Power Sources

All arc-welding processes require a continuous supply of electrical current in sufficient amount (amperage) and of proper voltage to maintain an arc. This current may be either alternating (AC) or direct (DC), but it must be supplied to the welding electrode through a device that enables its precise control. Only when the welding current is carefully controlled can the desired welding arc characteristics — and thus maximum welding efficiency — be obtained. The controlling device is called a power source. Current may be supplied to it from utility power lines, or developed within it by generators or alternators driven by close-coupled gasoline or diesel engines.

Various types of power sources provide a range of voltage across the welding arc from 13 to approximately 45 volts. The currents supplied through the power source may range from less than 10 amp to 1500 amp or more, the higher currents for automatic welding.

For efficient welding, the power source must permit control of the arc characteristics needed for a specific job. In one job, a forceful, deeply penetrating arc may be required, while, in another, a soft, less-penetrating arc may be necessary to avoid melt-through. Electrodes are designed for various welding positions and they help compensate for power sources that have no arc characteristic adjustment. The welding process also dictates the type of power source needed. Table 4-31 shows the power source requirements for various processes.

TABLE 4-31. Power Requirements for Arc-Welding Processes

Process	Output Characteristic	Type of Current	Polarity
SMAW Shielded metal-arc, gas tungsten-arc, submerged-arc	Constant Current*	AC or DC	DCEN, DCEP, or AC
FCAW Flux-cored	Constant Voltage	DC	DCEN, DCEP
GMAW Gas metal-arc	Constant Voltage	DC	DCEP

* In some applications, the submerged-arc process can use constant voltage DC.

CLASSIFICATION OF POWER SOURCES

Power sources are classified according to the type of current — AC or DC — and according to their output, which may be either constant current or constant voltage. A further classification designates the method by which energy is supplied to the power source — from a power line directly or through an electric motor, or from a gasoline or diesel engine.

Whatever the type of power source, its main function is to supply the type of current needed for welding. Alternating current direct from the power line goes through a transformer in AC welders that allows control of the current. Thus, a simple AC power source is fed 230-volt single-phase current the same as a kitchen stove, and a selector switch enables the operator to use what AC current he needs for the job — for example, a 225-amp output for 3/16-in. electrodes or 180-amp for 5/32-in. electrodes. A DC power source also gives similar control of the current. Direct current is produced from AC line power by either using the line power to run an electric motor that turns a DC generator (an electric motor-generator set) or running the line power through a transformer and then a rectifier (a rectifier set). Direct current may also be produced by driving a DC generator with any type of fuel-burning engine, such as a gasoline or diesel engine (engine-driven-generator set). A fuel-burning engine may also be used to produce AC for welding by using it to drive an alternator instead of a generator. Combination power sources, producing both AC and DC, are basically transformer-rectifier sets.

Welding power sources of all types are rated according to their current output. This rating is generally set by manufacturers in accordance with standards established by the National Electrical Manufacturers Association (NEMA). These standards are established on a conservative basis, requiring a rating well below the maximum overload capacity of the power source so that it will provide safe operation efficiently over a long period of time.

Ratings are given with a percentage "duty cycle." The duty cycle of a power source is the percentage of a ten-minute period that it can operate at a given output current setting. For example, if a power

source is rated 300 amp at a 60% duty cycle, it means that the machine can be operated safely at 300-amp welding current for 6 out of every 10 minutes. If this duty cycle is reduced in actual operation, the maximum permissible current is increased. Thus, at 35% duty cycle, this same 300-amp power source could be operated at 375 amp.

As noted previously, power sources are classified as "constant current" or "constant voltage." A constant current power source is one that delivers a current that changes only slightly with changes in voltage. A constant voltage machine is one that delivers current with the voltage rising or dropping only slightly with changes in current output.

Figure 4-4a shows a typical output curve for a constant current power source. This type of output

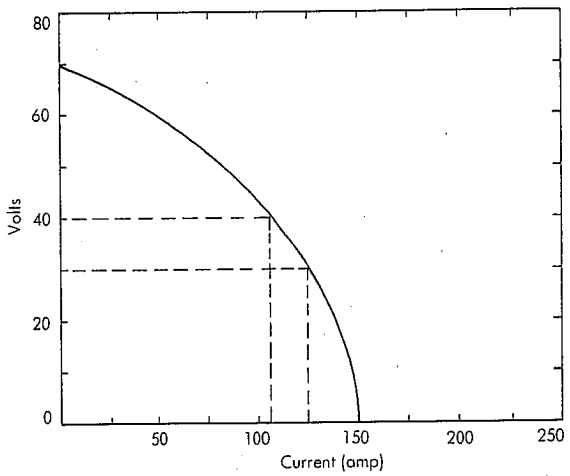

Fig. 4-4a. Typical output curve for a constant-current power source, adjusted for minimum current variation.

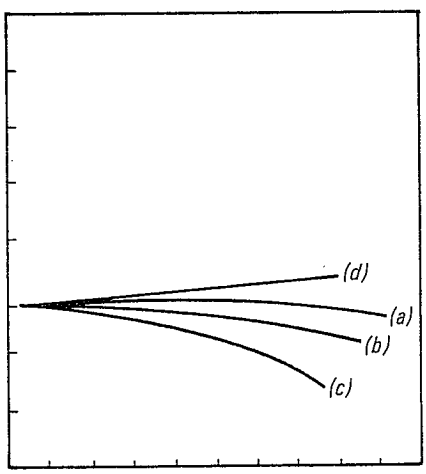

Fig. 4-4b. Typical output curves for a constant voltage power source.

is used for submerged-arc, gas tungsten-arc, and shielded metal-arc applications. Figure 4-4b shows typical output characteristics of a constant voltage power source. Here, the voltage in the constant voltage curve (a) rises slightly at the low currents and drops at the high currents. Most constant voltage power sources are designed with a small downward slope, as in curve (b), and have adjustments to increase the downward slope, as in curve (c). Some power sources have a rising slope, as in (d), but this type of output is becoming less common.

AC POWER SOURCES

Transformer Power Sources: The transformer power source is a voltage step-down transformer that changes high-voltage, low-amperage AC input current to low-voltage, high-amperage AC welding current. AC output transformer power sources usually operate on single-phase power. Most AC power produced in the United States is 60-hertz, and each time the polarity changes the voltage goes through zero, which tends to create an unstable condition in the arc. This problem, however, has been solved by designing better transient characteristics in the power source and better AC electrodes.

Transformer power sources have controls to stabilize and adjust the welding current. A system for controlling the output current is provided either through a series of taps into the secondary windings or by a movable or saturable reactor in the output circuit. The taps provide step control. A reactor provides a continuous stepless control. Various types of starters are used and some are equipped with

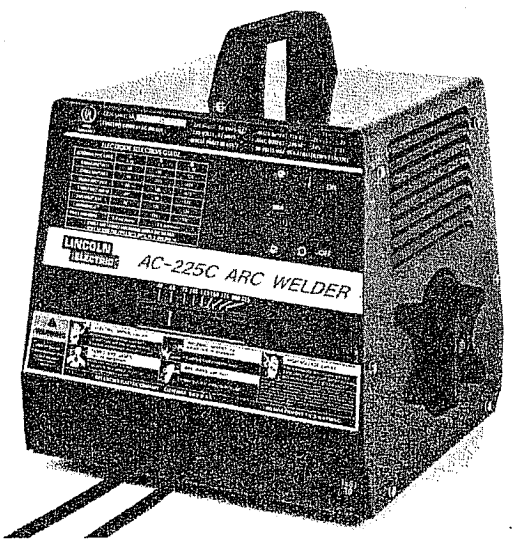

Fig. 4-5. A typical small AC transformer power source for light-duty and limited-service welding.