This manual provides critical safety instructions on the proper setup, operation, maintenance, and service of this machine/tool. Save this document, refer to it often, and use it to instruct other operators.

Failure to read, understand and follow the instructions in this manual may result in fire or serious personal injury—including amputation, electrocution, or death.

The owner of this machine/tool is solely responsible for its safe use. This responsibility includes but is not limited to proper installation in a safe environment, personnel training and usage authorization, proper inspection and maintenance, manual availability and comprehension, application of safety devices, cutting/sanding/grinding tool integrity, and the usage of personal protective equipment.

The manufacturer will not be held liable for injury or property damage from negligence, improper training, machine modifications or misuse.

Some dust created by power sanding, sawing, grinding, drilling, and other construction activities contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm. Some examples of these chemicals are:

- Lead from lead-based paints.
- Crystalline silica from bricks, cement and other masonry products.
- Arsenic and chromium from chemically-treated lumber.

Your risk from these exposures varies, depending on how often you do this type of work. To reduce your exposure to these chemicals: Work in a well ventilated area, and work with approved safety equipment, such as those dust masks that are specially designed to filter out microscopic particles.
Introduction

Foreword

We are proud to offer the Model H8103 Stirling Engine Kit 3. When used according to the guidelines set forth in this manual, you can expect years of trouble-free, enjoyable operation and proof of Grizzly’s commitment to customer satisfaction.

The specifications, drawings, and photographs illustrated in this manual represent the Model H8103 when the manual was prepared. However, owing to Grizzly’s policy of continuous improvement, changes may be made at any time with no obligation on the part of Grizzly.

For your convenience, we always keep current Grizzly manuals available on our website at www.grizzly.com. Any updates to your machine will be reflected in these manuals as soon as they are complete. Visit our site often to check for the latest updates to this manual!

Contact Info

If you have any comments regarding this manual, please write to us at the address below:

Grizzly Industrial, Inc.
C/o Technical Documentation Manager
P.O. Box 2069
Bellingham, WA 98227-2069
Email: manuals@grizzly.com

We stand behind our machines. If you have any service questions or parts requests, please call or write us at the location listed below.

Grizzly Industrial, Inc.
1203 Lycoming Mall Circle
Muncy, PA 17756
Phone: (570) 546-9663
Fax: (800) 438-5901
E-Mail: techsupport@grizzly.com
Web Site: http://www.grizzly.com

The Stirling Engine

The Stirling Engine was invented and developed by Reverend Dr. Robert Stirling and his brother, James, in the early 1800's.

In the conversion of heat into mechanical work, Stirling engines can achieve the highest efficiency of any real heat engine, limited only by the properties of the working gas, engine materials, and friction. These engines can run on any heat source of sufficient quality, including solar, chemical, and nuclear.

Compared to an internal combustion engine of a given power rating, Stirling engines have a higher initial cost and are usually larger and heavier. However, in recent years, the advantages of Stirling engines have become increasingly significant due to the rising concerns over energy and environmental issues.

The Stirling engine is a closed system and contains a fixed quantity of gas that, in this kit, is air. Unlike other types of piston engines that require outside ventilation, the Stirling engine is sealed, no gas enters or leaves the engine, and no valves are required. The Stirling engine cycles through four main processes—cooling, compression, heating and expansion. This is accomplished by moving the enclosed air back and forth between hot and cold heat exchangers.

The round, horizontal heating exchanger in contact with the alcohol burner warms the working air and the smaller cylinder on top cools it. A change in the enclosed air temperature will cause a corresponding change in gas pressure, while the motion of the piston causes the enclosed air to be alternately expanded and compressed.

In summary, the Stirling engine uses the energy difference between its hot and cold ends to create a cycle of alternately expanding and contracting a fixed amount of enclosed gas, and converting the temperature differences into mechanical power.
Safety

⚠️ WARNING
For Your Own Safety, Read Instruction Manual Before Operating this Machine

The purpose of safety symbols is to attract your attention to possible hazardous conditions. This manual uses a series of symbols and signal words intended to convey the level of importance of the safety messages. The progression of symbols is described below. Remember that safety messages by themselves do not eliminate danger and are not a substitute for proper accident prevention measures.

⚠️ DANGER Indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠️ WARNING Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠️ CAUTION Indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE This symbol is used to alert the user to useful information about proper operation of the machine.

⚠️ WARNING
Safety Instructions for Machinery

1. READ THE ENTIRE MANUAL BEFORE STARTING MACHINERY. Machinery presents serious injury hazards to untrained users.

2. ALWAYS USE ANSI APPROVED SAFETY GLASSES WHEN OPERATING MACHINERY. Everyday eyeglasses only have impact resistant lenses—they are NOT safety glasses.

3. ALWAYS WEAR A NIOSH APPROVED RESPIRATOR WHEN OPERATING MACHINERY THAT PRODUCES DUST. Wood dust can cause severe respiratory illnesses.

4. ALWAYS USE HEARING PROTECTION WHEN OPERATING MACHINERY. Machinery noise can cause permanent hearing loss.

5. WEAR PROPER APPAREL. DO NOT wear loose clothing, gloves, neckties, rings, or jewelry that can catch in moving parts. Wear protective hair covering to contain long hair and wear non-slip footwear.

6. NEVER OPERATE MACHINERY WHEN TIRED OR UNDER THE INFLUENCE OF DRUGS OR ALCOHOL. Be mentally alert at all times when running machinery.
WARNING

Safety Instructions for Flammable Liquids

1. **ADEQUATE VENTILATION.** A build-up of alcohol fumes can present an explosion hazard. Always make sure there is enough ventilation around the Stirling engine when it is in use.

2. **ISOPROPYL ALCOHOL.** Use only any commercially available isopropyl alcohol that is 99% pure. DO NOT mix this alcohol with other chemicals or substitute any other flammable substance or source to heat the Stirling engine.

3. **RESPONSIBLE USE.** Using a Stirling engine can present a fire hazard if not properly operated. Make sure that the operator of the engine is capable of handling the alcohol fuel and the hot engine. DO NOT let children operate this Stirling engine.

4. **KEEP AWAY FROM ELECTRICAL SOURCES.** Any electrical device or source can produce a spark that may ignite the alcohol fuel as it is being handled—such as cell phones, electrical outlets, computers, etc. Make sure the alcohol fuel is stored in proper containers away from electrical sources. Keep the Stirling engine safely away from electrical sources when in operation.

5. **REMOVE ALCOHOL AFTER USE.** Properly dispose or store any alcohol left in the reservoir of the Stirling engine after use. The flammable liquid in the reservoir can spill during movement and become a fire hazard.

6. **AVOID HOT ENGINE PARTS.** During the use of the Stirling engine, many parts become hot enough to burn the skin. DO NOT touch these parts until they are completely cooled.

7. **ALCOHOL DISPOSAL.** Always check your local codes and standards for proper disposal of flammable substances.

8. **CLEAN UP ANY SPILLS.** Although isopropyl alcohol will evaporate with time, a spill of this flammable liquid can present a fire hazard. If left for a period of time, isopropyl alcohol can damage other materials.

9. **DO NOT DRINK ALCOHOL FUEL.** Ingesting any type of alcohol fuel can lead to blindness or death. Keep containers of alcohol fuel tightly sealed and away from children.

10. **AVOID EYE OR SKIN CONTACT WITH ALCOHOL FUEL.** Alcohol fuel can damage eyes. Prolonged exposure of the skin to alcohol fuels can result in skin irritations. Avoid any personal contact with alcohol fuels, including ingestion.

11. **DO NOT LEAVE UNATTENDED.** Always directly supervise the Stirling engine when the alcohol fuel is lit or the engine parts are hot.

12. **FIRE SAFETY.** Always keep a fire extinguisher near when operating the Stirling engine or servicing the fuel reservoir. DO NOT have any other open flames or sources of sparks near the alcohol fuel at any time. DO NOT smoke near the alcohol fuel.

13. **SAFE ATTIRE.** Tie back long hair and loose clothing when operating the Stirling engine or working with the alcohol fuel.

14. **EXPERIENCING DIFFICULTIES.** If at any time you are experiencing difficulties performing the intended operation, stop using the engine! Contact our Technical Support at (570) 546-9663.
Setup & Assembly

Overview
Assembling the Model H8103 requires basic machining techniques, skills, and equipment—making this a great project for the hobby or aspiring machinist who is looking for a challenging and fun project.

Recommended for Setup
The following items are recommended to complete the setup process, but are not included with your machine.

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<thead>
<tr>
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<tbody>
<tr>
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<tr>
<td>Metric Tap &amp; Die Set</td>
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<td>Digital Calipers w/ Inch/MM Conversion</td>
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<td>Safety Glasses</td>
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<td>Set Screw M3-.5 x 8</td>
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<td>Set Screw M3-.5 x 10</td>
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<td>Phillips Head Screws M3-.5 x 8</td>
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<td>Cap Screws M4-.7 x 8</td>
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<td>Cap Screw M5-.8 x 20</td>
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<td>Cap Screw M5-.8 x 30</td>
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<td>Hex Nuts M4-.7</td>
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<td>Hex Wrenches 3,4mm</td>
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<td>Small Needle Nose Pliers</td>
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<td>Standard Screwdriver 3mm</td>
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<tr>
<td>Compressed Air (for cleaning)</td>
<td>As Needed</td>
</tr>
<tr>
<td>Light Machine Oil</td>
<td>As Needed</td>
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</table>

Metric Sizing
The components in these plans were designed to be machined to metric sizes and using metric threads.

If you are not familiar with metric sizing or metric threads, we recommend that you purchase a digital caliper with the capability of doing mm/inch conversions. We also recommend that you get a metric tap & die set for easily making the threads required.

For your convenience, below are common metric/inch equivalents:
- 1" = 25.4mm
- 1mm = 0.040"

Unpacking
This product was carefully packed when it left our warehouse. If you discover the contents are damaged after you have signed for delivery, please immediately call Customer Service at (570) 546-9663 for advice.

Save the containers and all packing materials for possible inspection by the carrier or its agent. Otherwise, filing a freight claim can be difficult.

When you are completely satisfied with the condition of your shipment, use the next three pages to inventory the contents.
Inventory

= Brass  = Aluminum or Steel
= Brass  = Aluminum or Steel
## Parts List & Inventory

<table>
<thead>
<tr>
<th>Ref No.</th>
<th>Part ID</th>
<th>Part No.</th>
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<th>Quantity</th>
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Machining Parts

The finished parts for your Stirling engine require precise machining and the equipment to do so. However, it is beyond the scope of this manual to provide instructions on how to machine these parts.

Use the machining specifications and illustrations beginning on Page 12 to produce the parts required to assemble your Stirling engine (all dimensions are in millimeters).

Note: Some parts have been pre-machined at our factory and are identified as such below. Also, there are some common fasteners and the wood base that are not included with this kit.

When you have completed machining the parts, you should have the finished parts listed below. Reference this information, the Assembly Diagram on Page 9, and Additional Assembly Instructions on Page 10 to complete the assembly of your Stirling engine.

### Finished Parts

<table>
<thead>
<tr>
<th>Ref No.</th>
<th>Qty</th>
<th>Specs Page</th>
<th>Finished Part Description</th>
<th>Ref No.</th>
<th>Qty</th>
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<td>Brass Hex Bolt M3-.5 x 12</td>
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<td>Slotted Pivot Connector #2</td>
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<td>Fly Wheel</td>
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### Pre-Finished Parts

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<td>13</td>
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<td>Wick Holder</td>
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### Common Fasteners & Wood Base (not provided)

<table>
<thead>
<tr>
<th>Ref No.</th>
<th>Qty</th>
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<tbody>
<tr>
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<td>8</td>
<td>Cap Screw M4-.7 x 8</td>
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<td>17</td>
<td>4</td>
<td>Hex Nut M5-.8</td>
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<td>Wood Base</td>
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<td>Set Screw M3-.5 x 10</td>
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<td>31</td>
<td>4</td>
<td>Cap Screw M5-.8 x 16</td>
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<tr>
<td>36</td>
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<td>Set Screw M3-.5 x 4</td>
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</table>
Assembly Diagram
As you enjoy assembling your Model H8103, take the opportunity to gain a better understanding of how your Stirling engine works.

Here are some general tips to help make your assembly process a successful experience:

- Establish a work area where the many small parts can be conveniently organized and stored.

- Make sure your hands and tools are clean and oil free when handling the parts. Dirt and grime will cause premature wear of the many moving parts.

- Use an aerosol can of compressed air or a clean brush to remove any debris you may find on the parts. Make sure each part is clean and dry before assembly.

- Take your time and be sure of the parts needed for each step—some of the parts appear very similar.

- Do not overtighten the fasteners. Many of the parts can be damaged by using excessive force.

- A very small amount of silicon lubricant may assist in assembling sliding parts.

Use the parts lists and Assembly Diagram beginning on Page 9, and the specific instructions in the following subsections to assemble your Stirling engine.

Preparation of the Base

Make and finish a wood base to your taste that is at least 1” wider on all sides than the base plate (see Figure 1).

The wood base needs four holes drilled to mount the Stirling engine assembly.

Position the base plate (Ref 16) on the wood base (Ref 18), and mark the position of the four holes onto the base.

**Note:** In the following instructions, parts will be referenced with the term Ref and a number. Use this reference number, the Assembly Diagram on Page 9 to aid in part identification.

![Figure 1. Base plate and wood base with location of holes to be drilled.](image1.png)

Drill four 7/32” holes through the wood base, as shown in Figure 1.

Positioning the Connecting Arms

When assembling the connecting arms (Ref 27) with the axles and other linkage, be sure that both connecting arms are even and aligned with one another, as shown in Figure 2.

![Figure 2. Connecting arms in correct alignment.](image2.png)
Lubrication

After you have completed the assembly of your Stirling engine, apply a drop or two of light machine oil at the three lubrication points shown in Figure 3. Re-lubricate as needed after use.

![Axle Bushing]

Figure 3. Model H8103 lubrication locations.

Operation

**WARNING**

Isopropyl alcohol is an extremely flammable and volatile liquid. Clean up any spills of alcohol and secure the fuel reservoir lid before lighting the wick. Keep all other flammable materials away from the engine during operation. Failure to heed this warning could result in serious property damage and personal injury.

When all of the assembly is finished and lubrication is complete, it is time to “fire up” your Stirling engine!

**To operate your Stirling engine:**

1. Make sure you have read and complied with all of the safety warnings in this manual, and have prepared your operation environment appropriately.

2. Fill the reservoir about ¾ full of 99% pure isopropyl alcohol and mount the reservoir lid with the wick showing only about ¼”.

3. Clean up any spills and remove the surplus fuel container away from the engine.

4. Place the reservoir into the provided base plate hole underneath the heating cylinder.

5. When you are ready, carefully light the wick.

   **Note:** *It may be necessary to spin the large flywheel by hand to start the engine moving.*

6. When you are finished using the engine, extinguish the wick and return the remaining alcohol safely back into the surplus container.
## Machining Specifications

<table>
<thead>
<tr>
<th>Ref No.:</th>
<th>Material</th>
<th>Qty To Make</th>
<th>Blank Description:</th>
<th>Finished Part Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aluminum</td>
<td>1</td>
<td>Aluminum Cylinder Blank 40 x 20mm</td>
<td>Eccentric Drive Wheel</td>
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**Part No.:** PH8103001  
**Part ID.:** HAE0301  

**Note:** All dimensions are in millimeters.
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<th>Ref No.</th>
<th>Material</th>
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<th>Blank Description</th>
<th>Finished Part Description</th>
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<tbody>
<tr>
<td>2</td>
<td>Brass</td>
<td>1</td>
<td>Brass Cylinder Blank 8 x 10mm</td>
<td>Bushing</td>
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<tr>
<td>PH8103002</td>
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<td>HAE0314</td>
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**Note:** All dimensions are in millimeters.

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<thead>
<tr>
<th>Ref No.</th>
<th>Material</th>
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<th>Blank Description</th>
<th>Finished Part Description</th>
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<tr>
<td>3</td>
<td>Brass</td>
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<td>Brass Hexagon Blank 5.5 x 36mm</td>
<td>Brass Hex Bolt M3-.5 x 12</td>
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<tr>
<td>PH8103003</td>
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<td>HAE0204</td>
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**Note:** All dimensions are in millimeters.

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H8103 Stirling Engine Kit 3
### Brass Plate Blank 85 x 10 x 3mm

<table>
<thead>
<tr>
<th>Ref No.</th>
<th>4</th>
<th>Material</th>
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<tbody>
<tr>
<td>Part No.: PH8103004</td>
<td>Brass</td>
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<td>Brass Plate Blank 85 x 10 x 3mm</td>
<td>Cooling Piston Connector Rod</td>
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<td>Part ID.: HAE0302</td>
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**Note:** All dimensions are in millimeters.

### Brass Cylinder Blank 8 x 20mm

<table>
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<th>Ref No.</th>
<th>6</th>
<th>Material</th>
<th>Qty To Make</th>
<th>Blank Description</th>
<th>Finished Part Description</th>
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</thead>
<tbody>
<tr>
<td>Part No.: PH8103006</td>
<td>Brass</td>
<td>1</td>
<td>Brass Cylinder Blank 8 x 20mm</td>
<td>Slotted Pivot Connector #1</td>
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<tr>
<td>Part ID.: HAE0215</td>
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**Note:** All dimensions are in millimeters.
Ref No.: 7  
Part No.: PH8103007  
Part ID.: HAE0216

Material: Brass  
Qty To Make: 1  
Blank Description: Brass Rod Blank 3 x 19mm  
Finished Part Description: Pin 3 x 12mm

Note: All dimensions are in millimeters.

Ref No.: 9  
Part No.: PH8103009  
Part ID.: HAE0309

Material: Aluminum  
Qty To Make: 1  
Blank Description: Aluminum Plate Blank 130 x 123 x 14mm  
Finished Part Description: Mounting Plate

Note: All dimensions are in millimeters.
### Part 1

**Ref No.:** 10  
**Part No.:** PH8103010  
**Material:** Brass  
**Qty To Make:** 4  
**Blank Description:** Brass Rod Blank 12 x 175mm  
**Finished Part Description:** Threaded Support Staff  

**Part ID:** HAE0308

**Note:** All dimensions are in millimeters.

![Brass Rod Blank 12 x 175mm](image)

### Part 2

**Ref No.:** 11  
**Part No.:** PH8103011  
**Material:** Aluminum  
**Qty To Make:** 1  
**Blank Description:** Aluminum Cylinder Blank 80 x 40mm  
**Finished Part Description:** Radiator  

**Part ID:** HAE0306

**Note:** All dimensions are in millimeters.

![Aluminum Cylinder Blank 80 x 40mm](image)
Ref No.: 14  
Part No.: PH8103014  
Part ID.: HAE0120  
Material: Aluminum  
Qty To Make: 1  
Blank Description: Aluminum Cylinder Blank 48 x 15mm  
Finished Part Description: Fuel Reservoir Lid

Note: All dimensions are in millimeters.

Ref No.: 15  
Part No.: PH8103015  
Part ID.: HAE0121  
Material: Aluminum  
Qty To Make: 1  
Blank Description: Aluminum Cylinder Blank 46 x 25mm  
Finished Part Description: Fuel Reservoir

Note: All dimensions are in millimeters.
Ref No.: 16  
Part No.: PH8103016  
Material: Aluminum  
Qty To Make: 1  
Blank Description: Aluminum Plate Blank 123 x 123 x 3.75mm  
Finished Part Description: Base Plate  
Part ID.: HAE0311

Note: All dimensions are in millimeters.

Ref No.: 19  
Part No.: PH8103019  
Material: Steel  
Qty To Make: 1  
Blank Description: Steel Rod Blank 3 x 87mm  
Finished Part Description: Heating Piston Drive Rod 85mm  
Part ID.: HAE0209

Note: All dimensions are in millimeters.
### Part No.: PH8103020

**Ref No.:** 20  
**Material:** Brass  
**Qty To Make:** 1  
**Blank Description:** Brass Cylinder Blank 10 x 40mm  
**Finished Part Description:** Heating Piston Drive Rod Shaft  

**Not To Scale**

**Note:** All dimensions are in millimeters.

### Part No.: PH8103021

**Ref No.:** 21  
**Material:** Steel  
**Qty To Make:** 2  
**Blank Description:** Steel A-Frame Blank  
**Finished Part Description:** A-Frame Bracket  

**Not To Scale**

**Note:** All dimensions are in millimeters.
Ref No.: 22
Part No.: PH8103022
Part ID.: HAE0210

Material: Brass
Qty To Make: 1
Blank Description: Brass Cylinder Blank 8 x 17mm
Finished Part Description: Slotted Pivot Connector #2

Note: All dimensions are in millimeters.

Ref No.: 23
Part No.: PH8103023
Part ID.: HAE0128

Material: Brass
Qty To Make: 1
Blank Description: Brass Hexagon Blank 5.5 x 25mm
Finished Part Description: Brass Hex Bolt M3-.5 x 12

Note: All dimensions are in millimeters.
<table>
<thead>
<tr>
<th>Ref No.</th>
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<th>Qty To Make</th>
<th>Blank Description</th>
<th>Finished Part Description</th>
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</thead>
<tbody>
<tr>
<td>24</td>
<td>Brass</td>
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<td>Brass Hexagon Blank 5 x 17mm</td>
<td>Brass Hex Nut M3-.5</td>
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<td>PH8103024</td>
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**Note:** All dimensions are in millimeters.

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<tr>
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<th>Material</th>
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<th>Blank Description</th>
<th>Finished Part Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Brass</td>
<td>1</td>
<td>Brass Plate Blank 51 x 10 x 3mm</td>
<td>Heating Piston Connector Rod</td>
</tr>
<tr>
<td>PH8103025</td>
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**Note:** All dimensions are in millimeters.
Ref No.: 26
Part No.: PH8103026
Material: Steel
Qty To Make: 1
Blank Description: Steel Rod Blank 4 x 20mm
Finished Part Description: Axle 16mm
Part ID.: HAE0305

Note: All dimensions are in millimeters.

Ref No.: 27
Part No.: PH8103027
Material: Brass
Qty To Make: 2
Blank Description: Brass Plate Blank 23 x 10 x 3mm
Finished Part Description: Connecting Arm
Part ID.: HAE0304

Note: All dimensions are in millimeters.
Ref No.: 28  
Material: Steel  
Qty To Make: 2  
Blank Description: Steel Rod Blank 4 x 36mm  
Finished Part Description: Axle 36mm  

Part No.: PH8103028  
Part ID.: HAE0303

Note: All dimensions are in millimeters.

Ref No.: 30  
Material: Aluminum  
Qty To Make: 1  
Blank Description: Aluminum Cylinder Blank 92 x 17mm  
Finished Part Description: Fly Wheel  

Part No.: PH8103030  
Part ID.: HAE0312

Note: All dimensions are in millimeters.
### Part 32: Brass Cylinder Blank 11 x 46mm
- **Ref No.:** 32
- **Part No.:** PH8103032
- **Material:** Brass
- **Qty To Make:** 2
- **Blank Description:** Brass Cylinder Blank 11 x 46mm
- **Finished Part Description:** Axle Shaft

**Note:** All dimensions are in millimeters.  

![Cylinder Blank](image)

### Part 35: Aluminum Hollow Cylinder Blank 25 x 13mm
- **Ref No.:** 35
- **Part No.:** PH8103035
- **Material:** Aluminum
- **Qty To Make:** 1
- **Blank Description:** Aluminum Hollow Cylinder Blank 25 x 13mm
- **Finished Part Description:** Lock Collar

**Note:** All dimensions are in millimeters.  

![Hollow Cylinder](image)
WARRANTY AND RETURNS

Grizzly Industrial, Inc. warrants every product it sells for a period of 1 year to the original purchaser from the date of purchase. This warranty does not apply to defects due directly or indirectly to misuse, abuse, negligence, accidents, repairs or alterations or lack of maintenance. This is Grizzly's sole written warranty and any and all warranties that may be implied by law, including any merchantability or fitness, for any particular purpose, are hereby limited to the duration of this written warranty. We do not warrant or represent that the merchandise complies with the provisions of any law or acts unless the manufacturer so warrants. In no event shall Grizzly's liability under this warranty exceed the purchase price paid for the product and any legal actions brought against Grizzly shall be tried in the State of Washington, County of Whatcom.

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