The *capacitor type* motor is available only in the small and fractional horsepower ratings. It is manufactured in three types:

1. Capacitor Start, limited to ¼ hp and smaller, using the condenser in starting and disconnecting the condenser by means of an automatic governor when operating at full speed. The starting torque is low; used for direct connected service only.

2. Capacitor Start, Capacitor Run having a condenser in the circuit while starting and running at speed. An auto transformer supplies high voltage while starting and normal voltage when the motor is operating at full speed. The change is accomplished by an automatic governor in the motor.

These motors have starting and operating characteristics suitable for the operation of the various types of air conditioning equipment within the range of sizes available. This type of motor has a constant speed characteristic.

The choice between the capacitor motor and repulsion, induction motor is largely a matter of personal opinion.

Adjustable speed motors in this type are available where low starting torque is satisfactory.

These motors do not have a governor but act as capacitor start and capacitor run motors with a fixed condenser in circuit at all times in addition to an auto transformer arranged with several taps, a few of which are selected to give the desired variation in speed.

3. Capacitor type motors with medium starting torque are also available in the construction described previously.

Split phase motors are available in sizes ¼ hp and smaller and should be used where high starting torque is not required (such as small fans, pumps and oil burners). The starting current is higher than for either the repulsion, induction, or capacitor motors. A special type, with enclosed end brackets and a thrust bearing, is available up to ½ hp for use with propeller fans mounted on the motor shaft. This type of motor has a constant speed characteristic.

Polyphase Motors

Squirrel cage induction motors are available in three types and a full range of sizes:

1. The normal torque, normal starting current squirrel cage motor has close speed regulation, high efficiency, high power factor, high pull-out torque, high starting torque and is suitable for general purpose applications. This motor has a large current inrush and a low starting current power factor. It operates with these characteristics only when started directly across the line on full voltage. When central stations require current limiting starting equipment on such motors, the starting torque is less. Current limiting hand operated compensators are standard equipment and have 50, 65 and 80 per cent taps, the 65 per cent tap being regularly connected when the compensator leaves the factory.

2. The normal torque, low starting current squirrel cage motor has approximately the same torque as the normal current motor, but the starting current is approximately 20 per cent less than the normal torque motor on full voltage and well within the recommended *EEI* limits on 30 hp sizes and smaller.

This motor lends itself to automatic or remote control because no current limiting starting equipment is necessary for 30 hp and smaller sizes. A magnetic starter with low voltage and thermal relay overload protection gives the most satisfactory service.

These switches may be controlled by push button, thermostat or pressure relay to meet the requirements of any particular installation.

3. The high torque, low current squirrel cage motor has a starting torque approximately 25 to 50 per cent greater than the normal torque motor on full voltage with starting current approximately 10 per cent less than the normal torque motor started on

full voltage, but within the required limits on 30 hp sizes and smaller. These motors are also started directly across the line on full voltage through a magnetic starter or other approved starting device.

These three types of motors are also available in two, three, or four speed designs with variable torque, variable horse power or constant torque characteristics. Two speed motors may be either single, or two winding; three speed motors are single, two, or three winding; and four speed motors are two, three, or four winding. When a motor is wound with a winding for each speed, better operating characteristics are obtained because no sacrifice is made for the other speed and operating characteristics approaching single winding motors may be expected.

Frequently, multispeed motors lend flexibility to an installation that cannot be obtained in any other way.

Multispeed motors are started, through magnetic starting equipment with overload and low voltage protection, directly across-the-line with compelling relays to insure starting on low speed regardless of the ultimate running speed. Starting on low speed limits the starting current to the starting current of the low speed winding and consequently lowers the maximum demand.

Often where the central station requires current limiting starting equipment for the normal torque, normal starting current motor, it is advisable to use the normal torque low starting current multispeed motor.

It is apparent from these motor characteristics that a squirrel cage motor may be selected for operating any air conditioning and allied equipment.

Automatic start induction motors are constructed with two windings on the rotor, one of which is a high resistance, squirrel cage winding used in starting and gives a high starting torque. A centrifugal mechanism within the motor switches to the second low resistance winding when the motor comes up to speed, thus obtaining running characteristics equal to the normal torque, normal current squirrel cage motor. The power factor of the starting current is high.

Split ring, wound rotor motors are built for two classes of service, constant speed and adjustable variable speed. The motors are identical in each case and use the same primary control, the only difference being in the secondary control.

Slip ring motors for constant speed service are used where high starting torque with low starting current is required for bringing heavy loads up to speed. The resistance is in the secondary or rotor circuit, only when starting, and is short circuited when the motor is up to speed.

For adjustable varying speed service, part or all of the secondary controller resistance is in the circuit whenever the motor is operating below full speed. The speed obtained with a given resistance in the secondary circuit is dependent on, and changes with, the load on the motor. The horsepower developed by the motor is approximately proportional to the speed, whereas the power required by the motor is practically the same at reduced speed as at full speed, hence the efficiency at reduced speeds is much lower than at full speed.

Synchronous motors are ordinarily used only where there is a necessity for, or advantage in, obtaining power factor correction. It is advisable to consider each application as a special case.