Use, Size, Construction of Building

The use, size and construction of a building are three factors which may influence or even govern the selection of a particular type of air distribution system, as is shown by the development of special high-pressure or high-velocity transmission and distribution systems for multi-room and other buildings. Generally, the physical construction of the individual rooms of a building, such as height and shape and the location of beams and other obstructions, influences the possible location of the supply ducts which in turn influences the outlet locations. The location of the supply ducts—above the ceiling or within the walls, in a furred space above corridors, or in the conditioned room itself—has an important bearing, therefore, upon the design of the air distribution system. A particular method of air distribution may be highly desirable but it may be impossible to use it, due to the location of beams and masonry walls.

Refer to section Specific Applications for a discussion of air distribution methods in various buildings.

Heat Gain or Loss

Local sources of heat gain or loss promote convection currents or cause stratification, and may, therefore, determine both the type and location of the supply outlets.

Generally, the outlets should be located to neutralize any undesirable convection currents set up by a concentrated heating load. If a concentrated source of heat 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 second method is more economical, as heat will be withdrawn at its source rather than be dissipated into the conditioned space. Where lighting loads are heavy and ceilings relatively high (five watts per sq ft and above 15 ft), the outlets should be located below the lighting load, and the stratified warm air removed by an exhaust or return fan. An exhaust fan is recommended if the wet-bulb temperature of the air is above that of the outside temperature, a return fan, if it is below this temperature. Either method reduces the requirements for supply air. If the lights are exposed, less saving can be realized than if they are enclosed, as a considerable portion of the energy is radiant.

An important function of any supply outlet during *winter heating* is to maintain the temperature difference between the floor and ceiling at the lowest possible value. Since the air within a room is never so perfectly mixed that all of it is at exactly the same temperature, a certain amount of stratification is inevitable. Unless the supply outlets are properly selected and located, the temperature difference will be large enough to result in discomfort to the occupants.

The proper selection and location of outlets is particularly difficult for rooms with large windows and exposed wall areas. Heat is lost primarily through these areas, and room air in contact with these surfaces is chilled and flows downward, causing drafts near the exposed surfaces and floor.

This condition can best be prevented by locating the air outlets under the windows, by discharging warm air across the exposed surfaces, or by providing supplementary radiation under the windows, in addition to the wall or ceiling air distribution outlets. This solution must be used for comfort installations in northern latitudes (outside temperatures below 40 F), when the building walls are uninsulated or single-glass windows are used.

In buildings located in regions where winter heating is a minor problem, high induction by ceiling or wall outlets may be employed to mix properly the entire room air with the supply air and to prevent downdrafts along the exposed surfaces. In northern latitudes, this solution can only be used if the buildings have double-glass windows and insulated walls, as otherwise the induction effort required for neutralization of the downdrafts is so great that the air motion in the room exceeds comfort limits. Where comfort conditions are not critical as in factories for heavy manufacturing, warehouses, etc., satisfactory results with high induction outlets can be obtained even in cold climates. For uninsulated walls and glass areas in these buildings some supplementary heating is often valuable. Wall diffusers, direct radiation or warm panels will satisfy these requirements for supplementary heating.

The location of exhaust or recirculating air openings at the base of large areas of glass is sometimes effective in reducing downdrafts into the occupied space.

Great care should be exercised in the use of supply-exhaust air outlets for heating in northern latitudes when considerable exposed wall and window surfaces are involved. In such cases additional radiation is usually required. When the system is used for ventilating only during the heating season, direct radiation should be regulated to provide heat until room and outside temperature are balanced. To avoid stratification, it is advisable to operate the fan continuously and to limit the temperature differential by supplying air at a high rate of change per hour.

Outlet Performance and Design

The physical laws of air distribution have, of course, a highly important influence upon the design of an acceptable distribution system.

Refer to section Ventilating Jets in Air Distribution for a discussion of the theory, and to section Outlet Performance for some specific advice with regard to such features as throw, drop, capacity, temperature differential, room air motion, permissible noise level, smudging and their influence upon practical air distribution.

Outlets should perform efficiently and conform to the esthetic appearance