PASSENGER BUS AIR CONDITIONING

The passenger bus designed for urban transportation operation presents a greater problem to the designer of heating systems than does the inter-urban bus. More frequent stops, and rapidly changing passenger load create this problem on urban vehicles. Provision of heat for the driver independent of the passenger heating system, is a further problem. The inter-urban bus, however, is usually a deluxe vehicle and may require a comfort cooling system. Space and weight limitations and vibration must be considered.

Heating

Recent designs of bus heating systems obtain improved air distribution. Heat in the engine coolant liquid is used to warm air by means of suitable finned coils and this heated air is distributed throughout the passenger space by ducts and outlets directed toward the floor. Some designs include finned surface near the floor in an application similar to that in railway passenger cars. Forced air circulation over this finned floor heating surface has been provided to increase its effectiveness. Oil burning booster heaters have been applied to many Diesel-powered buses to raise the temperature of the engine coolant for maximum engine operating efficiency, and to provide sufficient heat for the passenger space.

Ventilation

Air for ventilation is usually brought into a bus at the front, and distributed throughout the length of the passenger space by a duct or ducts near the ceiling. Except for a few designs employing 100 percent outside air for heating, no heating of the ventilating air has been provided. One recently designed distribution system for an inter-urban bus provides for a fixed minimum of outside air, and is arranged to increase the percentage of outside air to 100 percent when the heating or cooling load diminishes. The distribution ducts and diversion damper arrangement of this system make available two supply ducts and one return duct for heating and for cooling, with a changeover to all three ducts to supply air during the intermediate ventilating cycle. This system permits utilization of atmospheric cooling and ventilation to the greatest degree when it can be most economically employed in the interval between the heating and cooling demand.

Conventional throw-away type filters or renewable filters are used in intake air ducts for many vehicles. Electrostatic filters have been successfully used in some installations. The need for elimination of dirt is great, but the problem is complicated by space limitations and limited power.

Refrigeration

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

Complete systems add from 800 to 1300 lb to weight of the coach. Sometimes an auxiliary generator driven by the refrigeration system engine is used and serves to help charge the bus battery, thereby offsetting 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 for quick daily engine servicing. In all cases fuel is obtained from the main bus tanks, and in some, the main engine cooling system cools the air conditioning engine.

Control

Automatic temperature control is receiving more attention in the design of new vehicles. Some municipalities and states have enacted laws requiring that buses operated on their streets and roads be so equipped. The simplest control systems for heating of urban buses consist of a single thermostat to start and stop the blower of the heater unit. Improved heating systems employ a thermostat to control liquid flow to the heater cores by means of modulating valves, in combination with a means of stopping the heating blower when no heat is required. Heating and ventilating control is accomplished by controlling the volume of outside air, over and above the minimum required in accordance with the temperature in the passenger space, by means of automatic modulating dampers in the outside air intake, or by varying the speed of the ventilating air blowers.

In a large proportion of inter-city buses equipped with mechanical refrigeration, a single thermostat is used to start and stop the cooling operation. This may be accomplished by automatically starting an engine-driven compressor on the cooling demand or by engaging a clutch to drive the compressor. Modulated or graduated control of engine-driven compressors may be accomplished by automatic regulation of the engine throttle controlled from a thermostat in the passenger space. Complete control systems are available to coordinate operation of the heating, ventilating and cooling equipment from a single thermostat, with automatic change-over from heating to ventilating to cooling.

AUTOMOBILE SUMMER AIR CONDITIONING

The first attempts to cool automobiles mechanically were made in south western United States 1930–1940 with systems assembled from commercial components. Between 1939 and 1942 one car manufacturer built about 1500 cars equipped with a mechanical system. Customer acceptance was mixed and the project was dropped to be reactivated again in 1953. In 1952 the major automobile manufacturers decided that time was ripe to offer summer comfort cooling in their higher priced cars. The 1953 models were introduced and well accepted. In 1953 and 1954 about 125,000 units were sold. In 1955 some of the lower priced cars were available with summer cooling systems.

The basic components used are fundamentally the same as in any stationary air conditioning system using the vapor compression cycle. The engineering problem is to design for automobile application in which case the source of power is always a major obstacle to overcome. The best solution to date for automobile applications is to operate the condensing unit by belt drive from the car motor and then control the variable refrigerating capacity caused by the variable car motor speed by suitable means.

One to seven or more horsepower are required. Compressors must be capable of operating at speeds of 4000 to 5000 rpm to last in this service. Refrigeration capacity required is about $1\frac{1}{4}$ to $1\frac{1}{2}$ tons. Radiant heat, as well as high conduction heat gain due to single-glazed large glass areas, and