floor and overhead heating, has been satisfactory with provisions for high, medium, and low thermostat settings and in some cases, two settings have been satisfactory for cooling. In many cars the following points have been found to be satisfactory, 71 and 76 F for cooling, 60, 71 and 74 F for floor and overhead heating.

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 closed to prevent cool air from being introduced into the conditioned space.

ELECTRIC 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 cars now in service are electric lighted and equipped with fans. Power is furnished by storage batteries and axle generators of from 2 to 5 kw capacity. When air conditioning is installed the electrical load is increased approximately 1 kw for ice systems, 3.5 kw for steam systems and 10 kw for electro-mechanical compressor systems. Steam ejector systems require approximately 230 lb of steam per car per hour for a six ton unit. All of this power as well as the power required to move the extra weight must be supplied by the locomotive enroute and if a number of cars in the train are air conditioned, the effect on train performance should not be overlooked.

In the case of mechanical compressor systems the power is taken from the locomotive draw-bar, unless the compressor is driven by an internal combustion engine, while with the steam system most of the power is furnished in the form of steam which is a load on the locomotive boiler but not on the cylinders. The ice system takes the smallest amount of power from the locomotive since no power is required to produce refrigeration. The demand for power for cooling comes, however, at the time of year when steam for heating is not required and the demand for lighting is at a minimum.

Inasmuch as axle generators and mechanical driven compressors will not operate below a certain cut in speed and will not carry full load until a speed considerably higher than cut in speed is reached, it is quite apparent that the characteristics of the run such as schedule speed, top speed, number of stops, length of stops, percentage of time of operation at slow speed, length of run, etc., must be considered in the selection of equipment. Fig. 1 shows the tractive resistance of a 75 ton car with six wheel trucks without an axle generator, and with a 4 kw generator and for the same car with an increase in weight of five tons and with a 20 kw axle generator load.

The direct-drive compressor system has only the friction of the drive during starting and at low speeds. After the compressor cuts in, the load increases with the speed. The compressor output increases with the speed until maximum output is reached and then the drive efficiency decreases as the speed continues to increase so that the power input to the drive continues to increase and the greater power requirements come at the higher speeds.

Consideration must also be given to the power requirements for refrigeration while the car is at a standstill or running at slow speeds. The electrical energy required for the ice activated and steam systems is easily supplied from the storage battery. With the ice system a supply of ice is necessary and steam for the steam system can be supplied from the locomotive or from a stationary plant. The majority of the electro-mechanical systems are equipped with A.C., D.C. motors. While standing in the yards and stations the A.C. motor is connected to a 220 volt, 3 phase circuit. The majority of these equipments are so arranged that while operating on A.C. power the D.C. motor may be used as a generator for battery charging. If an auxiliary circuit is not available the D.C. compressor motor may be operated from the storage battery.

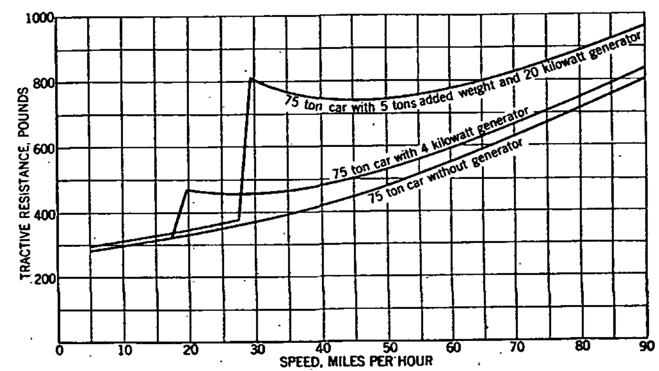

FIG. 1. TRACTIVE RESISTANCE OF 75 TON PASSENGER CAR WITH SIX WHEEL TRUCKS

The direct drive mechanical compressor systems are also equipped with A.C. motors for operation from auxiliary circuits. These equipments can only be operated when connected to the auxiliary circuit or while the train is running above the cut in speed of the drive.

COMPARATIVE SYSTEM COSTS

It is rather difficult to calculate the costs of car air conditioning due to the many variables involved. A study of reports covering a large number of cars of all kinds, operating under various conditions in all parts of the country, indicate a great variation in costs and weights for all systems. The following tabulation shows the average values for all cars considered.

	ICE	STEAM	MECH. COMP. ELECTRO	DIRECT DRIVE
Av. cost	$4000.00	$8200.00	$8200.00	$8200.00
Av. weight	8500 lb	11300 lb	9600 lb	8600 lb
Av. maintenance per 1000 car-miles	$2.00	$2.20	$3.85	$3.22
Av. ice capacity	4500 lb			
Av. ice consumption per hour	275 lb			