where the distance from the guard to the fan is more than 4 in., they shall not permit the passage of a cylindrical rod ¾ in. in diameter.

Motor Speed Classifications

A Constant-speed motor is one in which the speed remains practically constant with changes in load; e.g., a d-c shunt-wound motor or a-c squirrel-cage motor with low slip.

A Varying-speed motor is one in which the speed varies with the load, usually decreasing when the load increases; e.g., a d-c series motor or an induction motor with large slip.

An Adjustable-varying-speed motor is one in which the speed can be adjusted gradually, but when once adjusted for a given load will vary in considerable degree with change in load; e.g., a shunt-wound d-c motor adjusted by armature resistance control.

An Adjustable-speed motor is one in which the speed can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load; e.g., a d-c shunt motor with field-resistance control. The standard ratings for open-type, adjustable-speed motors, having a speed range of 3 to 1 and greater are in accordance with the following:

(1) A standard continuous horsepower rating at 150 percent of minimum speed with a temperature rise of 40 C.

(2) The next higher standard continuous horsepower rating at 3 times minimum speed with a temperature rise of 40 C.

(3) Between 150 percent of minimum speed and 3 times minimum speed, the standard continuous horsepower rating with a temperature rise of 40 C will vary with the speed along a straight line connecting these two horsepower ratings. No further increase in horsepower is recognized above 3 times minimum speed.

(4) Below 150 percent of minimum speed the lower continuous horsepower rating (see preceding item 1) will apply with a temperature rise of 50 C.

Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 20 hp, 40 C at 600 rpm and 25 hp, 40 C from 1200 to 1600 rpm. Between 600 and 1200 rpm the rated horsepower increases directly with speed from 20 to 25 hp.

(5) Motors may also be rated 1 hour with temperature rise of 50 C with the higher horsepower rating (see preceding item 2) throughout the entire speed range.

Example: 20/25 hp, 400 to 1600 rpm. This motor may be rated 25 hp, 50 C 400/1600 rpm; 1 hour.

Mechanical Modifications

Vertical Mountings are available for such applications as pumps and agitators. This type of application may require a special umbrella-type hood to protect against dripping liquids.

Flanged Mountings are available for use where motors are built in as part of machines. Motors may also be supplied with flush plate mountings, suitable for close coupled pump and similar applications.

CHAPTER 46

RESIDENTIAL SUMMER AIR CONDITIONING

Consumer Requirements, Equipment Capacity Selection, Types of Equipment, Types of Systems, Gas Year-round Air Conditioners, Heat Pump Year-round Air Conditioners, Location of Cooling Equipment, Operating Sound Level, Air Distribution Methods, Operating Costs, Effects on Future House Design

SUMMER air conditioning of residences has become a major factor in the air-conditioning industry. It is receiving increasing support from home owners, builders and architects. Although residential air conditioning began at the same time as comfort applications in theaters and department stores, it received its initial impetus when equipment for use with warm air furnaces was introduced in the late 1930's.

CONSUMER REQUIREMENTS

Present practice is to design residential summer air conditioning on the basis of an 80 F indoor temperature. In using this basis it is assumed that the home owner will operate the system continuously with a thermostat setting of 75 or 76 F and thereby take advantage of the thermal storage in the house and household furnishings to reduce the peak temperatures. The preference of the individual home owner must, however, be considered in selecting the design indoor temperature and may require that a temperature lower than 80 F be selected, particularly in existing homes and higher cost custom-built homes. Analog computed studies and field investigations[1] have apparently demonstrated the adequacy of the 80 F indoor temperature as a basis for equipment selection procedure for lower cost homes.

To assure comfort, it is essential that the proposed operation and performance of the system be explained to the user in advance. Usually the greatest degree of comfort can be obtained by keeping the house closed and operating with a fixed thermostat setting throughout the cooling season. In some climates the opening of the house to utilize *night-air cooling* creates humidity difficulties that take several hours to overcome during the following day. The use of *night-air cooling* may lead to unsatisfactory conditions when the equipment is not turned on again sufficiently early the next day. It will also allow unfiltered air to enter the house thus reducing the cleanliness advantage of air conditioning.

EQUIPMENT CAPACITY SELECTION

Considerable study and research relating to the problems of load calculations for residential air conditioning have convinced engineers and researchers that the load calculation methods used for commercial and industrial air conditioning are not directly applicable to residential air conditioning.

There are three industry-sponsored methods of calculating residential air conditioning loads: *ARI Standard* 610-56, *Application Engineering Standard for Year-Round Residential Air Conditioning;*[2] *NWAH & ACA Manual* 11, *Summer Air Conditioning;*[3] and *I=B=R* No. C-30, *Cooling Load Calculation Guide.*[4] Published procedures of reliable manufacturers, when used in conjunction with their equipment, are also adequate.

All of the industry methods mentioned employ cooling load factors for the various components of the load that are averaged over a peak period of several hours and thereby make allowance for thermal storage effects. They avoid the possibility of pyramiding non-concurrent, instantaneous peak loads.

With most methods it is possible to select the desired design indoor temperature, and the commonly used outdoor temperature for the area as listed in Chapter 13.

The use of any capacity selection procedure based on a rule of thumb such as *10 average windows or doors per ton* or *600 sq ft of floor area per ton* should be avoided. Insulation, glass areas, shading effects, and solar orientation must be given careful consideration by using an engineering procedure for estimating the load.

TYPES OF EQUIPMENT

Hermetic, semi-hermetic and split systems are available for the mechanical refrigerating portion of residential air conditioning systems. The hermetic units are of the factory-sealed refrigerant charge type which require cutting into the system for either the addition of charge or replacement of any part of the refrigerant cycle. The semi-hermetic types are factory assembled (and may be shipped with a refrigerant charge), but have readily accessible arrangements for adding refrigerant or changing parts. The split systems are generally separate low-side (evaporator coil) and high-side (compressor and condenser) assemblies.

Each of these types has advantages and features which make it suitable for various applications. For example, the hermetic type of system can be made with simpler parts and is less subject to leaks, but the cooling system must be designed to route the air through the fixed arrangement of the cooling coil. The field-assembled components of a split system can more readily meet the requirements of existing homes already heated with warm air systems.

All three types of systems have been made with water-cooled or air-cooled condensers. Where water for condensing purposes is readily available and of low cost, it is usually the preferred medium of heat disposal. The air-cooled condensing method has been rapidly gaining in popularity, although cooling towers and evaporative condensers also have been used for residential applications.

Cooling towers in home installations may present unacceptable complications, such as the necessity of using water