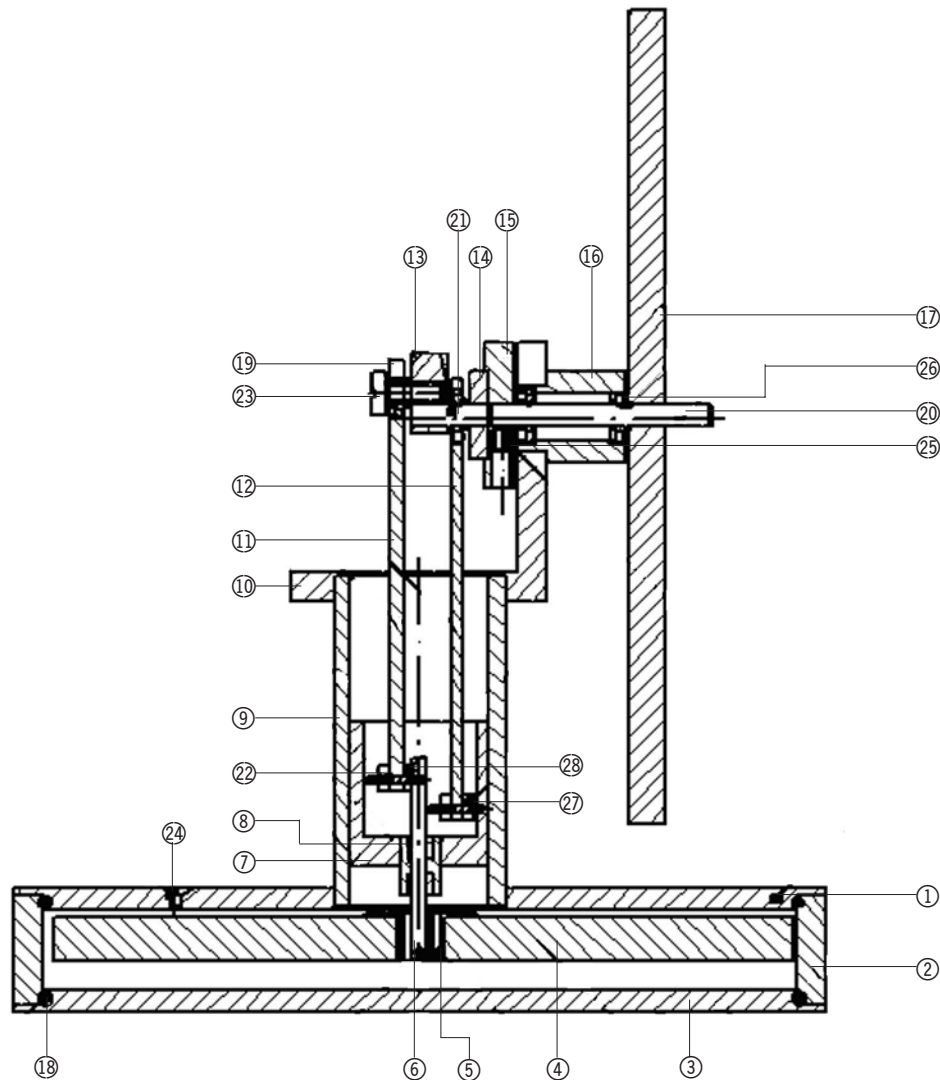


## Low-temperature Stirling motor kit U10061

### Instruction sheet

08/05 ALF



- |                    |                        |                      |                            |
|--------------------|------------------------|----------------------|----------------------------|
| ① Top plate        | ⑧ Main piston socket   | ⑮ Crank disc         | ⑳ Cylinder rods 1x8 (2x)   |
| ② Wall of housing  | ⑨ Main cylinder        | ⑯ Bearing socket     | ㉑ Cylinder head screw M3x8 |
| ③ Bottom plate     | ⑩ Bracket              | ⑰ Flywheel           | ㉒ Countersunk screw M2x3   |
| ④ Displacer        | ⑪ Short connecting rod | ⑱ Gaskets (2x)       | ㉓ Threaded rod M2x5        |
| ⑤ Displacer socket | ⑫ Long connecting rod  | ⑲ Ball bearings (4x) | ㉔ Washers (6x)             |
| ⑥ Displacer rod    | ⑬ Crank face           | ⑳ Crankshaft         | ㉕ Wide clamping discs (3x) |
| ⑦ Main piston      | ⑭ Insert               | ㉑ Crankshaft journal | ㉖ Narrow clamping disc     |

The low-temperature Stirling motor demonstrates how a Stirling motor operates as well as the principles of its design.

## 1. Description, technical data

The low-temperature Stirling motor is set in motion even by the heat of the human hand. It only requires a temperature difference of 5°C between the ground and the top plate. The main cylinder is made of precision glass. The displacer cylinder and the flywheel are transparent acrylic so that the motion of the main piston, the displacer piston and the crank drive can all be seen clearly. The crankshaft and connecting rods have miniature precision bearings to minimise friction. Due to the matt black coating of the top plate, the Stirling motor can also be operated using solar power.

Speed:	80 rpm approx. at $\Delta T$ 10°C
Flywheel:	110 mm $\emptyset$
Dimensions:	138 mm x 110 mm $\emptyset$

## 2. Assembly instructions

### 2.1 Finishing

- All components with burred edges should have their burrs filed off using a flat or triangular file.
- File down the surfaces on any workpieces if desired.

### 2.2. Assembly

#### 2.2.1. Making a permanent assembly

- We recommend use of “UHU plus endfest 300”, “UHU plus schnellfest” or similar 2-component epoxy resin adhesive. In order to prevent damage to the coating of the top plate, avoid any contact with solvents. Owing to the differing expansion coefficients of the materials, do not allow any of the components to increase temperature during the hardening of the adhesive. Aluminium will contract much more on cooling than the glass cylinder, thus creating tension in the glass leading to a decrease in the internal diameter of the main cylinder or possibly even causing it to break. Glueing together to make the connections should generally be performed at a consistent temperature of approximately 20°C.
1. Glue the main cylinder ⑨ to the bracket ⑩ at room temperature, then glue it to the ① top plate.
  2. Fasten the bearings ⑱ inside the bearing socket ⑲. Force the ball race ⑱ onto the crankshaft ⑳ and apply a thin adhesive film to three points on its outer surface. Then push the ball race ⑱ into one of the two recesses of the bearing socket ⑲. Any surplus adhesive should be removed with a cloth soaked in white spirit. Always wipe towards the outside when

doing this to prevent adhesive penetrating into the bearings. From the other side push another ball race ⑲ onto the crankshaft ⑳ and proceed as before. To achieve best alignment of the two ball races ⑲ leave the crankshaft ⑳ in the same position until the adhesive has hardened.

3. Glue the insert ⑭ into its recess in the crank disc ⑮. Make sure that both surfaces being adhered are flush together. There is a marking on the outer surface of the insert ⑭. Align this marking along the transverse bore of the crank disc ⑮.
4. Next, glue the crank shaft journal ㉑ into the bore of the insert ⑭.
5. Glue cylinder rods ㉒ into the bore of the displacer rod ⑥ and the main piston ⑦. No adhesive residue whatever may remain on the running surfaces of the cylinder rods ㉒. Push the cylinder rods into the relevant bores till about 2 mm protrudes and apply a small amount of adhesive to the protruding end. Then push the cylinder rod ㉒ into its correct position and remove any surplus adhesive as above. Make sure the cylinder rod ㉒ of the main piston ⑦ is glued so that it is slightly recessed so that it does not damage the running surface of the main cylinder ⑨ later on.
6. When glueing the displacer socket ⑤ into the bore of the displacer ④ proceed as follows. Push the displacer rod ⑥ into the main piston’s socket ⑧ then push the main piston ⑦ into the main cylinder ⑨. Next, attach the displacer socket ⑤ to the displacer rod ⑥. Glue this into the bore of the displacer ④ and position the complete module on the underside of the displacer ④ so that the displacer ④ just touches the top plate ①. Leave these components in this position until the adhesive has fully hardened to ensure that the displacer ④ and top plate ① remain parallel.
7. Finally glue the bearing socket ⑲ into the bore of the bracket ⑩.

#### 2.2.2. Making a temporary assembly

1. Press the ball race ⑱ into the bore of the connecting rods ⑪ and ⑫. All the bearings are supplied without lubricant. To ensure that the bearings ⑱ run smoothly always use the supplied, semi-spherical washers ㉓ in the assembly. The spherical side of the washers ㉓ should face the ball bearing ⑱.
2. Push the first washer ㉓, the long connecting rod ⑫, the second washer ㉓ and the face of the crank ⑬ onto the crankshaft journal ㉑. The small marking on the edge of the crank face ⑬ should be to the right of the crankshaft journal ㉑ as seen in the diagram.
3. Push the first wide clamping disc ㉔, the long connecting rod ⑫ and the second wide clamping disc ㉔ onto the cylinder rod ㉒ of the main piston ⑦, having lubricated it slightly first. The diameter of the

clamping disc's 27 bore is greater on one side than the other so that it is easier to slide it onto the cylinder rod 22.

4. Slide the piston rod 7 into the main cylinder 9. **The main piston 7 moves inside the cylinder 9 with no lubrication so do not attempt to apply any lubricant!** The entire mechanism is also designed to run with no lubrication so that no lubricant is necessary.
5. Now attach the crank disc 15 with its threaded rod 25 to the crankshaft 20 having first inserted a washer 26. One more washer 26 and the flywheel 17 should now be slid onto the other side of the crankshaft 20, making sure that there is as little axial play as possible. If necessary, attach the flywheel 17 to the crankshaft 20 with a little bit of glue.
6. The narrow clamping disc 28, the short connecting rod 11, and the third wide clamping disc 27 are next to be slid onto the cylinder rod 22 of the displacer 6, having first applied a little lubricant. Then slide the displacer rod 6 into the main piston socket 8.
7. Now attach the short connecting rod 11 to the crank face 13 separated by a washer 26 using the cylinder head screw 23.
8. Carefully slide the displacer socket 5 onto the displacer rod 6, having first glued it into the displacer 4 itself.
9. Lay the O-ring gaskets 18 inside the bottom plate 3 and press them into the side of the housing 2 using constant, firm pressure. To make this easier, the O-ring gasket 18 can first be lubricated with some washing-up liquid.
10. Press the top plate 1 into the other side of the housing 2 in a similar way. This connection can be undone when necessary, by pushing a small wedge (e.g. a small screwdriver) between the top plate 1 and the housing 2. If necessary a small opening can be filed into the side of the housing 2 to make inserting the tool easier.

### 2.3. Fine adjustment

- Fine adjustment is required to ensure that there is only minimal separation between the displacer 4 and the top or bottom plate.

- After aligning the marking to the insert 14 and the crank face 13 the stroke of the displacer should be slightly too short. By turning the crank face 13 on the crankshaft journal a little bit it can be made longer (see exploded view, next page).
- Turning the flywheel 17 afterward forces the displacer socket 5 onto the displacer rod 6 when the displacer 4 meets the top plate 1.
- Make the stroke of the displacer long enough so that in one revolution the displacer 4 touches gently against both the top plate and the bottom plate.
- Then shorten the stroke very slightly by turning the crank face 13 back a tiny bit.
- The displacer 4 and the top or bottom plate should now be separated by a very small but even amount.
- Finally, turn the crankshaft 20 so that the main piston 7 is in the middle of its stroke. Then firmly screw the countersunk screw 24 into the top plate 1.

### 3. Test of functionality

- Place the Stirling motor on the palm of your hand or a surface that is heated, e.g. on top of a cup of hot water.
- After about 1-2 minutes the base plate should have heated up sufficiently. On hot days, the temperature difference may not be great enough. If so cool the top plate with a damp cloth.
- Spin the flywheel clockwise (looking towards the crankshaft).
- The Stirling motor rotates in an anti-clockwise direction when the top plate is heated, e.g. by sunlight or by a lamp. In this instance, place the Stirling motor on a cool surface such as a windowsill.

### 4. Storage and cleaning

- The Stirling motor requires no lubrication.
- Store the Stirling motor in a dust-free location.
- To clean the Stirling motor use a moist cloth, possibly with some mild soap. Never clean acrylic components using solvents or aggressive cleaning agents.

