

# HIGH-FREQUENCY INDUCTION HEATER



## Contact

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This manual shall be made available to all users of this high-frequency induction heater. To ensure the best results and maximum durability of this U.S. SOLID LLC (here after U.S. SOLID or The Company) product, read and follow all instructions carefully. Failure to do so may lead to serious bodily injury and catastrophic damage to the heater, supplies, or surrounding area. All safety suggestions must be followed closely and precautions must be taken to guarantee this heater is only used by qualified personnel who have understood this guide.

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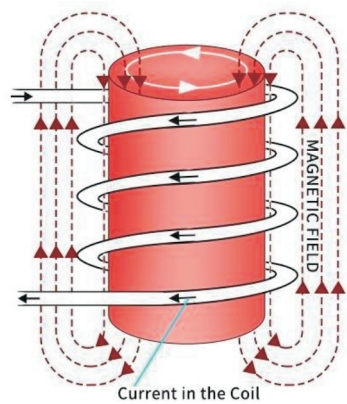
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## I. Specifications

Output Power	Turns Ratio	Power Supply	Non-handheld Type	Handheld Type
15kW	16:1	Single Phase 110V or 220V	USS-HFIH00001	USS-HFIH00015
	16:2	Single Phase 110V or 220V	USS-HFIH00011	
25kW	18:1	Three Phase 380V or 480V	USS-HFIH00003	USS-HFIH00016
	18:2	Three Phase 380V or 480V	USS-HFIH00012	
35kW	18:1	Three Phase 380V or 480V	USS-HFIH00004	USS-HFIH00018
40kW	18:1	Three Phase 380V or 480V	USS-HFIH00008	USS-HFIH00019
60kW	18:1	Three Phase 380V or 480V	USS-HFIH00006	USS-HFIH00020
80kW	18:1	Three Phase 380V or 480V	USS-HFIH00014	USS-HFIH00021

## II. Operating Principles

Induction heating is a contact-free heating process which uses high-frequency electricity to generate heat. When an alternating current (AC) flows through the coil while a workpiece is positioned inside, an electromagnetic field is generated. Once the current alternates (i.e., changes) direction, the direction of the electromagnetic field also changes. Because this new electromagnetic field contradicts the initial magnetic field, this process produces an eddy current (sometimes referred to as Foucault's current). Based on Joule's first law,<sup>1</sup> Joule heating is then generated. As time passes, the density of the workpiece increases, leading to growing resistance,<sup>2</sup> which in turn generates more Joule heating, causing the workpiece to get incrementally hotter.



<sup>1</sup> Joule's first law:

$$Q = I^2RT$$

Q: Joule heating

I: Eddy current

R: resistance

T: time

<sup>2</sup> Resistance:

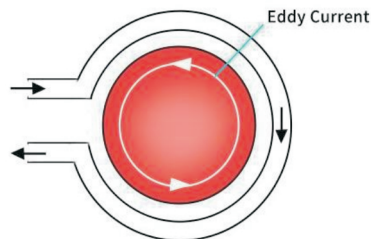
$$R = \rho \frac{L}{S}$$

R: resistance

P: resistivity of the metal

L: length

S: cross-section



## III. Getting Started

Thank you for purchasing the U.S. SOLID high frequency induction heater. Please read the manual in its entirety, or visit our website where you can find all the information about the high frequency heater as well as instructional videos on how to operate it.

<https://ussolid.com/collections/high-frequency-heater-html>

Changes in technology happen often and rapidly, which is why our team at U.S. SOLID reserves the right to modify the specifications and procedures for this high-frequency induction heater immediately and without notice. The Company will not assume responsibility for equipment damage or malfunction due to improper operation, incorrect repairs, or use of unauthorized parts.

This induction heater has passed rigorous testing and extensive research and development. Like all of our products, it is made with quality materials at a reasonable price. This induction heater is suitable for heating a variety of metals in different sizes.

You have 30 days from the date of delivery to return this product. If the returned item has been opened, a 15% restocking fee will be applied. We provide a 12-month warranty from the date of the sale. Within the warranty window, we are responsible for any replacement parts needed caused by quality issues. If you want to return a defective item, please contact our customer service team to receive a free prepaid shipping label for your return. To expedite the warranty process, please describe the issue and include the following information: purchase date, order number, name of the original purchasing entity, delivery address, and serial number. After the 12-month warranty period, we offer to replace parts at current retail cost, but complete product returns will not be accepted.

The warranty will only be in effect if all instructions in the manual are followed. The warranty does not cover damage caused by force majeure (e.g., natural disasters such as hurricanes, floods, or earthquakes).

This manual includes basic safety precautions and instructions for installation, operation, and maintenance.

## IV. Safety Instructions

- This machine should only be operated by adults who have read and fully understood this manual.
- When operating this machine, remove all metal items such as rings and watches from hands and arms. Metal exposure in the coil may cause heating and result in serious bodily harm.
- Due to the magnetic field generated by the induction heater, individuals with pacemakers or other medical devices should not work near or stay close to the equipment. Other sensitive devices, such as watches, magnetic media, or electronic circuits, may also be affected. It is recommended to maintain a minimum safe distance of 0.5 meters (20 inches).
- Installation and connections of the equipment must be carried out with all power turned off.
- Use only original parts provided by us to ensure your safety and optimal product performance.
- Ensure that the coil is properly installed with insulating sleeves to restrict the risk of sparks and fires.
- Water should be circulated through the equipment before powering on, and cooling water must flow through the interior and the sensor. High-quality circulating cooling water can extend the lifespan of the high-frequency induction heater. Poor water quality may lead to rust, scratches, and blockages inside the equipment, causing damage to the machine. The recommended types of water (in order of priority) are distilled water, softened water, purified water, and filtered water.
- The equipment must be grounded, placed on a stable and flat surface, and the machine casing should be grounded with copper wire of at least 6mm to prevent electrical hazards.
- After the equipment is powered on, do not touch any connecting wires on the device.
- Avoid high-power operation without load and running under no-load conditions for an extended period.
- The host device and extension device are connected using cable quick connectors.
- Proper matching of the turns between the host device and extension device is necessary for optimal heating effects. When customers match or make their own induction coils, please refer to the "Principles of Induction Coil" section in this manual or contact us for consultation.
- The two control lines between the host device and extension device, one 2-core aviation plug line and one 5-core aviation plug line, play a crucial role in protecting the equipment. During operation, it is essential to ensure these connections. When abnormal occurrences are detected in the extension device, these two control lines provide feedback to the host for control, allowing timely shutdown of the host to protect the equipment from damage. If these two lines are not connected, under normal circumstances, it will not affect the use of the equipment. However, when abnormal situations occur, the protective function is lost, resulting in significant damage.
- The host device, extension device and induction coil of the equipment must all be water-cooled, with a clean water source to prevent blockage of the cooling pipes, which could cause overheating and damage to the equipment.
- After work is completed, be sure to continue circulating cooling water for at least 5-10 minutes.
- The working environment should be clean, free of corrosion, oil fumes, metal dust, and high-temperature conditions.
- The heater is designed for industrial environments with an ambient temperature of 1°C-45°C (34°F-113°F).
- Place materials heated by the heater in a safe location to prevent injuries.
- When adjusting, repairing, or storing the machine, always turn off the power and unplug the machine.

## V. Installation

When first receiving the induction heating machine, be careful when removing the machine from its box. This product is a heavy piece of equipment. The machine comes with one assembled coil, and one piece of copper tubing to create your own coil.

Start by connecting the assembled coil to the machine. It is important that it is screwed in tightly, as water will be running through the coil. Use a wrench to tighten the connecting bolts.

Once the coil is connected, water input and output can start being routed. One hose is provided, but it is possible more hoses will be needed (found at any hardware store). A water circulation pump or a water chiller may be used as a cooling device.

You can also connect the heater to a tap water outlet. In this case, it is important that the tap water is clean and has enough water pressure. Dirty water will lead to the machine breaking down. Please make sure the flow rate of the cooling water is at least 7.5 L/min, the water pressure is more than 0.3 MPa, and the head should be more than 30 m (98 ft).

Next, set up the wires. Make sure the wiring used is at least 9 gauge wire. Connect the ground, live and neutral wires to their designated spots on the back of the machine. Check that no wire is exposed from the connections, as this could present a potential fire or electrocution hazard.

It is important that the machine is set up in a place free of debris and clutter. Make sure hoses and wires for the machine are secured to avoid tripping hazards.

## VI. Operation

- Ensure all installation work has been completed.
- Turn on the cooling water.
- Close the external power switch, close the air switch at the back of the equipment, and close the front panel power switch.
- Adjust the shape of the sensor to fit the heating requirements of the workpiece.
- Place the workpiece to be heated into the induction heater.
- Refer to the description of the panel section below, adjust the various parameters on the panel, and turn the knobs to the desired positions.
- Press the "Start" Button on the control panel, or press the foot switch to start heating.
- Press the "Stop" Button on the control panel, or release the foot switch to stop heating.
- When selecting panel operation, please unplug the foot switch (or remote switch), press the "Start" Button for the equipment to work, and press the "Stop" Button for the equipment to stop.
- For manual operation: (1) When selecting foot switch operation, press the foot switch to start the equipment. Release the foot switch to stop the equipment. (2) If not selecting foot switch operation, press the "Start" Button on the panel, the equipment will work continuously. To stop, press the "Stop" Button.
- For automatic operation: Press the foot switch once, the equipment will start working, automatically time, complete the heating process, and stop working automatically.
- When shutting down, first turn off the front panel power switch, then turn off the external main switch, and then turn off the water.

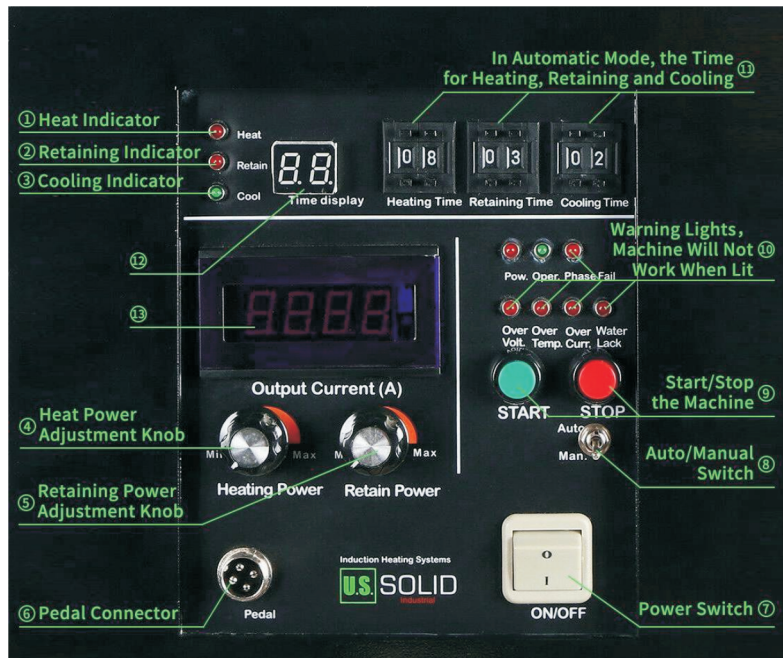
## VII. Principles of Induction Coil

- Use copper tubes with a wall thickness greater than 1mm, copper tubes with a diameter larger than  $\Phi 8$ , or square copper tubes to wind the induction coil. If the copper tube is too small or too long, its resistance heat will be significant, leading to the burning of the induction heater or heating the cooling water to boiling, accompanied by a bubbling sound, which should be avoided as much as possible.
- The optimal coupling gap between the induction coil and the heated part of the workpiece is 5-15mm.
- When heating materials with poor magnetic properties such as copper or aluminum, the number of turns in the induction coil should be increased.
- When other conditions remain constant, the larger the induction coil, the more turns it has, the lower the frequency, the higher the number of turns in the secondary winding, and the higher the induction coil current.
- When the maximum output position is reached, the current display shows the maximum, but the heating effect is not good when the workpiece is inserted into the induction coil and the current remains constant, it indicates that the load is too light, or the gap between the load and the induction coil is too small, or the number of turns in the induction coil is too few. In this case, reduce the size of the induction coil, i.e., reduce the gap between the induction coil and the workpiece; if the gap is already small, increase the number of turns in the induction coil.
- When the output oscillating current cannot be adjusted to the maximum, and adding a load causes the current to drop significantly or even stop automatically, it indicates that the load is too heavy, or the gap between the load and the induction coil is too small, or the number of turns in the induction coil is too high. As long as it does not stop automatically, it does not affect the use, and the heating efficiency is also very high. However, if automatic shutdown occurs, increase the size of the induction coil appropriately, i.e., increase the gap

between the induction coil and the workpiece. If the gap is already large, reduce the number of turns in the induction coil.

- For flat heating of workpieces that are difficult to place inside the induction coil or for heating non-magnetic metal materials (such as copper, aluminum), different shapes of magnetic conductors (ferrite magnetic cores) can be used to greatly increase the equipment's power output.
- The design of the induction coil directly affects the heating effect. It is recommended to use the induction coil designed by us. If self-designing, be sure to consult us.
- When the inductance of the induction coil is too large or too small, the load is too heavy or too light, and the power does not reach the rated power, resulting in poor heating effects, special customized equipment is required.
- The size of the induction coil, the number of turns in the induction coil, the material and shape of the workpiece, and the selection of the number of turns in the secondary winding need to be appropriately matched to achieve higher heating efficiency and better heating effects.

## VIII. Front Panel in Auto Mode



- ① Heat Indicator: When lit, the machine is heating the workpiece.
- ② Retaining Indicator: When lit, heat is retained using the current set by the Retain Power Adjustment Knob.
- ③ Cooling Indicator: When lit, current is no longer running through the coil, allowing for the workpiece to cool down.
- ④ Heat Power Adjustment Knob: Controls the current going through the coil in manual mode, and during the heating portion in automatic mode. It is recommended to start at a low current when first turning the machine on, and then slowly increase the current by rotating the knob as the machine warms up. The more this knob is turned clockwise, the higher the temperature of the workpiece will get.
- ⑤ Retaining Power Adjustment Knob: Controls the current when in heat retention mode. This is only applicable when the machine is in automatic mode.
- ⑥ Pedal Connector: If the foot pedal is connected to the machine, the machine can

be controlled using the pedal instead of the Start/Stop Buttons on the machine.

- ⑦ Power Switch: Turns the machine on or off.
- ⑧ Auto/Manual Switch: Switches the working mode between automatic and manual.
- ⑨ Start/Stop Buttons: Starts or stops the working process when the pedal is not connected.
- ⑩ Warning Lights (Over Volt, Over Temp, Over Current, Water Lack, and Phase Fail): When one of these light up, the machine will cease operating. Different lights indicate different issues: Either too much voltage or current is running, the machine is overheating, the water pressure to the machine is not high enough, or the phase power is failing.
- ⑪ Time for Heating, Retaining, and Cooling:
  - Heating Time: Time (in seconds) for heating the workpiece according to the level selected using the Heat Power Adjustment Knob.
  - Retaining Time: Time (in seconds) for heat retention of the workpiece, according to the level selected using the Retain Power Adjustment Knob.
  - Cool Time: Time (in seconds) for cooling. No selection possible.
- ⑫ Time Display: Displays the time of the current phase when in automatic mode. When the Heat Indicator lights up, it shows the heating time. When the Retaining Indicator lights up, it shows the retaining time. When the Cooling Indicator lights up, it shows the cooling time.
- ⑬ Output Current: When twisting the Heating Power Knob, this shows the heating power. When twisting the Retain Power Knob, it shows the retain power. When the machine is operating, it shows the induced current on the coil.

## IX. Operation in Auto Mode

When the machine is in automatic mode, heating of the workpiece will be controlled by setting the Heating Time, Retaining Time, and Cooling Time. These numbers can be between zero and 99 seconds. Once your desired times are set, simply press the Start Button and insert the workpiece. The coil will be energized at the level selected using the Heat Power Adjustment Knob and will stay at this level for the duration of the selected Heating Time. The Heat Light will be on during this period.

After that time has elapsed, the program enters Retaining Mode. The coil will still be energized, but at the level selected using the Retaining Power Adjustment Knob for the duration of the selected Retaining Time. During this period, the Retain Light will be on.

Finally, the machine enters Cooling Mode. The coil will not be energized for the duration of the selected Cooling Time. Once the program is finished, to run it again, simply press the Start Button again. Automatic mode can be very useful for repeating the same action on different workpieces. Similarly, when soldering, brazing, or otherwise needing two different working temperatures, automatic mode can provide that as well.

Step 1: Flip the On/Off Switch to turn on the machine.

Step 2: Press the - or + button to set the Heating Time, Retaining Time, and Cooling Time.

Step 3: Twist the Heating Power Adjustment Knob to set the heating power. Step 4: Twist the Retain Power Adjustment Knob to set the retaining power.

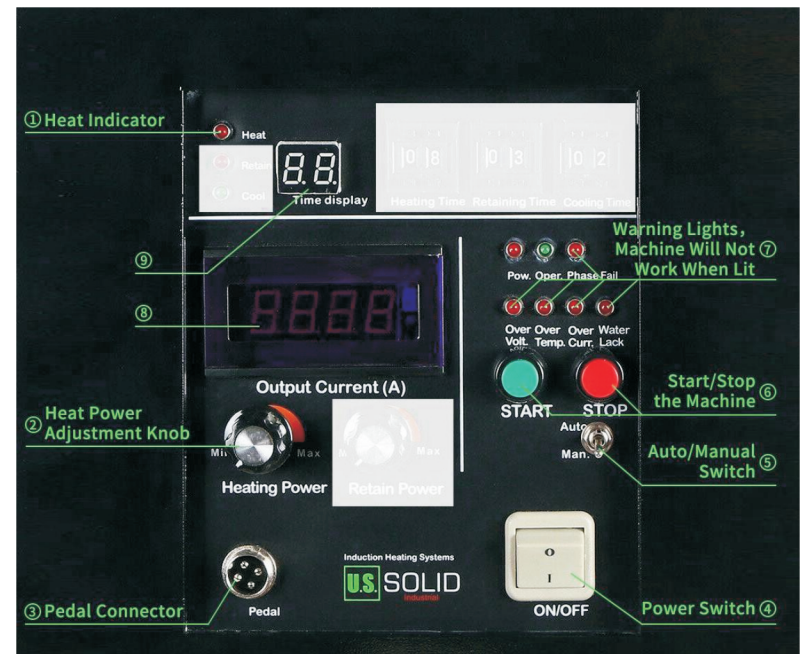
Step 5: Press the Start Button (or press the foot pedal) to start the heating process.

Step 6: Turn off the machine and unplug the heater when not in use.

### Notes:

- "Oper." light flashes and the machine beeps when the machine is in use.
- If the pedal is connected to the machine, you can only start the machine by pressing foot pedal.

## X. Front Panel in Manual Mode



⑦ Warning Lights (Over Volt, Over Temp, Over Current, Water Lack, and Phase Fail):

When one of these lights turns on, the machine will cease operating. Different lights indicate different issues. Either too much voltage or current is running, the machine is overheating, the water pressure to the machine is not high enough, or the phase power is failing.

⑧ Time Display: Shows the working time (in seconds). This increases as time passes.

⑨ Output Current: When turning the Heating Power Knob, this displays the heating power. When the heater is working, it shows the induced current on the coil.

**Note:** Indicators and knobs covered by a gray box  in the picture means they do not affect the heater when in manual mode.



## XI. Operation in Manual Mode

Adjust the Heat Power Adjustment Knob to the desired level, then press the pedal to energize the coil. Insert your workpiece into the coil to begin heating. The further the Heat Power Adjustment Knob is turned clockwise, the hotter your workpiece will get.

- Step 1: Flip the On/Off Switch to turn on the heater.
- Step 2: Twist the Heating Power Adjustment Knob to select the heating power. Step 3: Press the Start Button or press the foot pedal to start heating.
- Step 4: Turn off and unplug the heater when not in use.

**Note:** If the pedal is connected to the machine, you can only start the machine by pressing foot pedal.

## XII. Potential Applications

Applications	Notes
Brazing	Hybrid welding of different materials. Clean the surfaces to be used. Dimension of the workpiece should be less than 1.2 x 1.2x 1.2 ".
Diathermy	The diameter of the workpiece should be less than 5 mm (3/16").
Sealing	This can be used to seal and cap different machines. Be aware of the metal type used in the seal.
Hardening	Many metals can be heat-treated to induce hardening. Most often, this process requires quenching right after heating, so have a quenching station available.
Annealing	Some heat-treated metals will end up softer. Be aware of the type of metal you are heat-treating; results can differ.
Soldering	Much like brazing, clean the surfaces to be used. Be aware that solder can melt very quickly.
Smelting	Many metals can be smelt, e.g., copper, silver, and gold. Please note the total metal weight should be less than 1 kg (2.2 lbs).

## XIII. Other Factors

In actual use, many factors will determine the speed and temperature of the heating process. While the adjustment knobs do control current, the heating power also depends on the material of the workpiece, the thickness of the workpiece, the shape of the coil, the number of turns in the coil, and the area of the turns within the coil. When using your own coil, it is recommended to try different heat settings to ensure the heater is correctly calibrated for your exact use case.

## XIV. Selection Instruction

Heating type	Application range	Frequency selection	Power selection
Brazing	Composite welding of different materials such as brazing tips, turning tools, reamers, milling cutters, drill bits, etc. and stainless steel pot bottoms.	The principle is that the larger the welding volume, the lower the frequency should be. For tools with a volume less than 30*30*30mm <sup>3</sup> , high frequency can be used. For those with a volume greater than 30*30*30mm <sup>3</sup> , medium frequency should be used.	It depends on the specific workpiece shape, material, solder, etc.
Workpiece heat transfer	Fasteners, standard parts, auto parts, hardware tools, rigging, hot upsetting and hot rolling of twist drills, etc.	The principle is that the larger the diameter of the workpiece, the lower the frequency should be. For example: Choose medium frequency 1-20kHz for diameters above Φ20mm. Choose high frequency 20-100kHz for diameters between Φ5mm and Φ20mm. Choose ultra-high frequency 100-500kHz for diameters below Φ5mm.	Choose the appropriate power according to production efficiency. The greater the power, the faster the speed. Please consult us for details.
Heat treatment	Shafts, gears, sprockets, machine tool guide rail accessories, metal wire annealing, hydraulic accessories, auto parts, knives, scissors, stainless steel pot annealing, etc.	The principle is that the shallower the hardened layer of the workpiece is required, the higher the frequency should be. For example: For less than 1mm, choose ultra-high frequency 100-500kHz. For 1-2.5mm, choose super-audio 20-100kHz. For more than 2.5mm, choose medium frequency 1-20kHz.	Combined with the workpiece shape, quenching method, hardening hardness, hardened layer requirements and materials. Please consult us for details.
Smelting	Gold, silver, copper, lead and other precious metals.	Usually medium frequency is selected, and high frequency can be selected for small capacity.	Depends on the specific furnace and production efficiency. Please consult us for details.
Others	Heating film for aluminum-plastic pipes, steel-plastic pipes, cables, and wires; aluminum foil sealing used in food, beverage, and pharmaceutical industries.	Depending on the specific situation. Please consult us for details.	Depending on production speed, material, and temperature. Please consult us for details.
Special functions and supporting equipment	Such as dual-frequency equipment, multi-load matching type (dual heads, multiple taps), automatic control type, one-to-two, bridge oil pipeline bends, constant power and constant current, and soft connection sensors.	Please consult us for details.	Please consult us for details.

## XV. Troubleshooting

<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● Over Temperature Light comes on.</li> </ul> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>● Machine overheated.</li> <li>● Water is too hot.</li> </ul> <p><b>Solutions:</b></p> <ul style="list-style-type: none"> <li>● Allow the machine time to cool off, then restart.</li> <li>● Ensure the water temperature is less than 40°C (104°F) before it enters the machine. Remember to always use cool, clean water.</li> </ul>
<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● Over Voltage Light comes on.</li> </ul> <p><b>Cause:</b></p> <ul style="list-style-type: none"> <li>● The machine is not hooked up to the proper voltage.</li> </ul> <p><b>Solution:</b></p> <ul style="list-style-type: none"> <li>● Make sure the machine is hooked up to the appropriate voltage, based on the model.</li> </ul>
<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● Over Current Light comes on.</li> </ul> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>● Internal issue.</li> <li>● Coil design issue.</li> </ul> <p><b>Solutions:</b></p> <ul style="list-style-type: none"> <li>● Contact us for help.</li> <li>● Ensure the coil does not have too many turns, covers too much space, or other issues.</li> </ul>

<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● The machine will not power on.</li> </ul> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>● The circuit breaker is tripped.</li> <li>● The fuse is blown.</li> <li>● The connections between the power supply and the machine are loose.</li> <li>● The outlet does not have power.</li> </ul> <p><b>Solutions:</b></p> <ul style="list-style-type: none"> <li>● Reset the circuit breaker.</li> <li>● Replace the fuse.</li> <li>● Unplug the machine and tighten all connections.</li> <li>● Check that electricity is reaching the machine.</li> </ul>
<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● Machine beeps when attempting to start the machine.</li> </ul> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>● Coil not properly connected.</li> <li>● Improper coil design.</li> </ul> <p><b>Solutions:</b></p> <ul style="list-style-type: none"> <li>● Check the connection between the coil and the machine.</li> <li>● Ensure the coil does not have too many turns or covers too much area enclosed within it.</li> </ul>
<p><b>Problem:</b></p> <ul style="list-style-type: none"> <li>● Water Lack Light comes on.</li> </ul> <p><b>Causes:</b></p> <ul style="list-style-type: none"> <li>● Lack of water pressure.</li> <li>● Leak in hoses.</li> </ul> <p><b>Solutions:</b></p> <ul style="list-style-type: none"> <li>● Ensure the water source is pressurized.</li> <li>● Fix any leaks in the water hoses.</li> </ul>