or to distributing slots at the edges of the package racks. Some coaches employ a false ceiling to provide a duct, with delivery taking place from numerous perforations in the ceiling.

Return air grilles and filters are usually located near the rear ceiling where the evaporator is placed. Outside air intakes and filters are located preferably near the front of the vehicle so as not to contaminate this supply with exhaust fumes and road dust. Of the 30 cfm circulated per person, about 8 to 10 cfm are outside air. Power for the motor driving the centrifugal fans is obtained from the bus battery.

More recently a coach design has been brought out which provides for a number of return air outlets below the seats; these permit return air to enter a longitudinal duct below the floor. The filters and evaporator are located in this duct near the front of the vehicle. A central heating coil utilizing waste heat from the coach engine is also located in this duct. Conditioned air is delivered through a pair of vertical ducts to a package rack distribution scheme.

Summer conditioning systems for these vehicles range in cooling capacity from 36,000 to 48,000 Btu per hour. Mechanical compression systems using dichlorodifluoromethane are used, and are powered by water cooled, gasoline engines of approximately 14 hp.

Complete systems add from 800 to 1300 lb to the weight of a coach. Sometimes an auxiliary generator driven by the air conditioning engine is used and serves to help charge the bus battery, thereby offsetting the power drain imposed by the ventilating blower. Belted reciprocating compressors and direct driven V-type and rotary compressors are used, with engine speeds up to about 1800 rpm. Air cooled condensers for this service require about 5000 cfm of outdoor air, and this is provided by either centrifugal or propeller type fans belted or direct driven by the air conditioning engine. Preventing noise and vibration from affecting passengers is of vital importance. Installations must be made so that quick daily servicing of the engine is possible. In all cases fuel is obtained from the main bus tanks, and in some cases the main engine water cooling system is used to cool the air conditioning engine.

In the de luxe equipment, after the driver has started the air conditioning engine by means of its own cranking motor, the engine speed is modulated automatically as the refrigeration demand is partially met, and if this demand is then fully met, the engine is stopped thermostatically. Restarting when the cooling thermostat is no longer satisfied is accomplished either automatically or manually. The various protective and automatic devices on the refrigerant and engine systems make some of the bus air conditioning control systems quite complicated.

AUTOMOBILE SUMMER AIR CONDITIONING

Recently summer cooling has been applied to automobiles. The average present day automobile with little insulation, large, single glazed window areas, and high infiltration and exfiltration losses, requires about 15,000 Btu per hour of cooling capacity. One system utilizes a reciprocating compressor belted from the main engine fan shaft thus operating at varying speeds up to 3000 rpm. The resulting refrigeration capacity varies from about 6000 Btu per hour at idling speed to 24,000 Btu per hour at maximum car speed.

A dry air condenser is placed in front of the engine radiator, and the liquid and suction refrigerant lines run back under the car floor to the

evaporator which is located in back of the rear seat. Conditioned air is delivered into the car just above the shelf near the back of the rear seat. A return grille is provided under the rear seat, and the recirculated air is filtered. Outdoor air is provided by infiltration. Power for the air circulating blowers is obtained from the car storage battery. Equipment of this nature increases the car weight approximately 200 lb.

AIRPLANE AIR CONDITIONING

Complete air conditioning of planes in flight has received little attention probably because of added weight of equipment necessary. Under ordinary conditions heating and temperature control become the chief considerations. Passenger and military planes even at low level flying require no cooling and at extreme altitudes the design temperature of the atmosphere is as low as 60 deg below zero.

In the operation of internal combustion engines the heating value of fuel appears approximately one-third as power, one-third transferred to cooling fluid, and one-third in the exhaust gases.

Ordinarily, the heat in the exhaust gases is ample for all heating needs, despite the excessive transmission loss due to high speed, low temperatures, and light wall construction. The maximum coefficient of heat transmission without insulation is found to be 2.3. The minimum coefficient with insulation is 0.3. For present day construction a value of 0.6 may be assumed for speeds not exceeding 300 mph. Naturally, the waste heat in the exhaust gases offers an attractive source for designers of heating equipment, who have followed closely the development of heating as applied to land structures. In first attempts heat was obtained from an annular space surrounding the exhaust pipe, from which branches conducted the heated air to grilles or to seats of passengers. The speed of the plane eliminates the need for a fan or pump. In present practice danger of carbon monoxide contamination is reduced by the use of both primary and secondary heat exchangers.

Heating systems using hot air are in use for passenger and military planes. Steam systems have been used with boilers located in the path of exhaust gases but difficulty experienced in preventing freezing of the water has apparently rendered this system unattractive. A similar system using glycol is in use and requires special care because of the peculiar qualities of glycol. Thermostatic control, mixing dampers and air distribution vary little from standard practice. Controlling devices are built to withstand the extensive vibrations experienced. Planes requiring air conditioning when on the ground are satisfactorily serviced by portable air conditioning machines. High flying airplanes—above an elevation of 14,000 ft—require oxygen supply or pressurized cabins. The compression of the outside air by the supercharger raises the temperature of the cabin air from an extremely low to a comfortable high. The compression of the air also increases the humidity. Cleanliness at flying altitude is not a consideration, except under special conditions such as above deserts or upon encountering dust storms. In small planes carrying several passengers or crew, localized heating and ventilation are provided. Electrically heated clothing and oxygen masks often are required in combat aircraft. At high altitudes pressurized cabins require no special oxygen supply.

Medium bombers at one time were equipped with separately fired heating units, but larger bombers, to meet the heating load imposed by