UNITED SCIENTIFIC SUPPLIES, INC.

OPERATING INSTRUCTIONS AND ACTIVITY GUIDE

LOW TEMPERATURE DIFFERENCE STIRLING ENGINE

LTDSE1

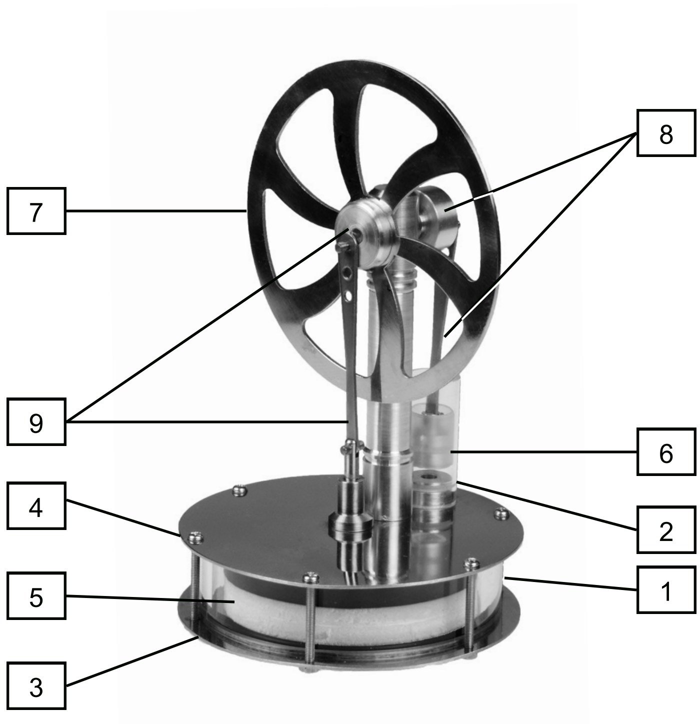

Figure 1

DESCRIPTION

The Low Temperature Difference Stirling Engine is a closed cycle regenerative heat engine that inter-converts heat and mechanical energy using temperature differences less than 100°C. It is "closed cycle" because the working fluid—air—is permanently enclosed in the engine, and it is "regenerative" because a portion of the heat discarded in one cycle is saved for use in the next cycle. It also qualifies as an external combustion engine, since the heat source to maintain the temperature difference is outside the engine.

The engine is shown in *Figure 1*. The air is enclosed in a pair of connected cylinders, the displacement cylinder (1) and the compression cylinder (2). The displacement cylinder has two metal end plates (3 & 4) which are held at different temperatures to operate the engine. Inside the displacement cylinder is a loosely fitting piston (5) that moves air between the end plates and stores heat. Inside the compression cylinder is a tightly fitting power piston (6) that compresses the air in the cylinders and drives the flywheel (7) through a connecting rod and eccentric wheel (8). A second connecting rod and wheel (9) drives the displacement piston and maintains the correct relationship between the positions of the two pistons.

OPERATING INSTRUCTIONS

THEORETICAL BACKGROUND

The Stirling engine was invented and patented in 1816 by Robert Stirling, a Scottish clergyman, with the help of his engineer brother James. Stirling was searching for a safer alterative to the steam engines of his time, whose boilers were liable to explode from excessive steam pressure.

The Stirling engine, like other heat engines, moves a working fluid around a pressure and temperature cycle to convert heat energy into mechanical work. But unlike many other designs, it can also convert mechanical energy into heat. When used this way, it is usually referred to as a heat pump.

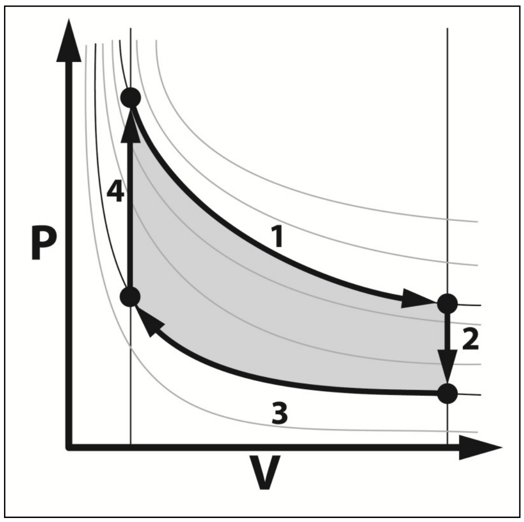

Figure 2

Figure 2 shows an idealized pressure-volume diagram (pV diagram) for the gaseous working fluid in a Stirling engine, which is usually air.
Note that the product pV represents energy, as can be understood from a simple dimensional argument:

> The dimensions of pressure are [force]/[length]^2
> The dimensions of volume are [length]^3
> So the dimensions of pressure x volume are [force]x[length], which are the dimensions of energy.

An area on the pV diagram therefore represents an amount of energy, and moving a substance around a pressure-volume cycle that is represented by a closed area on the pV diagram will cause a certain amount of thermal energy to be expended or absorbed each cycle, depending on the sequence of events (clockwise or counterclockwise around the cycle.)

The curved lines on the pV diagram of *Figure 2* are isothermal lines—each line represents a pressure-volume curve for the engine's working fluid at a particular temperature. Lines higher up on the diagram are for higher temperatures, and lines lower down are for lower temperatures. Vertical lines on the diagram, changing pressure at constant volume, represent heating or cooling at a fixed volume. These lines are sometimes called *isochores*.