An idea for producing even distribution of air consists of a perforated ceiling made of a suitable architectural surface and installed a small distance below the normal ceiling level of the room. In the space provided by this suspended ceiling a plenum chamber is formed into which the conditioned air is introduced. From the plenum space the air is permitted to diffuse through the large number of small ceiling openings into the room.

Railroad Cars

The early practice of air conditioning railroad passenger cars consisted of a system of bulkhead distribution for the conditioned air. The air was discharged through an inlet opening at each end of the car toward the middle with the flow parallel to the long dimension of the car. This type of installation resulted in drafts in the middle of the car and was considered unsatisfactory except for small sections that did not require large quantities of air. Later designs incorporated a duct delivery system on each side of the car roof directing the air through numerous inlet openings toward the middle of the car where the two air streams come in contact and deflect downward, gradually filtering into the aisle. At the present time, several center duct air distribution systems are used in railroad car applications. In some instances, square or circular ceiling outlets connected to a center duct have been used, which distribute the air along the ceiling in widening circles and at right angles to the inlet opening. Another method consists of a continuous slot in the bottom of the duct to which is attached a flat plate so that the air is deflected along the car ceiling. There are also installations in which the ceiling of the car is constructed of perforated metal through which the conditioned air flows through thousands of openings from a plenum chamber. Extensive tests of all methods of air distribution indicate that desirable results are obtained from an inside center duct with a large number of openings.

Sleeping cars present a special problem in air distribution on account of the berth curtains. In some cars, each lower berth is equipped with an individual fan to draw in cooled air from the aisle. In other cars, small individual ducts with adjustable air outlets deliver air from the central supply system to each lower berth. Upper berths require no special arrangement.

BALANCING SYSTEM

In designing an air conditioning system, it should be the aim of the engineer to so proportion the duct system that proper distribution of air to every outlet will be obtained. Since this is almost impossible to accomplish in practice, it becomes necessary to have means of balancing the system to secure the desired amount of air in each space. There are a number of ways in which this may be accomplished, some of which are listed:

1. Dampers on the supply grilles.
2. Dampers on the return grilles.
3. Dampers in the supply ducts.
4. Dampers in the return ducts.
5. Reducing the effective area of some outlets by blank-offs.
6. Combinations of dampers in both supply and return air.

Dampers on the supply grilles themselves are objectionable because of their effect on the air stream. Dampers on the return grilles are frequently helpful in building up a static pressure in the room to prevent infiltration of outside air, and at the same time reduce the volume of incoming air. However, it is frequently impossible to sufficiently reduce the incoming air by this method alone. A damper in the supply duct some distance back of the outlet forms a very satisfactory means of regulating the flow without disturbing distribution across the outlet face. A damper in the return air duct has the advantage over one immediately behind the grille in that it does not tend to create high localized velocities through the grille as the latter might do if nearly closed. Blank-offs consisting of pieces of sheet metal covering a portion of the outlet face can frequently be used satisfactorily, although determination of just what is required is a matter of experiment, and the balancing of the system is not nearly so conveniently accomplished as with dampers. Dampers in both supply and return air form the most flexible means of controlling the supply to the room and the static pressure within the room. When feasible, these dampers, particularly those in the supply ducts, should be a substantial distance from the outlet, and ahead of the acoustic duct lining if used. Due consideration should also be given to the use of the several volume control and uniform distribution devices now available. See *Catalog Data Section*.

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PROBLEMS IN PRACTICE

1 ● What important factors are involved in the correct distribution of air to an enclosed space?

Not only is it important to distribute the air from the fan to the various spaces served by the system, but also the air must be properly distributed within the enclosed space to give complete satisfaction.

2 ● Upon what basis should the selection of supply outlets be based?

If possible, the selection should take advantage of the maximum velocity permissible from a noise standpoint.

3 ● What factors in grille design effect the length of air throw?

a. The temperature difference between incoming and room air, *b.* height of grille above floor, *c.* face velocity, *d.* core area, *e.* core aspect ratio, and *f.* design of grille.

4 ● How does the height of a supply outlet affect the temperature differential within a room?

In general, the higher the outlet is above the floor, the greater may be the difference between room air and incoming air temperatures.