

Arc Welding Power Sources 260

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Class Outline

Objectives
What Are Power Sources?
Classification of Power Sources
Constant Current Power Sources
Constant Voltage Power Sources
AC Power Sources
Alternators
Transformers
Reactors
Types of Reactors
Silicon-Controlled Rectifiers
DC Power Sources
Generators
Rectifiers
Inverters
Power Factor
Energy Efficiency
Electrical Safety
Summary

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Objectives

- Define power source.
- Describe how welding power sources are classified.
- Describe characteristics of constant current power sources.
- Describe characteristics of constant voltage power sources.
- Describe common uses for AC.
- Describe how an alternator works.
- List the components of a transformer.
- Describe how a reactor works.
- List types of reactors.
- Describe how a silicon-controlled rectifier works.
- Describe common uses for DC.
- Describe how a generator works.
- Describe how a rectifier works.
- Describe how an inverter works.
- Explain the importance of power factor.
- Explain the importance of energy efficiency.
- Describe the electrical risks associated with power sources.



Figure 1. A generator produces DC through the use of a mechanical device.



Figure 2. An alternator produce AC through the use of a mechanical device.

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What Are Power Sources?

A **power source** is a device that supplies the needed amount of electricity for a given application. Arc welding depends on the heat generated from **electricity**. The **electric arc** produces intense heat and melts the base metals to make a weld, as Figure 1 shows. Thus, selecting the proper power source for arc welding is very important.

The welding power source that you use must be the right one for your project. The best power source for a welding application provides as much or as little power as necessary. Welding power sources are unique because they require low **voltage** and high **amperage**. This is unlike the high-voltage low-amperage power that power companies supply to industries. There are many different types of welding power sources that produce welding power in different ways. Figure 2 shows a sample of welders that use different power sources.

This class will teach you about the different types of power sources used for arc welding. You will also learn how an arc welding power source is classified and how these power sources generate welding power.



Figure 1. The arc uses electricity to melt the base metals.



Figure 2. These welders generate power in different ways.

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Classification of Power Sources

Welding power sources are classified by how the welder gets its power. Some welders generate their power through a fuel-powered engine. Other types of welders plug into available outlets and convert industrial power into welding power.

Welders are described in terms of their **output**. A welder's output can be described as **constant current** or **constant voltage**. Output is represented visibly with a **static volt-ampere curve**. The static volt-ampere curve records the current output as it compares with the voltage output. The **slope** for a volt-ampere curve is called an **output slope**. This is a visual indicator that charts the difference between a welder's voltage output and its amperage output.

Another form of welder output is the type of current it generates. Welders can produce **alternating current** (AC) or **direct current** (DC). Some welders, like the one in Figure 1, can produce AC and DC, as well as both constant current and constant voltage.

Welders are also classified by their **duty cycle**. A welder's duty cycle is the amount of time that it performs work in a ten-minute period before it must rest. For example, a machine with a 70% duty cycle can perform work for 7 minutes and must cool down for 3 minutes. Figure 2 shows how duty cycle is identified on the welder. Exceeding a welder's duty cycle could cause the machine to break. However, some welders have a feature which will cause the machine to shut down in the event of exceeding duty cycle.



Figure 1. This machine can run on constant current or constant voltage. It can also use alternating current or direct current.

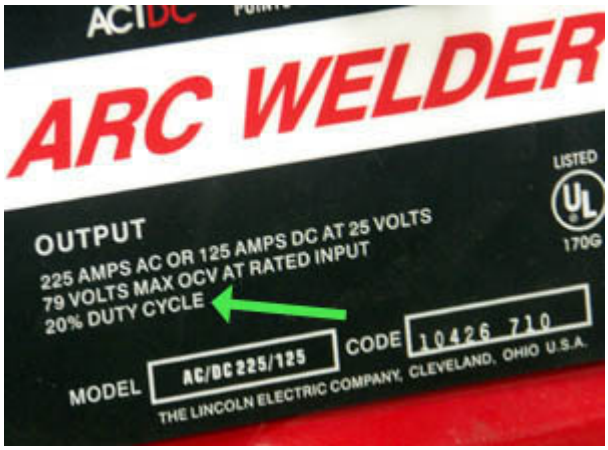


Figure 2. This machine has a 20% duty cycle, which means that it must cool for 8 minutes after two minutes of work.

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Constant Current Power Sources

A **constant current** power source, or **CC welder**, produces a relatively constant amount of current with varying amounts of voltage. Even if the current output varies slightly in these machines, voltage will change significantly.

CC welders are used for manual welding processes, like **gas tungsten arc welding** (GTAW), **shielded metal arc welding** (SMAW), shown in Figure 1. In these processes, the **weldor** controls **arc length**. A change in arc length causes a change in voltage. In other words, an arc that increases in length requires a greater amount of voltage to overcome the increase in **resistance** . As a result, when the arc length changes while using a CC welder, the CC welder adjusts so that the current remains relatively constant.

Constant current welders produce steep output slopes, indicating that there is a much greater change in voltage output than in current output with these machines. These output slopes are referred to as **droop curves**, or **droopers**. Figure 2 shows a typical droop curve for a constant current machine.



Figure 1. SMAW uses constant current.

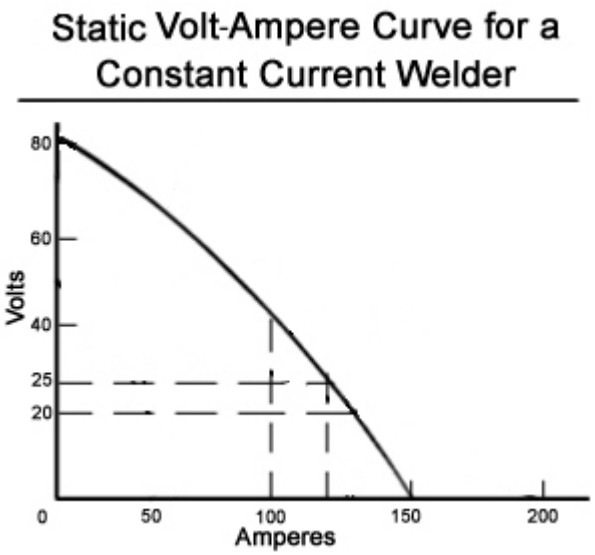


Figure 2. Constant current machines produce steep output slopes, often referred to as droopers.

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Constant Voltage Power Sources

A **constant voltage** power source, or **CV welder**, produces a relatively constant amount of voltage with varying amounts of current. Even if the voltage output varies slightly in these machines, current will change significantly. CV welders are used with continuously fed consumable wire electrodes. For example, **gas metal arc welding** (GMAW), shown in Figure 1, and **flux-cored arc welding** (FCAW) use constant voltage welders. In these processes, the weldor does not have to control arc length like in manual processes. As a result, the voltage remains constant.

Voltage remains relatively constant with CV welders, even if the weldor changes the position of the welding gun and slightly changes arc length. The closer the welding gun is to the workpiece, the hotter the arc will be, but the voltage will remain the same. Pulling the welding gun away from the arc causes the amperage to drop and the voltage to remain the same.

CV welders stabilize the arc. These types of welding machines are considered **self-regulating systems** because they regulate both voltage and amperage.

CV welders produce output slopes that are almost completely horizontal. This indicates that the change in amperage is significantly more than the change in voltage, as you can see in Figure 2.



Figure 1. GMAW uses constant voltage.

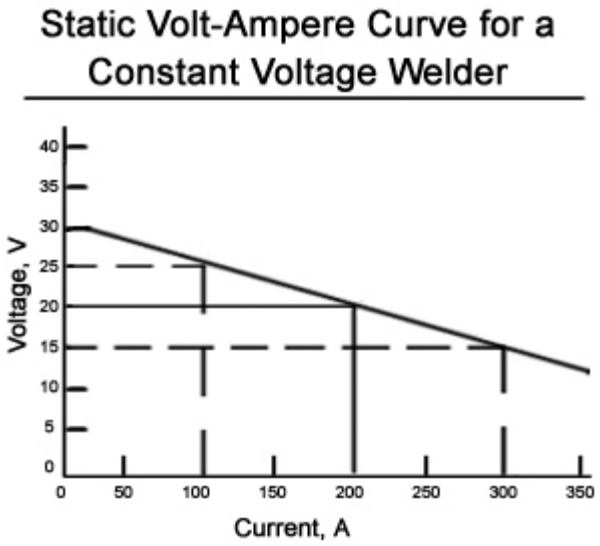


Figure 2. Constant voltage machines produce nearly horizontal output slopes.

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AC Power Sources

If a **circuit** uses alternating current, or **AC**, it means that the electricity does not flow in just one direction. The direction of current flow repeatedly reverses direction from flowing toward the negative to the positive direction. In other words, the electrode switches between carrying a positive charge and a negative charge.

AC can be limiting for welding because it generally does not yield an arc that is as smooth as DC. However, certain types of welding require AC. AC is preferred when welding heavy-plate steel in the flat position. It is also preferred when welding with **high-deposition electrodes**. As you can see in Figure 1, AC welders are often smaller than DC welders. As a result, small AC welders are ideal for farms, garages, hobbyists, and the light maintenance work shown in Figure 2. AC also does not cause **arc blow**. Welders switch to AC when arc blow is a problem.

AC is the type of current that is readily available in most North American outlets. However, the power supplied to industries is high voltage and low amperage. Welding requires low voltage and high amperage. This means that the AC industrial power must be converted to AC welding power.



Figure 1. AC welders are often smaller than DC welders.



Figure 2. AC welders are convenient for light maintenance work.

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Alternators

An **alternator** produces AC from a mechanical device. This mechanical device can be an electric motor, a gasoline-powered engine, or a diesel-powered engine. Figure 1 shows a welder that uses an alternator.

An alternator uses many **electromagnets**. An electromagnet is a magnet that forms as a result of an electric current. An alternator produces its AC by turning a **rotor** inside many electromagnets. A rotor is a rotating part found inside a mechanical device. Many **windings** of wire are wrapped around the rotor to create the electromagnets, as Figure 2 illustrates. When the rotor rotates, it creates a **magnetic field**. This magnetic field creates about 115 to 230 volts of AC. This voltage can be adjusted with the settings on the machine and can be used for welding.

Gasoline- or diesel-powered alternators are especially convenient to use on job sites because they serve as portable power sources for powering small tools and lights in addition to their normal welding output. In fact, an alternator can provide up to 12,000 **watts** of power.



Figure 1. An alternator produces AC through the use of a mechanical device.

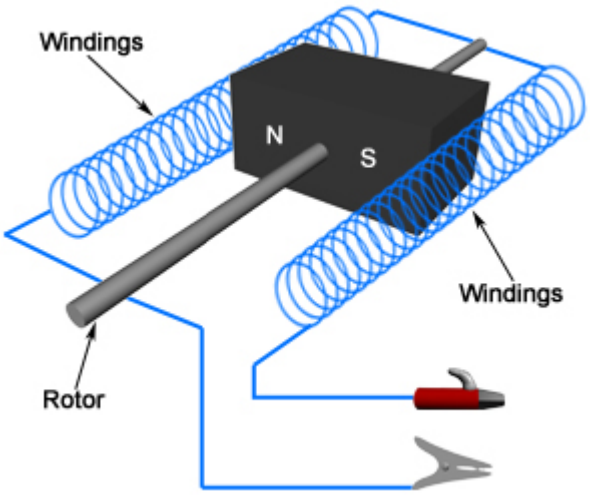


Figure 2. The alternator creates AC when the rotor rotates in a magnetic field.

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Transformers

AC welders that do not use an engine to generate their own power must be plugged into a wall outlet. These welders must transform industrial power into welding power. To do this, the voltage must be reduced. The device that adjusts voltage is called a **transformer**. There are two types of transformers, step-up transformers and step-down transformers. **step-up transformers** increase voltage. Welding uses **step-down transformers**, like the one in Figure 1. These types of transformers convert high-voltage, low-amperage industrial power into low-voltage, high-amperage welding power. A step-down transformer converts industrial power from 220 to 440 V to about 60 to 80 V. The three major components of a transformer are illustrated in Figure 2:

- The **primary winding** contains multiple thin wires wrapped into a **coil**. When electricity flows through this coil, it creates a magnetic field. Each time the AC changes its direction, it causes the current in the primary winding to stop flowing. This also causes the magnetic field to collapse and pass over to the secondary winding.
- The **secondary winding** is a coil that consists of fewer, but thicker wires than the primary winding. Current in the secondary coil moves in one direction, always opposite the direction of the current in the primary coil. The secondary coil generates current 120 times per second. This means that a transformer completes a full cycle 60 times per second. A full cycle happens when both the primary and secondary windings induce current.
- The **laminated iron core** is positioned in the center of the windings and ensures that current does not stray from its intended flow. The windings are placed close together around the iron core, but are independent of each other.



Figure 1. This step-down transformer is wired into the wall outlet so welding power is readily available.

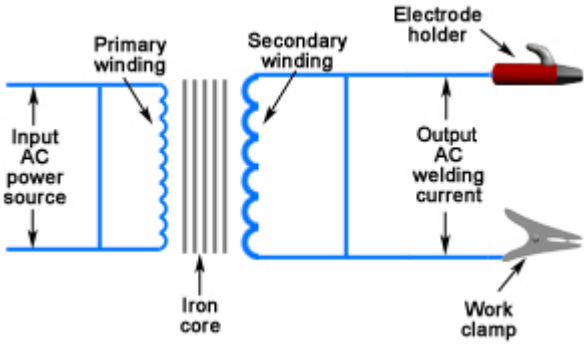


Figure 2. The major components of a transformer.

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Reactors

A **reactor**, illustrated in Figure 1, is a device that adjusts the transformer output. Although the electrical output generated by a transformer is low voltage and high amperage, the current is not yet suitable for welding. The current that comes out of the transformer is rippled and subject to irregular flow. As a result, it must be smoothed out or stabilized before it can be used for welding.

The reactor adjusts the amperage of the transformer output to the desired welding amperage. In other words, when you adjust the settings on the welder, you adjust it to provide a certain amount of amperage. It is the reactor that obtains this desired amount of amperage. The way in which the reactor controls welding amperage depends on the type of reactor in the machine. Currently, many different types of reactors exist.

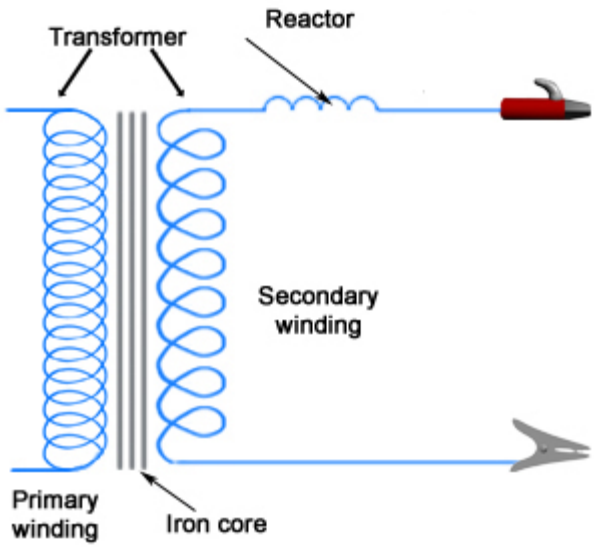


Figure 1. The reactor stabilizes and adjusts transformer output.

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Types of Reactors

Three common types of reactors include:

- A **tap reactor**, shown in Figure 1, selects the proper amount of welding amperage. It "taps" into segments of the secondary winding of the transformer and provides **step control**. This means that the tap reactor does not exert a continuous control of transformer output. Instead, a control selects the number of windings to use in the transformer. If more secondary windings are selected, current decreases. If less secondary windings are selected, current increases.
- A **movable iron reactor**, shown in Figure 2, keeps the transformer windings stationary while a piece of iron moves between the windings to control amperage. This device is unlike the tap reactor because it does not require a control to select the number of windings to use. A movable iron reactor also provides smoother control than the tap reactor.
- A **silicon-controlled rectifier**, or **SCR**, shown in Figure 3, is an electrical control that uses a low-voltage, low-amperage DC circuit, even though it is often used for AC circuits. An SCR is powered when voltage is applied to its switch, or **gate**.The SCR provides very precise step-less control.

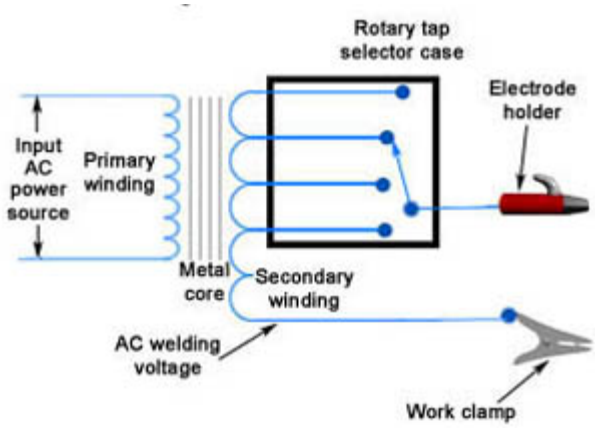


Figure 1. A tap reactor selects the amount of windings to use in the transformer.

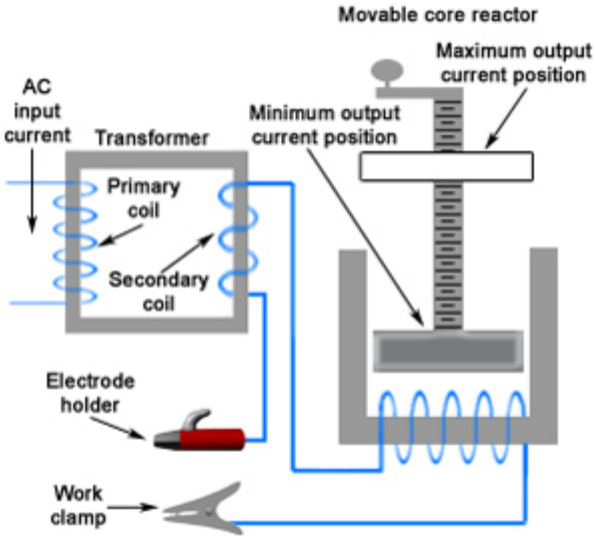


Figure 2. A movable iron reactor moves a chunk of iron between the windings.

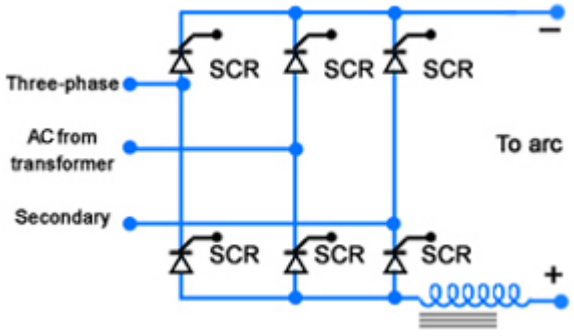


Figure 3. An SCR allows current to flow in one direction only.

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Silicon-Controlled Rectifiers

One of the most popular forms of controlling transformer output for AC power sources is the **silicon-controlled rectifier**, or SCR. The SCR, illustrated in Figure 1, is located in the secondary winding of the transformer. The SCR is powered with a switch called a **gate**. It also has two terminals, an **anode** on one end, and a **cathode** on the other, which carry opposite charges. An anode usually carries a positive charge, and a cathode usually carries a negative charge. However, an SCR will function only if the anode is negative and the cathode is positive. If positive voltage is applied to the gate, the SCR powers on. Once the gate is switched on, the SCR only allows current to flow in one direction, when the anode is negative, and the cathode is positive. This current will stop flowing if the welder changes its direction, if the anode is negative and the cathode is positive, or if the power is turned off.

When an SCR is switched on early in a transformer's **half cycle**, or during the time when the primary winding induces current, it allows more current to generate. When an SCR is switched on late in each half cycle of a secondary winding, it allows less current to generate. SCR machines can easily provide the necessary power for **hot starts** and for **pulse welding**. These features require the highest welder settings.

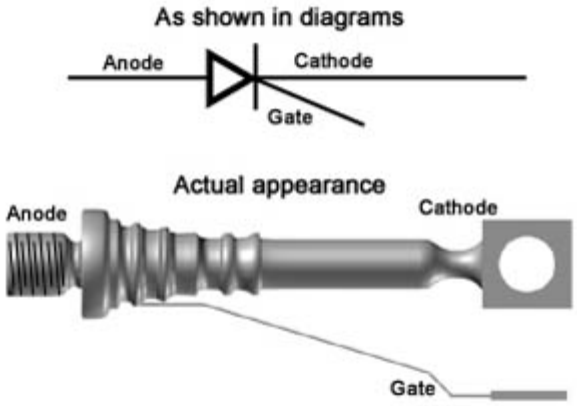


Figure 1. The SCR functions only when the anode is negative, and the cathode is positive.

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DC Power Sources

Unlike AC, DC flows continuously in one direction from a negative charge to a positive charge. Although DC flows only one way, you can manipulate it to flow in the appropriate direction, which is its **polarity**. When welding with **straight polarity**, the electrode is negative, and the workpiece is positive, which means that electricity flows from the electrode to the workpiece. When welding with **reverse polarity**, the electrode is positive, and the workpiece is negative, which means that electricity flows from the workpiece to the electrode.

Most welding applications favor direct current over alternating current because DC does not interrupt the path of its flow to change direction like AC. DC yields a smoother welding arc. GMAW and FCAW use only DC. Figure 1 shows a GMAW welder that uses only DC. DC is also required when welding sheet metal and **stainless steel**. Many electrodes, especially **nonferrous electrodes** and **low-hydrogen electrodes**, also use DC because of its smoother arc. In addition, DC is preferred when using high welding speeds and when welding out-of-position, as shown in Figure 2. However, DC's main limitation is that it can cause arc blow.

Unlike AC, DC is not readily available in most North American outlets. To obtain direct current, a welder must transform the available AC to welding current, and then convert the AC welding current to DC welding current.



Figure 1. GMAW only operates on DC.



Figure 2. DC is preferred when welding out-of-position.

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Generators

Like an alternator, a **generator** automatically produces its own welding power through the use of a mechanical device. The difference is that a generator produces DC power, while an alternator produces AC power. Generators are motor- or engine-driven and run on diesel or gasoline fuel. Like alternators, generators can also serve as an alternate power source for a worksite. However, generators cannot support as much power as an alternator. Figure 1 shows a welder that uses a generator.

Figure 2 illustrates the interior of a generator. Generators use an **armature** with many separate coils wound around it. Each armature coil winding is attached to a **commutator**. A commutator is a copper terminal that conducts current. The commutator touches at least two stationary devices, each called a **brush**. Brushes are only used in pairs. One brush carries a negative charge, and the other carries a positive charge. One or more electromagnets, called **field windings**, surround the armature. Field windings remain stationary and create a magnetic field.

Once the armature rotates as a result of the mechanical device, the armature coil windings pass through the magnetic field produced by the field windings. In turn, this creates an electrical current in the armature coil windings. Since current is only induced in one direction, DC is produced. The more armature coil windings, brushes, and field windings a generator has, the smoother the DC.



Figure 1. A generator produces DC through the use of a mechanical device.

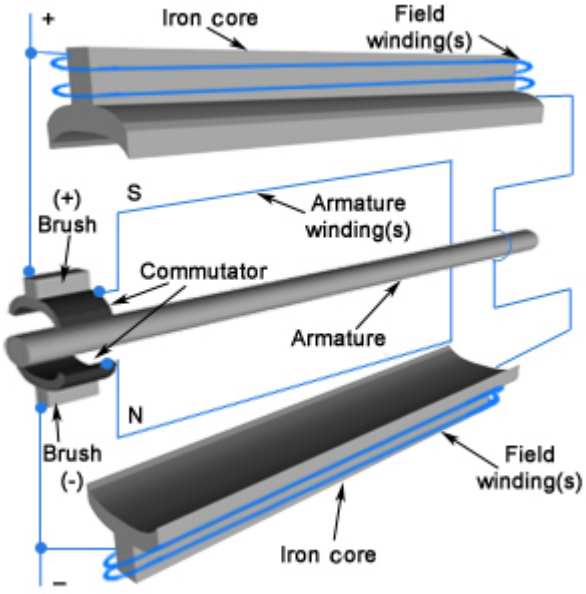


Figure 2. The generator creates DC when the armature rotates in a magnetic field.

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Rectifiers

DC power sources that are not powered by mechanical devices are converted from industrial power to welding power in much the same way as AC power sources. The industrial power must first pass through a transformer to decrease voltage and increase amperage. The power must then pass through a reactor to stabilize and adjust the current. However, to convert this AC welding power DC, it must take some additional steps. Figure 1 shows the interior of a DC welder. The device used in many welding machines to convert AC welding power to DC welding power is called a **rectifier**.

A rectifier is a device that permits current to flow in one direction only. AC constantly reverses its direction, but a rectifier directs AC to flow in one direction. A rectifier can also control whether or not this current flow has straight polarity or reverse polarity.

The path of the DC that comes out of the rectifier is rippled and not as smooth as desirable, which can lead to an unstable arc. To correct this, many DC welding machines use an **inductance coil**, also called a **choke** or **stabilizer**. An inductance coil smoothes out the path of the rippled DC. Figure 2 illustrates the complete process to convert AC industrial power to DC welding power.

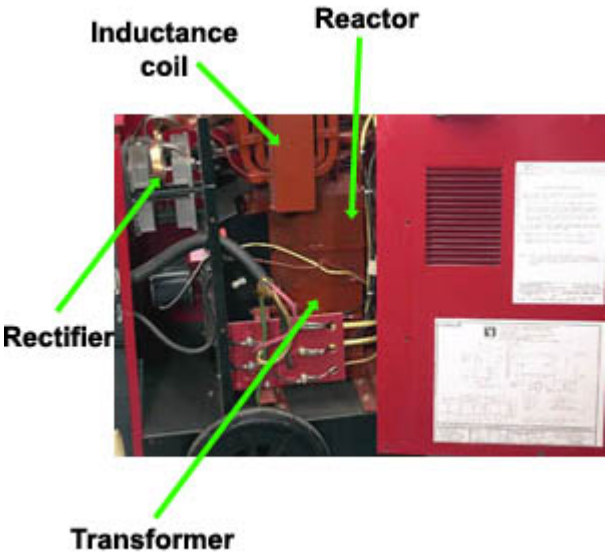


Figure 1. This welder changes AC welding power to DC welding power.

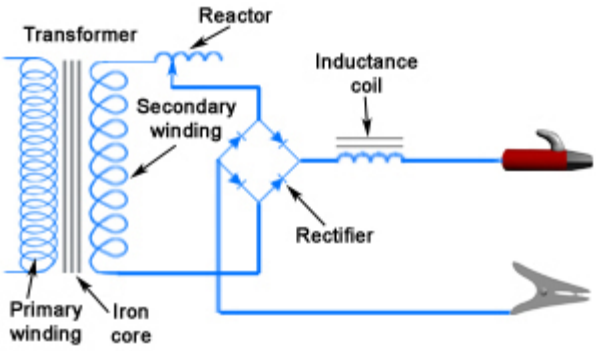


Figure 2. To obtain DC welding power, the incoming power must pass through a transformer, rectifier, and inductance coil.

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Inverters

While a traditional transformer-based DC power source is fully functional, there are many new types of DC welders that have more desirable characteristics. One new type of welder is the **inverter**. Inverters are usually DC power sources. They weigh much less than traditional machines and are much more **energy efficient**.

Figures 1-3 illustrate how an inverter works. When industrial AC enters an inverter, it immediately passes through a rectifier. This creates high-voltage, low-amperage DC. This current then passes through a filter, much like the inductance coil, to smooth out the rippled DC. Next, the current passes through an **insulated gate bipolar transistor**, or **IGBT**.

The IGBT is the most important component of the inverter. The incoming current for the IGBT must be DC. The IGBT changes the incoming DC to AC and elevates it to frequencies as high as 20,000 **Hertz**. The high-frequency AC then passes through a step-down transformer that converts the current to low voltage, high amperage. Next, the current goes through a rectifier to change the current back to DC. Finally, the current passes through an inductance coil to smooth out the rippled DC.

The fact that IGBTs operate at such high frequencies allows inverters to be very lightweight. Standard 200-amp inverters weigh about 35 pounds, while a traditional 200-amp transformer-based welder can weigh over 175 pounds.

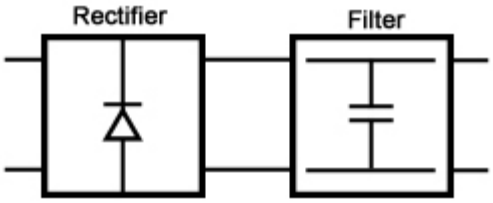


Figure 1. Industrial AC power first passes through a rectifier and a filter.

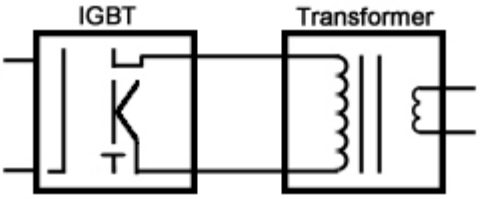


Figure 2. Next, the current passes through an IGBT and a transformer.

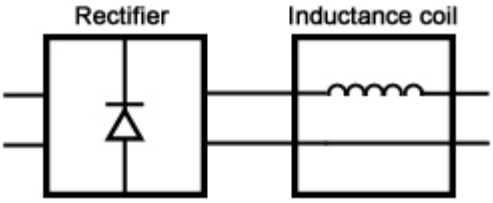


Figure 3. Finally, the current passes through a rectifier and an inductance coil.

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Power Factor

Power factor is the relationship between the amount of power a welding machine draws from the power company and the amount of power going back to the power company as waste. Power factor is derived by calculating the amount of power that the machine draws in versus the amount of power that the machine returns back to the power company. For example, a machine with 50% power factor, or a power factor of 0.5, uses only 50% of the power that it draws from the power company. If this machine draws 100 amps of current from the power company, it would return 50 amps back to the power company. However, a machine with 100% power factor, or a power factor of 1, uses 100% of the power it draws from the power company. If this machine draws 50 amps of current from the power company, it would use all 50 amps, returning no waste.

Traditional transformer-based welders have a power factor of about 60-70%. Inverters have about a 90% power factor. This means that you can run two inverter machines using about the same amount of power that runs one traditional transformer-based machine. In other words, two inverter machines can run without increasing the amount of power that you draw from the power company. For example, the six inverters pictured in Figure 1 can run on about as much power as it takes to run three transformer-based machines. Another advantage is that machines with a greater power factor use smaller input cables and fuses.



Figure 1. These six inverters can run on the same power that it takes to run three transformer-based machines.

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Energy Efficiency

A key reason to use machines with more advanced technology like inverters is because they are **energy efficient**. A machine that is energy efficient does not waste electricity. Transformer-based machines require a lot of heat to power the transformers. This heat is considered waste, since heat should be concentrated in the arc, not within the machine. Figure 1 summarizes the advantages of energy-efficient welders.

Inverters are more energy efficient than transformer-based machines because they run on much higher frequencies and as a result lose less heat during welding. Typically, top-of-the-line transformer-based machines can only get up to 83% energy efficient. However, a basic inverter can be up to 94% energy efficient.

Energy-efficient machines ultimately save costs because they use less electricity. Keep in mind that energy efficiency is not the same as power factor. A machine that has poor power factor but has good energy efficiency may be cheaper to run than a machine with high power factor and poor energy efficiency. You are generally charged for the energy that you use, which is efficiency, and not the energy that you return back to the power company, or power factor.

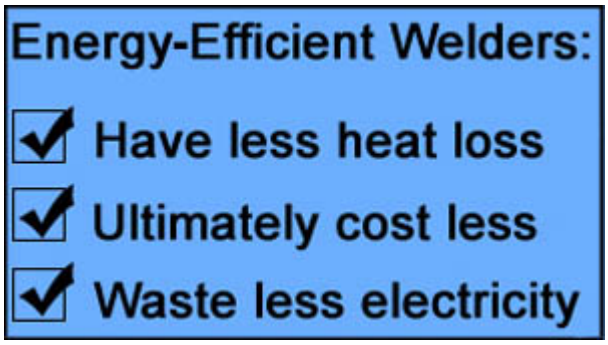


Figure 1. Energy-efficient welders have many advantages.

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Electrical Safety

When working with power components, remember that the risk of electrical shock is one of the most serious hazards to the welder. You must always follow the electrical safety guidelines listed in Figure 1 and read all warning labels on welding equipment, like the one in Figure 2. Any electrical shock over 30 volts can be fatal. Both primary voltage shock and secondary voltage shock are serious risks to the welder.

Primary voltage shock can be anywhere from 120-480 volts. This happens when the power is on and you touch a lead inside the welder, and then touch the welder case or other grounded metal at the same time. **Secondary voltage shock** can be from 60-100 volts and occurs when you touch the electrode, while another part of your body touches the workpiece. Remember that even if a welder is switched off, a charge still exists inside the machine.

Along with electrical safety concerns, welders that are powered by mechanical devices require further safety precautions. Engine-powered equipment must be used only in open, well-ventilated areas. Never add fuel near an arc or when the engine is on. Allow the engine to cool before re-fueling, and take care not to spill fuel. Keep all hands, hair, clothing, and tools away from belts, gears, fans, or any other moving equipment.

No matter which power source you use, keep all equipment in its proper position and in good repair. Only trained technicians should repair welders.



Figure 1. Always observe all electrical safety precautions.



Figure 2. Read all warning labels on all welding equipment.

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Summary

A welding power source supplies the electricity for the welding application. Welders are classified by the type of power source they use, output, and duty cycle. Constant current power sources produce a relatively constant amount of current with changes in voltage, resulting in a drooping output slope. Constant voltage power sources produce a relatively constant amount of voltage with changes in current, resulting in a nearly horizontal output slope.

AC power sources are generally preferred for lighter maintenance work because they are smaller, more compact power sources. Alternators use a mechanical device to produce AC and do not need to be plugged into a wall outlet. If an AC power source needs to be plugged in, it requires a step-down transformer. Transformers convert high-voltage, low-amperage industrial power to low-voltage, high-amperage welding power. Transformer output must also pass through a reactor, which stabilizes the current and adjusts the amperage. Common types of reactors include tap reactors, movable iron reactors, and silicon-controlled rectifiers.

DC power sources are often favored for most welding applications. DC yields a smooth, concentrated arc. Generators use a mechanical device to produce DC and do not need to be plugged into a wall outlet. If a DC power source needs to be plugged in, it also requires a transformer. However, after DC power passes through a transformer, it must pass through a rectifier and an inductance coil. A rectifier converts AC power to DC power, and an inductance coil smoothes out rippled DC. A new option for DC power sources is the inverter. The inverter is lightweight and much more energy efficient.

Power factor is the relationship between how much power a machine draws from the power company versus how much power it returns to the power company. A welder that is energy efficient does not waste a lot of electricity because most heat is concentrated in the arc, not in the machine.

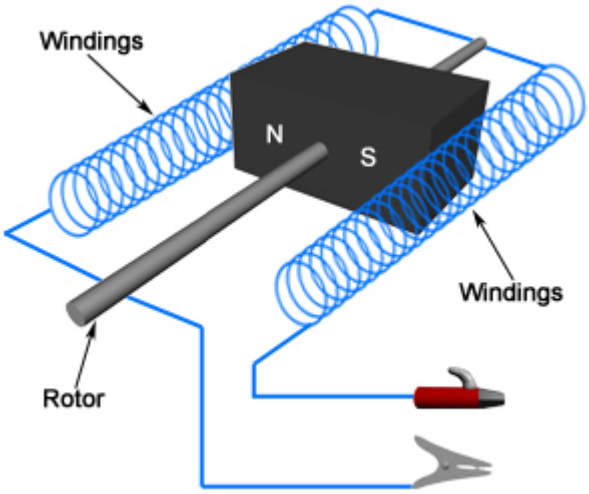


Figure 1. An alternator creates AC when the rotor rotates in a magnetic field.

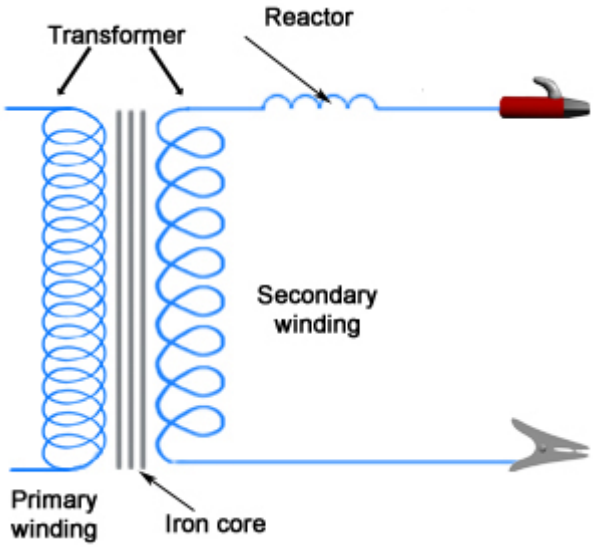


Figure 2. The reactor stablizes and adjusts transformer output.

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Class Vocabulary

AC	The abbreviation for alternating current.
alternating current	Current that regularly reverses the direction of its flow. Gas tungsten arc welding (GTAW) often uses AC.
alternator	A device that generates alternating current through the use of a mechanical device like an engine or a motor.
amperage	A measurement that indicates the amount of current flowing in a circuit. Amperage is measured in amperes.
anode	An electrical terminal that usually carries a positive charge. In welding, an SCR powers on only if the anode is negative.
arc blow	A condition that occurs when the arc does not follow its intended path from the electrode to the workpiece. Arc blow can cause undesirable weld beads.
arc length	The distance the arc stretches from the electrode to the workpiece. Longer arc lengths require more voltage.
armature	A device found in generators that has many separate coils wound around it. When the armature rotates in the generator, it creates a magnetic field, which produces direct current.
brush	A device found inside a generator that is used only in pairs. One brush carries a negative charge, and the other carries a positive charge. The brushes touch the current-carrying commutator.
cathode	An electrical terminal that usually carries a negative charge. In welding, an SCR powers on only if the cathode is positive.
CC welder	An abbreviation for a constant current welder.
choke	Another name for inductance coil or stabilizer.
circuit	A controlled path for electricity. Arc welding requires a closed electrical circuit.
coil	A wound spiral of two or more turns of wire used to conduct current.
commutator	A current-conducting device found inside a generator. Commutators are made of copper and touch one or more pairs of brushes.
constant current	Welding using a current that varies slightly with significant changes in voltage. Constant current, or CC, is often used in shielded metal arc welding (SMAW) and gas tungsten arc welding (GTAW).
constant voltage	Welding using a voltage that varies slightly with significant changes in current. Constant voltage, or CV, is often used for gas metal arc welding (GMAW) and flux-cored arc welding (FCAW).
CV welder	An abbreviation for constant voltage welder.
direct current	Current that flows in one continuous direction. Gas metal arc welding (GMAW) and flux-cored arc welding (FCAW) require DC.
droop curve	The type of output slope produced by a constant current welder. Droop curves have a steep slope and are sometimes called droopers.
drooper	The type of output slope produced by a constant current welder. Droopers have a steep slope and are sometimes called droop curves.
duty cycle	The amount of time in a ten-minute period that a welder can perform work without overheating. In the shop, welders with a higher duty cycle are preferred.
electric arc	The area in which electricity jumps from the electrode to the workpiece. The heat generated by the electric arc melts the base metals.
electricity	The energy created by the movement of electrons. Electrical energy can be converted into light, heat, or motion.
electromagnet	A magnet formed from electric current. An electromagnet is typically formed by wrapping several windings of wire around an iron core.
energy efficient	A characteristic of welders that signifies good use of electricity. Energy efficient devices do work using smaller amounts of electricity, which costs less.
field winding	A type of wire that acts as an electromagnet and creates a magnetic field inside a generator.
flux-cored arc welding	An arc welding process that uses a continuously fed consumable electrode that contains flux in a hollowed-out center. It is also referred to as FCAW.
gas metal arc welding	An arc welding process in which a bare wire electrode and inert or active shielding gas is fed to the weld through a welding gun. It is also referred to as GMAW or MIG welding.
gas tungsten arc welding	A very precise arc welding process that uses a nonconsumable tungsten electrode. It is also referred to as GTAW or TIG welding.
gate	The switch that powers a silicon-controlled rectifier. A gate only allows the SCR to switch on if the current is flowing in the proper direction.

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generator	A device that generates direct current through the use of a mechanical device like an engine or a motor.
half cycle	Half of one complete cycle. A half cycle of a transformer occurs when the secondary coil induces current. A full cycle occurs when both the primary coil and secondary coil induce current.
Hertz	A unit of measurement indicating a single cycle of alternating current.
high-deposition electrode	An electrode that deposits a large amount of filler metal into a weld joint.
hot start	A feature on some welders that allows welding to begin with very high settings. Hot starts prevent sticking the electrode.
IGBT	The abbreviation for insulated gate bipolar transistor.
inductance coil	An electrical device that smoothes out the rippled path of DC power after it passes through the rectifier. The inductance coil is sometimes called the choke or stabilizer.
insulated gate bipolar transistor	A type of filter used in inverter-based power sources that elevates incoming power to frequencies as high as 20,000 Hz. Insulated gate bipolar transistors are often referred to by their abbreviation, IGBT.
inverter	An arc welding power source that operates at very high frequencies and is much more energy efficient than transformer-based machines.
laminated iron core	The device found in a transformer that is located in the center of the primary and secondary winding. The laminated iron core ensures that current does not stray from its intended flow.
low-hydrogen electrode	An electrode that is used to weld specialized materials that are susceptible to cracking.
magnetic field	The space in which a magnetic force exists.
movable iron reactor	A type of reactor that controls transformer output by moving a piece of iron between the windings that remain stationary.
nonferrous electrode	An electrode that does not contain iron. Nonferrous electrodes are used to weld nonferrous metals.
output	The type of power that the welder produces. Forms of output include direct current (DC), alternating current (AC), constant current (CC), and constant voltage (CV).
output slope	The name given for the slope on a static volt-ampere curve.
polarity	The direction of current flow in a direct current (DC) circuit.
power factor	The relationship between the amount of power a welder draws from the power company and the amount of power it returns to the power company. Ideally, a welder has a power factor of 1, or 100%.
power source	A device that generates electricity. Arc welder power sources can be plugged into a wall outlet, or they can generate electricity through the use of a mechanical device like a motor or generator.
primary voltage shock	An electrical shock from 120-480 volts that occurs in arc welding from touching a lead inside a switched-on welder and then touching the welder case or other grounded metal at the same time.
primary winding	The first winding that current passes through in a transformer. The primary winding contains multiple thin wires that are wrapped into a coil.
pulse welding	A type of welding that uses a transfer method in which as little as one droplet of metal forms on the end of the electrode at a time. Pulse welding requires the highest welder settings.
reactor	An electrical device that smoothes out transformer output and adjusts amperage according to the desired settings on the welder.
rectifier	An electrical device that converts AC power to DC power. Rectifiers allow current to flow in one direction only.
resistance	The opposition to current flow. Electricity flows in the path of least resistance.
reverse polarity	Current in arc welding that flows from a negative workpiece to a positive electrode.
rotor	A device found in alternators that contains many windings of wires. When the rotor rotates inside the alternator, it creates a magnetic field, which produces alternating current.
SCR	The abbreviation used for silicon-controlled rectifier.
secondary voltage shock	An electrical shock from 60-100 volts that occurs in arc welding from touching the electrode while another part of the body touches the workpiece.
secondary winding	The second winding that current passes through in a transformer. The secondary winding contains fewer, but thicker wires that are wrapped into a coil.
self-regulating system	A characteristic of constant voltage welders. Constant current welders are considered self-regulating systems because a change in arc length automatically adjusts the electrode melting rate.
shielded metal arc welding	An arc welding process that uses a flux-coated consumable rod electrode. It is also referred to as SMAW or stick welding.

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silicon-controlled rectifier A type of reactor that controls transformer output by allowing current to flow in one direction only. Silicon-controlled rectifiers are often referred to as SCRs.

slope The angle of a line that appears when comparing two variables on a graph.

stabilizer Another name for inductance coil or choke.

stainless steel A type of steel that contains more than 15% chromium and exhibits excellent corrosion resistance.

static volt-ampere curve A type of graph used to chart a welder's voltage output versus its amperage output in a given time period.

step control A means of controlling transformer output by selecting the amount of windings to use. Step control is not preferred, because it is not a smooth, continuous control of transformer output.

step-down transformer A type of transformer used for welding power sources that converts high-voltage, low-amperage industrial power to low-voltage, high-amperage power.

step-up transformer A type of transformer that increases voltage. Arc welding does not use step-up transformers.

straight polarity Current in arc welding that flows from a negative electrode to a positive workpiece.

tap reactor A type of reactor that controls transformer output by selecting the number of windings to use.

transformer An electrical device that adjusts voltage.

voltage The electrical force or pressure that causes current to flow in a circuit. Voltage is measured in volts.

watt A unit of measurement that indicates the amount of electrical power in a circuit.

weldor A term sometimes used to refer to the person who welds.

winding Wire wrapped around a core or into a coil that is used to conduct current. The more windings used in a power source, the more amperage the power source can generate.

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