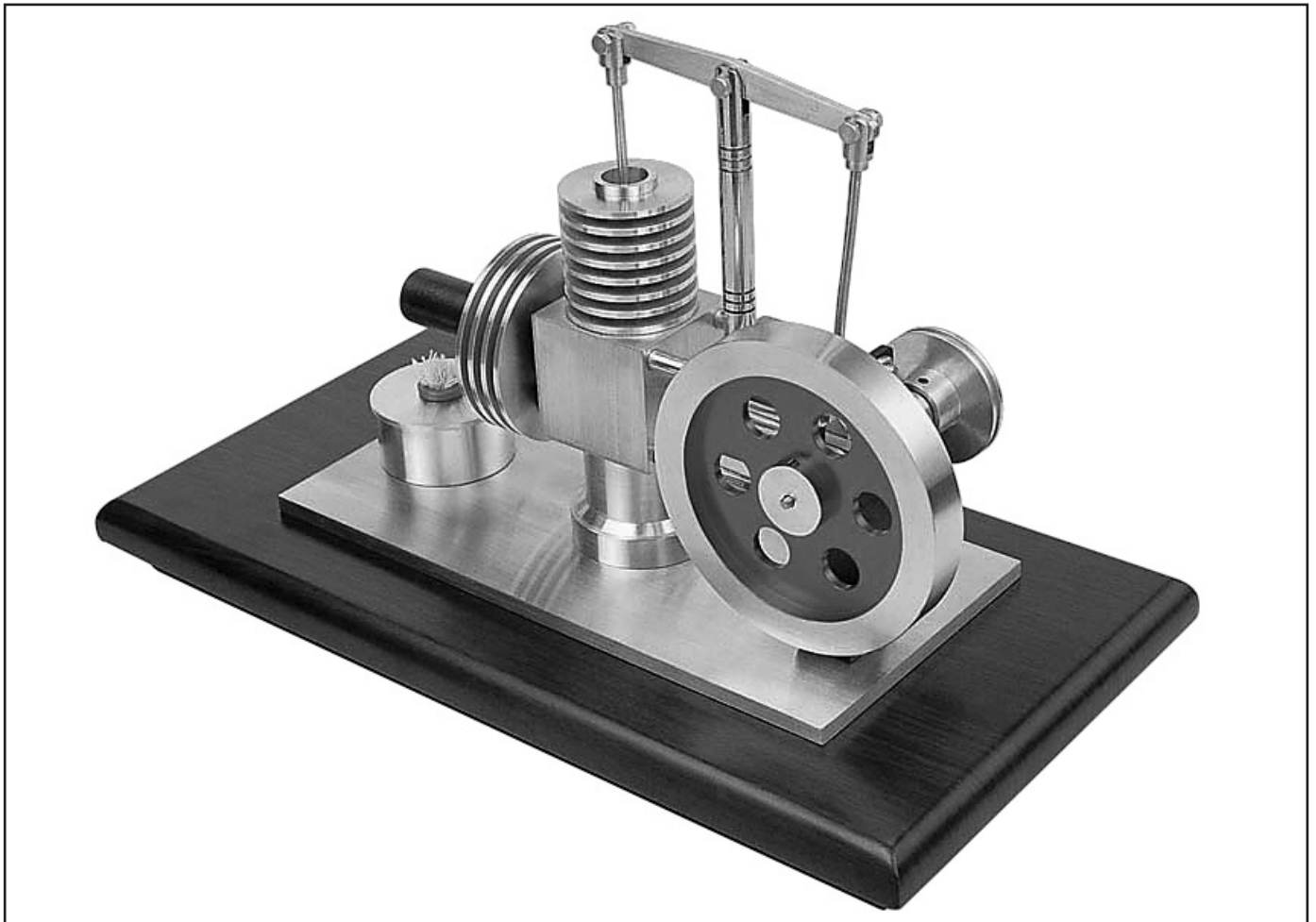


Grizzly *Industrial, Inc.*®

MODEL H8101 STIRLING ENGINE KIT 1 OWNER'S MANUAL



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#TS9303 PRINTED IN CHINA

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Introduction

Foreword

We are proud to offer the Model H8101 Stirling Engine 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 H8101 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:

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P.O. Box 2069
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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
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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 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 commercially available isopropyl alcohol that is 99% pure. DO NOT mix this alcohol with other chemicals or use 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 Stirling engine reservoir 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 FUEL 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 & Assembly

Overview

Assembling the Model H8101 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.

Description	Qty
• Lathe & Mill (or Lathe/Mill)	1
• Metric Tap & Die Set.....	1
• Digital Calipers w/ Inch/MM Conversion	1
• Safety Glasses	1
• Set Screw M3-.5 x 8.....	1
• Set Screw M3-.5 x 10.....	1
• Phillips Head Screws M3-.5 x 8	4
• Cap Screws M4-.7 x 8.....	4
• Cap Screw M4-.7 x 25	1
• Cap Screw M5-.8 x 20	1
• Cap Screw M5-.8 x 30	1
• Flat Washers 3mm	2
• Hex Nuts M4-.7	4
• 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

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

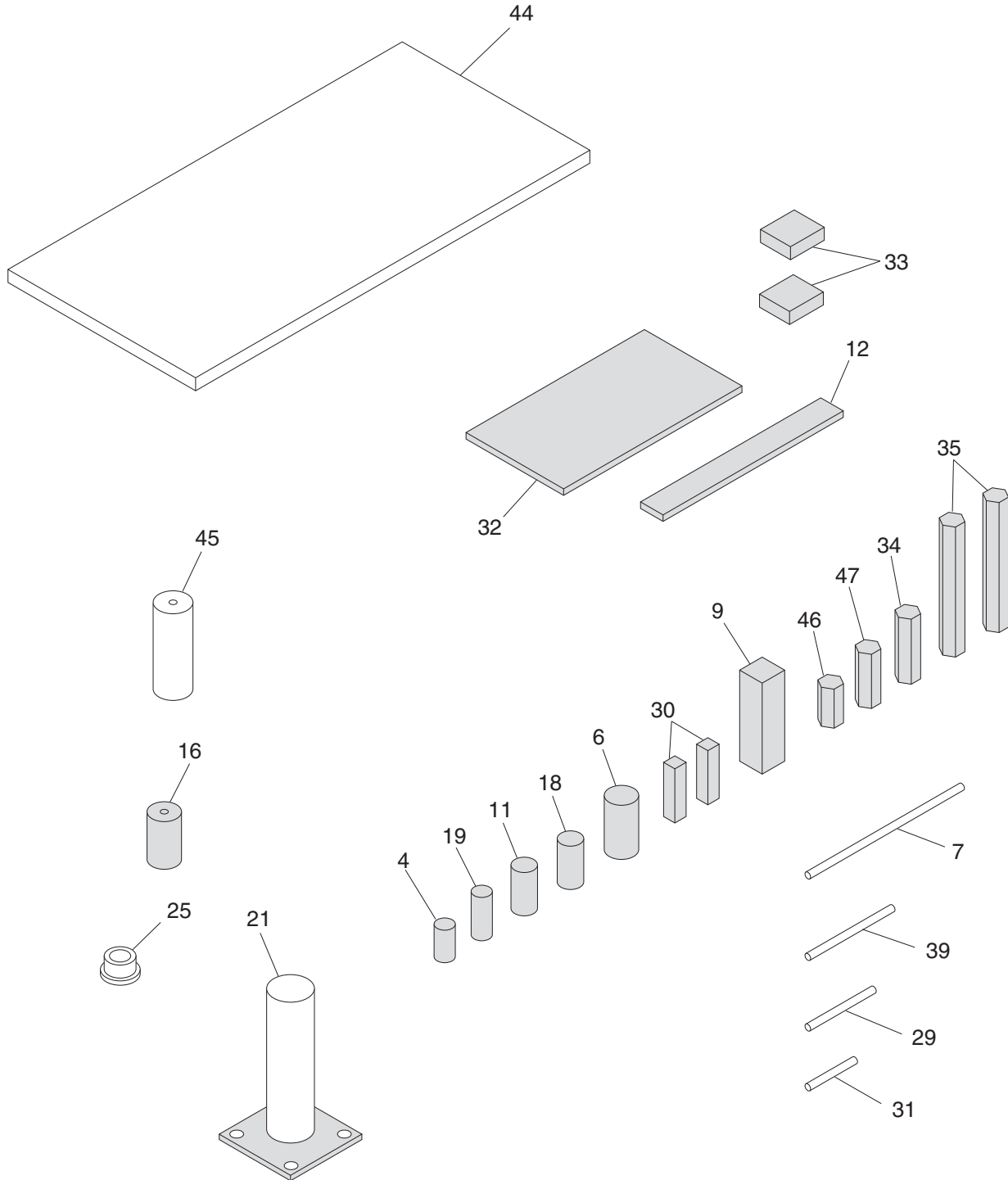
This product was carefully packed when it left our warehouse. If you discover the contents are damaged after you have signed for delivery, *please immediately call Customer Service at (570) 546-9663 for advice.*

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.

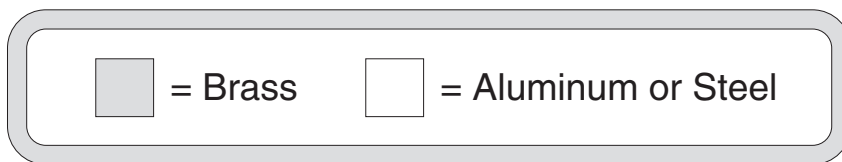
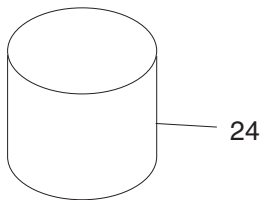
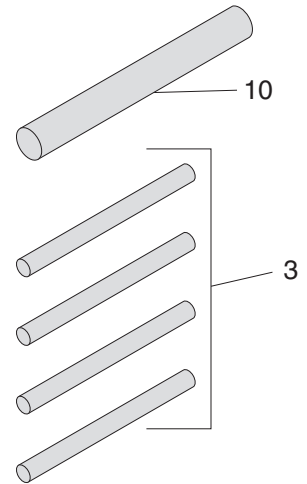
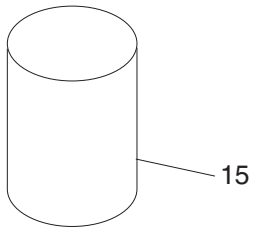
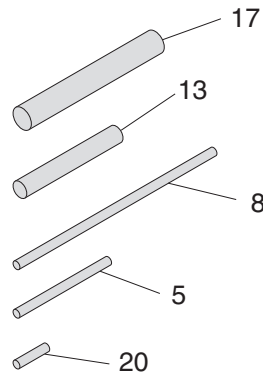
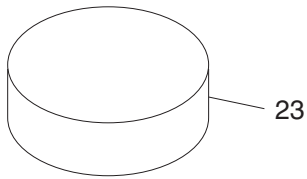
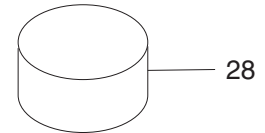
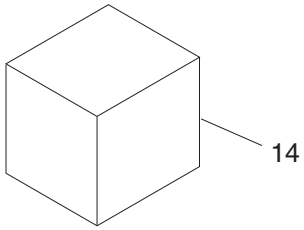
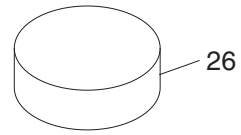
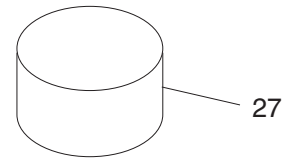
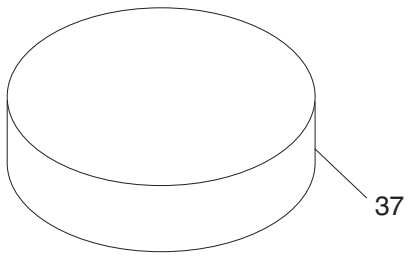


Inventory



■ = Brass □ = Aluminum or Steel





Parts & Inventory List

Ref No.	Part ID	Part No.	Description	Quantity
3	HAE0108	PH8101003	BRASS ROD BLANK 6 X 72MM	4
4	HAE0123	PH8101004	BRASS CYLINDER BLANK 8 X 15MM	1
5	HAE0124	PH8101005	BRASS ROD BLANK 3 X 40MM	1
6	HAE0103	PH8101006	BRASS CYLINDER BLANK 13 X 25MM	1
7	HAE0122	PH8101007	STEEL ROD BLANK 3 X 82MM	1
8	HAE0119	PH8101008	BRASS ROD BLANK 3 X 86MM	1
9	HAE0109	PH8101009	BRASS SQUARE BLANK 12 X 12 X 42MM	1
10	HAE0115	PH8101010	BRASS ROD BLANK 11 X 92MM	1
11	HAE0118	PH8101011	BRASS CYLINDER BLANK 10 X 20MM	1
12	HAE0117	PH8101012	BRASS PLATE BLANK 96 X 12 X 3MM	1
13	HAE0111	PH8101013	BRASS ROD BLANK 6 X 42MM	1
14	HAE0110	PH8101014	ALUMINUM CUBE BLANK 65 X 45MM	1
15	HAE0112	PH8101015	ALUMINUM CYLINDER BLANK 40 X 55MM	1
16	RB1	PH8101016	BRASS COOLING PISTON 13 X 22MM	1
17	HAE0125	PH8101017	BRASS ROD BLANK 8 X 58MM	1
18	HAE0126	PH8101018	BRASS CYLINDER BLANK 10 X 20MM	1
19	HAE0130	PH8101019	BRASS CYLINDER BLANK 8 X 20MM	1
20	HAE0131	PH8101020	BRASS ROD BLANK 3 X 13MM	1
21	RQ1-00	PH8101021	HEATING CYLINDER	1
23	HAE0114	PH8101023	ALUMINUM CYLINDER BLANK 62 X 20MM	1
24	HAE0116	PH8101024	ALUMINUM CYLINDER BLANK 45 X 40MM	1
25	P01	PH8101025	WICK HOLDER	1
26	HAE0120	PH8101026	ALUMINUM CYLINDER BLANK 48 X 15MM	1
27	HAE0121	PH8101027	ALUMINUM CYLINDER BLANK 45 X 25MM	1
28	HAE0127	PH8101028	ALUMINUM CYLINDER BLANK 42 X 20MM	1
29	HAE0105	PH8101029	STEEL ROD BLANK 3 X 35MM	1
30	HAE0102	PH8101030	BRASS SQUARE BLANK 6 X 6 X 25MM	1
31	HAE0104	PH8101031	STEEL ROD BLANK 3 X 25MM	1
32	HAE0106	PH8101032	BRASS PLATE BLANK 95 X 52 X 3MM	1
33	HAE0107	PH8101033	BRASS SQUARE BLANK 18 X 16 X 6MM	2
34	HAE0129	PH8101034	BRASS HEXAGON BLANK 5.5 X 30MM	1
35	HAE0128	PH8101035	BRASS HEXAGON BLANK 5.5 X 60MM	2
37	HAE0113	PH8101037	ALUMINUM CYLINDER BLANK 95 X 25MM	1
39	HAE0101	PH8101039	STEEL ROD BLANK 3 X 45MM	1
44	HAE0132	PH8101044	ALUMINUM PLATE BLANK 210 X 100 X 6MM	1
45	RQ1.04-01	PH8101045	ALUMINUM HEATING PISTON 15 X 40MM	1
46	HAE0134	PH8101046	BRASS HEXAGON BLANK 5.5 X 18MM	1
47	HAE0133	PH8101047	BRASS HEXAGON BLANK 5.5 X 25MM	1



Machining Parts

The finished parts for your Stirling engine require precise machining and the experience and equipment to do so.

Use the specifications and illustrations beginning on **Page 13** to produce the parts required to assemble your Stirling engine (all dimensions are in millimeters).

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

After 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

Ref No.	Qty	Specs Page	Finished Part Description	Ref No.	Qty	Specs Page	Finished Part Description
3	4	13	Threaded Connection Rod	23	1	22	Radiator
4	1	14	Slotted Pivot Connector #2	24	1	22	Cooling Cylinder Base Support
5	1	14	Bent Connector Rod	26	1	23	Fuel Reservoir Lid
6	2	15	Round Eccentric Connector	27	1	23	Fuel Reservoir
7	1	15	Heating Piston Drive Rod	28	1	24	Pulley
8	1	16	Bent Drive Rod	29	1	24	Axle 34mm
9	1	16	Rocker Arm Shaft Support	30	2	25	Connecting Arm
10	1	17	Rocker Arm Shaft	31	1	25	Axle 20mm
11	1	17	Slotted Pivot Connector #1	32	1	26	Bracket
12	1	18	Rocker Arm	33	2	26	Axle Bushing
13	1	18	Drive Rod Sleeve	34	3	27	Brass Hex Nut M3-.5
14	1	19	Cooling Cylinder Base	35	3	27	Brass Hex Bolt M3-.5 x 11
15	1	19	Cooling Cylinder	37	1	28	Fly Wheel
17	1	20	Cooling Piston Drive Rod	39	1	28	Axle 40mm
18	1	20	Slotted Pivot Connector #4	44	1	29	Bottom Plate
19	1	21	Slotted Pivot Connector #3	46	1	29	Brass Hex Nut M2-.4
20	1	21	Pin	47	1	30	Brass Hex Bolt M2-.4 x 12

Pre-Finished Parts

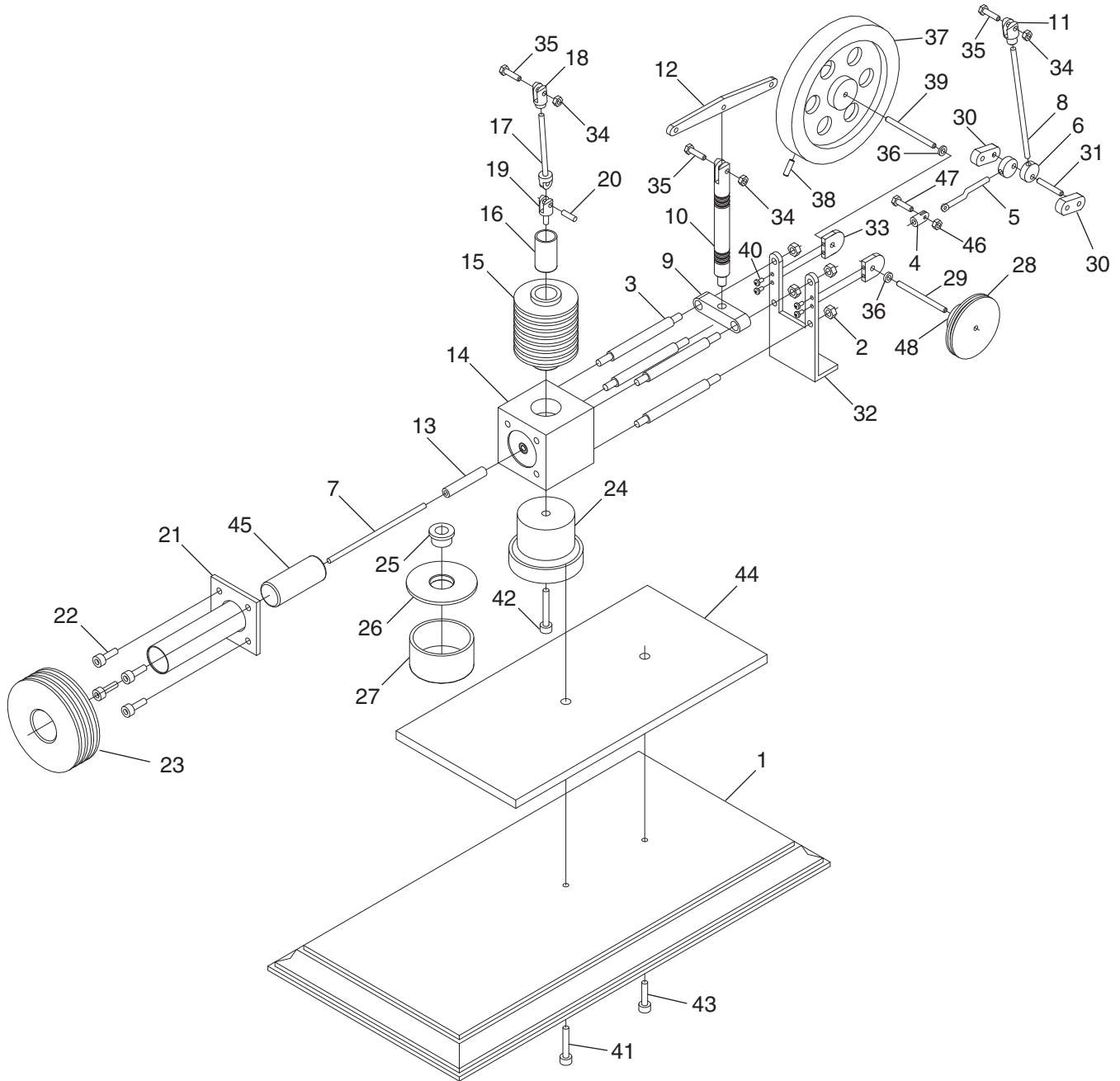
Ref No.	Qty	Finished Part Description	Ref No.	Qty	Finished Part Description
16	1	Cooling Piston	25	1	Wick Holder
21	1	Heating Cylinder	45	1	Heating Piston

Common Fasteners & Wood Base (not provided)

Ref No.	Qty	Description	Ref No.	Qty	Description
1	1	Wood Base	40	4	Phillips Head Screw M3-.5 x 8
2	4	Hex Nut M4-.7	41	1	Cap Screw M5-.8 x 30
22	4	Cap Screw M4-.7 x 8	42	1	Cap Screw M5-.8 x 20
36	2	Flat Washer 3mm	43	1	Cap Screw M4-.7 x 25
38	1	Set Screw M3-.5 x 10	48	1	Set Screw M3-.5 x 8



Assembly Diagram



Additional Assembly Instructions

As you enjoy assembling your Model H8101, 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 assembling the finished 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.

Mounting the Base

Make and finish a wood base to your taste that is at least 1" larger than the aluminum bottom plate on all sides (see **Figure 1**).

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 and the **Assembly Diagram** on **Page 9** 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**).

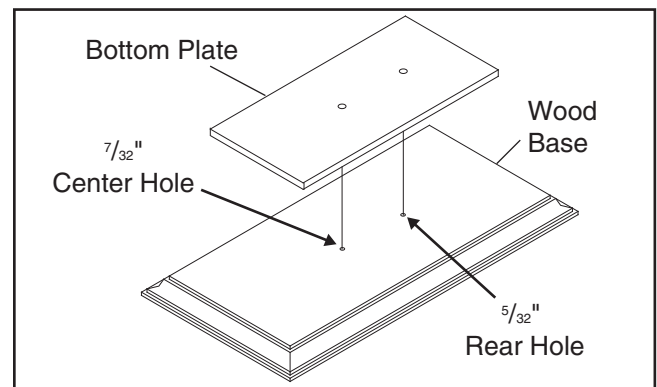


Figure 1. Bottom plate and wood base with location of holes to be drilled in the base.

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**.



Drilling the Vent Hole

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**.

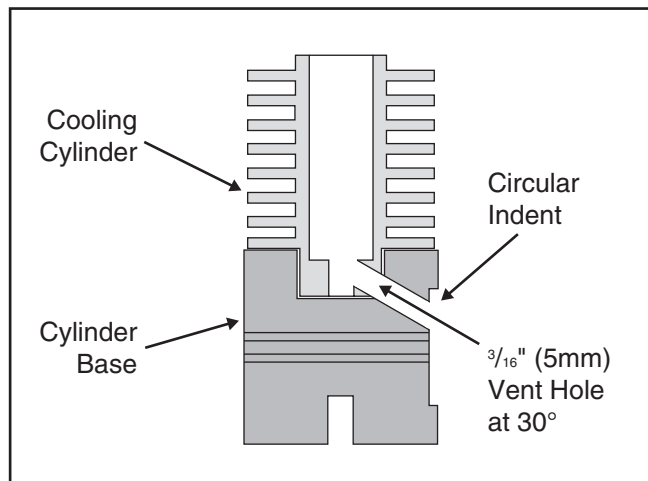


Figure 2. Cooling cylinder and base assembly showing location of 30° vent hole.

Drill a $\frac{3}{16}$ " (5mm) hole at a 30° upward angle through the side of the 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.

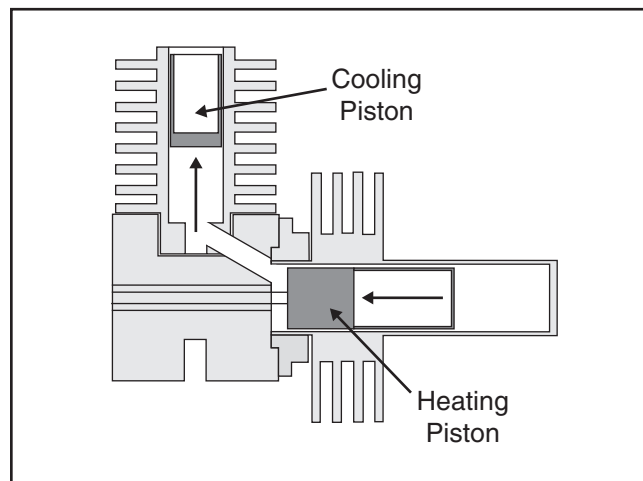


Figure 3. Pistons positioned in opposing points and traveling in opposite directions.

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**.

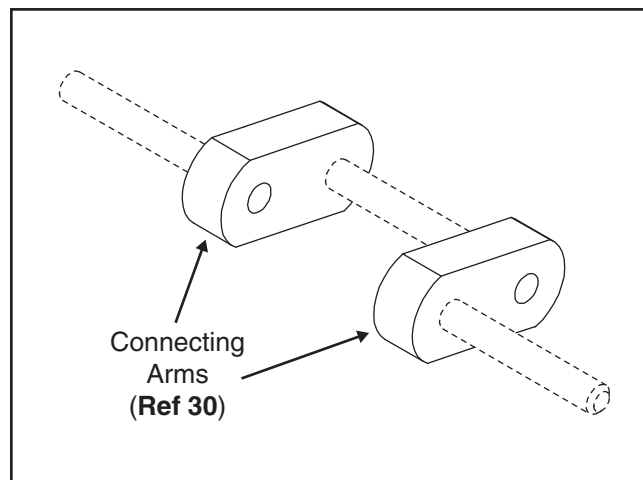


Figure 4. Connecting arms in correct alignment with one another.



Lubrication

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

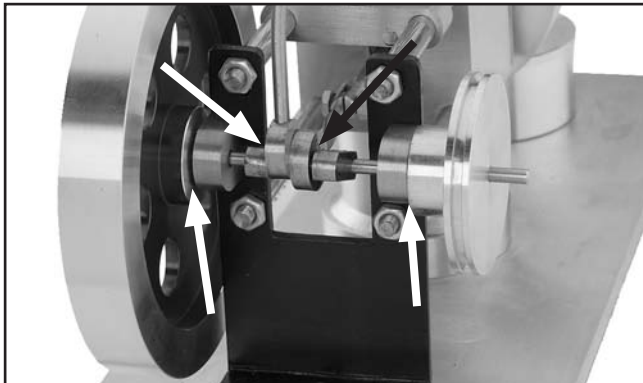


Figure 5. Axle and connector lubrication points (shown from rear of engine).

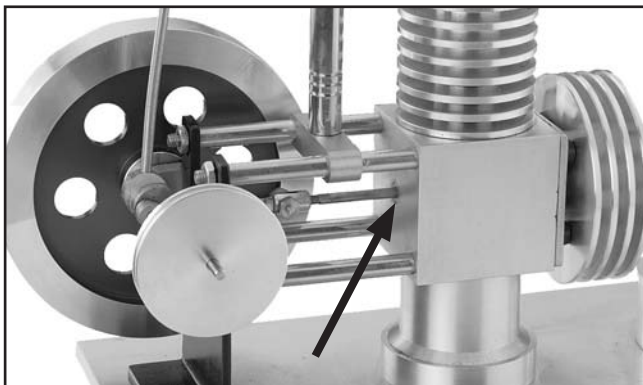


Figure 6. Heating piston drive rod lubrication point.

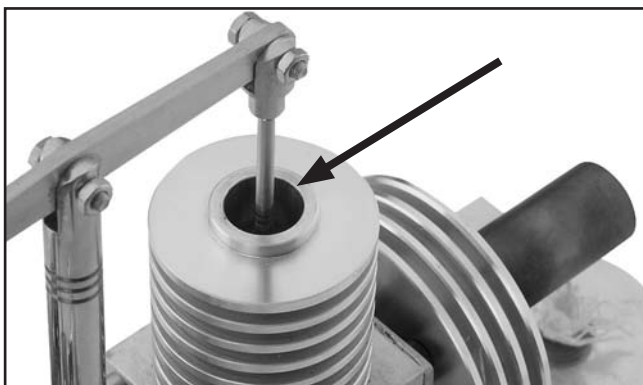



Figure 7. Cooling cylinder and piston lubrication point.

Operation

	<p>!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.</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:

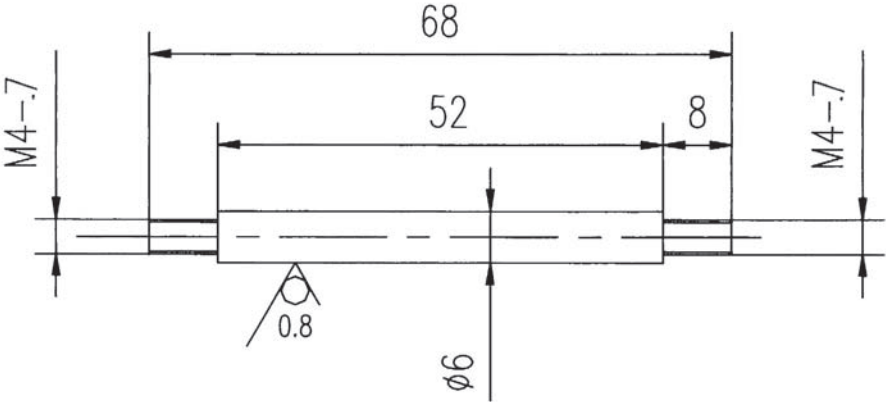
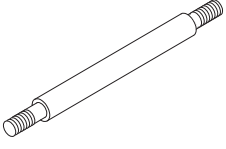
1. Make sure you have read and complied with all of the safety warnings in this manual, and have prepared your operation environment appropriately.
2. Fill the reservoir about $\frac{3}{4}$ full of 99% pure isopropyl alcohol and mount the reservoir lid with the wick showing only about $\frac{1}{2}$ ".
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.



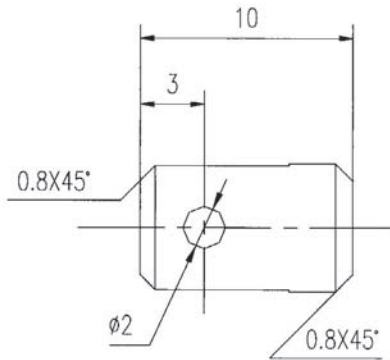
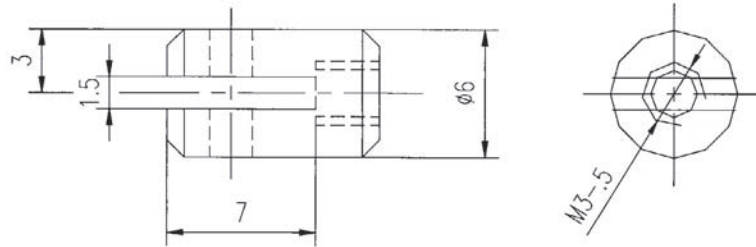
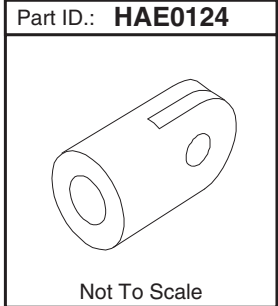
Machining Specifications

Ref No.: 3	Material	Qty To Make	Blank Description: Brass Rod Blank 6 x 72mm
Part No.: PH8101003	Brass	4	Finished Part Description: Threaded Connection Rod 68mm
Part ID.: HAE0119			
 <p>Not To Scale</p>			

Note: All dimensions are in millimeters.

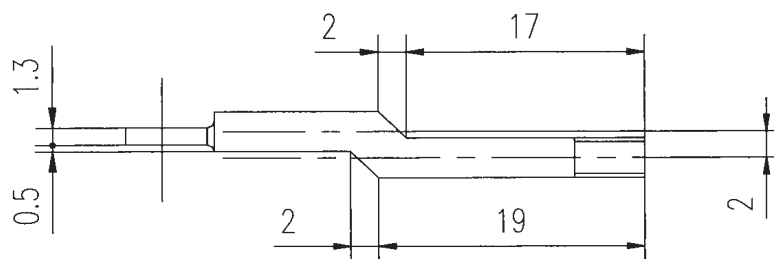
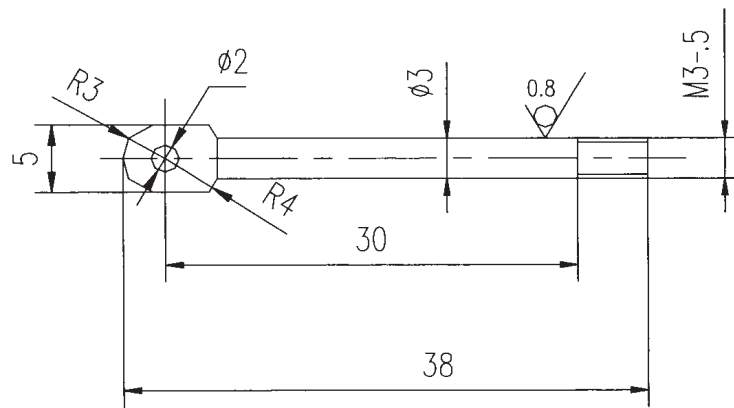
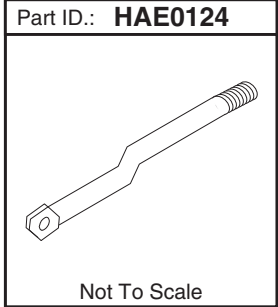


Ref No.: 4	Material	Qty To Make	Blank Description: Brass Cylinder Blank 8 x 15mm
Part No.: PH8101004	Brass	1	Finished Part Description: Slotted Pivot Connector #2



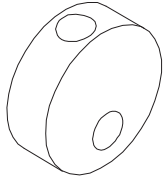
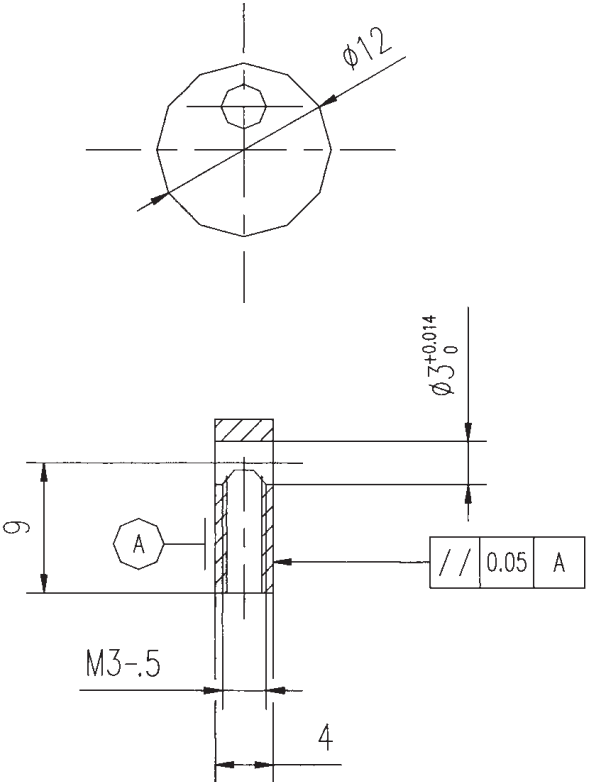
Note: All dimensions are in millimeters.

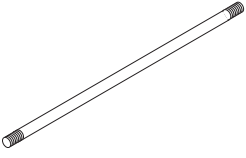
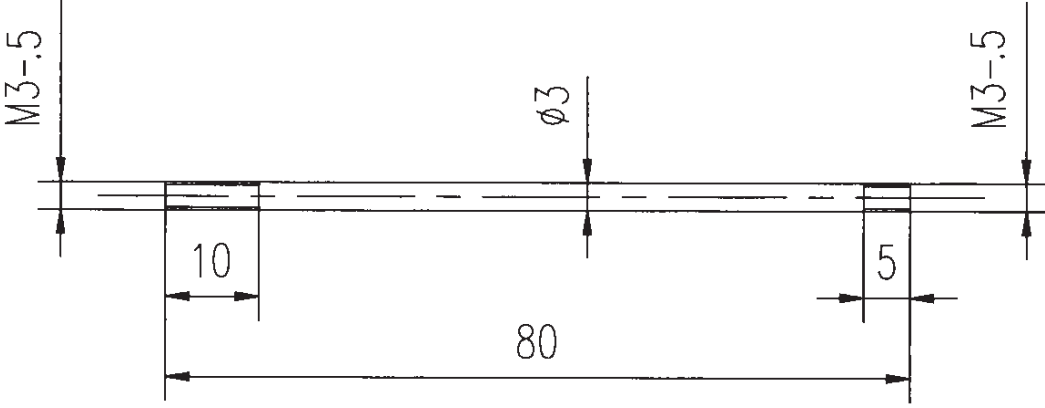
Ref No.: 5	Material	Qty To Make	Blank Description: Brass Rod Blank 3 x 40mm
Part No.: PH8101005	Brass	1	Finished Part Description: Bent Connector Rod 38mm




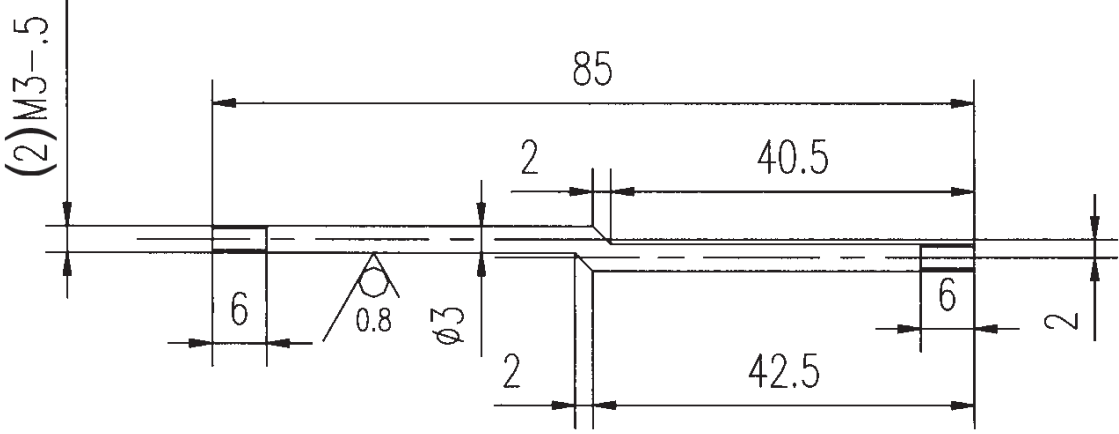
Note: All dimensions are in millimeters.

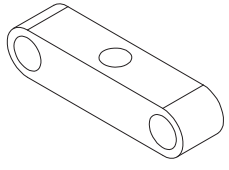
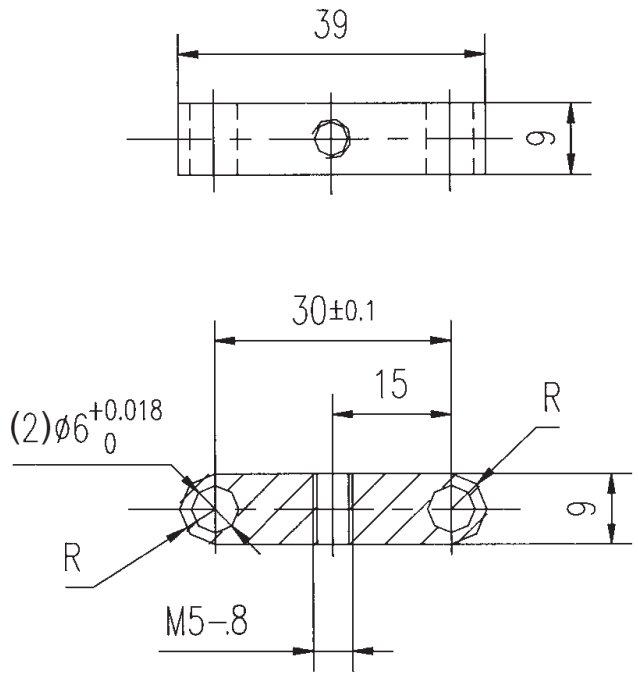


Ref No.: 6	Material	Qty To Make	Blank Description: Brass Cylinder Blank 13 x 25mm
Part No.: PH8101006	Brass	2	Finished Part Description: Round Eccentric Connector
Part ID.: HAE0103			
 Not To Scale			
Note: All dimensions are in millimeters.			


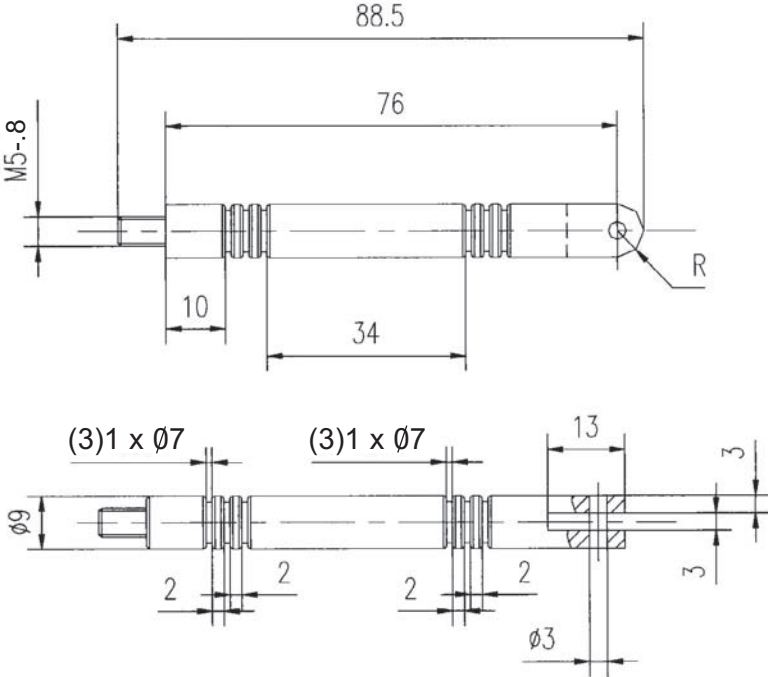
Ref No.: 7	Material	Qty To Make	Blank Description: Steel Rod Blank 3 x 82mm
Part No.: PH8101007	Steel	1	Finished Part Description: Heating Piston Drive Rod 80mm
Part ID.: HAE0122			
 Not To Scale			
Note: All dimensions are in millimeters.			

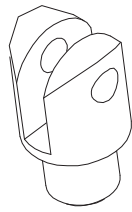
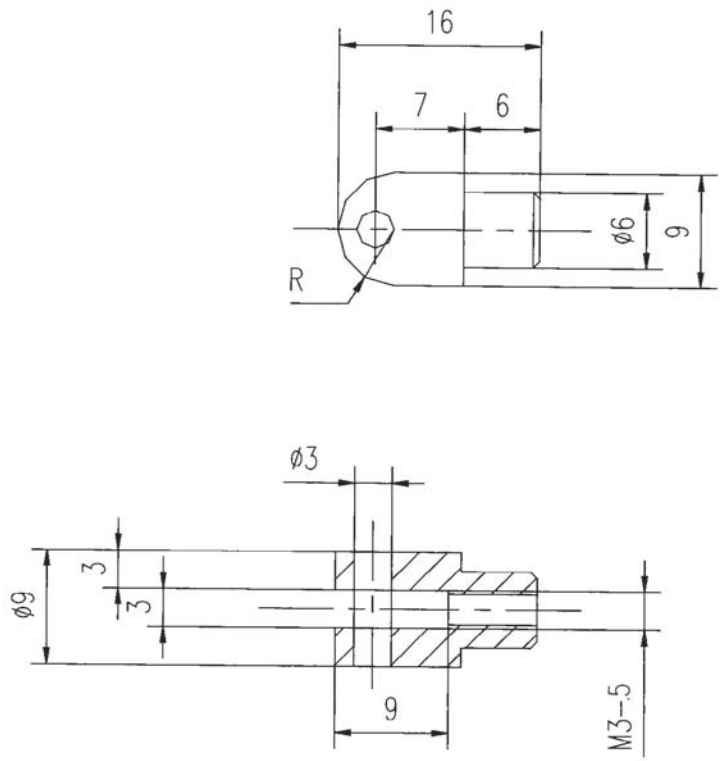


Ref No.: 8	Material	Qty To Make	Blank Description: Brass Rod Blank 3 x 86mm
Part No.: PH8101008	Brass	1	Finished Part Description: Bent Drive Rod 85mm
Part ID.: HAE0119			
 <p>Not To Scale</p>			
 <p>Note: All dimensions are in millimeters.</p>			

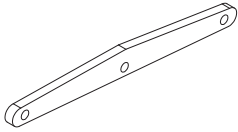
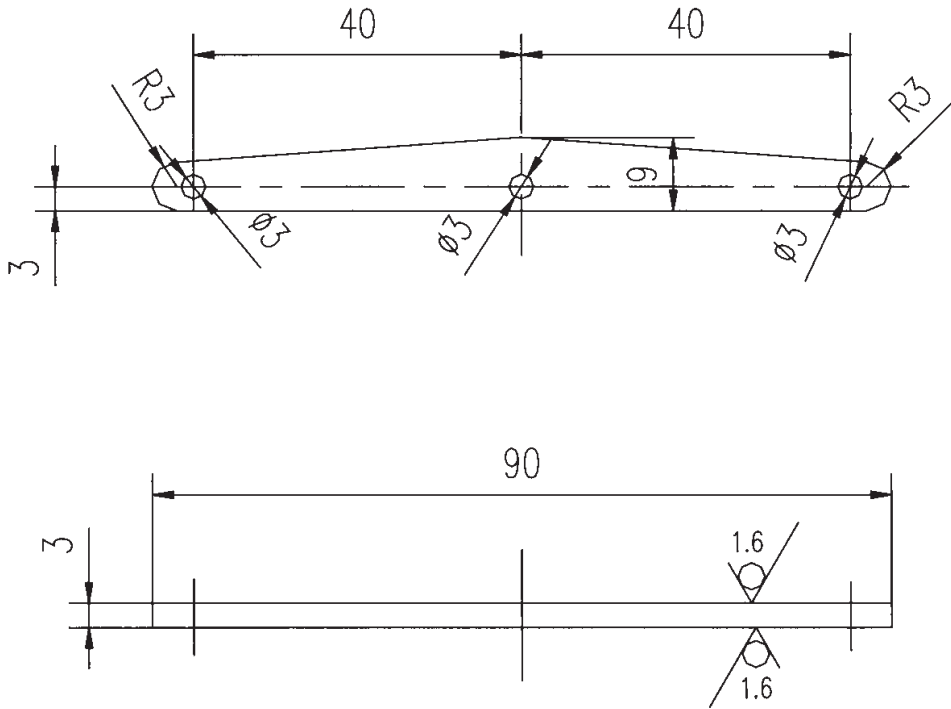
Ref No.: 9	Material	Qty To Make	Blank Description: Brass Square Blank 12 x 12 x 42mm
Part No.: PH8101009	Brass	1	Finished Part Description: Rocker Arm Shaft Support
Part ID.: HAE0109			
 <p>Not To Scale</p>			
 <p>Note: All dimensions are in millimeters.</p>			

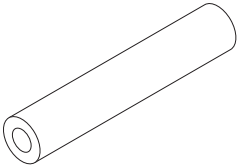
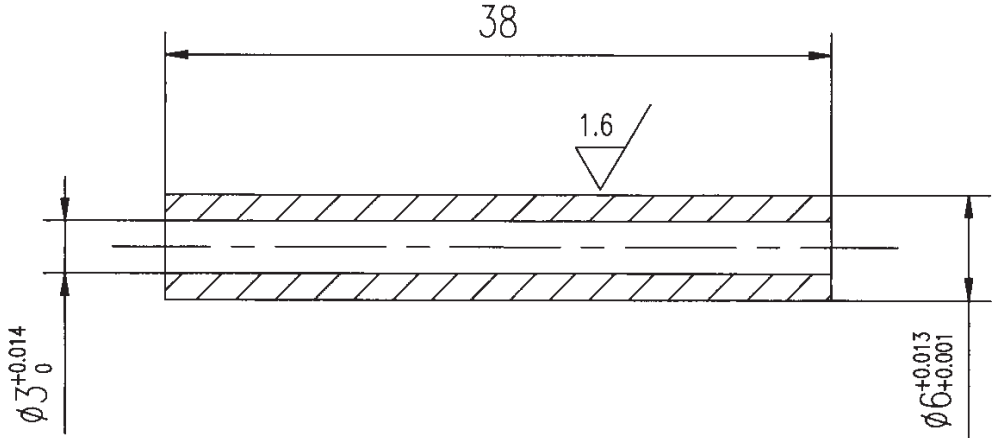


Ref No.: 10	Material	Qty To Make	Blank Description: Brass Rod Blank 11 x 92mm
Part No.: PH8101010	Brass	1	Finished Part Description: Rocker Arm Shaft
Part ID.: HAE0115			
 Not To Scale			
<p>Note: All dimensions are in millimeters.</p>			

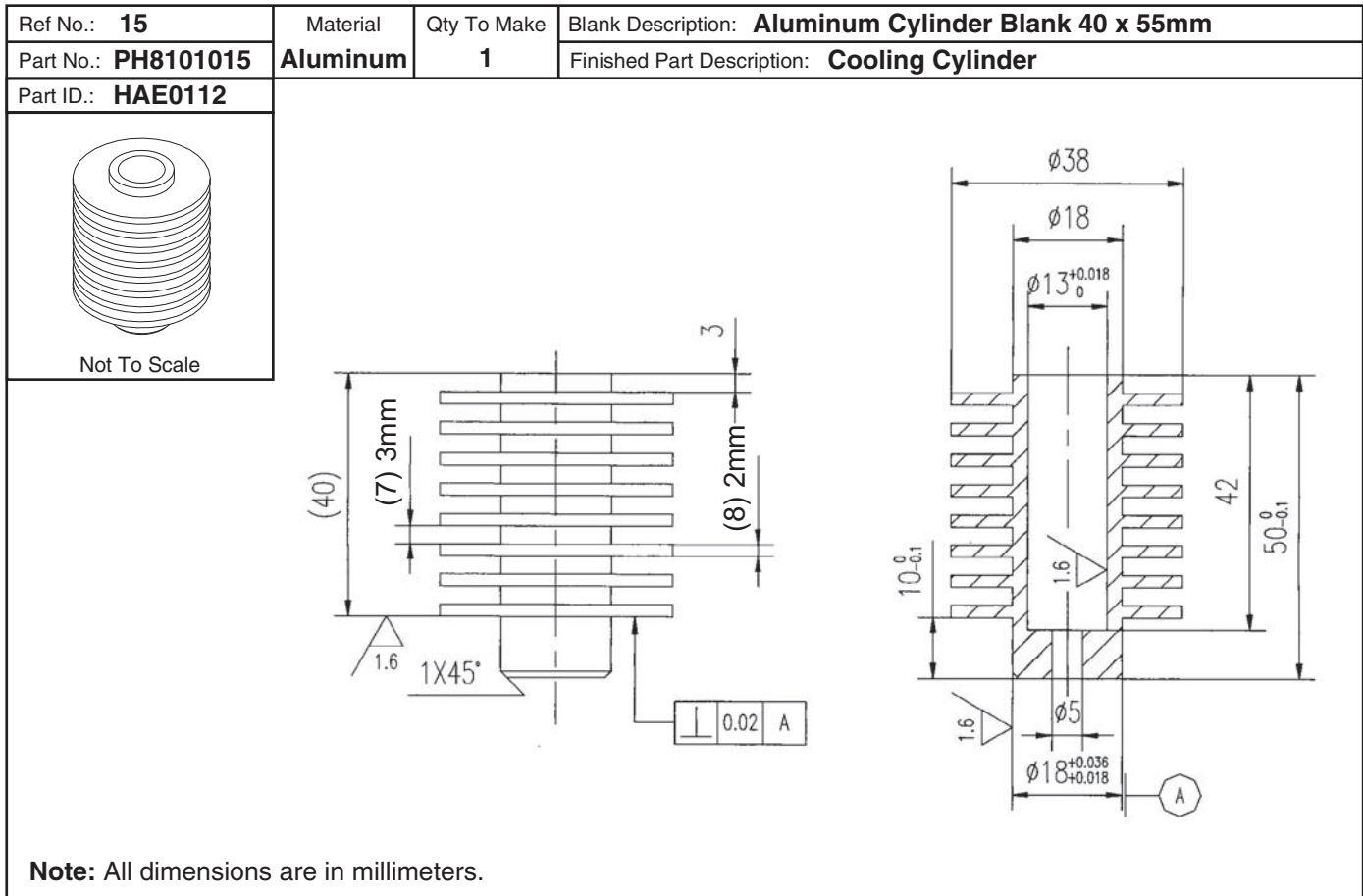
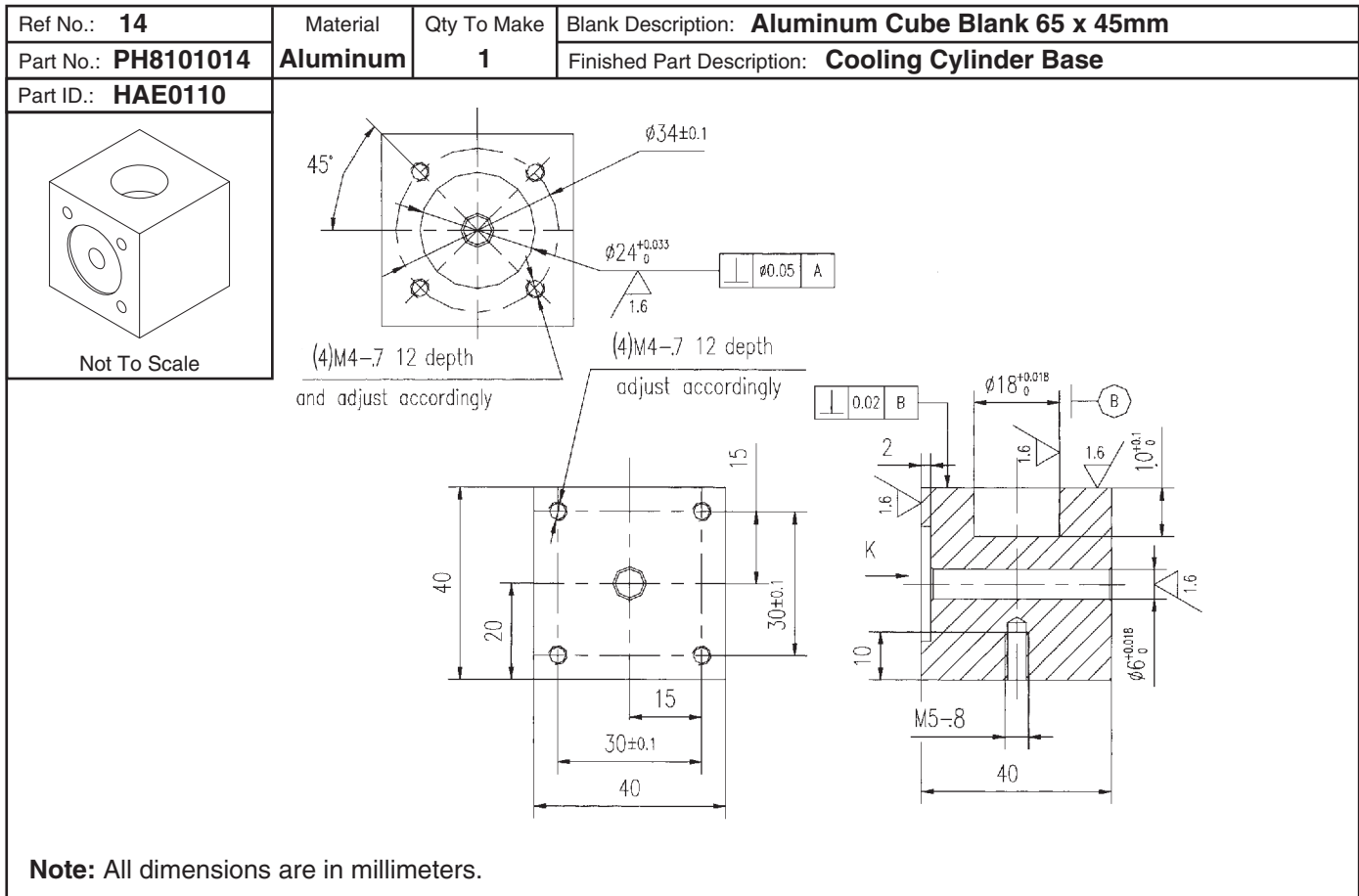
Ref No.: 11	Material	Qty To Make	Blank Description: Brass Cylinder Blank 10 x 20mm
Part No.: PH8101011	Brass	1	Finished Part Description: Slotted Pivot Connector #1
Part ID.: HAE0118			
 Not To Scale			
<p>Note: All dimensions are in millimeters.</p>			



Ref No.: 12	Material	Qty To Make	Blank Description: Brass Plate Blank 96 x 12 x 3mm
Part No.: PH8101012	Brass	1	Finished Part Description: Rocker Arm
Part ID.: HAE0117			
 Not To Scale			
Note: All dimensions are in millimeters.			

Ref No.: 13	Material	Qty To Make	Blank Description: Brass Rod Blank 6 x 42mm
Part No.: PH8101013	Brass	1	Finished Part Description: Drive Rod Sleeve
Part ID.: HAE0111			
 Not To Scale			
Note: All dimensions are in millimeters.			

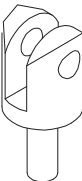
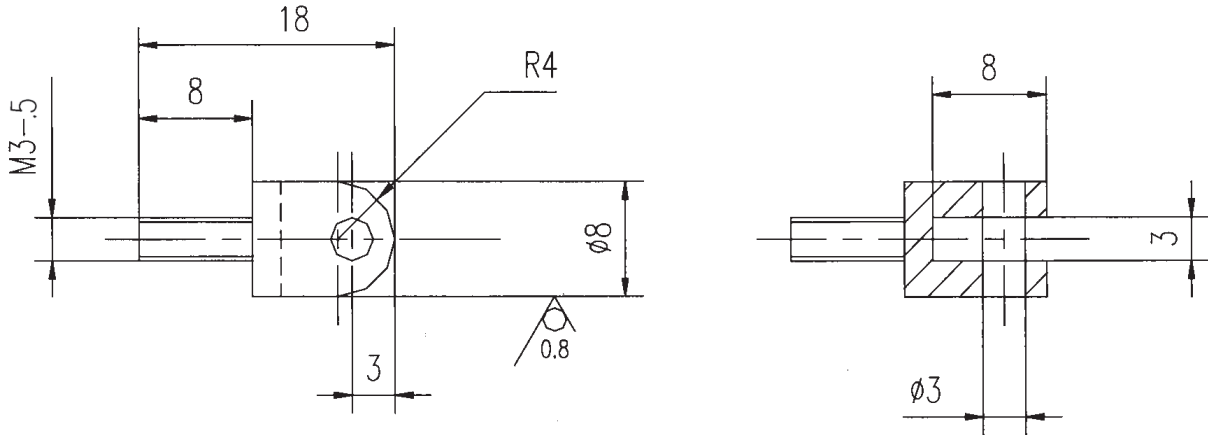


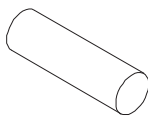
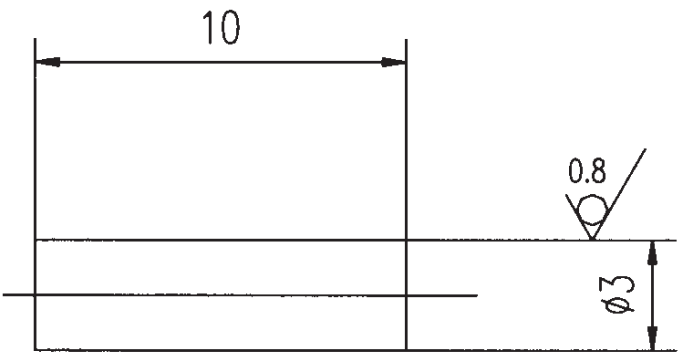


Ref No.: 17	Material Brass	Qty To Make 1	Blank Description: Brass Rod Blank 8 x 58mm
Part No.: PH8101017			Finished Part Description: Cooling Piston Drive Rod 55mm
Part ID.: HAE0125			
<p>Not To Scale</p>			
<p>Note: All dimensions are in millimeters.</p>			

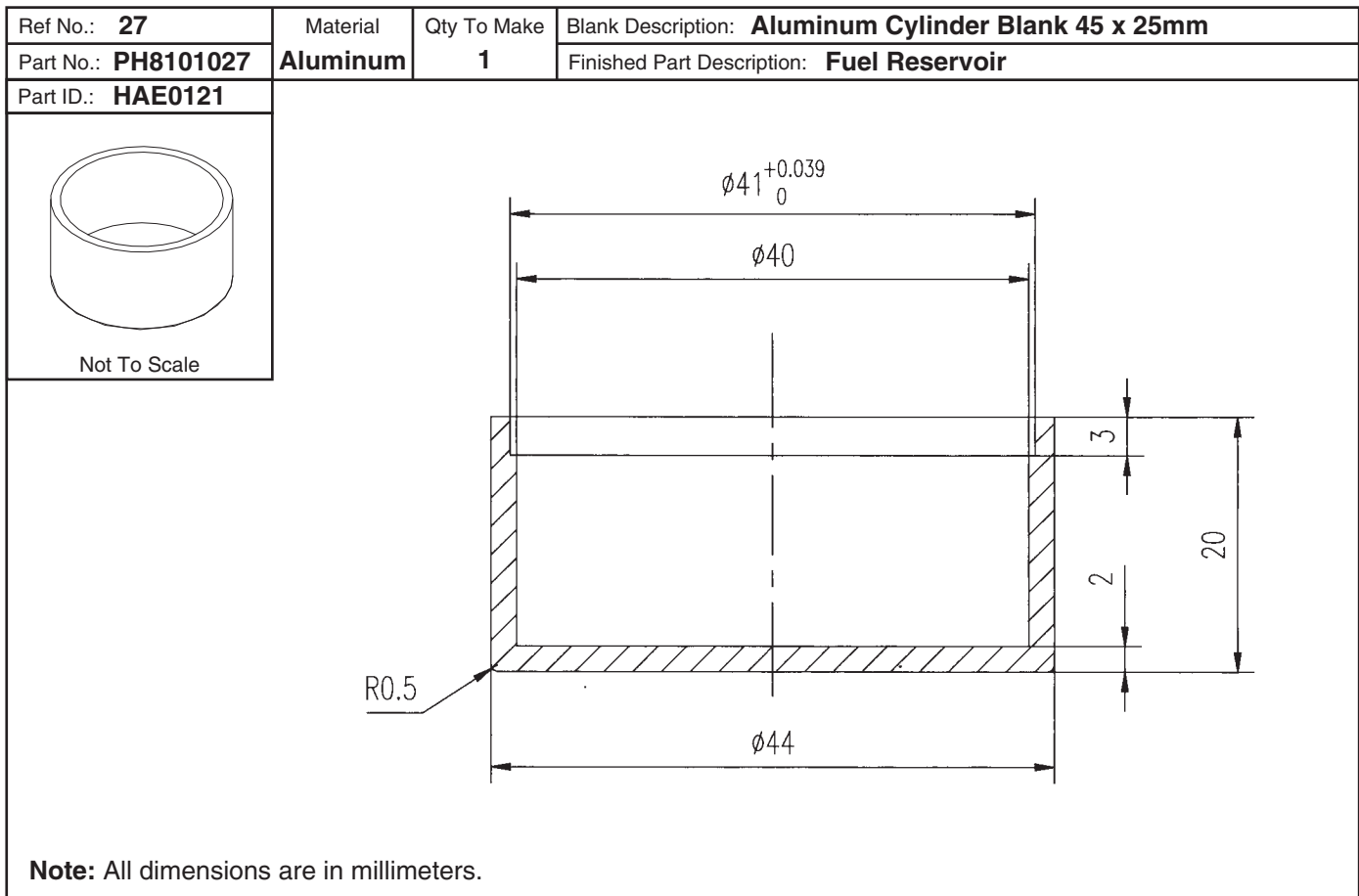
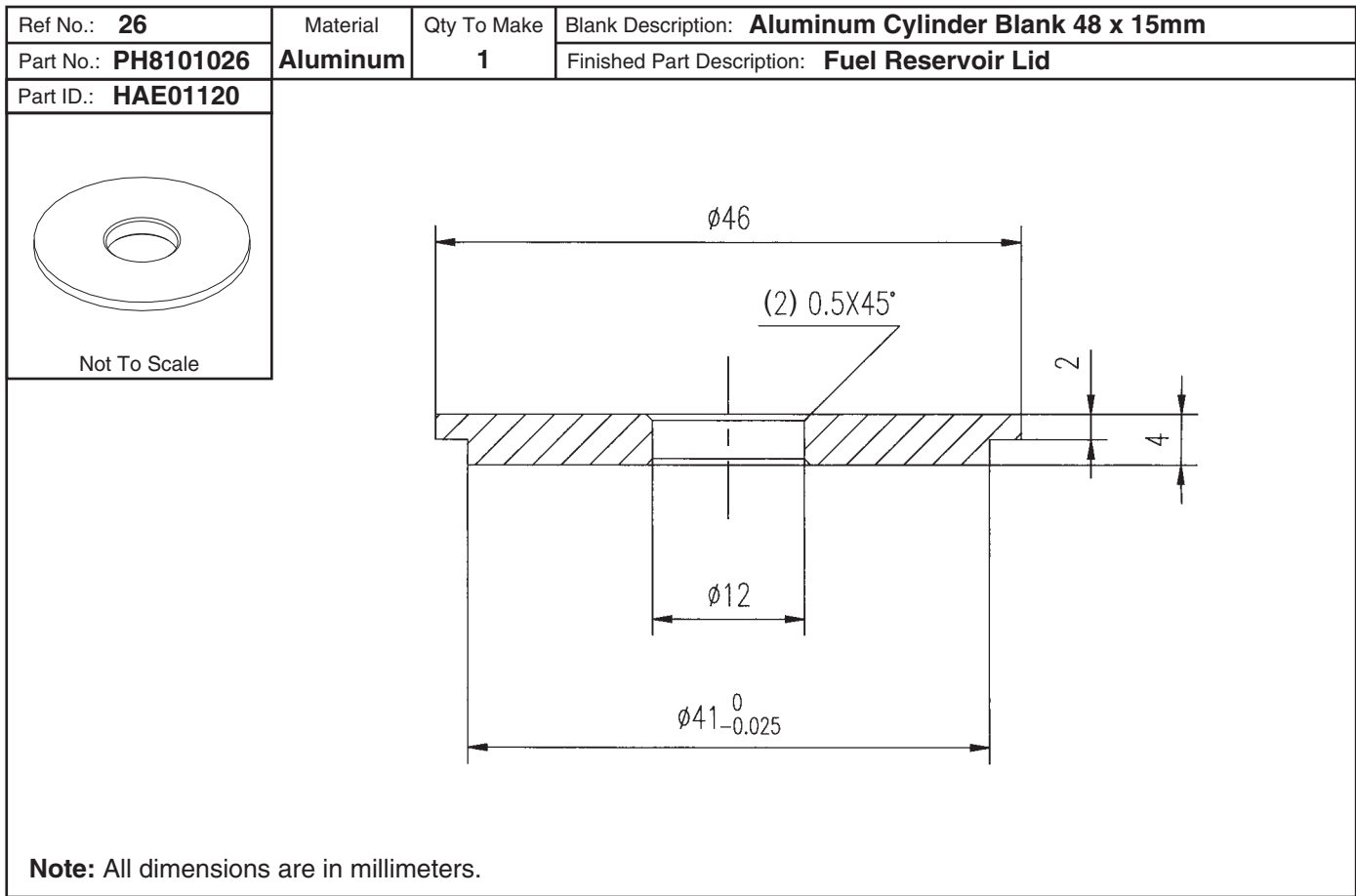
Ref No.: 18	Material Brass	Qty To Make 1	Blank Description: Brass Cylinder Blank 10 x 20mm
Part No.: PH8101018			Finished Part Description: Slotted Pivot Connector #4
Part ID.: HAE0126			
<p>Not To Scale</p>			
<p>Note: All dimensions are in millimeters.</p>			

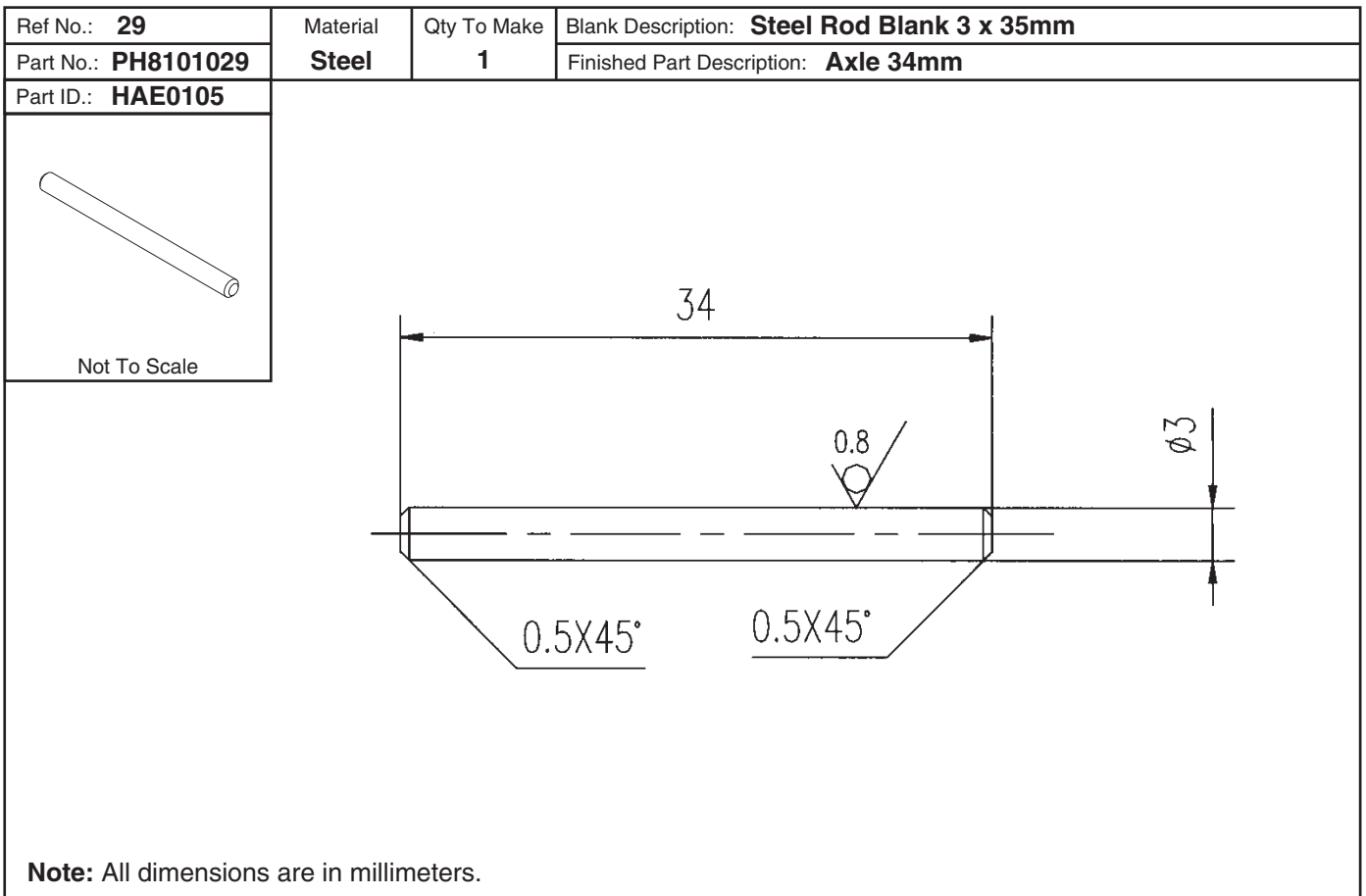
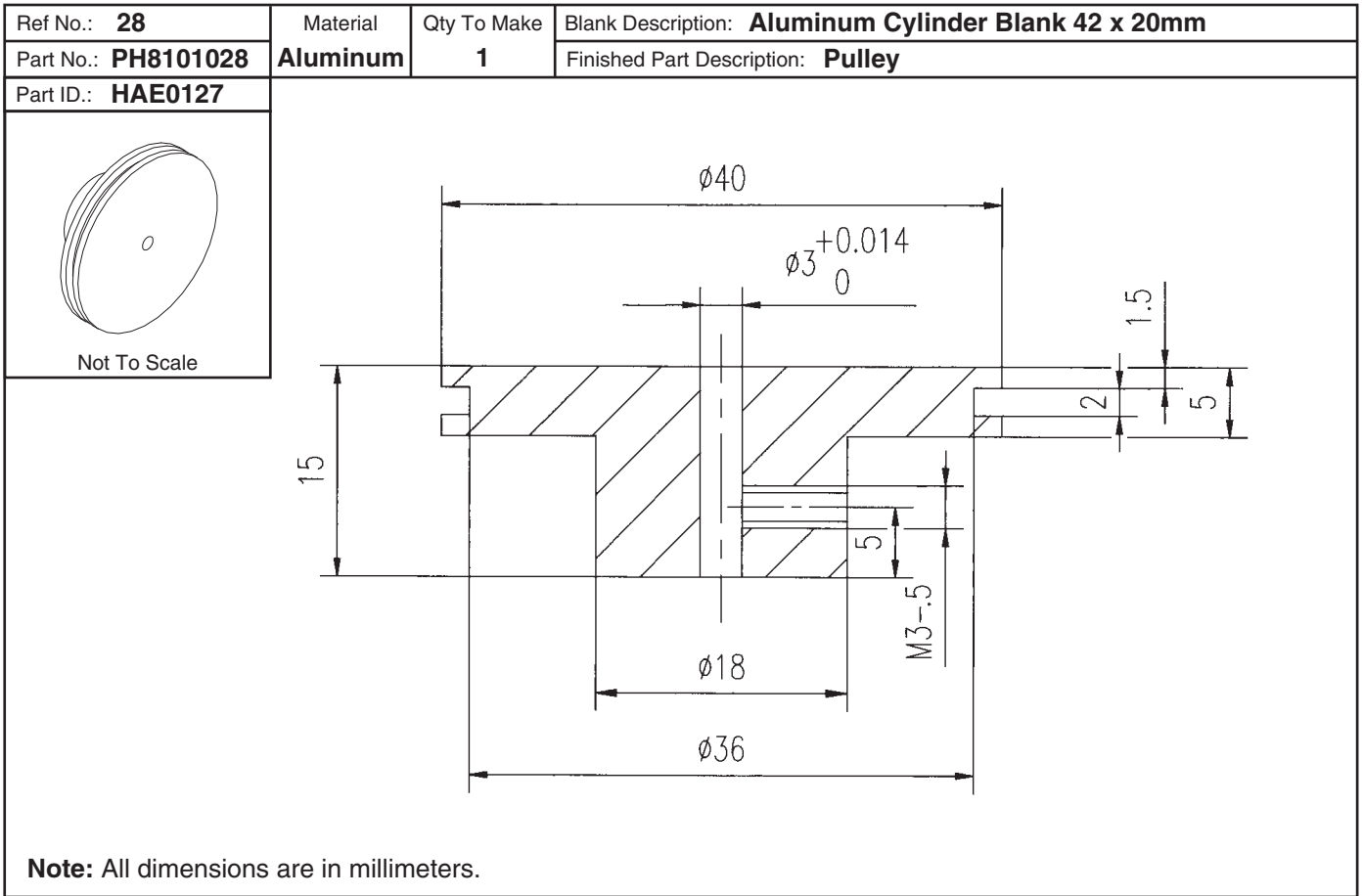


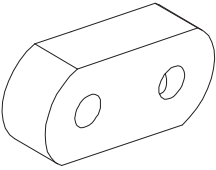
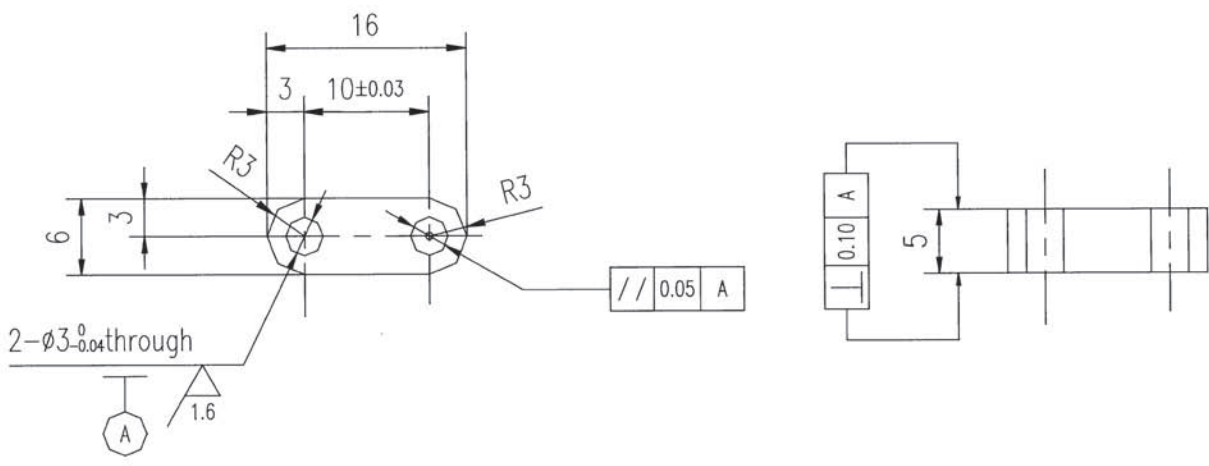
Ref No.: 19	Material	Qty To Make	Blank Description: Brass Cylinder Blank 8 x 20mm
Part No.: PH8101019	Brass	1	Finished Part Description: Slotted Pivot Connect #3
Part ID.: HAE0130			
 <p>Not To Scale</p>			
			
<p>Note: All dimensions are in millimeters.</p>			

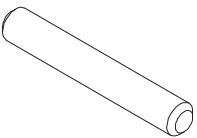
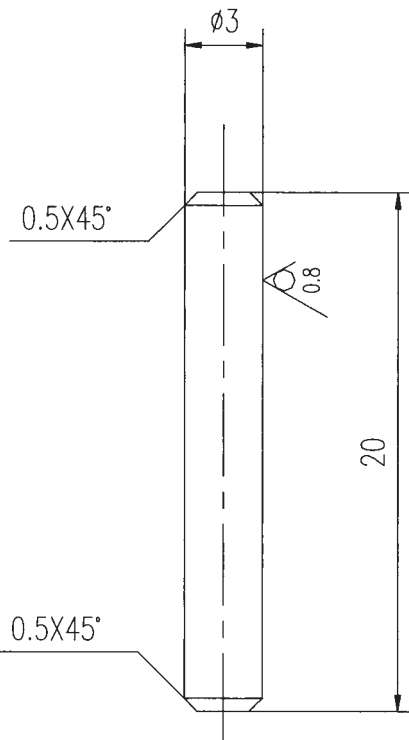
Ref No.: 20	Material	Qty To Make	Blank Description: Brass Rod Blank 3 x 13mm
Part No.: PH8101020	Brass	1	Finished Part Description: Pin 10mm
Part ID.: HAE0131			
 <p>Not To Scale</p>			
			
<p>Note: All dimensions are in millimeters.</p>			



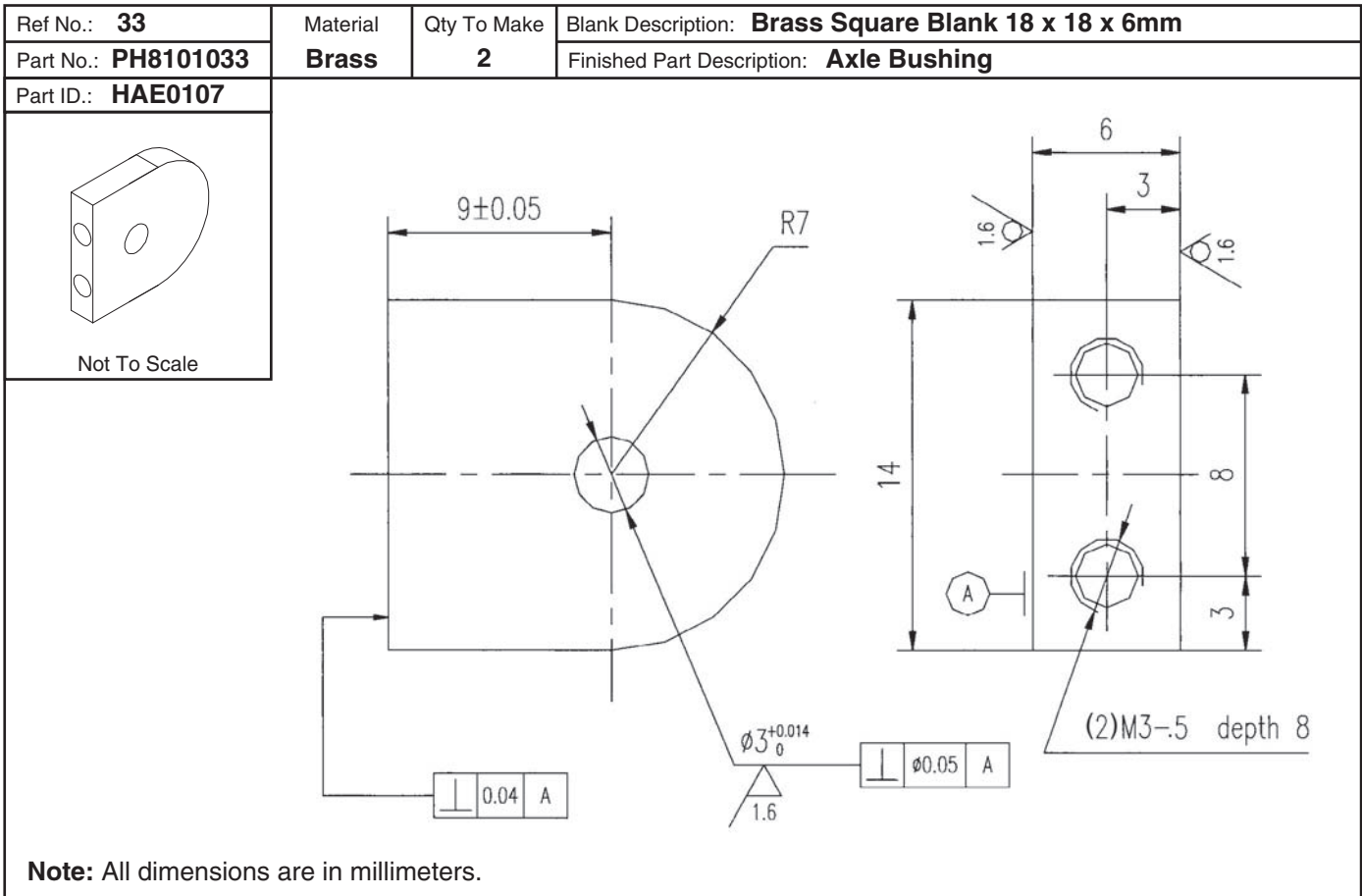
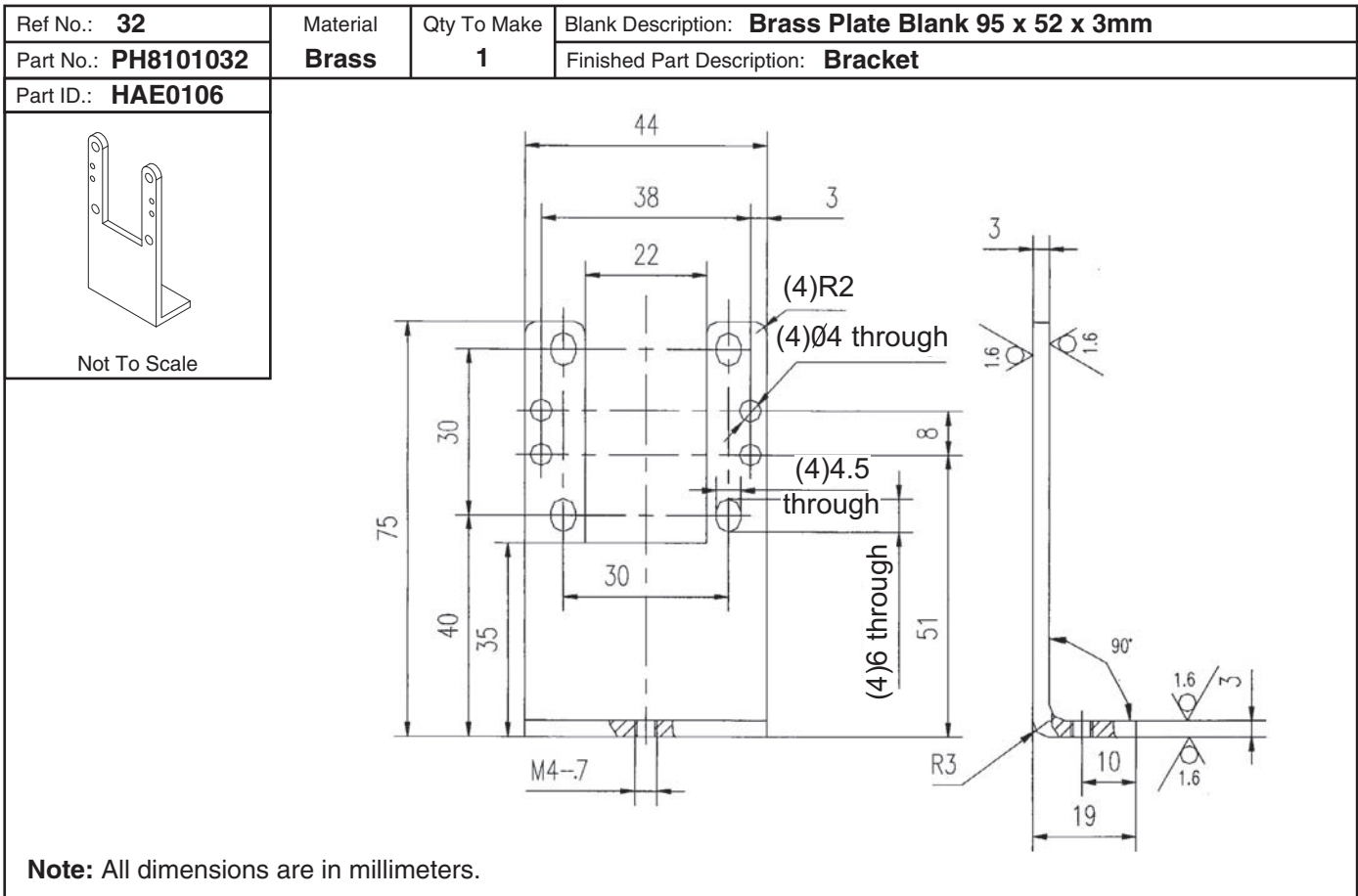


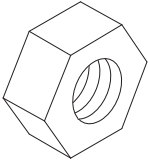
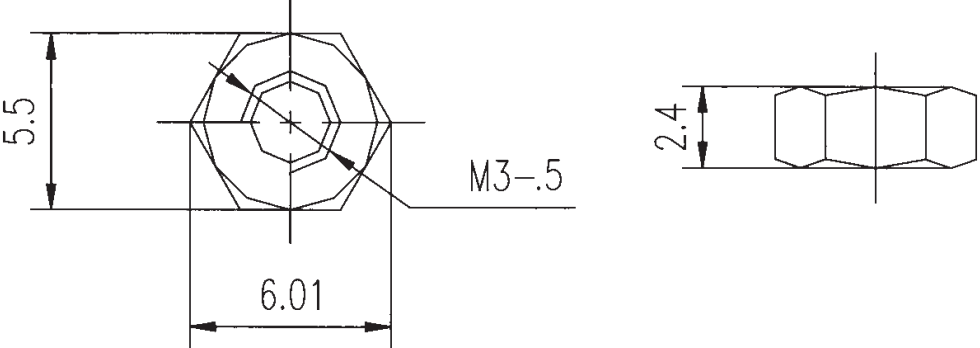


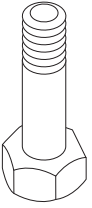
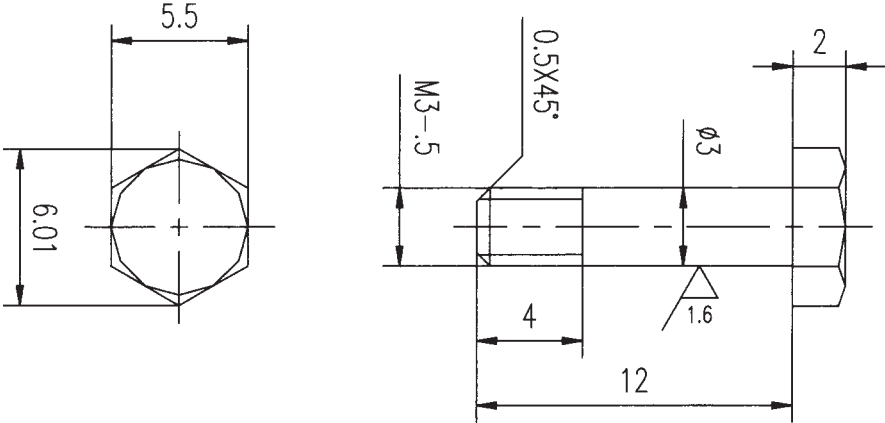
Ref No.: 30	Material	Qty To Make	Blank Description: Brass Square Blank 6 x 6 x 25mm
Part No.: PH8101030	Brass	2	Finished Part Description: Connecting Arm
Part ID.: HAE0102			
 <p>Not To Scale</p>			
 <p>Note: All dimensions are in millimeters.</p>			

Ref No.: 31	Material	Qty To Make	Blank Description: Steel Rod Blank 3 x 25mm
Part No.: PH8101031	Steel	1	Finished Part Description: Axle 20mm
Part ID.: HAE0104			
 <p>Not To Scale</p>			
 <p>Note: All dimensions are in millimeters.</p>			

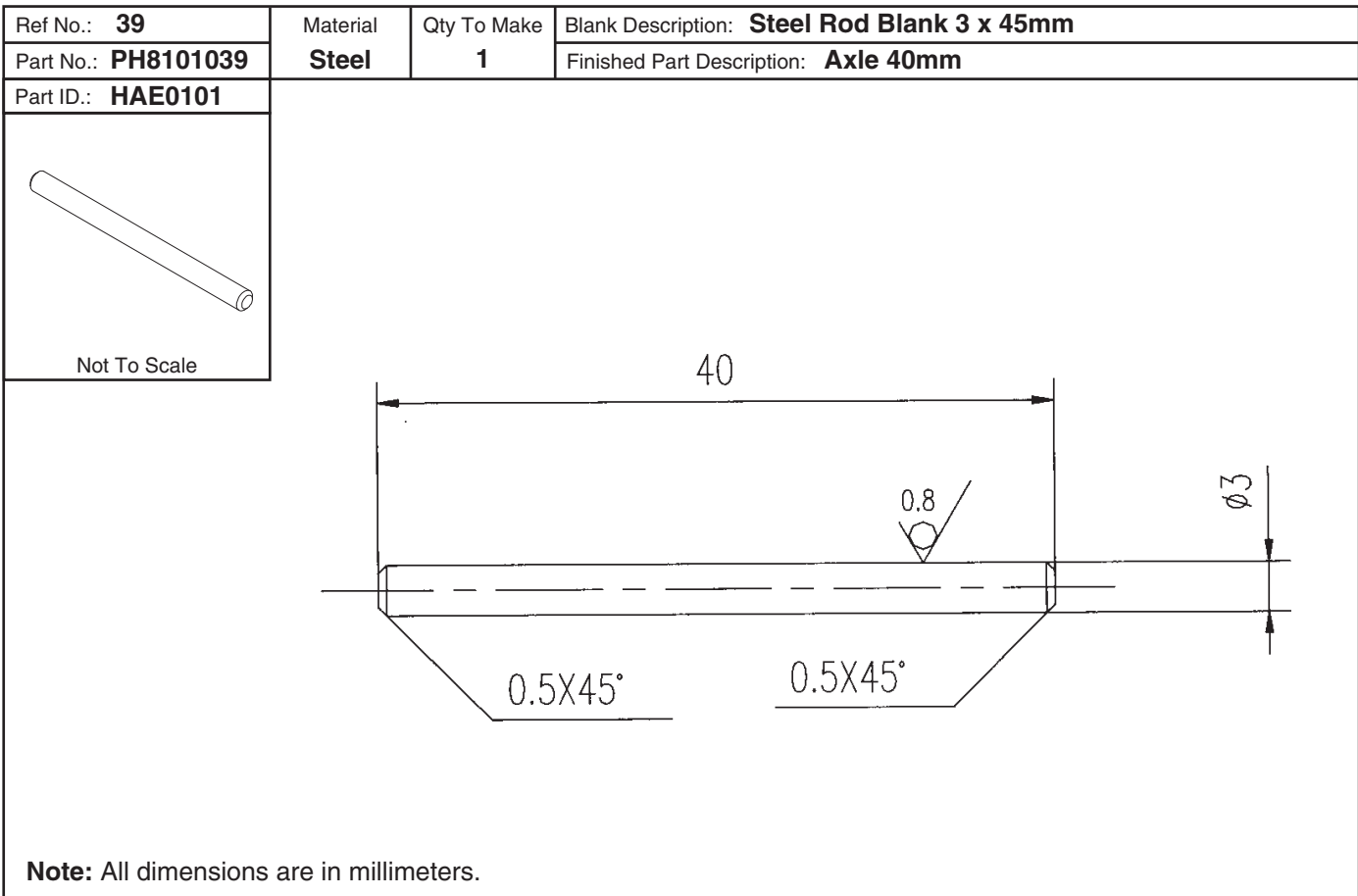
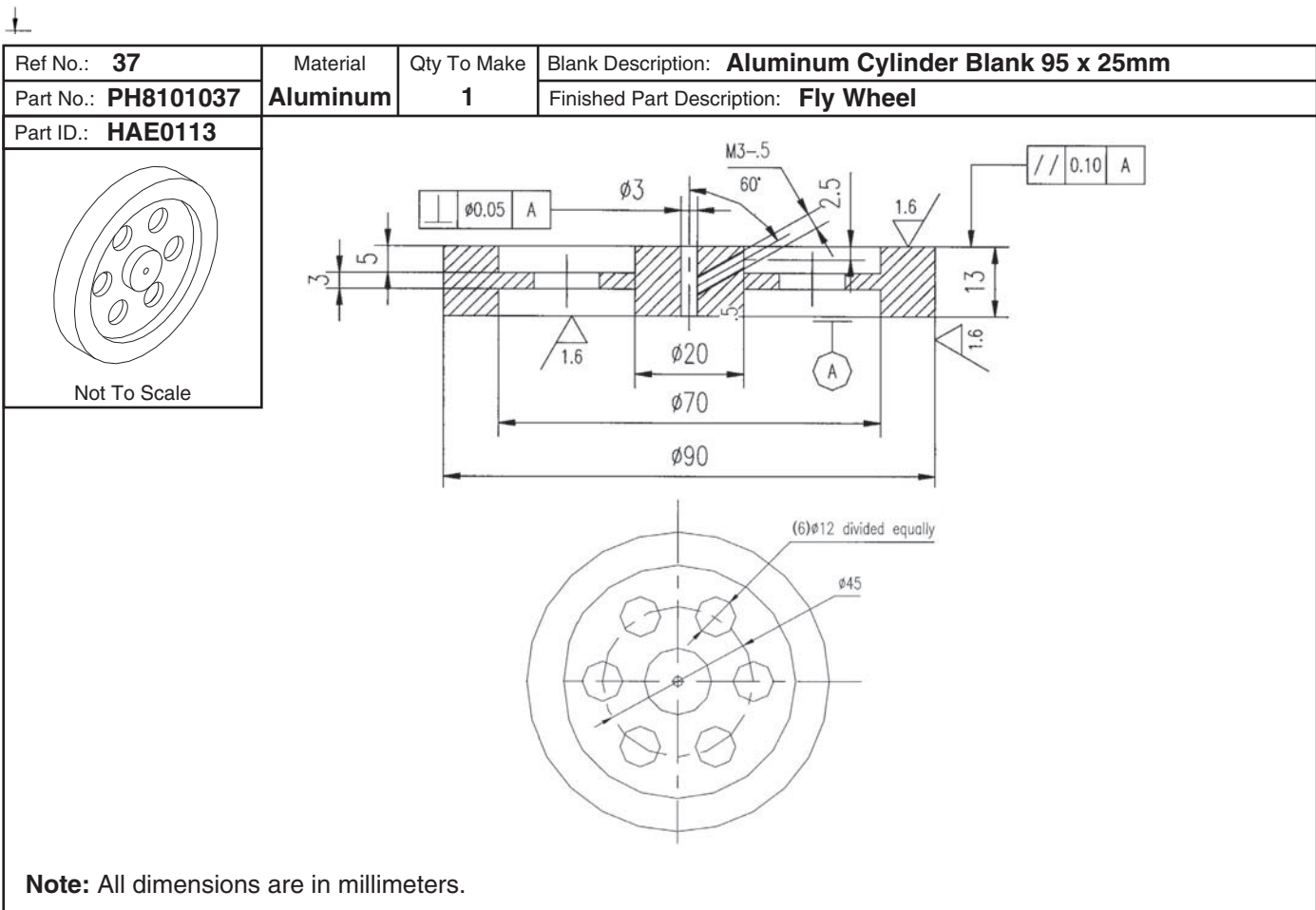


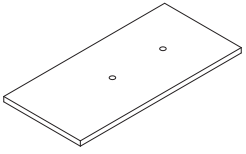
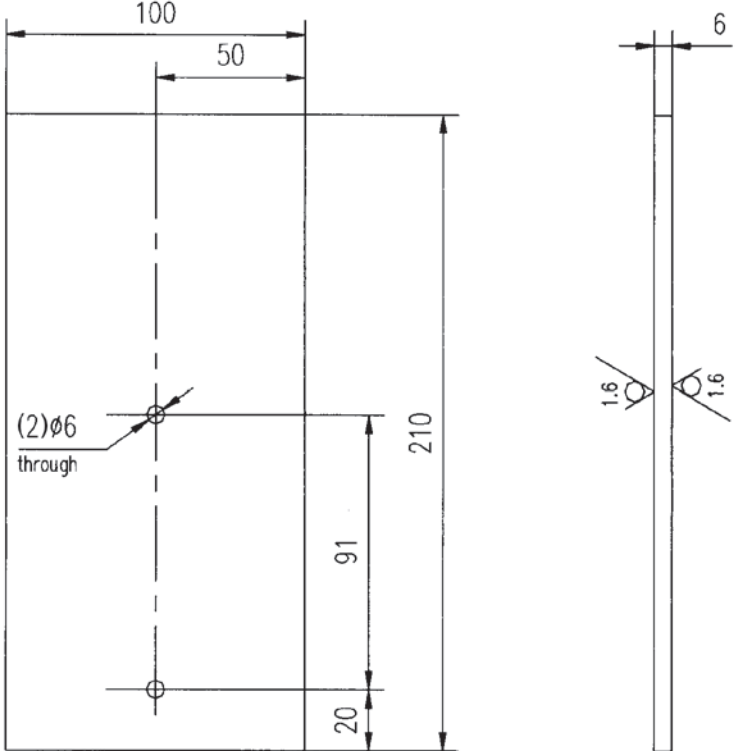


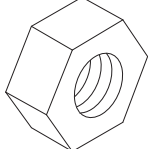
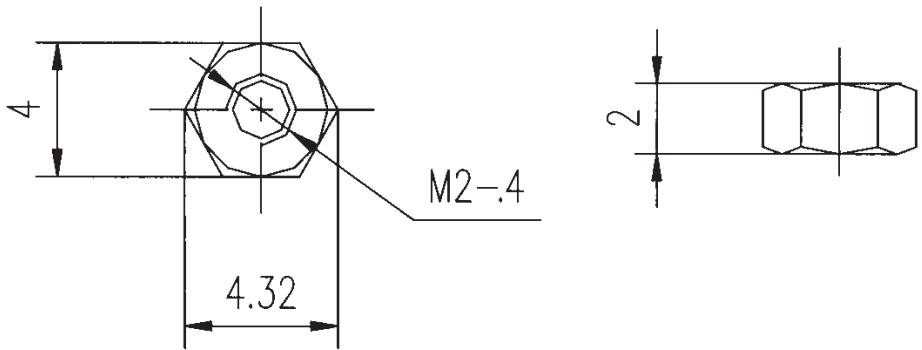
Ref No.: 34	Material	Qty To Make	Blank Description: Brass Hexagon Blank 5.5 x 30mm
Part No.: PH8101034	Brass	3	Finished Part Description: Brass Hex Nut M3-.5
Part ID.: HAE0129			
 Not To Scale			
<p>Note: All dimensions are in millimeters.</p>			

Ref No.: 35	Material	Qty To Make	Blank Description: Brass Hexagon Blank 5.5 x 60mm
Part No.: PH8101035	Brass	3	Finished Part Description: Brass Hex Bolt M3-.5 x 11
Part ID.: HAE0128			
 Not To Scale			
<p>Note: All dimensions are in millimeters.</p>			





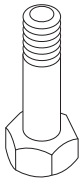
Ref No.: 44	Material	Qty To Make	Blank Description: Aluminum Plate Blank 210 x 100 x 6mm
Part No.: PH8101044	Aluminum	1	Finished Part Description: Bottom Plate
Part ID.: HAE0132			
 <p>Not To Scale</p>			
			
<p>Note: All dimensions are in millimeters.</p>			

Ref No.: 46	Material	Qty To Make	Blank Description: Brass Hexagon Blank 5.5 x 18mm
Part No.: PH8101046	Brass	1	Finished Part Description: Brass Hex Nut M2-.4
Part ID.: HAE0134			
 <p>Not To Scale</p>			
			
<p>Note: All dimensions are in millimeters.</p>			

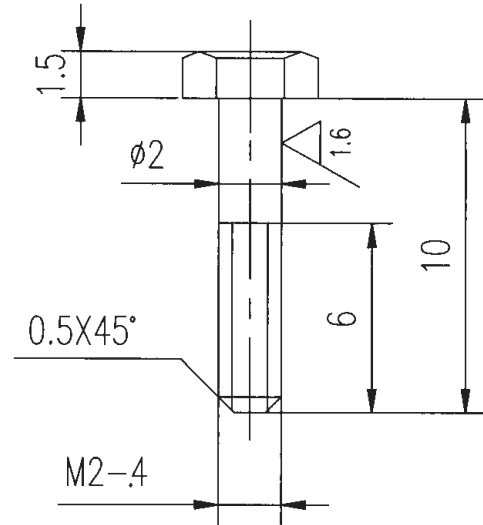
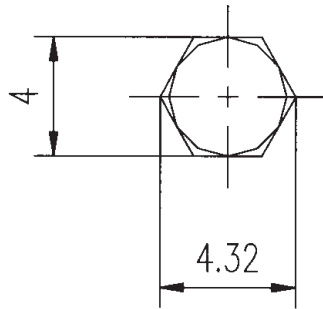


Ref No.: 47	Material	Qty To Make	Blank Description: Brass Hexagon Blank 5.5 x 25mm
Part No.: PH8101047	Brass	1	Finished Part Description: Brass Hex Bolt M2-4 x 12

Part ID.: **HAE0133**



Not To Scale



Note: All dimensions are in millimeters.



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