centage of outside air should be kept as low as possible to maintain the air in the proper condition in order to minimize the heat or cooling load.

For normal conditions, 10 cfm of outside air per passenger is sufficient. When smoking is permitted, 12 to 15 cfm per passenger should be admitted. Under exacting demands and adverse condition, it may be necessary to increase the quantity to 20 cfm per passenger.

Method of Air Distribution

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.

For details of air distribution and duct design, see Chapters 28 and 29.

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.

The grille used for this purpose should be designed and arranged so as to obstruct the vision of passengers, but still allow the air to pass from the room to the recirculating grille at the air conditioning unit.

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.

STEAM OR VAPOR HEATING EQUIPMENT

The majority of cars in service are heated by circulating low pressure steam or vapor through pipes located along the side walls near the floor. When an air conditioning unit, using air from the outside, is installed it is necessary to provide a heating coil to warm the air during cold weather. Usually from 30 to 40 per cent of the heat required is supplied from the air conditioning unit and the balance from the floor heating system. It is necessary to have sufficient floor radiation to keep water lines in the car from freezing while standing in the yard with the air conditioning unit shut off. In new and some rebuilt cars, finned pipes are used for the floor heat to provide greater radiation surface. A few cars have the heating pipes enclosed in a duct, through which air is forced by a fan, the warmed air discharging through numerous openings along the floor. The amount of heat required depends upon the type and construction of the car, especially the amount and kind of insulation, outside temperature, wind velocity and direction, train speed, number of passengers, and inside temperature desired. In severe weather, with temperatures from −10 to −20 F, an average of approximately 200 lb of steam per car per hour is required. Pullmans require approximately 250 lb per hour, coaches 150 to 175 lb per hour and baggage cars 150 lb per hour.

COOLING EQUIPMENT

Three general types of cooling or refrigerating equipment are being used with satisfactory results. These are the ice-activated, the steam-ejector and the mechanical compression systems. These systems when arranged for car use, function the same as in stationary service, but must be more compact and lighter in weight. See Chapter 24 for description of the general principles of the various systems.

The mechanical compression systems are divided into three general classes depending upon the type of drive for the compressor, namely, the electro mechanical, the direct mechanical, and the internal combustion engine mechanical. The compressor of an electro mechanical compression system is driven by an electric motor, the power for which is supplied by a generator and a storage battery. The generator is driven from the car axle by a gear, belt, or other type of mechanical drive. The compressor of a direct mechanical compression system is driven directly from the car axle by means of a mechanical drive, the speed of the compressor being regulated by an electric speed control which permits slippage at high train speeds. The compressor of the third type of mechanical compression