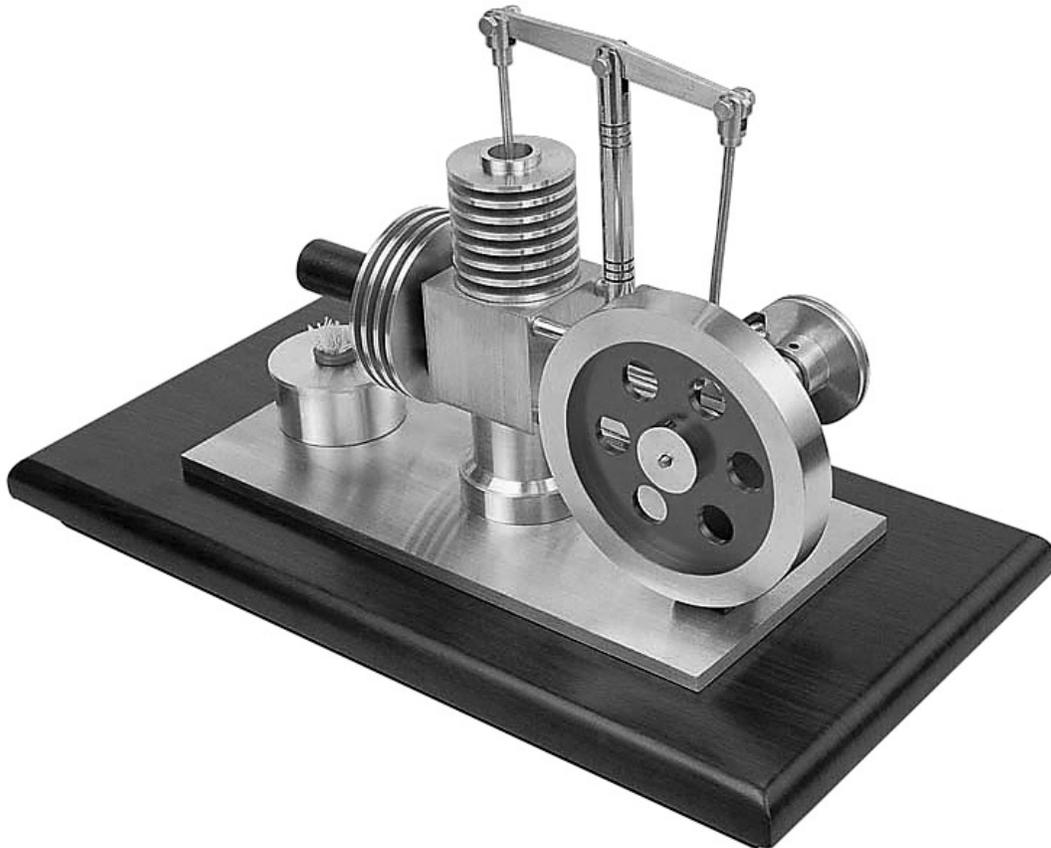


# *Grizzly* *Industrial, Inc.*®

## MODEL H8102 STIRLING ENGINE MACHINED KIT 1 OWNER'S MANUAL



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**WARNING: NO PORTION OF THIS MANUAL MAY BE REPRODUCED IN ANY SHAPE  
OR FORM WITHOUT THE WRITTEN APPROVAL OF GRIZZLY INDUSTRIAL, INC.**

#TS9148 PRINTED IN CHINA



## **WARNING!**

**This manual provides critical safety instructions on the proper setup, operation, maintenance and service of this machine/equipment.**

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

**The owner of this machine/equipment 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, blade/cutter 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.**



## **WARNING!**

**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

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## Foreword

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We are proud to offer the Model H8102 Stirling Engine Machined Kit 1. 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 H8102 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

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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

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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 finned 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

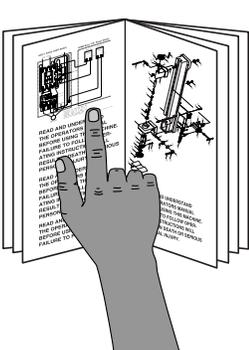
## Safety Instructions for Flammable Liquids

- 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 during 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

## Setup Safety



**!WARNING**  
This machine presents serious injury hazards to untrained users. Read through this entire manual to become familiar with the controls and operations before starting the machine!



**!WARNING**  
Wear safety glasses during the entire setup process!

## Items Needed for Setup

The following items are needed to complete the setup process, but are not included with your machine:

Description	Qty
• Safety Glasses .....	1
• Hex Wrenches 3,4mm.....	1 Ea
• Small Needle Nose Pliers .....	1
• Standard Screwdriver 3mm.....	1
• Phillips Head Screwdriver #1 .....	1
• Compressed Air (for cleaning) ...	As Needed
• Light Machine Oil .....	As Needed

## Unpacking

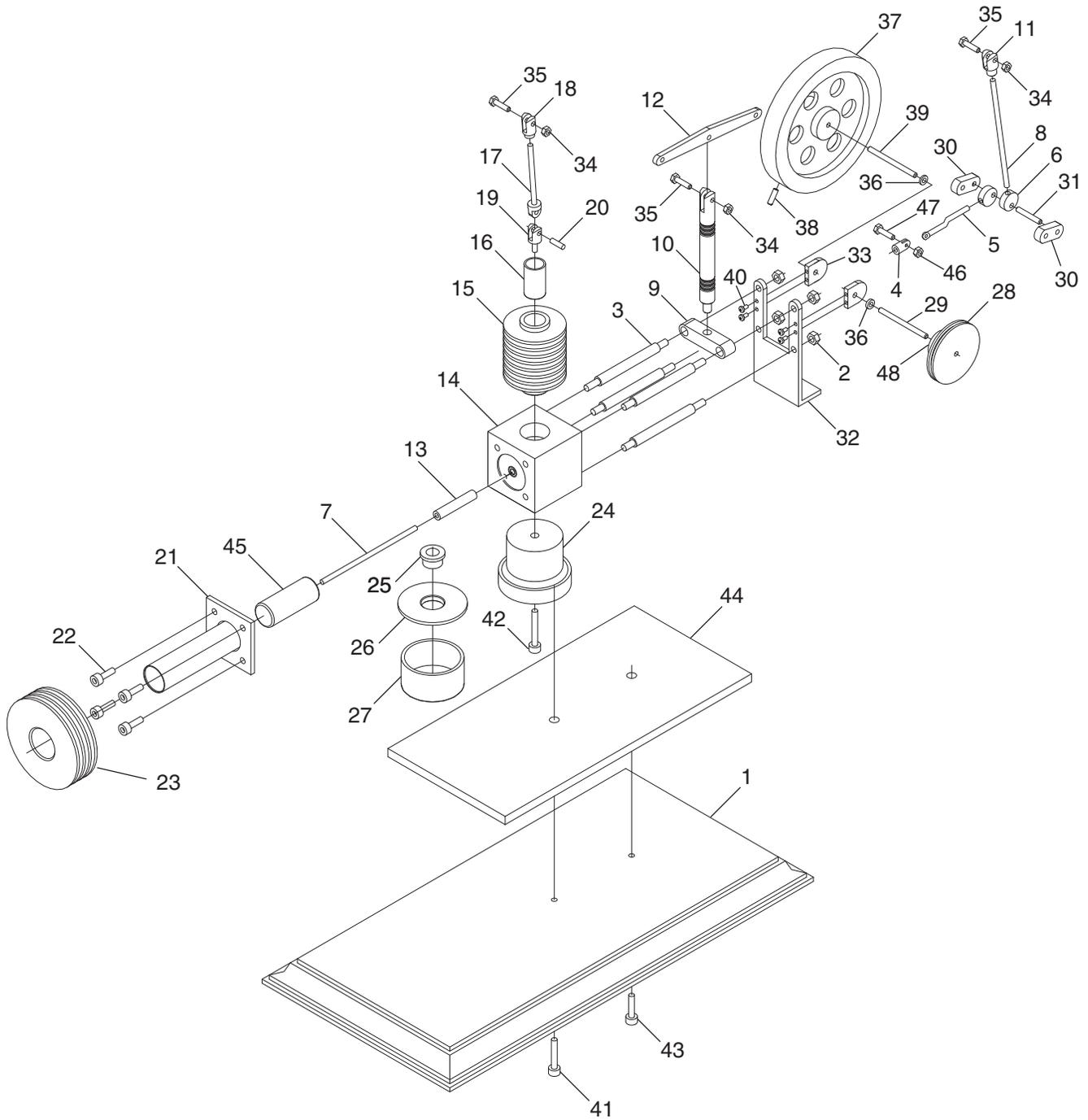
The Model H8102 was carefully packed when it left our warehouse. If you discover the contents are damaged after you have signed for delivery, *please immediately call Customer Service at (570) 546-9663 for advice.*

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 2 pages to inventory the contents.



# Parts Breakdown



# Parts List & Inventory

Ref No.	Part No.	Description	Quantity
1	PH8102001	BASE	1
2	PN04M	HEX NUT M4-.7	4
3	PH8102003	THREADED CONNECTION ROD 68MM	4
4	PH8102004	SLOTTED PIVOT CONNECTOR #2	1
5	PH8102005	BENT CONNECTOR ROD 38MM	1
6	PH8102006	ROUND ECCENTRIC CONNECTOR	2
7	PH8102007	HEATING PISTON DRIVE ROD 80MM	1
8	PH8102008	BENT DRIVE ROD 85MM	1
9	PH8102009	ROCKER ARM SHAFT SUPPORT	1
10	PH8102010	ROCKER ARM SHAFT	1
11	PH8102011	SLOTTED PIVOT CONNECTOR #1	1
12	PH8102012	ROCKER ARM	1
13	PH8102013	DRIVE ROD SLEEVE	1
14	PH8102014	COOLING CYLINDER BASE	1
15	PH8102015	COOLING CYLINDER	1
16	PH8102016	COOLING PISTON	1
17	PH8102017	COOLING PISTON DRIVE ROD 55MM	1
18	PH8102018	SLOTTED PIVOT CONNECTOR #4	1
19	PH8102019	COOLING PISTON CONNECTOR	1
20	PH8102020	PIN 10MM	1
21	PH8102021	HEATING CYLINDER	1
22	PSB18M	CAP SCREW M4-.7 X 8	4
23	PH8102023	RADIATOR	1
24	PH8102024	COOLING CYLINDER BASE SUPPORT	1
25	PH8102025	WICK HOLDER	1
26	PH8102026	FUEL RESERVOIR LID	1
27	PH8102027	FUEL RESERVOIR	1
28	PH8102028	PULLEY	1
29	PH8102029	AXLE 40MM	1
30	PH8102030	CONNECTING ARM	2
31	PH8102031	AXLE 20MM	1
32	PH8102032	BRACKET	1
33	PH8102033	AXLE BUSHING	2
34	PH8102034	BRASS HEX NUT M3-.5	3
35	PH8102035	BRASS HEX BOLT M3-.5 X 11	3
36	PW07M	FLAT WASHER 3MM	2
37	PH8102037	FLY WHEEL	1
38	PSS47M	SET SCREW M3-.5 X 10	1
39	PH8102039	AXLE 34MM	1
40	PS79M	PHLP HD SCR M3-.5 X 8	4
41	PSB95M	CAP SCREW M5-.8 X 30	1
42	PSB15M	CAP SCREW M5-.8 X 20	1
43	PSB162M	CAP SCREW M4-.7 X 25	1
44	PH8102044	BOTTOM PLATE	1
45	PH8102045	HEATING PISTON	1
46	PH8102046	BRASS HEX NUT M2-.4	1
47	PH8102047	BRASS HEX BOLT M2-.4 X 12	1
48	PSS82M	SET SCREW M3-.5 X 8	1



# Assembly

As you enjoy assembling your Model H8102, 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.

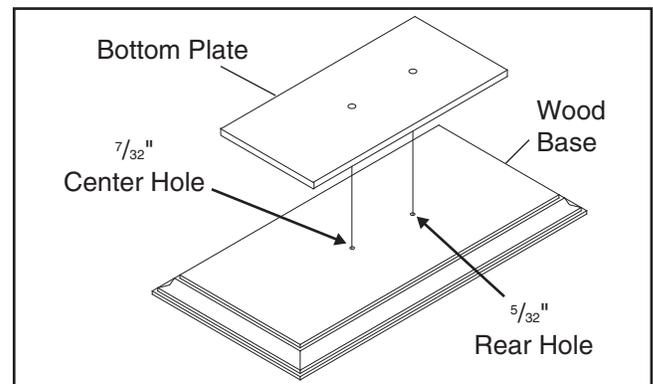
Use the **Parts Breakdown** on **Page 5** and the specific instructions in the following subsections to assemble your Stirling engine.

## Preparing the Base

The wood base needs two holes drilled for the cap screws that hold the metal bottom plate, the cooling cylinder assembly, and the rear bracket in place.

**Note:** In the following instructions, parts will be referenced with the term **Ref** and a number. Use this reference number, the **Parts Breakdown** on **Page 5**, and the **Parts List & Inventory** on **Page 6** to aid in part identification.

Position the bottom plate (**Ref 44**) on the wood base (**Ref 1**), and mark the position of the two holes onto the base (see **Figure 1**).



**Figure 1.** Bottom plate and wood base with location of holes to be drilled in the base.

Drill a  $\frac{7}{32}$ " hole through the wood base for the center hole, and a  $\frac{5}{32}$ " hole near the end of the base, as shown in **Figure 1**.

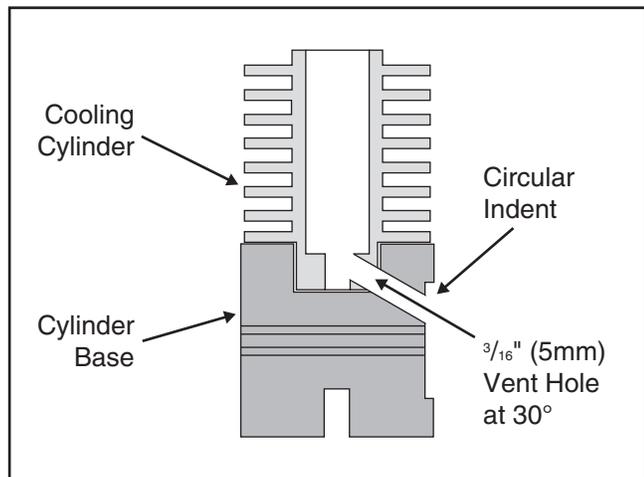
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## Drilling the Vent Hole

In order for the internal air to move from the heating cylinder to the cooling cylinder, you must drill a  $\frac{3}{16}$ " (5mm) vent hole at a 30° angle through the cooling cylinder base (Ref 14) and cooling cylinder (Ref 15) assembly.

Firmly seat the cooling cylinder into the top of the cooling cylinder base as shown in **Figure 2**.



**Figure 2.** Cooling cylinder and base assembly showing location of 30° vent hole.

Drill a  $\frac{3}{16}$ " (5mm) hole at a 30° upward angle through the side of the of the cylinder base and into the bottom cavity of the cooling cylinder.

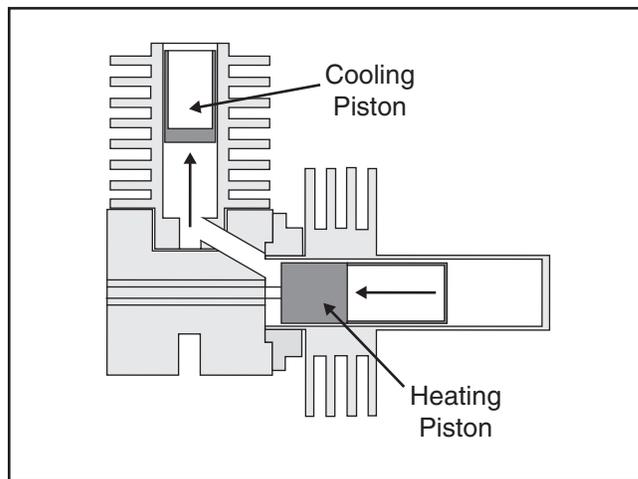
**Note:** Make sure the hole starts above the center hole in the circular indent, as shown in **Figure 2**.

Clean out any metal debris after drilling.

## Positioning the Pistons

One piston needs to draw the air into its cylinder as the other piston pushes the air out of its cylinder. This cooperative process is a significant part of the Stirling engine's efficiency.

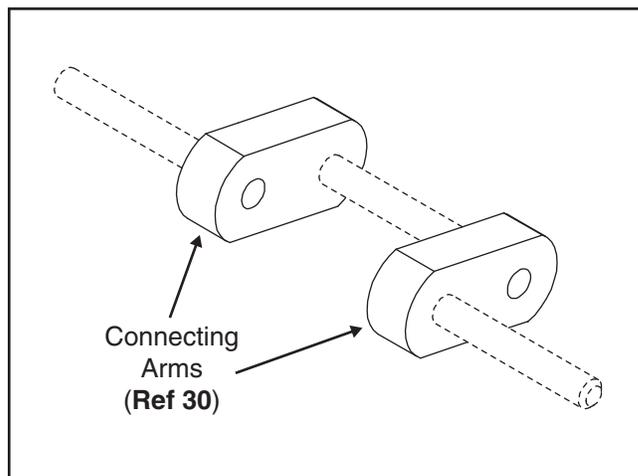
In order for the pistons to work together, assemble the linkage so that operating cycle of the pistons are directly opposite of one another. See **Figure 3** for an illustration of this positioning.



**Figure 3.** Pistons positioned in opposing points and traveling in opposite directions.

## Positioning the Connecting Arms

When assembling the connecting arms (Ref 30) with the axles and other linkage, be sure that both connecting arms are even and aligned with one another, as shown in **Figure 4**.

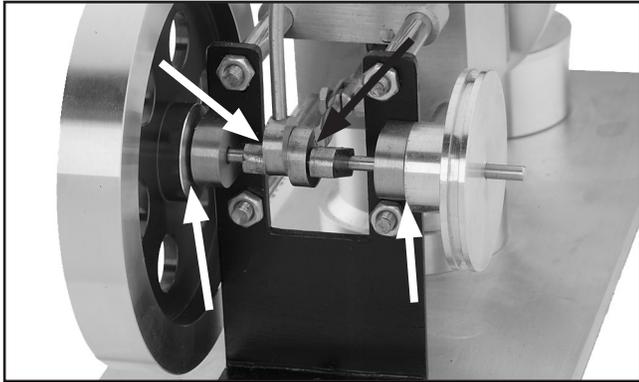


**Figure 4.** Connecting arms in correct alignment with one another.

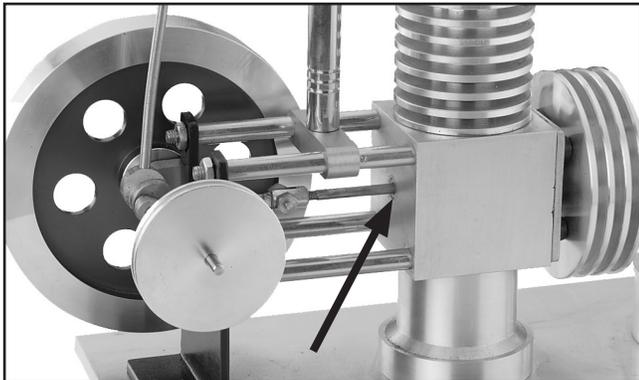


# Lubrication

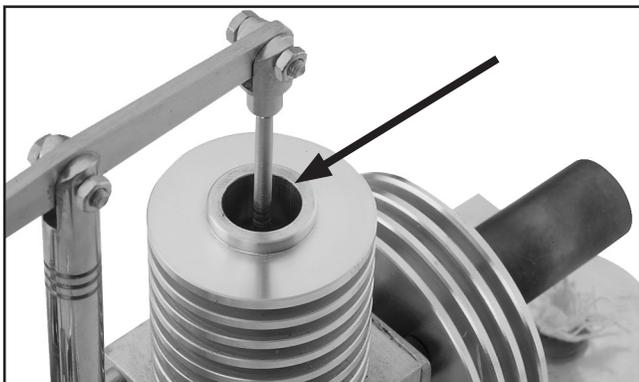
After you have completed the assembly of your Stirling engine, apply a drop or two of light machine oil at the lubrication points shown in **Figures 5–7**. Re-lubricate as needed after use.



**Figure 5.** Axle and connector lubrication points (shown from rear of engine).



**Figure 6.** Heating piston drive rod lubrication point.



**Figure 7.** Cooling cylinder and piston lubrication point.

# Operation

	<p><b>!WARNING</b> 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.</p>
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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  $\frac{3}{4}$  full of 99% pure isopropyl alcohol and mount the reservoir lid with the wick showing only about  $\frac{1}{2}$ ".
3. Clean up any spills and remove the surplus fuel container away from the engine.
4. Place the reservoir directly under the end of 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.



# WARRANTY AND RETURNS

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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.

We shall in no event be liable for death, injuries to persons or property or for incidental, contingent, special, or consequential damages arising from the use of our products.

To take advantage of this warranty, contact us by mail or phone and give us all the details. We will then issue you a "Return Number," which must be clearly posted on the outside as well as the inside of the carton. We will not accept any item back without this number. Proof of purchase must accompany the merchandise.

The manufacturers reserve the right to change specifications at any time because they constantly strive to achieve better quality equipment. We make every effort to ensure that our products meet high quality and durability standards and we hope you never need to use this warranty.

Please feel free to write or call us if you have any questions about the machine or the manual.

Thank you again for your business and continued support. We hope to serve you again soon.