system is driven by an internal combustion engine operating on propane. Sufficient fuel for several days' operation is carried in drums mounted in a rack under the car.

The refrigerant frequently used in the mechanical compression systems is dichlorodifluoromethane. The condensers are cooled by blowing a large quantity of outside air over the dry condenser coils, or over the coils wet by a spray of water to obtain the benefits of evaporative cooling. The latter method gives lower discharge pressures which is a distinct advantage when operating at high outside temperatures. A device gaining in popularity is a liquid subcooler by means of which the liquid refrigerant is subcooled by evaporative cooling, producing more available refrigeration at the air conditioning unit.

Another type of system which has been tried for railway passenger car air conditioning uses dry ice as the refrigerant, the equipment being essentially the same as for the water ice-activated system. Until an adequate supply of dry ice can be assured at a stable and reasonable price, this system will not be a serious competitor to the other three types now in use.

The capacity required in the refrigerating system depends upon a number of factors such as size and type of construction of car, thickness and kind of insulation used, the amount of heat produced within the car by motors, lights, and other appliances, the amount of outside air, the intensity of solar radiation, the number of occupants, and the inside temperature desired. The sun load on a bright day is about 1.2 tons. For average cars on sunny days, with high outside temperatures and humidities, from 65,000 to 80,000 Btu per hour will have to be removed from the interior of the car to maintain an inside effective temperature within the comfort zone. This means that a refrigerating capacity of from 5.5 to 7.0 tons will be required.

HUMIDITY CONTROL

The temperature to be maintained in a car depends upon the outside temperature and the humidity desired inside the car. With a low humidity it is necessary to maintain a higher temperature to establish a desirable comfort condition. Little humidity control has been attempted on cars up to the present time. A certain degree of automatic humidity control is secured with cooling, but the relative humidity obtained depends largely on the temperature of the evaporator, which should be below the dew-point temperature of the air. With certain outside atmospheric conditions it may not be possible to operate the conventional equipment with a sufficiently low evaporator temperature to reduce the humidity without dropping the temperature too low. One method has been developed whereby the evaporator temperature is carried below the dew-point a sufficient amount to insure dehumidification and then the cold air is heated to the proper temperature by passing it over coils through which part of the high temperature liquid from the condenser is by-passed. Such a system is costly and has not been generally applied.

During the heating season humidification is desirable from a comfort standpoint, but unless properly controlled, condensation will appear on

the windows. A steam or water spray controlled by a humidistat will provide the necessary moisture for humidification. There are several cars with this feature now in use.

TEMPERATURE CONTROL

The control of the air conditioning equipment should be simple and automatic in order to eliminate the human element for the selection of the control point. The use of a centralized panel for all switches, fuses, relay, etc., will simplify the installation and operation. Generally, separate thermostats are used for heating and cooling control. The best location for the thermostats depends upon the car layout and method of air distribution and can best be determined for any particular type of car and equipment by careful consideration of the several factors involved. The floor heat thermostats are usually located near the floor. The overhead heat and cooling thermostats are placed in the upper part of the car, sometimes in the air ducts or at the recirculating grille. All thermostats should be located so that the air can circulate freely around them. Maintenance of uniform comfort conditions for cooling, floor and overhead heating, has been satisfactory with provisions for a high, a medium, and a low thermostat setting and in some cases two settings have been satisfactory for cooling. In many cars the following points have been found to be satisfactory: 72, 74, and 76 F for cooling, and 60, 71 and 74 F for floor and overhead heating.

A few cars are in operation in which the inside temperature is varied dependent upon the outside temperature in order to prevent too high a differential between inside and outside temperatures. The maximum inside dry-bulb temperature permitted by these controls is usually 80F.

The heating and refrigerating equipment should be interlocked so that they cannot both operate at the same time. While heating, the control should be so arranged that in case of a steam failure the blower fan will stop or the outside air intake should be closed to prevent cold outside air from being introduced into the conditioned space.

POWER SUPPLY

One of the most important problems to be solved in connection with railway car air conditioning is that of power supply. The majority of non air-conditioned cars now in service are electrically lighted and equipped with fans. Power is furnished by storage batteries and axle generators of from 2 to 5 kw capacity.

Electric Power Requirements

When air conditioning is installed the electrical load is increased, according to the type of system as indicated in Table 1. To furnish this additional electric power, the capacity of the axle generators must be increased to 4 to 20 kw, and the storage battery capacity increased, in addition to that required by the car lighting system by 400 to 700 amp-hr for the electro-mechanical system, by 150 to 300 amp-hr for the steam-ejector and direct drive mechanical systems, and by 50 to 200 amp-hr for the ice-activated and internal combustion engine mechanical systems.