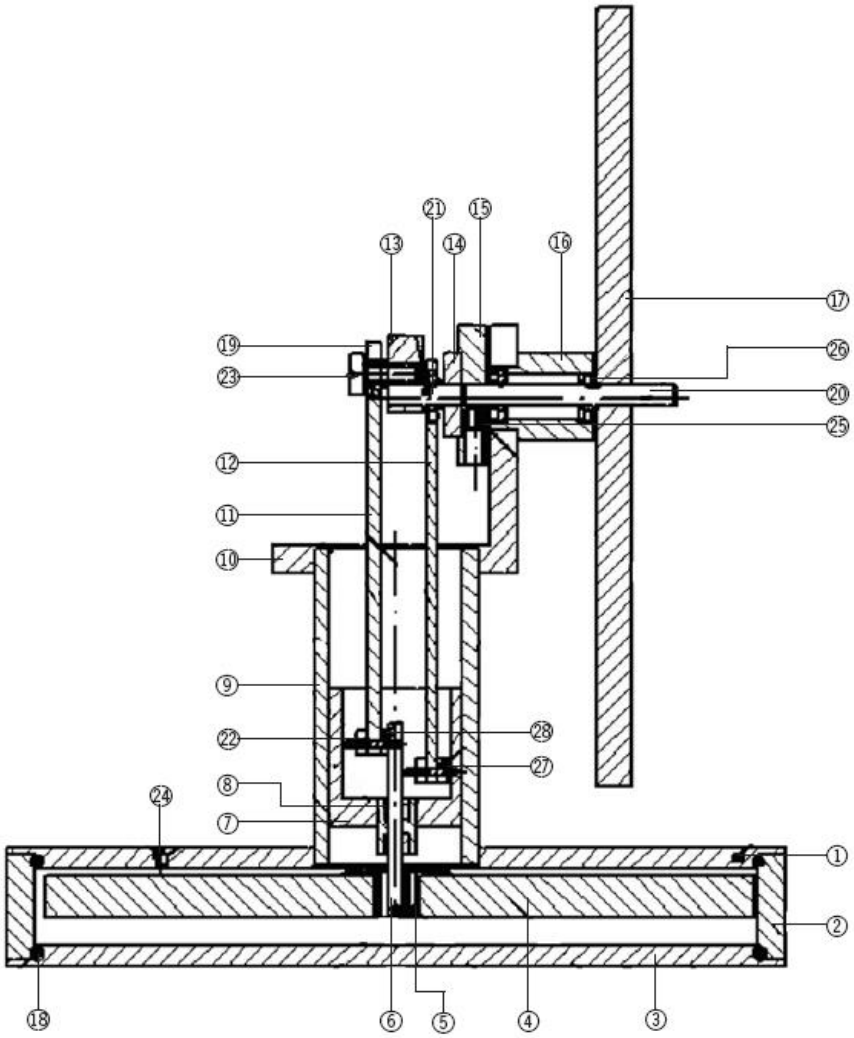
3B SCIENTIFIC® PHYSICS

Low-Temperature Stirling Engine, Kit 1002599

Instruction sheet

05/18 SD



1 Top plate
2 Housing ring
3 Bottom plate
4 Displacer
5 Displacer bushing
6 Displacer rod
7 Operating piston
8 Operating piston bushing
9 Operating cylinder
10 Elbow joint
11 Connecting rod, short
12 Connecting rod, long
13 Crank disc A
14 Insert
15 Crank disc B
16 Bearing bush
17 Flywheel
18 O-Ring (2x)
19 Ball bearing (4x)
20 Crankshaft
21 Crank pin
22 Cylindrical pin 1x8 (2x)
23 Cheese-head screw M3x8
24 Flat-head screw M2x3
25 Threaded pin M2x5
26 Shim (6x)
27 Adjusting collar, wide (3x)
28 Adjusting collar, thin

1. Description

This low-temperature model is used to demonstrate the operation and basic design of a Stirling engine.

The low-temperature Stirling engine can be powered by the warmth of the human hand alone. It only requires a temperature difference of about 5°C between the bottom and top plates.

The operating cylinder consists of precision glass, while the displacement cylinder and flywheel are made of acrylic glass. This allows the movement of the operating piston, displacement piston and crank mechanism to be observed clearly. The crankshaft and connecting rod are furnished with high-precision miniature ball bearings in order to minimize losses due to friction.

The matt black coating of the top plate also allows the Stirling engine to run on solar energy.

2. Technical data

Speed:	approx. 80 rmp at ΔT 10ºC
Flywheel:	110 mm diam.
Dimensions:	138 mm x 110 mm diam.

3. Mounting instructions

3.1 Finishing

- Deburr all units with a smoothing file or a scraper.
- If you like, polish the aluminium parts.

3.2 Mounting

3.2.1 Gluing

We recommend to use 2-component epoxy resin glues. To avoid the destruction of the coating of the top plate, do not use any solvents. Due to the different expansion coefficient of the material, do not at all warm these units during thermosetting. The aluminium units would shrink far more than the glass cylinder exerting tension on it – and so the inner diameter of the operating cylinder would shrink or it can even break. Basically the connections should be glued at approx. 20° C.

- 1. Glue the operating cylinder (9) at room temperature to the elbow joint (10) and then to the top plate (1).
- 2. Fasten the ball bearing (19) in the bearing bush (16). For this shift a ball bearing (19) onto the crankshaft (20) and furnish on 2-3 points the surface with a thin glue film. Push the ball bearing (19) in one of the two windings of the bearing bush (16). Clean the remaining glue if applicable with a cloth soaked in ethyl alcohol (spirit). Thereby wipe implicitly from the inside outwards to avoid getting glue into the ball bearing. From the other side shift the second ball bearing (19) on the crankshaft (20) and continue as before. To get the optimal axial direction of the two ball bearings (19) leave the crankshaft (20) in this position until the glue is hardened.
- 3. Glue the insert (14) in the gap of the crank disc B (15). Pay attention that the two surfaces lie planar one on the other. On the peripheral surface of the insert (14) is a marker. This marker should align with the cross-hole of the crank disc B (15).
- 4. Now glue the crank pin (21) into the drill hole of the insert (14).
- 5. Glue one cylindrical pin (22) each in the drill hole of the displacer rod (6) and the operating piston (7). Attention: keep the faces of the cylindrical pin (22) free from glue. Therefore bring the cylindrical pin up to approx. 2 mm in the according drill hole and put some glue on the protruding end. Next push the cylindrical pin (22) in the designated position and remove the remaining glue as described above. Pay attention that the cylindrical pin (22) of the operating piston (7) should be glued slightly counter-sunk, so that the tread of the operating cylinder (9) will not be damaged later.
- 6. By bonding the displacer bushing (5) into the drill hole of the displacer (4) proceed as follows. Push the displacer rod (6) into the operating piston bushing (8) and then the operating piston (7) into the operating cylinder (9). Now plug the displacer bushing (5) on the displacer rod (6). Glue this into the drill hole of the displacer (4) and place this module on the bottom side of the displacer (4) so that top plate (1) and displacer (4) get in touch. Leave these units in this position until the glue is totally hardened, to assure the parallelism between displacer (4) and top plate (1).
- 7. Finally glue the bearing bush (16) into the drill hole of the elbow joint (10).

3.2.2 Mounting

- 1. Press the ball bearing (19) into the drill holes of the connecting rods (11) and (12). All ball bearings are unlubricated for delivery. To provide a free run for the ball bearing (19), always use the delivered, slightly convex shims (26). Thereby mount the convex side of the shim (26) turned to the ball bearing (19).

- 2. Shift the first shim (26), the long connecting rod (12), the second shim (26) as well as the crank disc A (13) onto the crank pin (21). The small marker on the peripheral surface of the crank disc A (13) should stand to the right from the crank pin (21). This marker should be aligned with the marker on the insert (14).
- 3. Then shift the first wide adjusting collar (27), the long connecting rod (12) as well as the second wide adjusting collar (27) onto the lubricated cylindrical pin (22) of the operating piston (7). The diameter of the drill hole of the wide adjusting collar (27) is on one side slightly larger and so it is easier to shift it on the cylindrical pin (22).
- 4. Insert the operating piston (7) into the operating cylinder (9). The operating piston (7) runs dry in the operating cylinder (9) i.e. lubricate in no case! Also the whole mechanic system runs dry and does not need greasing.
- 5. Now fasten the crank disc B (15) with the threaded pin (25) on the crankshaft (20) where the shim (26) was put before. Put another shim (26) and the flywheel (17) on the other side of the crank shaft (20) but leave a minimal axial clearance. Fix the flywheel (17) with some glue on the crankshaft, if necessary (20).
- 6. Push the thin adjusting collar (28), the short connecting rod (11), as well as the third wide adjusting collar (27) onto the lubricated cylindrical pin (22) of the displacer rod (6) and insert the displacer rod (6) into the operating piston bushing (8).
- 7. Now fasten the short connecting rod (11) with the cheese-head screw (23) on the crank disc A (13) while using the shims (26).
- 8. Carefully push the displacer bushing (5) glued into the displacer (4) onto the displacer rod (6).
- 9. Put the O-ring (18) into the bottom plate (3) and press it under constant strong pressure in the housing ring (2). To facilitate this procedure you can embalm the O-ring (18) with some washing-up liquid before.
- 10. Press the top plate (1) from the other side in the same way to the housing ring (2). To dismantle this connection (if needed) push a thin wedge (e.g. screwdriver) between top plate (1) and housing ring (2). If necessary you can rasp a small gap in the frontal area of the housing ring (2) to facilitate the entering of this tool.

3.3 Adjusting

The objective of the adjustment is to get a full stroke of the displacer (4) with only a minimal gap left between displacer and top- and bottom plate (1, 3) respectively.

- 1. After aligning the markers on the insert (14) and the crank disc A (13) the stroke of the displacer is still too small. It can be enlarged by slightly turning the crank disc A (13) on the crank pin (21) (refer to exploded drawing).
- 2. Then carefully rotate the flywheel (17). Doing this the displacer rod (6) will be shifted in the displacer bushing (5).
- 3. Increase the stroke of the displacer (4) so much that by one turn the displacer (4) hits the top- and the bottom plate lighty.
- 4. After this rewind the crank disc A (13) a little bit.

Now a minimal gap should be established between displacer (4) and top- and bottom plate (1, 3) respectively.

- 5. Finally turn the crankshaft (20) so that the operating piston (7) is located in the middle of the housing. Then screw the flat-head screw (24) firmly into the top plate (1).

4. Testing

- Place the Stirling engine on your hand or any other warm surface, e.g. on a cup with hot water.
- The bottom plate will heat up sufficiently after 1 or 2 minutes. In warm weather, the temperature difference might prove too small, in which case the top plate would need to be cooled with a moist cloth.
- Set the flywheel in clockwise motion (relative to the front end of the crankshaft).

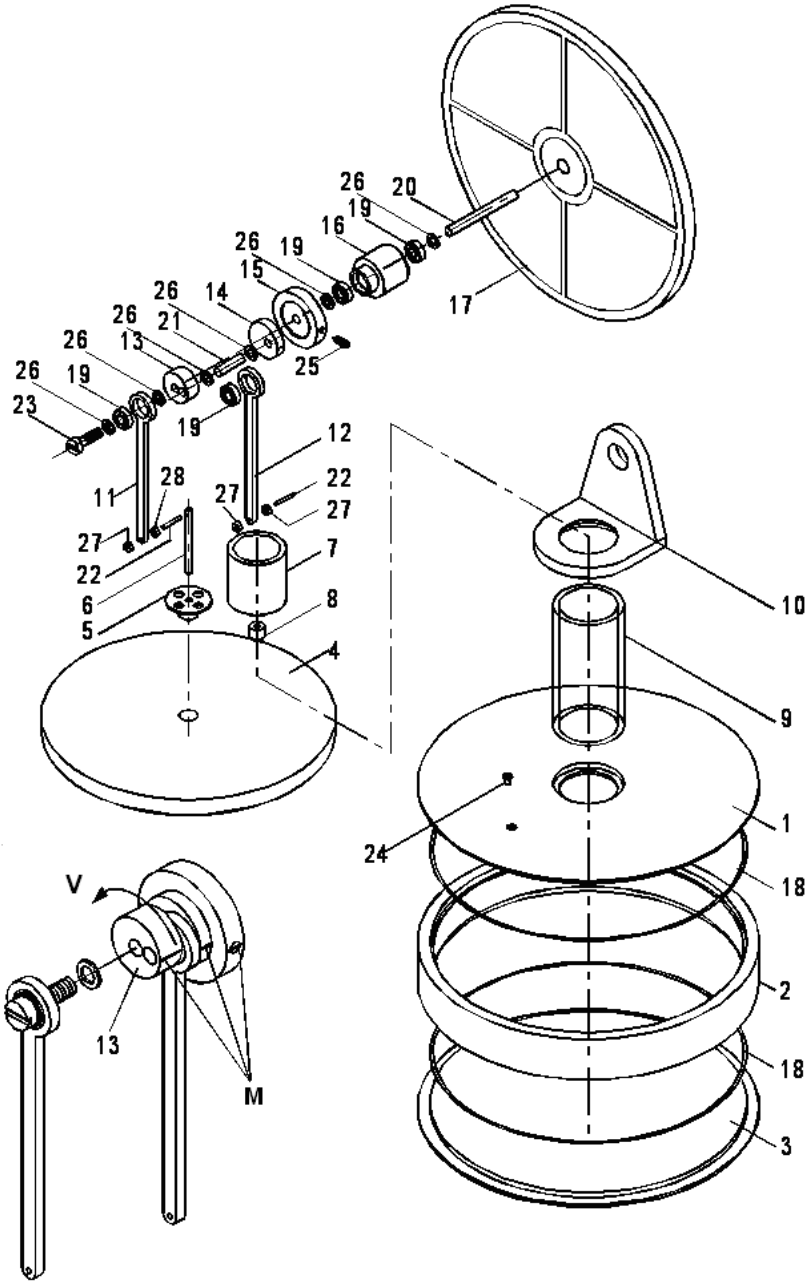
The Stirling engine will turn anti-clockwise if the top plate heats up, for instance, through solar radiation or warmth emanated by a lamp.

- For this purpose, place the engine on a cool surface such as a window sill

5. Care and maintenance

The Stirling engine does not need any lubrication.

- Avoid exposure of the device to dust.
- To clean the Stirling engine use a wet cloth with dish washing liquid, if necessary.
- Never clean the acrylic glass pieces with solvent or any aggressive cleaning agent.



Exploded drawing
V: Stroke increase, M: Markers