per cent of the heating equipment is necessary to handle only the outside air load.

For normal conditions, 10 cfm of outside air per passenger is sufficient. When smoking is permitted, at least 15 cfm should be admitted. In some of the dining cars and deluxe sleeping cars, outside air rates as high as 20 and 30 cfm per occupant are used.

Method of Air Distribution

The fact that the amount of space devoted to railway passengers may be as low as 60 cu ft per person (ranging as high as 190 cu ft per person), coupled with the high air flow rates made necessary by severe ventilation and sun loads, makes the problems of air distribution and air delivery in railway cars critical ones.

Various methods may be used to distribute the air delivered to the interior of the car by the circulating fan or blower. The methods commonly used are:

1. A duct lengthwise along the center of the car.
2. One or two side ducts built on the outside of monitor-roofed cars, or on the inside of turtle-backed or arched-roofed cars.
3. Free discharge at the end bulkheads, or by free discharge from a unit placed overhead in the center of the car, discharging toward the ends. This bulkhead delivery system, while inexpensive, is apt to cause complaints due to drafts, and, accordingly, is not being favored.

Delivery grilles and plaques are used, and are often designed to give considerable entrainment and mixing to avoid cool drafts.

Smoking rooms present a special problem. The cloud of smoke that usually hangs near the ceiling can be broken up by having the incoming air directed along the ceiling in all directions at a velocity somewhat higher than that used for the rest of the car. The air should be exhausted from the room by a fan or through a grille to the washroom or lavatory, and then outside by a fan in a ventilator.

For compartments an adjustable supply duct outlet grille of suitable size and design should be provided and provisions made in the door or partition for the removal of the air to be recirculated.

Lower berths in sleeping cars and office cars should be provided with an adjustable air outlet which will discharge the amount of air desired at low velocity in any direction so that the occupant can regulate the ventilation to meet his own requirements.

In cars containing but one or two rooms or compartments, satisfactory results may be obtained by discharging the air directly from the conditioning unit into the upper part of the car. Care must be taken to have a proper discharge velocity. If the velocity is too low, the air will drop before reaching the end of the car and if too high it will discharge against the end bulkhead and be reflected back. Care must be exercised to secure proper circulation, otherwise objectionable drafts will be experienced.

The recirculating air grilles are usually of the straight flow type, and should be located so that objectionable drafts will not be created by the return air. The outside air intakes, located in the car vestibule, on the side of the car, or on the roof of the car, depending upon the location of the cooling coils, should be of ample size to permit the entrance of sufficient outside air. On many of the recently air-conditioned cars, there are no dampers or shutters at the outside air intakes, the percentage of outside air being controlled by blocking the flow through the recirculating grille.

Air Cleaning

All of the air circulated by the blower is filtered before passing over the cooling coils. In some cars the outside and recirculated air are filtered separately before mixing, while on others the air from the two sources is mixed before passing through a common filter. Filters in use are made of metal, wool, cloth, spun glass, hemp, paper, hair, and wire screen. Most filters have a viscous coating of oil for greater cleaning efficiency. Some types may be cleaned, retreated, and returned to service while other types are discarded when dirty.

RAILWAY PASSENGER CAR WINTER AIR CONDITIONING

The majority of cars in service use steam from the locomotive or from a head-end, oil-fired boiler as a source of energy for winter heating. In some instances electrical energy from either a head-end generating set or motive power supply is utilized for resistance heating. In still other cases electrical energy and waste heat from individual car engine-generator sets is employed. The peak heating loads which depend largely upon the amount of insulation used in the car, the type of windows (whether single or double glazed), and the ventilation rate, may vary from 150,000 to 250,000 Btu per hour.

In order to temper the cold outside air, about 30 to 50 per cent of the total heat energy required is distributed by means of finned coils or resistance heaters located in the outside air duct. The remainder is usually transmitted to the car air by finned tubing located along the sides of the car near the floor, thus preventing cold convection currents falling from the car windows from reaching the feet of the passengers.

RAILWAY PASSENGER CAR SUMMER AIR CONDITIONING

Three general types of cooling or refrigerating equipment are being used in the 11,700 railway cars which are now air conditioned in the United States. Of these 3,900 are ice-activated, 1,900 use steam jet systems, and 5,900 employ mechanical compression schemes. These systems which functionally are identical with those used for stationary applications (see Chapter 25) are modified in design to meet the requirements of mobile service. Contrasted with stationary applications of summer conditioning equipment, the use of water as a final means of heat disposal from condensers cannot be resorted to because water in such quantities cannot be transported economically. Accordingly, air cooled or evaporative condensers are always used, with the result that mobile cooling equipments operate at higher temperature, pressure, and power requirement levels than stationary equipment.

The maximum cooling and dehumidifying load which depends largely upon the amount of insulation, the type of windows, the ventilation rate, the sun intensity, and the number of passengers may vary from 60,000 to 96,000 Btu per hour.