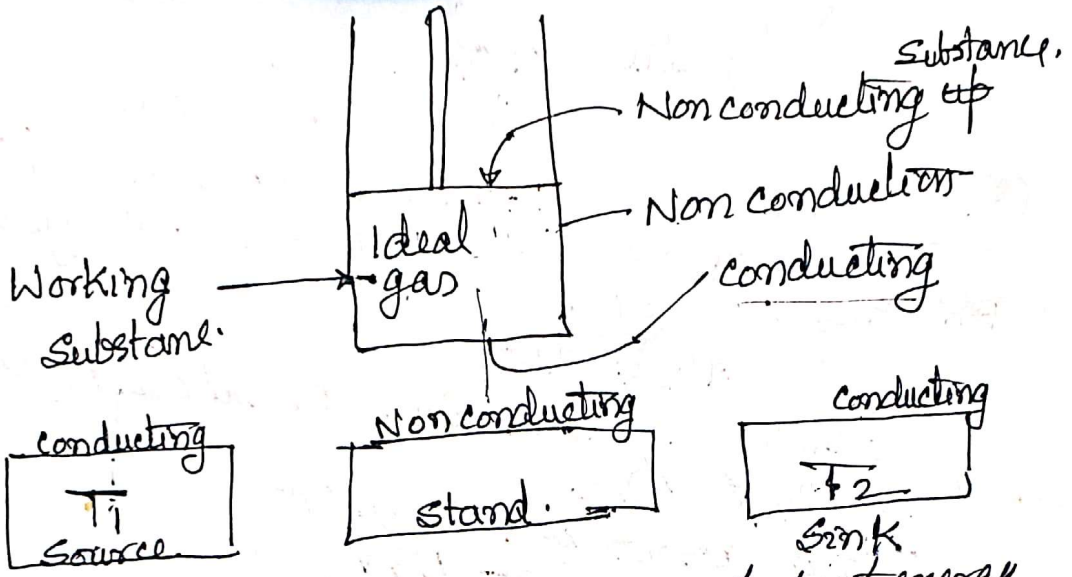
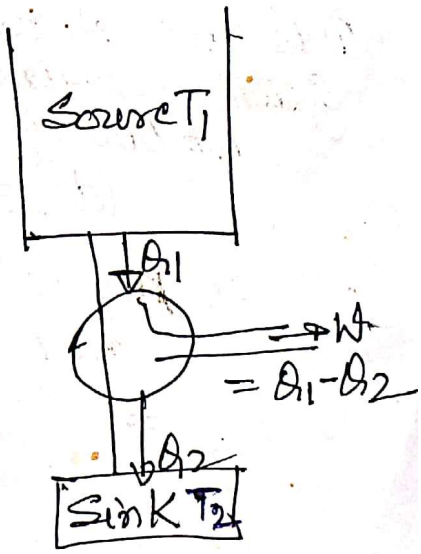


Engine is a device which converts heat energy into mechanical work. Carnot's engine consist of following parts

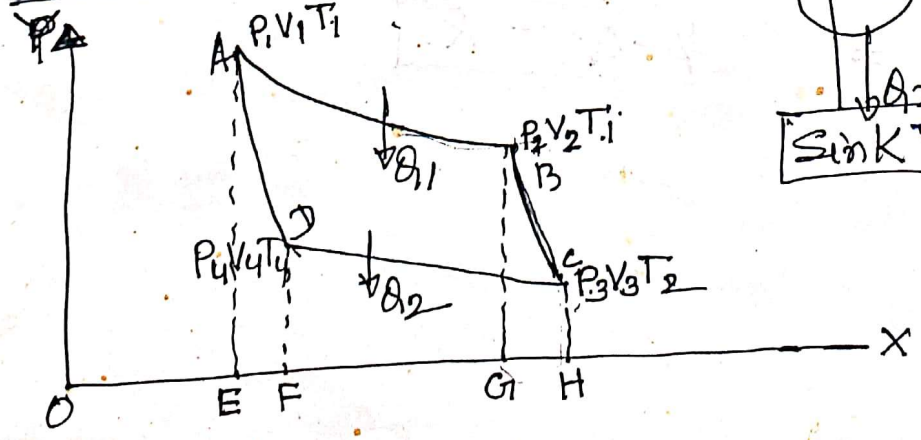
① Source :- It is a hot body at temp (T_1) which gives the heat energy to working substance.

② Sink :- It is a cold body at constant temp T_2 which receives the energy by working substance

③ Working Substance :- It is a substance in the form of fluid (liquid or gases) on which the engine performs its cyclic operation.



Working of Carnot's engine



Working or carnot cycle:-

① At first the working substance is kept at the source of temp T_1 and gas is expanded isothermally from state P_1V_1 to state P_2V_2

The ~~working~~ Work done by the gas.

$$W_1 = \int_{V_1}^{V_2} P dV = RT_1 \text{Log} \frac{V_2}{V_1}$$

$$Q_1 = \text{Area ABGE}$$

② The engine is placed on the insulated stand. It is expanded adiabatically to the Pressure P_3 & Volume V_3

The workdon in adiabatic expansion

$$W_2 = \frac{R(T_1 - T_2)}{\gamma - 1}$$

$$= \text{Area (BCHG)}$$

③ The engine is placed on the sink T_2 and it is compressed isothermally to the pressure P_4 & Volume V_4. The workdone

$$W_3 = \int_{V_3}^{V_4} P dV = -RT_2 \text{Log} \frac{V_4}{V_3}$$

$$\text{or, } Q_2 = -RT_2 \text{Log} \frac{V_4}{V_3} = \text{Area (CDEH)}$$

④ Finally the engine is placed on the insulating stand and compressed adiabatically to pressure P_1 and Volume V_1. Workdone:

$$W_4 = -R\left[\frac{T_1 - T_2}{\gamma - 1}\right]$$

$$= \text{Arcared (DAcd)}.$$

The total Workdone by the engine.

$$W = W_1 + W_2 + W_3 + W_4$$

$$\text{or, } W = RT_1 \log\frac{V_2}{V_1} + \frac{R(T_1-T_2)}{\gamma-1} - RT_2 \log V_3/V_4 \ldots$$

$$- \frac{R(T_1-T_2)}{\gamma-1}$$

$$W = RT_1 \log\frac{V_2}{V_1} - RT_2 \log V_3/V_4$$

$$= Q_1 - Q_2 \qquad \text{(A)}$$

Efficiency of the engine.

$$\eta = \frac{W}{Q_1} = \frac{RT_1 \log\frac{V_2}{V_1} - RT_2 \log V_3/V_4}{RT_1 \log V_2/V_1}$$

$$\eta = 1 - \frac{T_2}{T_1} \cdot \log V_3/V_4 / \log(V_2/V_1)$$

$\because \log V_3/V_4 = \log V_2/V_1$ adiabatically Process.

$$\therefore \boxed{\eta = \left(1 - \frac{T_2}{T_1}\right)\%} \qquad \text{(B)}$$

In general, $\eta = 1 - Q_2/Q_1$

$$1 - T_2/T_1 = 1 - Q_2/Q_1$$

$$\Rightarrow \boxed{\frac{Q_1}{Q_2} = \frac{T_2}{T_1}} \qquad \text{(C)}$$