



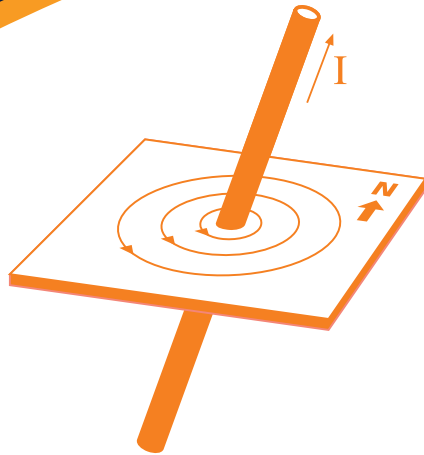
Ambrell[®]
INDUCTION HEATING SOLUTIONS
an inTEST Company



Induction Heating Work Coils

Experience the Excellence.™

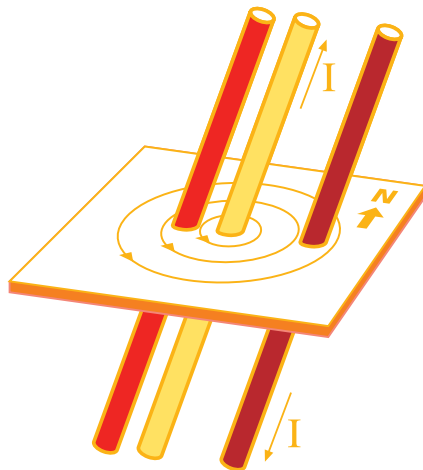
Work Coil Basics



A current flowing in a conductor creates a magnetic field. An alternating current creates an alternating field which produces an alternating current in a second conductor (the work piece). The current in the work piece is proportional to the field strength.

The transformer effect is where the amount of current induced in the work piece is proportional to the number of turns on the coil and is generated as a mirror image of the work coil.

The work coil, also known as the inductor, is the component in the induction heating system that defines how effective and how efficiently the work piece is heated. Work coils range in complexity from a simple helical (or solenoid) wound coil consisting of a number of turns of copper tube wound around a mandrel to a coil precision machined from solid copper and brazed together.



The work coil is used to transfer the energy from the induction heating power supply and workhead to the work piece by generating an alternating electromagnetic field. The electromagnetic field generates a current that flows in the work piece as a mirror image to the current flowing in the work coil. As the current flows through the resistivity of the work piece it generates the heat within the work piece from I^2R losses.

A second heating principle, hysteric heating is also in effect when the work piece is a magnetic material such as carbon steel. Energy is generated within the work piece by the alternating magnetic field changing the magnetic polarity within the work piece. Hysteric heating occurs in the work piece only up to the Curie temperature (750° C for steel) when the materials magnetic permeability decreases to 1.



Coil Design

Coil design is essential to the effectiveness and efficiency of an induction heating process. Ambrell designs the coil by first understanding where the heat needs to be generated in the part to perform the process, and then designs the coil to achieve the heating effect.

Induction coils are water-cooled copper conductors made of copper tubing that is readily formed into the shape of the coil for the induction heating process. Induction heating coils are cold and do not themselves get hot when water is flowing through them.

Matching the coil to the induction power supply is also essential to the efficiency of the process. Ambrell's frequency-agile induction systems are easily matched to a wide range of coils by using the multi-tap output transformer in the power supply.

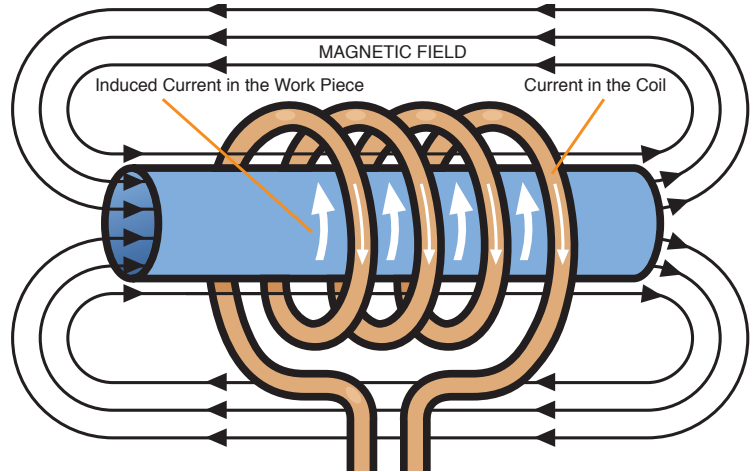
How Does an Induction Coil Work?

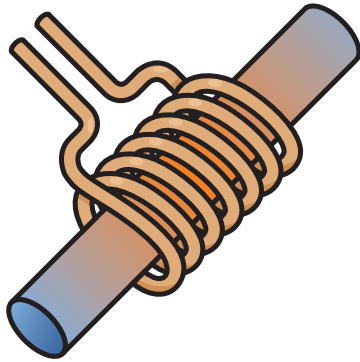
The work coil is used to transfer energy to the work piece using an alternating electromagnetic field.

The alternating current flowing through the coil generates the electromagnetic field which induces a current flowing in the work piece as a mirror image to the current flowing in the work coil.

The work coil, also known as the inductor, is the component in the induction heating system that defines how effectively and how efficiently the work piece is heated.

Work coils range in complexity from a simple helical wound (or solenoid consisting of a number of turns of copper tube wound around a mandrel) to a coil precision-machined from solid copper and brazed together.



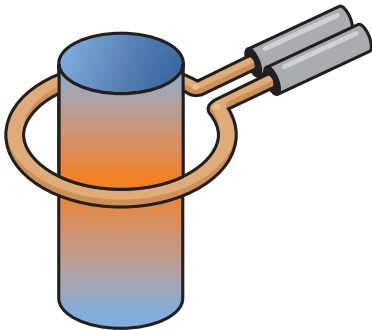


Multi-turn Helical Coil

The helical (solenoid) is the most common and efficient coil with the number of turns defining the width of the heating pattern. The work piece can be stationary in the coil to provide a defined heating band in “single shot heating.” Or, the work piece is moved through the coil to heat the whole part with a highly uniform heating pattern called “scan heating.”

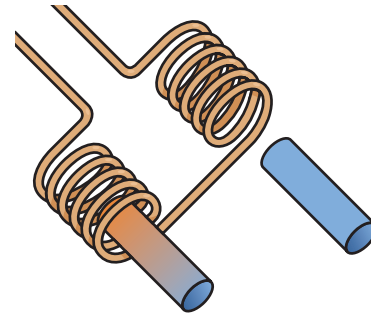
Single-Turn Coil

Single-turn coils are ideal for heating a narrow band of a work piece or the tip of a work piece. These coils can also scan the length of a work piece and are commonly used for heat treating. These coils are often tight to the part to provide a precise heat pattern.



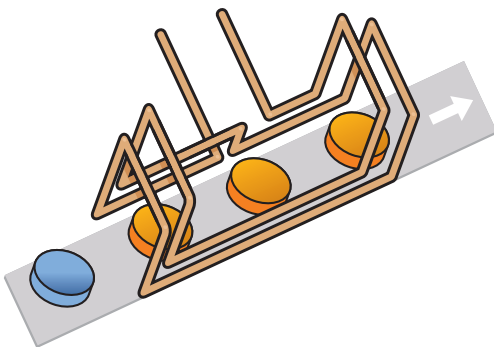
Multi-Position Helical Coil

Multi-position coils are often used to produce more parts in a given time while allowing for the full heating process. While one work piece is being heated on one position, the other coil can be unloaded and reloaded for the next heating cycle. Any number of positions are possible but typically up to 8 positions are practical.



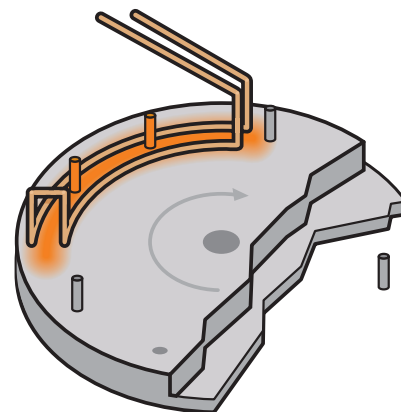
Channel Coil

Coils can be formed so the work piece is moved through the electromagnetic field by a linear transport mechanism. The work piece is heated as it moves through the channel coil and the coil can be configured to heat all of the part or just a single band.



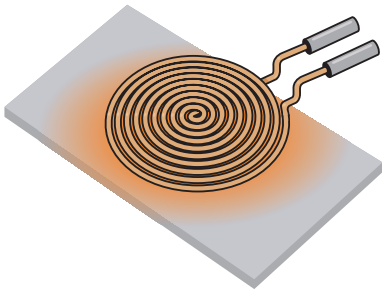
Curved Channel Coil

Channel coils are often curved to fit onto a rotary table and are configured to occupy one of the steps in a multistep assembly process.



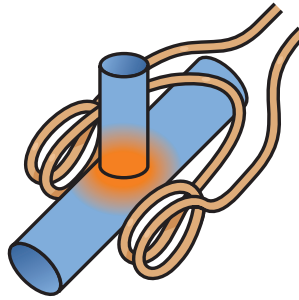
Pancake Coil

Pancake coils are used when it's necessary to heat the work piece from only one side or when it's not possible to surround the part.



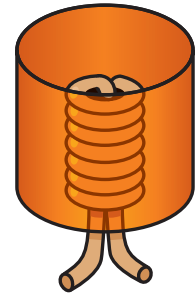
Split Helical Coil

Single or multiple turn split helical coils are used when it's not possible to get access to the heat area using a helical coil.



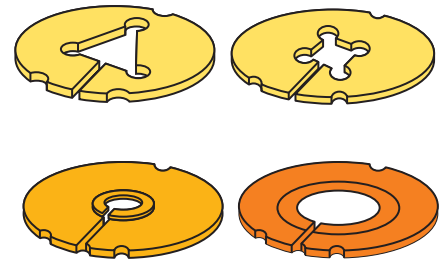
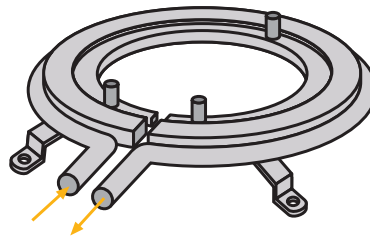
Internal Coil

Internal bores can be heated using single- or multiple-turn internal coils.



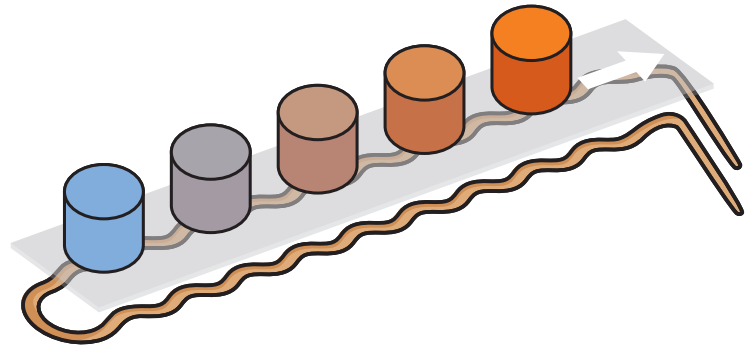
Concentrator Plate Coil

Concentrator plates are used in single or multiple turn coils to focus the coil current to produce a defined heating effect in the work piece. These coils may also have a master coil with inserts designed to heat different shaped parts.



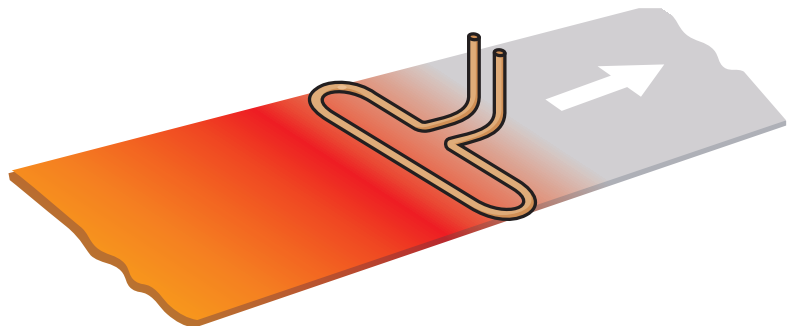
Coils and Conveyors

Many parts are heated while being transported by a conveyor system. As long as the conveyor material is not electrically conductive, the magnetic field will pass through the conveyor and heat the work piece as it passes through the field.



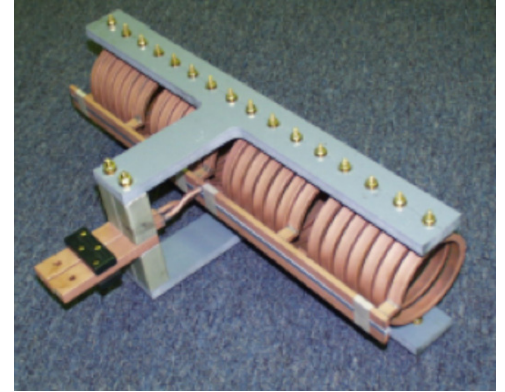
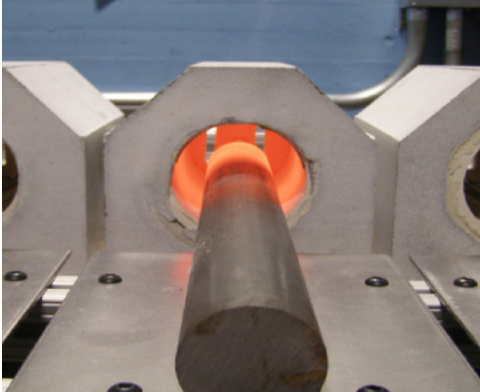
Hair-Pin Coil

A long thin single- or multiple-turn coil is used to heat a long thin zone on a part, or used to heat a moving web of thin steel or aluminum.





Encapsulated Coils



Once the coil is designed, and heating pattern proven, it's common to encapsulate the coil for thermal insulation from the process and to make the coil assembly more robust in harsh environments. Typical encapsulation materials are concrete, ceramics, and epoxy or thermoplastics.

Single-turn coil with ferrite concentrator. Field concentrators are used on coils to intensify the electromagnetic field, increasing the current density in the work piece. Concentrator materials are ferrites at high frequency and shim steel at low frequencies.

Multi-turn helical coil with turns fixed with studs and plates, also showing quick release connection blocks.



Coil mounted under a conveyor for heating metal cans.



EASYCOIL

The flexible EASYCOIL is a coil that is ideal for large, irregularly shaped work pieces that cannot be heated with a traditional copper coil. It is used with Ambrell EASYHEAT™ and EKOHEAT® induction heating systems – up to the 250 kW model.

Free Application Testing from THE LAB

With a Reputation for Delivering Extraordinary Results, Our Applications Laboratory is the Gold Standard in the Industry.

Our Applications Laboratory – known in the industry as THE LAB – is where we solve our customers' most challenging heating applications every day.

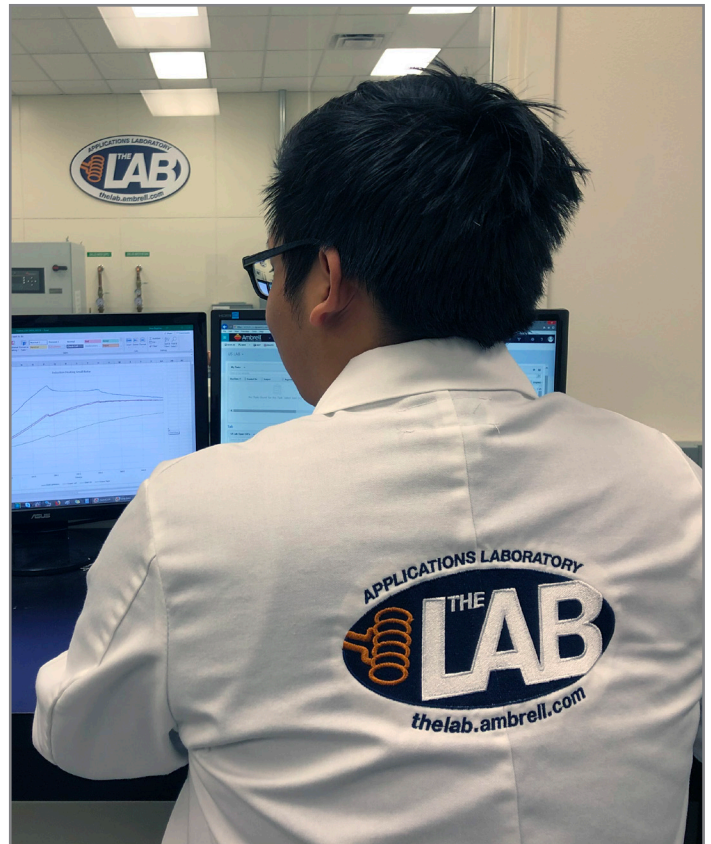
Dr. Girish Dahake, Sr. Vice President of Global Applications, leads a worldwide team of elite engineers who are uniquely qualified to assist you with your heating process needs. Under the guidance of Dr. Dahake, our engineers have evaluated thousands of applications in THE LAB, so it's likely we have already assessed an application similar to yours.

Ambrell's team of engineers is world-renowned for producing extraordinary results. Our innovative and effective induction heating solutions consistently deliver performance excellence in one application after another. It's why THE LAB is the gold standard in the industry.

Have our team of expert engineers design and test the optimal solution for your application, free of charge. All it takes are three easy steps:

- 1. Send us your parts and process requirements**
- 2. Our engineers will analyze your process and heat your parts to develop the right solution for your specific application**
- 3. You will receive your parts back for inspection as well as a video of the heating process of your parts, and a laboratory report with a system recommendation**

We also invite you to visit THE LAB where you can experience our state-of-art testing facility, which is fully equipped with Ambrell induction heating systems and hundreds of proven coils. In addition, you can interface with our engineers and see first-hand how they design prototype coils and develop effective solutions to maximize the efficiency of your heating process.



“Induction heating is a precise, repeatable and efficient method of heating. However, in order to maximize the benefits of induction, it's critical to have the correct system and coil design. Our global team of highly-skilled engineers look forward to assessing your application and making the right recommendation for your process.”

**Dr. Girish Dahake,
Sr. Vice President, Global Applications**

For more information, contact us today at +1 585 889 9000 or visit thelab.ambrell.com



*Our global reach includes a direct sales team
along with an extensive distribution,
channel partner and OEM network.*

About Ambrell

Founded in 1986, Ambrell Corporation, an inTEST Company, is a global leader in the induction heating market. We are renowned for our application knowledge and engineering expertise. In addition, our exceptional product quality and outstanding service and support are at the core of our commitment to provide a superior customer experience.

We are headquartered in the United States with additional operations in Europe including the United Kingdom and the Netherlands. All Ambrell products are designed, engineered and built at our manufacturing plant in the United States, which is an ISO 9001-certified facility. Over the last three decades we have expanded our global reach through an extensive distribution, channel partner and OEM network. Today, we have more than 17,000 systems installed in over 50 countries.



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