Sage Model Notes

SplitCycleCooler_RotaryDrive.scfn

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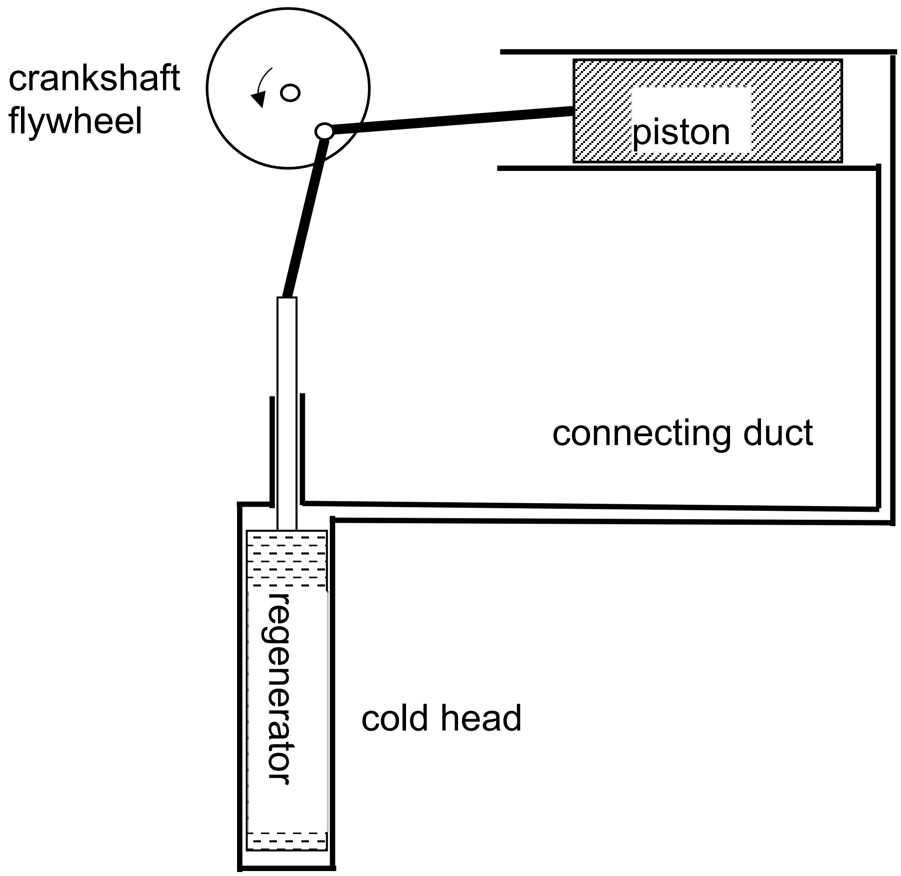
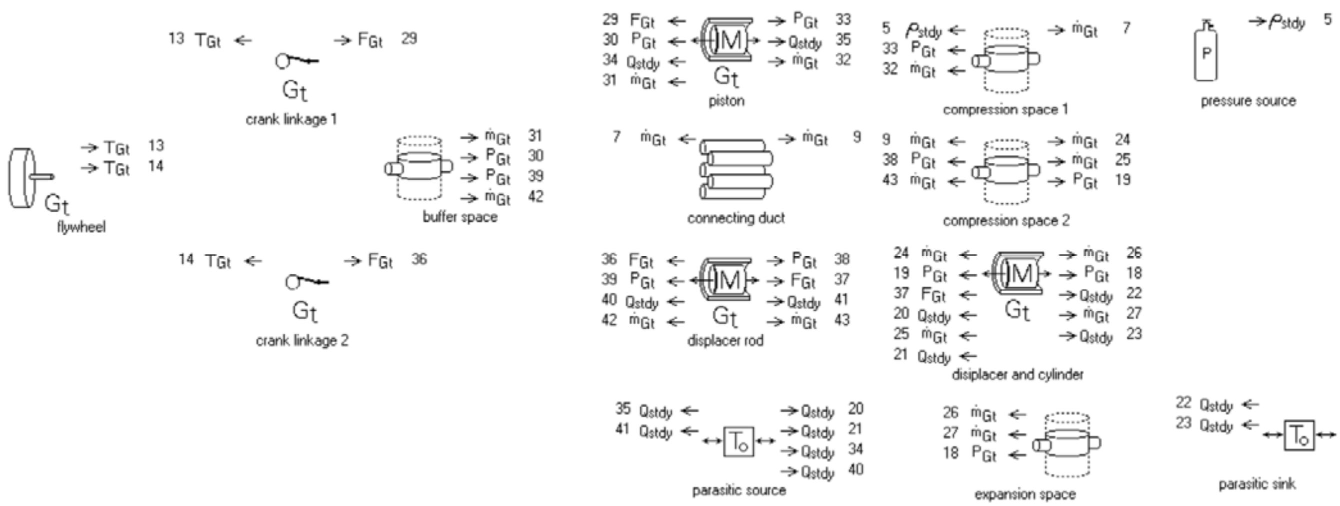
A model for a split-cycle stirling cooler with rotary drive linkages controlling piston and displacer motions:



This model derives from the **SplitCycleCooler.stl** model, except that instead of piston and displacer moving according to free-piston dynamics they are constrained by rotary drive components similar to the **AlphaEngineFlywheel.stl** model.

The root model is organized like this:



On the left is a flywheel connected to two linkage components with phase relationship defined by input variables. Linkage 1 connects to the *piston* reciprocating mass and linkage 2 connects to the *displacer rod* reciprocating mass, which in-turn connects to the displacer body reciprocating mass inside the *displacer and cylinder* component.

Compared to the original **SplitCycleCooler.stl** model there is a *buffer space*, representing the space in which the rotary drive components reside. Clearance seals in the *piston* and *displacer rod* components connect *compression space 1* and *compression space 2* gas domains to the *buffer space* gas domain.

Also new compared to the original **SplitCycleCooler.stl** model are root-level user-defined inputs for some of the important model dimensions:

```
XpAmp           piston amplitude (m)                        3.000E-03
XdAmp           displacer amplitude (m)                     3.000E-03
Dpis            piston cylinder ID (m)                      1.000E-02
Ddis            displacer cylinder ID (m)                   6.000E-03
Drod            displacer rod cylinder ID (m)               3.000E-03
```

Inputs for the two *crank linkages* and the *piston*, *displacer rod* and *displacer and cylinder* components are recast in terms of these. Two user-defined variables representing piston and displacer frontal areas are also defined for reference:

```
Apis            frontal area                                7.854E-05
  0.25*Pi*Sqr(Dpis)
Adis            frontal area                                2.827E-05
  0.25*Pi*Sqr(Ddis)
```

The mean volume inputs for the variable-volume spaces are recast in terms of the above user-defined variables to prevent negative volume errors when the inputs change. For example, in the *compression space 1* component the mean volume is recast to

```
Volume = 1.25 * XpAmp * Apis
```

The effect is to provide a minimum volume of 25% of the swept volume amplitude at piston top-dead-center.

Optimization

The model contains a rudimentary optimization specification. The objective is to maximize het cooling power *Qlift*, subject to compressor PV power equal to 10 W (*Wpv* = 10).

Optimized variables are piston and displacer diameters *Dpis* and *Ddis*.

The results are summarized by root-level user-defined outputs:

```
Qlift            net heat lift                                  7.179E-01
  QliftGross - QparaSink
Qrej             net heat rejection                             1.072E+01
  Qbuffer + Qduct + Qcs2 + QparaSource + QpisSeal + QrodSeal + QdisSeal
Wpv              net pv input                                   1.000E+01
  -(Wpis1 + Wpis2)
```

This optimization is intended as a starting point for more serious design optimizations.