

the constant speed motor with the exception that the starting resistor must be designed for speed regulating duty and must therefore be capable of carrying the motor current continuously. Speed controllers are available both for constant torque applications and varying torque drives (such as required by fans) in which the torque is reduced considerably at reduced speed.

The *Adjustable Voltage* type of speed control is also often known as the variable voltage or Ward-Leonard system. For machines requiring a wide range in speed control and a large number of steps of control this type of system is used most extensively. The drive consists of one or more d-c motors, the armatures of which are supplied with power from a d-c generator and the fields of all machines are excited from a constant

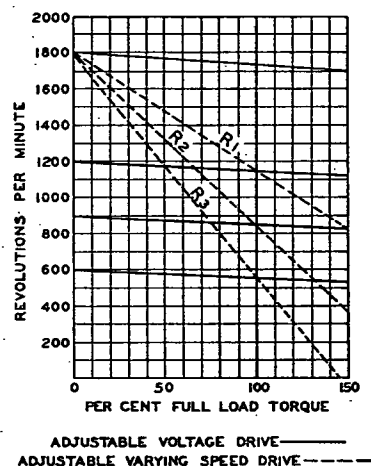


FIG. 3. SPEED TORQUE CHARACTERISTICS OF ADJUSTABLE VARYING SPEED DRIVE AND ADJUSTABLE VOLTAGE DRIVE

voltage exciter. A schematic diagram of connections for an adjustable voltage drive is shown in Fig. 4. In most cases the d-c generator is a part of a three-unit set including a constant speed a-c driving motor, and a constant voltage exciter. As the voltage on the generator and consequently on the d-c motor or motors is adjusted by a rheostat in the generator field circuit, a great many steps are thus obtained in an efficient manner. With constant field excitation on the motor the speed of the motor will vary approximately as the voltage on the generator.

Extremely wide speed ranges are possible with the adjustable voltage type of drive. Ranges as high as 10 to 1 are common and, by the addition of field control on the motors, ranges as high as 40 to 1 are permissible. This type of drive provides the advantage of good speed regulation over the entire speed range, as shown in Fig. 3 in which this type of drive is compared with the adjustable varying speed drive.

Typical specifications for d-c motor control are shown in Table 3.

ALTERNATING CURRENT MOTORS

Alternating current motors are divided into two main classifications: *polyphase* and *single phase* (see Table 1), according to the type of power supply used. They are further subdivided as to the type of motor winding.

When polyphase power is available it is usually found more economical to apply polyphase motors in preference to single phase motors. A typical 5 hp, 1200 rpm capacitor start-induction run single phase motor, for instance, will cost approximately twice as much as the corresponding three phase *Design B* squirrel-cage motor. In addition, the polyphase motor has the advantages of higher power factor and higher efficiency.

Polyphase Motors

The three types of polyphase motors are: *squirrel-cage induction* motors, *wound rotor induction* motors, and *synchronous* motors.

Squirrel-cage motors are specified by NEMA standards providing a variety of speed and torque characteristics. *Design A* motors provide

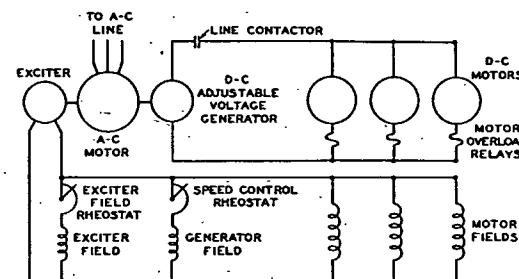


FIG. 4. COMPONENT PARTS OF AN ADJUSTABLE VOLTAGE DRIVE

normal starting torque at starting current in excess of *Design B* motors and are suitable for constant speed application, to equipment such as fans and blowers. *Design B* motors provide normal starting torque with NEMA starting current values which are acceptable by many power companies for full voltage starting. They are used for the same type of application as *Design A*. *Design C* motors provide high starting torque with starting current same as *Design B* and are used on compressors started without unloaders, and on reciprocating pumps. *Design D* motors have high slip* and are used with flywheels for widely pulsating loads on equipment such as reciprocating compressors and pumps where other motors would draw high peak currents.

Figs. 5, 6, 7, and 8 illustrate the characteristics of squirrel-cage motors. It will be noticed by inspection of Fig. 6 that both power factor and efficiency are improved if the motors are operating as near rated load as possible. In addition, as shown in Fig. 8, power factor and efficiency are better for higher speed motors.

Typical specifications for squirrel-cage motors are shown in Table 4.

Wound Rotor motors are used for applications requiring high starting

* Refer to Glossary at end of chapter.