

Stirling Engine: Part Fabrication Guide
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FlyWheel

Part Fabrication Steps

Tools Needed: Turning tool, .125 drill bit, .249 drill bit, cutting fluid (water-based), measuring caliper

FlyWheel Fabrication:

Lathe Fabrication Process:

I. Facing Operation:

Side #1:

1. Before placing on the lathe, the handle on the flywheel left from casting was cut off, leaving approximately 1 inch of the handle left.
2. Place the flywheel inside of the 3-jaw chuck, placing the 1-inch part of the handle on the clamp itself.
3. Check the cutting tool insert and confirm it is the turning tool.
4. Set speed to 685 rpm and have cutting fluid ready.
5. Face stock until completely smooth and most ridges are gone while applying cutting fluid.

Side #2:

1. Flip the flywheel so the base is clamped onto the 3-jaw chuck.
2. Face across the face of the handle in increments of 0.100 until you reach 0.200-inch length of the handle.
3. Before facing more, zero the x-axis at the 0.200 length mark, which is measured with a caliper.
4. Face to a depth of 0.14 inches.
5. Now, you will move on to face the outer rim of the flywheel.
6. Keep the same rpm speed of 685 rpm.
7. Measure the thickness of the flywheel using calipers.
8. Zero the z-axis on the outer rim of the flywheel.
9. Face the front of the flywheel until you reach 0.96 thickness, but do not face all the way to the center of the flywheel. Only face until you reach the outer rim of the handle.

II. Turning Operation:

1. Measure the diameter of the handle using calipers.
2. Zero the z-axis to the tip of the handle of the flywheel.
3. Turn the handle of the flywheel 0.14 inches along the x-axis until a diameter of 0.75 is reached.
4. Now, we will move to turning the outer rim of the flywheel. Measure the diameter of the flywheel using calipers.
5. Zero the z-axis to ensure it is at the tip of the flywheel.
6. Turn the flywheel until a diameter of 3.78 inches is reached.

III. Drilling Operation: (on lathe)

1. While the flywheel is still in the 3-jaw chuck, place the .249 drill bit into the tailstock drill chuck.
2. Tighten the .249 drill bit and bring the entire tailstock close to the flywheel.
3. Turn on the lathe at 685 rpm and drill a through hole into the center of the flywheel.

Milling Fabrication Process:

1. Check part dimensions
2. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
3. Place parallels on the sides of the clamping device to raise the flywheel higher for the through-drilling operation.
4. Secure flywheel on top of the parallels and in the clamping device, with the 3-spoke part of the flywheel facing upwards.
5. Make sure that the spoke where the hole will be is parallel to the parallels in terms of direction.
6. Set speed to approximately 500 rpm for the edge finder.
7. Edge find the outer side of the flywheel along the x-axis & set to zero. Account for 0.1 inch difference in diameter of the edge finder.
8. Edge find the top of the spoke where the hole will be along the y-axis & set to zero. Account for 0.1 inch difference in diameter of the edge finder.
9. Take out edge finder and replace with the .125 drill bit. Secure into the spindle.
10. Set the x-axis to be 2.89 inches from the right side of the flywheel, so that it is 1.00 inches from the center of the flywheel.
11. Measure the width of the spoke with the caliper and set the y-axis to be half the width of the spoke away from the spoke edge.
12. Use aluminum cutting fluid and place it around the area.
13. Set the speed to approximately 700 rpm.
14. Drill the hole through the entire flywheel.

Piston Wheel Part Fabrication Steps

Tools Needed: Turning tool, B drill(.238), .251 reamer, counter sink, chamfer tool, part off tool, cutting fluid (oil), micrometer, measuring caliper, #2 drill, #29 drill, 8-32 tap, tap handle, tap guide, edge finder, drill chuck, .125 drill

FlyWheel Fabrication:

Lathe Fabrication Process:

Turning Process:

1. Check tool post for parallelism and check that it is secure to compound
2. Check cutting tool for insert
3. Check that cutting tool insert holder is properly seated in the tool post holder
4. Adjust tool to cut to center (as demonstrated)
5. Clamp round stock in the 3 jaw chuck securely
6. Set speed to 685 RPM
7. Face stock until blank. Zero the z axis on the DRO.
8. Turn OD to 1.25 and a depth of .6.
9. Turn 2nd outer diameter to 0.625 and a depth of 0.25
10. On last pass turn to depth of 0.275.
11. Clean up back face.
12. Measure 0.25 depth and face to dimension.
13. Use chamfer tool to deburr edges.
14. Center drill using #4 center drill
15. Use "B" drill, which is 0.238 inches, and drill to depth to the mark on the drill.
16. Set speed to 120-185 RPM.
17. Use 0.251 reamer and cutting oil. Ream until tool bottoms out.
18. Use countersink and chamfer 0.152 bore.
19. Attach the part off tool and check insert and if tool is centered
20. Touch tool to face of part. Zero z-axis on the DRO.
21. Move the tool in the x away from the face and move tool in the Z to 0.595.
22. Set speed to 270 RPM and part off flywheel. Use coolant.
23. Remove stock from machine
24. Hold the piston wheel lightly by the 0.625 diameter and face flange to 0.125.
25. Countersink bore.

Milling Operation:

1. Check part dimensions
2. Clamp fixture/jig in vise
3. Find center of piston wheel using edge finder. Use 850-1000 RPM.
4. Zero X and Y axis at part center
5. Move either axis (not both) to 0.4

6. Center drill with #2 or #3 CD drill
7. Drill 0.125 thru hole. Use 800-950 RPM. Repeat this process of moving 0.4 in each direction for all 4 holes.
8. If there is a remaining burr around the hole, use center drill to lightly deburr.
9. Remove part from fixture and fixture from vise.
10. Using the vise, clamp on part flange.
11. Using edge finder, find part center off larger diameter.
12. Use edge finder to find tap hole locations.
13. Center drill deep enough with countersink, drill with #29, hand tap with #8-32 tap.
14. Mark part with your ID Mark

Flywheel Post

Part Fabrication Steps

Tools Needed: 0.25 end mill, 0.136 drill bit, 0.496 drill bit, 0.51 reamer, cutting fluid (oil), micrometer, measuring caliper, edge finder, drill chuck, cutting fluid(water)

Milling Operation:

I. End Milling Operation

End mill Side #2:

1. Check part dimensions
2. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
3. Place parallels on the sides of the clamping device to raise the flywheel post higher for the thru-drilling operation; ensure the side is hanging out of the clamped device for milling.
4. Secure flywheel post on top of the parallels and in the clamping device.
5. Measure the length of the post using calipers.
6. Place edge finder into spindle and secure well.
7. Zero the x-axis to the edge of the post. Make sure to account for the 0.1 inch radius of the edge finder.
8. Replace edge finder with .25 endmill and set speed to 700 RPM.
9. End Mill side of the post until the 3.00 length is achieved. Use cutting coolant fluid(water) as needed.

End mill Side #1:

10. Remove from the clamped flywheel post and turn so that the other side is hanging out of the clamped device for milling.
11. Secure flywheel post on top of the parallels and in the clamping device.
12. Measure the width of the post using calipers.
13. Place edge finder into spindle and secure well.
14. Zero the x-axis to the edge of the post. Make sure to account for the 0.1 inch radius of the edge finder.
15. Replace edge finder with .25 endmill and set speed to 700 RPM.
16. End Mill side of the post until the 2.5 width is achieved. Use cutting coolant fluid(water) as needed.

II. Drilling Operation

1. While the piston post is still in that position, we will drill the main hole.
2. Place the edge finder in the spindle and zero the y-axis to the edge of the post. Make sure to account for the 0.1 inch radius of the edge finder.
3. Replace the edge finder with the 0.496 inch drill bit.
4. Set the x axis to 0.5 inches and the y-axis to 1.25 inches.

5. Put cutting fluid on the piston post and drill the hole in that location all the way through.

III. Drilling Operation

1. Remove from the clamped flywheel post and turn so that the thin side, bottom of the piston post is facing upwards.
2. Clamp the piston post on the vise and secure.
3. Switch the drill bit with the edge finder.
4. Zero the x and y axis to the edge of the piston post using the edge finder.
5. Move 0.38 inches along x-axis and .125 along the y-axis.
6. Place cutting oil on surface.
7. Replace edge finder with .136 drill bit. Set the z-axis to be 0 at the face of the piston post.
8. Drill blind hole 0.4 inches in depth.
9. Move to 2.13 inches from the edge along the x-axis. Stay at the same y-axis location.
10. Set the z-axis to be 0 at the face of the piston post.
11. Drill blind hole 0.4 inches in depth.

Piston Housing Part Fabrication Steps

Tools Needed: Turning tool, chamfer tool, cutting fluid (oil), micrometer, measuring caliper, drill chuck, 0.623 drill bit, 0.625 reamer, 0.25 drill bit, 0.125 endmill, 0.14 drill bit, edge finder, cutting fluid(water)

Lathe Operation:

I. Turning and Facing:

1. Check tool post for parallelism and check that it is secure to compound
2. Check cutting tool for insert
3. Check that cutting tool insert holder is properly seated in the tool post holder
4. Adjust tool to cut to center
5. Clamp round stock in the 3 jaw chuck securely
6. Set speed to 685 RPM
7. Measure the length of the round stock using calipers.
8. Zero the z-axis and face until the stock is smooth and the length of the entire piston housing is 1.90 inches.
9. Zero the x-axis and measure the diameter of the stock using the calipers.
10. Turn the stock until the halfway point of the material along the x-axis is reached. Turn until the diameter of the stock is 0.73 inches.
11. Use cutting fluid throughout this process to minimize heat.
12. Flip the stock material inside the 3-jaw chuck and repeat the process to reduce the diameter of the stock to 0.73 inch in thickness.

II. Drilling

1. While the piston housing is still in the 3-jaw chuck, place the .623 drill bit into the tailstock drill chuck.
2. Tighten the .623 drill bit and bring the entire tailstock close to the piston housing.
3. Mark the drill bit to a depth of 1.188 inches.
4. Turn on the lathe at 685 rpm and drill a blind hole into the center of the piston housing until the mark on the drill bit is reached. Do not go further than that marking. Use plenty of cutting fluid.
5. Replace the 0.623 drill bit with the 0.625 reamer.
6. Turn on the lathe and ream the inside of the piston housing until it reaches the end of the blind hole. Use plenty of cutting fluid.
7. Turn off lathe and flip the piston housing inside the 3-jaw chuck to the other side.
8. Replace the 0.625 drill bit with the 0.25 drill bit. Secure well.
9. Turn on the lathe and drill a through hole until it breaks into the other side.

10. Use plenty of cutting fluid.

Vertical Mill Operations

1. Check part dimensions
2. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
3. Place parallels on the sides of the clamping device to raise the piston housing higher; ensure top of the piston housing is above the parallels and clamping device.
4. Secure piston housing on top of the parallels and in the clamping device.
5. Zero the x-axis to the edge of the post. Make sure to account for the 0.1 inch radius of the edge finder.
6. Replace edge finder with .125 endmill and set speed to 700 RPM.
7. End Mill top of the piston housing until the 0.75 length is achieved. Use cutting coolant fluid(water) as needed.
8. Replace the endmill with the 0.14 inch drill bit. Place the drill 0.36 inches away from the zeroed edge.
9. Place cutting oil on the part. Zero the z-axis to the flat end-milled surface.
10. Set the drill speed to 600 RPM.
11. Drill the hole .15 inches in depth along the z-axis. Do not cut all the way through.

Piston
Part Fabrication Steps

Tools Needed: edge finder, drill chuck, cutting fluid (oil), micrometer, 0.125 drill bit

Vertical Mill Operations

12. Check part dimensions
13. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
14. Place parallels on the sides of the clamping device to raise the piston higher.
15. Secure piston on parallels and in the clamping device.
16. Zero the x-axis to the edge of the piston. Make sure to account for the 0.1 inch radius of the edge finder.
17. Zero the y-axis to the edge of the piston. Make sure to account for the 0.1 inch radius of the edge finder.
18. Replace edge finder with .125 drill bit and set speed to 700 RPM.
19. Place cutting oil on top of the drilling area.
20. Move the drill bit .13 inches along the x-axis and down along the y-axis .31 inches.
21. Drill the hole all the way through.

Base Part Fabrication Steps

Tools Needed: edge finder, drill chuck, cutting fluid (oil), micrometer, .13 drill bit

Vertical Mill Operations

1. Check part dimensions
2. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
3. Place parallels on the sides of the clamping device to raise the piston higher, so that the thru holes can go all the way through.
4. Secure base on parallels and in the clamping device.
5. Zero the x-axis to the edge of the base. Make sure to account for the 0.1 inch radius of the edge finder.
6. Zero the y-axis to the edge of the base. Make sure to account for the 0.1 inch radius of the edge finder.
7. Set the spindle speed to 700 RPM.
8. Replace the edge finder with a .13 inch drill bit.
9. Move along the x-axis 2.21 inches and along the y-axis 0.44 inches.
10. Drill the thru hole using cutting fluid
11. Move along the x-axis to 6.27 inches at the same y-axis position.
12. Drill the thru hole using cutting fluid
13. Move along the y-axis down 2.19 inches at the same x-position.
14. Drill the thru hole using cutting fluid
15. Move along the x-axis back to 2.21 inches at the same y-position.
16. Drill the thru hole using cutting fluid

Piston Post Part Fabrication Steps

Tools Needed: edge finder, drill chuck, cutting fluid (oil), micrometer, .177 drill bit, .201 drill bit

Vertical Mill Operations

1. Check part dimensions
2. Place edge finder into the spindle and secure using the break at the top left corner of the machine.
3. Place parallels on the sides of the clamping device to raise the piston higher, so that the thru holes can go all the way through.
4. Secure piston post on parallels and in the clamping device.
5. Zero the x-axis to the edge of the piston post. Make sure to account for the 0.1 inch radius of the edge finder.
6. Zero the y-axis to the edge of the piston post. Make sure to account for the 0.1 inch radius of the edge finder.
7. Set the spindle speed to 700 RPM.
8. Replace the edge finder with a .177 inch drill bit.
9. Move along the x-axis 0.5 inches and along the y-axis 1.50 inches.
10. Drill the thru hole using cutting fluid
11. Move along the x-axis to 2.095 inches and 0.23 along the y-axis.
12. Drill the thru hole using cutting fluid
13. Move along the x-axis down 2.47 inches and 0.23 along the y-axis.
14. Drill the thru hole using cutting fluid
15. Replace the .177 drill bit with a .201 inch drill bit.
16. Move along the x-axis 0.69 inches and 0.53 along the y-axis.
17. Drill the thru hole using cutting fluid
18. Move along the x-axis 0.315 inches and 0.53 along the y-axis.
19. Drill the thru hole using cutting fluid