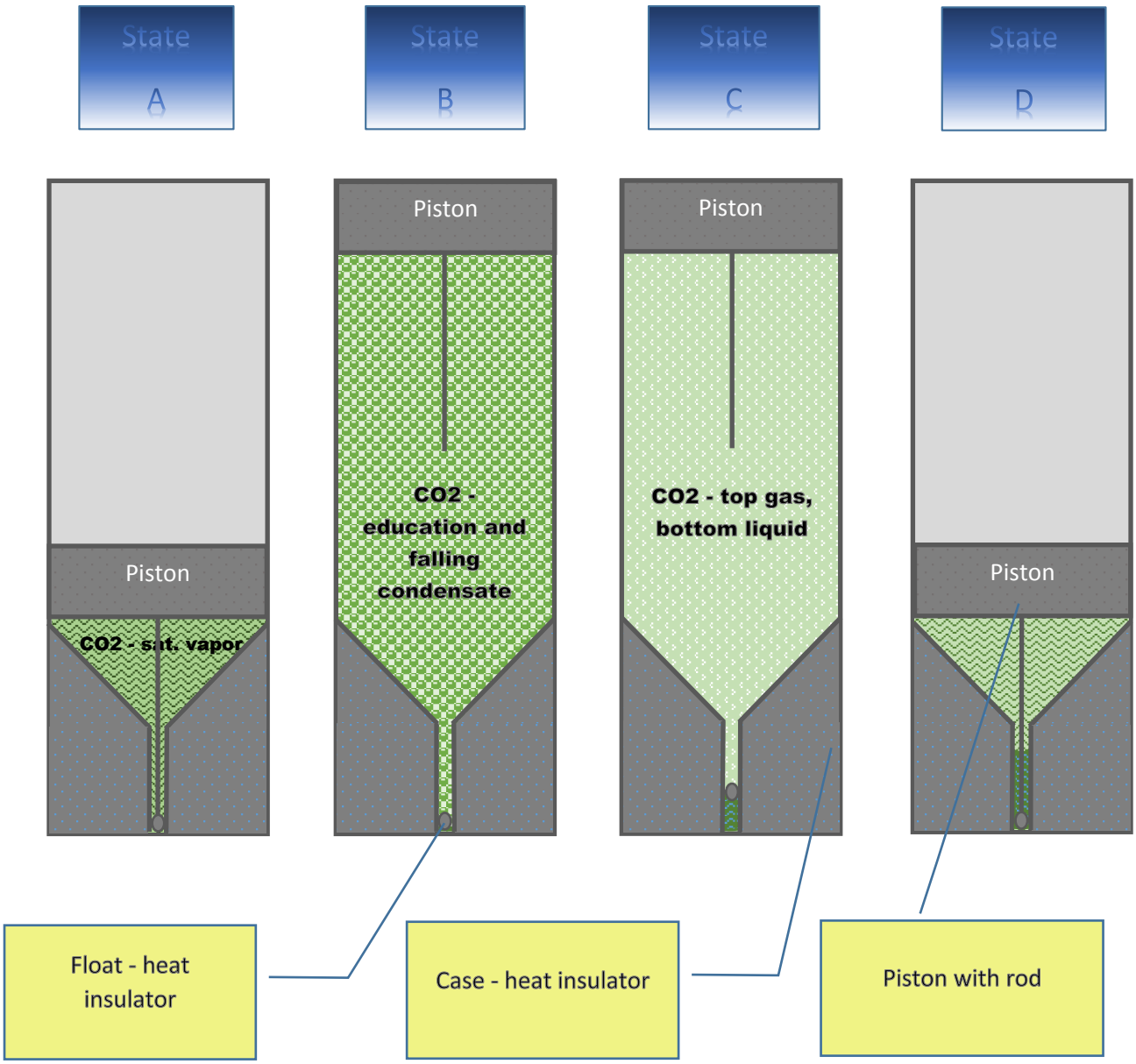
Dedicated to my grandfather, Kutin Gennady Ivanovich

Energy source: evaporation – condensation

Consider the adiabatic expansion and compression of the vapor of carbon dioxide inside a sealed cylinder the piston through the states of A – B – C – D, fig. 1. The cylinder and piston are made of a thermally insulating material. The cylinder has in its lower part, the inner surface narrowing like a funnel with a spout.

When adiabatic expansion of carbon dioxide (Fig. 1, state A – B) portion of the molecules pass into the liquid phase due to the strong cooling of the gaseous medium.

Fig. 1



Formed by condensate of carbon dioxide in the adiabatic expansion under the force of gravity will be collected in the narrow neck of the funnel (Fig. 1, state B).

In the neck of the funnel on the surface of the liquid phase floats float – a thermal insulator with a density less than the density condensate of carbon dioxide. The purpose of the float – to prevent heat transfer between condensate and steam to carbon dioxide as long as the piston is returned to its original state.

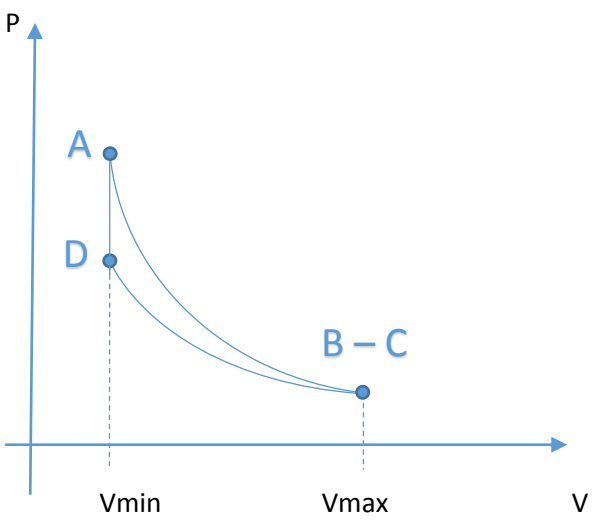
When the piston moves down (fig. 1, C - D) some of the gas penetrates into the condensate through the gap between the thermal isolator float and the body thermal isolator and condensed.

Rod connected to the piston when the piston returning to the initial state, moves the float to the lower funnel neck portion, and thereby discloses a process for heat exchange between vapor carbon dioxide and condensate carbon dioxide. (Fig. 1 , state D). During this exchange heat of the carbon dioxide condensate returns to a gaseous state, and the temperature of the gas is equal to the original, the system "piston – cylinder" is returned to its original state as a closed system (Fig. 1, state A).

Evaporation and condensation of carbon dioxide can be a source of energy to the consumer, as a result, formation of a differential pressure under the piston for full its progressive – relapsing course A – B – C – D, fig. 2. If a consumer receives a value of useful work, the internal energy of the "cylinder – piston" reduced by the value of the work. This decrease can be filled heat exchange system "piston – cylinder" with the environment.

Useful work that can take the consumer is equal to area of the figure A – B – C – D – A excluding the costs of energy to overcome the forces of friction and heat losses.

Fig. 2



Calculation of the pressure difference.

For insulated systems under the piston with the volume Vmin (see Fig. 2, we have an initial capacity is finite: Vmin) enthalpy is equal to:

$$H = U + P \times Vmin, \quad (1)$$

here: H – enthalpy of the system, J.; U – internal energy of the system, J.; P × Vmin – work that can produce piston, displacing volume Vmin in an equilibrium system, J.

In the transition the piston from the state A to the D through of the B and C, the kinetic energy of the piston is absorbed by the inelastic impact the float, taking into account the thermal protection system and the lack the transfer of useful work to the consumer, then the increase enthalpy (Δ - is increase):

$$\Delta H = 0 \quad (2)$$

$$\Delta U + \Delta P \times Vmin = 0 \quad (3)$$

As condensation occurs with the release of heat of condensation (Qcond.):

$$\Delta U = Qcond. \quad (4)$$

Rewrite (3) with (4):

$$Qcond. + \Delta P \times Vmin = 0 \quad (5)$$

We obtain:

$$\Delta P = - Qcond. / Vmin, \quad (6)$$

here: Qkond. – Heat of condensation, J.; Vmin – the initial and final volume of the space below the piston per cycle A – B – C – D, ΔP – pressure difference between states A and D.

Conclusion: the change in pressure due to condensation of the gaseous medium in an adiabatic expansion process equals a negative sign to the heat of the condensation of the gaseous medium divided by the volume.