The Recycled Condensed Streams Return to Boiler
EFFICIENT VAPOR (STEAM) ENGINE/PUMP IN A CLOSED SYSTEM USED AT LOW TEMPERATURES AS A BETTER STIRLING HEAT ENGINE/REFRIGERATOR

I. CROSS-REFERENCE TO RELATED APPLICATIONS


II. FIELD OF PRACTICE

[0002] The present disclosure pertains to the field of Shiao’s vapor (steam) engine/pump for generating power at lower temperatures by using either water or liquefied gases as a working fluid via a closed system. Particularly, the present disclosure relates to a closed system steam engine process that will not discharge hazardous waste stream into the heat sink, which is useful for nuclear steam engine modifications.

III. BACKGROUND

[0003] In recent years, conventional steam engine, air conditioner, and refrigerator systems have demanded higher efficiency, and also higher power producing design requirements. The conventional closed Stirling engine runs at low pressure and generates low power. If a Stirling engine could produce higher power, a piston would contain higher pressure air in a closed space, resulting in a very difficult problem for mechanical sealing of moving parts.

[0004] A conventional steam engine typically operates at only about 30% efficiency, and conventional air conditioner and refrigerator systems require totally outside power to run their compressors, and thus cannot produce any valuable power.

[0005] Conventional air conditioner and refrigerator systems are considered heat pumps because they have similar process elements of a heat engine or a steam engine, though they are called by different names. The conventional heat pump runs its process in a counter clock-wise direction through four process elements (freezer→compressor→cooling condenser→expansion valve→back to freezer), which is the reverse direction of the conventional heat engine or steam engine process (combustion chamber (boiler)→turbines (piston engine)→cooling condenser→exhaustion pipe (or pump in the steam engine process)). Therefore, the heat engine process can generate power, but the heat pump process can only be run totally by the outside power through its compressor.

[0006] Typically, a conventional heat pump would not operate as a conventional heat engine simply by only reversing its process direction to generate power. This is because heat pump systems include a heat exchanger called the cooling condenser which a warm waste stream to be removed its heat from the useful working fluid. This cooling condenser uses a colder fluid pumped into the condenser performing the heat exchanging work. That cooling fluid is typically cold water because it is cheaper and easier to get, and its temperature is around room temperature both for the heat engine and heat pump processes.

[0007] If a heat pump were operated similar to the heat engine process by only reversing its operation direction, the temperature of the cooling fluid would be much lower than the waste stream if there were a cooling condenser in this process. In a conventional heat engine, the temperatures of the refrigerant and cooling fluid run much lower than room temperature, the cooling fluid will take much more outside power than a conventional heat engine can provide. There would be no net benefit to only reversing the processes’ operation directions without taking the condenser apart.

[0008] Therefore, since a cooling condenser extracts heat from the working fluid, there is no net benefit to just only reversing the operating direction from the conventional heat pump into a conventional heat engine process without taking cooling condenser apart. Efficiency would be enhanced by removing the cooling condenser from the heat engine/heat pump processes and adding a compressor/pump to substitute for the condenser. This would allow the heat pump to run the heat engine process by reversing its operation direction and generate power. Like a palm Stirling engine, the heat source is the body temperature. A temperature difference of only 7°F can provide enough energy to run the palm Stirling engine. The moving action of the palm Stirling engine’s piston generates work, a part of which is the work of the expansion. In accordance with the gas laws, the expansion itself cools down its working fluid’s temperature as an internal cooling condenser. (As in a cloud chamber, that excess expansion work causes the saturated steam to cool down, drop in temperature, and precipitate out from the vapor stream). An extra external condenser is not needed to do the same cooling job, since this excess expansion work is already done in the internal virtual condenser. 

[0009] For example: Suppose there is a tank of gasoline on top of a dry well. When the valve of the gasoline tank is opened, the gasoline starts to flow into the well. Suppose there are two processes: one is heat engine process (a combustion engine set at the bottom of the well), another one is heat pump process (an oil pump set at the bottom of the well). In order to keep the well dry and to separate two liquid levels, the heat engine process combusts inlet gasoline generating power and keeping the well dry at the same time. The heat pump process takes wall power for pumping the inlet useful gasoline out of the well, continuously keeping the well dry and fluid levels separated.

[0010] In another example, outside of a room, the temperature is high (100°F). Inside a freezer, temperature is low (−40°F). This defines an “energy well” having a top of 100°F and a bottom of −40°F. In order to keep the temperature levels separate and to keep this energy well’s inside temperature low, continuously there are two processes that can be used: a heat pump process ejects the incoming useful thermal energy out of the energy well by taking wall power and keeping the two temperature levels separated continuously, as in a refrigerator; a heat engine process uses the incoming useful thermal energy (100% of which represents 100 thermal units) and thereby generates electricity (which uses 30%, where 30 thermal units have been extracted out to generate electricity) Thus, the air has less thermal energy and a lower
temperature (left over from the remaining 70% or 70 thermal units left). This 70% energy left results into the colder air, which is needed in the refrigeration system and it generates 30 units of electricity at the same time. Wall power is not required to run a heat engine/pump process and to keep energy continuously flowing into the thermal energy well, and the heat engine/pump process generates useful electricity and colder air at the same time.

IV. SUMMARY

[0011] The present method and apparatus utilizes a large cross section area of a boiler's vapor outlet, and a much smaller cross-sectional area of a boiler's returning vapor inlet with check valves. The boiler's condensed phase returning piping is concurrently disposed into the boiler to let the vapor stream continuously flow-in and flow-out through a reciprocating (or V-type, or circular type) two-phase piston engine's expanding/compressing to generate power. By compressing vapor/pumping the liquid, the condensed phase may still take partial power at low temperatures. The condensed two-phase stream will be pushed back into a boiler, easily and immediately after the condensed phase goes back through check valves. At the same time, the two-phase piston/pump substitutes the cooling condenser position while using pushing power, expanding excessively, and cooling down the vapor phase as an implicit virtual condensing process, those complete this vapor (steam) engine cycle (which process may use refrigerants or liquefied gases as its working fluid) without discharging warm cooling water, thermal pollution, and radioactive pollution, which can be done by new nuclear power plants from major steam engine modifications.

[0012] An advantage of the present method and apparatus is a more efficient heat engine/pump process, with no need for a cooling condenser, and no waste thermal pollution. The present method and apparatus simply uses compressing power partially from the piston and pushing this used condensed phase stream back into the boiler through its much smaller passage and check valves.

[0013] Another advantage of the present method and apparatus is the flexibility of the heat engine process (without condenser). Liquefied gases (oxygen, nitrogen, or air) can be used as its working fluid for transferring energy and extracting work as with air conditioner and refrigerator systems, which can have more temperature gradient, less heat transferring surface area, shorter heat transfer time, and smaller heat exchanger size (i.e., a smaller boiler).

[0014] Another advantage of the present innovation is that in the boiler, the outside hot air blow to the boiler and supplies heat to the working fluid. After the outside air contacts the colder working fluid, the air's temperature will drop significantly to become cooler air, which can be used in a refrigeration system without taking wall power to run it.

[0015] Yet another advantage of the present boiler is that its return vapor inlet is much smaller than the boiler steam outlet cross section area and the returning condensed phase is concurrently piped into the boiler with check valves. In this way, compressing the condensed phase through a smaller passage takes power partially from the piston's main power, and more easily pushes the waste stream back into the boiler. The smaller passage compressing power is partially from the piston's main power, from which the compressing power is much less than the piston's main power, as expressed in the following relationship:

\[
\text{Piston force} = \frac{\text{Pressure}_{\text{cold}} \times \text{Area}_{\text{inlet}}}{\text{Pressure}_{\text{hot}} \times \text{Area}_{\text{outlet}}}
\]

[0016] The present embodiments represent a cyclic process, whose effect can generate power from the ambient temperature of a solar energy component. After heat is transferred, the system cools down the surrounding temperature to lower than room temperature (i.e., transfers heat energy into work from solar energy (by using liquefied gases (oxygen, nitrogen, or air) as its working fluid). In this way, the surrounding environment supplies heat by contact with the cold working fluid and the surrounding temperature cools down the fluid into lower than its room temperature, which could be used as an air conditioning system. Then, the present vapor engine process compresses the waste streams back into the boiler (a place of restoring heat), directly without discarding any waste heat into the heat sink as the thermal pollution or unexpected thermal load.

[0017] The present high efficiency vapor engine/pump process can use either water or liquefied gases for its working fluid by using (1) a slow-speed-balanced piston engine/ flywheel attached with a high ratio gear reducer to increase its generator's speed and meet its power generation requirements at 3,600 rpm, and (2) a two-phase pump to compress the waste gas and liquid phases back into the boiler through the smaller passage with check valves' controlling the flow direction.

[0018] The present embodiments provide improvements over conventional steam engines, air conditioner, and refrigerator systems. And the present two-phase pump can compress the low temperature condensed-stream directly back into the boiler without using a conventional cooling condenser, which takes out the latent heat from the system and loses its power efficiency.

[0019] The present vapor engine/pump process can allow the steam engine have over 50% efficiency, and can also let the air conditioner and refrigerator produce power with this high efficiency, which also use a smaller heat transfer surface area. This new vapor engine/pump process is a closed system and the vapor's pressure is as high as the steam engine's pressure. It is composed of a boiler and the (reciprocating, V-type, or circular) steam engine with suitable concurrent returning piping. It runs higher pressure and generates higher power than the low pressure, low power Stirling engine does.

[0020] The present vapor engine/pump process has a higher efficiency of over 50%, and can produce power and cool down surrounding’s temperature to lower than the room temperature. This powerful vapor engine/pump process can use either water or liquefied gases for its working fluid in a closed system at low temperatures without damaging the environment (no chemical leaking, no warm cooling water discharging, no thermal pollution, and no radioactive or hazardous waste). Therefore, it is recommended to be used in new nuclear power steam engine's modifications.

V. BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The present methods and apparatuses may take physical form in certain parts and arrangement of parts, embodiments of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:
FIG. 1 is a schematic diagram of the conventional heat engine process with its cooling condenser;

FIG. 1A is a thermodynamic diagram of the conventional heat engine process with its cooling condenser;

FIG. 2 is a schematic diagram of the conventional heat pump process with its cooling condenser;

FIG. 2A is a thermodynamic diagram of the conventional heat pump process with its cooling condenser;

FIG. 3 is a schematic diagram of the first stroke of the present vapor (steam) engine/pump process in a closed system with the two-phase running piston expansion process without the cooling condenser;

FIG. 3A is a thermodynamic diagram of the first stroke of the present vapor (steam) engine/pump process with the two-phase running piston expansion process without the cooling condenser;

FIG. 4 is a schematic diagram of the second stroke of the present vapor (steam) engine/pump process in a closed system with the two-phase running piston pumping process without the cooling condenser;

FIG. 4A is a thermodynamic diagram of the second stroke of the present vapor (steam) engine/pump process with the two-phase running piston pumping process without the cooling condenser;

FIG. 5 is a schematic diagram of the third stroke of the present vapor (steam) engine/pump process in a closed system with the two-phase returning streams through check valves process back into boiler without the cooling condenser;

FIG. 5A is a thermodynamic diagram of the third stroke of the present vapor (steam) engine/pump process with the two-phase returning streams through check valves process back into boiler without the cooling condenser;

FIG. 6 is a schematic diagram of the new two-phase, slow-running piston/ flywheel attached with a high ratio gear reducer to increase its generator's speed and meet its power generation requirements at 3,600 rpm; and the new contacting/grinding reaction high power DC generator.

VI. DETAILED DESCRIPTION

With reference now to FIGS. 1-2A, the conventional heat engine process includes a superheated steam boiler [11], superheated steam pump engine (or turbine) [12], cooling condenser [13], and pump [14]. The conventional heat pump process includes a freezer [21], compressor [24], cooling condenser [23], and liquid-to-gas expansion valve [22]. With reference now to FIGS. 3 and 3A, the present vapor (steam) engine/pump processes include a saturated steam boiler [31] and a two-phase piston engine [32] of the reciprocating, V-type, or circular type vapor (steam) engine for two-phase expansion [33] and pumping [34] in Shiao’s cycle. If one of liquefied oxygen, nitrogen, or air is used as the boiler's [31] working fluid [35], the ambient energy supplies its heat (enthalpy) [38] to the boiler [31] and the ambient air energy will be extracted [38] for evaporating the liquid working fluid in the boiler [31]. The ambient air then cools down to below the room temperature. This is an air conditioning effect [38], but runs in a closed vapor (steam) engine/pump cycle.

With reference now to FIGS. 5 and 5A, the present vapor (steam) engine/pump processes include a saturated steam boiler [31] and a two-phase piston engine [32] for two-phase expansion [33] and pumping [34] in Shiao’s cycle. If one of liquefied oxygen, nitrogen, or air is used as the boiler's [31] working fluid [35], the ambient energy supplies its heat (enthalpy) [38] to the boiler [31] and the ambient air energy will be extracted [38] for evaporating the liquid working fluid in the boiler [31]. The ambient air then cools down to below the room temperature. This is an air conditioning effect [38], but runs in a closed vapor (steam) engine/pump cycle.

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C.) to 600°F (315°C). And the liquefied oxygen operating temperature is approximately 120 K (−153°C). The liquefied nitrogen’s operating temperature is approximately 100 K (−173°C) as the designated working fluid.

After the working fluid absorbs heat from the ambient/ambient heat sources, the liquid phase is evaporated into the high pressure saturated vapor. This higher pressure saturated vapor is used to generate power through the two-phase piston, which is designed to be durable and balanced to run at a slow speed with better stability, more pressure difference, less ball-bearing friction, and less mechanical fatigue. The slow piston/flywheel is attached to a high ratio gear reducer to increase its generator’s speed and meet its power generation requirements (3,600 RPM).

After the saturated vapor stream has gone through the vapor (steam) engine/pump process, work is extracted out from this high pressure steam. Because work has already been extracted out from the saturated vapor stream, this steam’s pressure and temperature will drop into low pressure and low temperature condensed streams. Then, these condensed-phase streams are compressed back into the boiler through much smaller passage with check valves controlling its flow direction.

The pumping process includes a smaller return passage, and a high pressure piston pumps the waste streams back into the boiler in order to complete the vapor (steam) engine’s working fluid closed cycle through generating power at low temperatures without using the conventional cooling condenser at that lower temperature.

The pump uses a strong piston with fresh saturated high vapor pressure to compress those two-phase waste streams by less power, which is partially gotten from the strong piston power back into the boiler to complete this vapor (steam) engine’s process cycle.

The present vapor (steam) engine process does not require a cooling condenser since the pumping process compresses the waste streams directly back into the boiler. Therefore, no waste heat drops from the lower temperature waste stream into the surroundings and a cooling condenser is not needed, which are highly recommended for new nuclear steam engine’s modifications.

The compressing process with a smaller condensed phase passage needs less power from the piston’s main power source, which is shown in the following:

\[
\text{Piston force} = \frac{\text{Pressure}_{\text{condensed phase}} \times \text{Area}_{\text{piston}}}{\text{Speed}_{\text{piston}}} \times \text{Compressing force} = \frac{\text{Pressure}_{\text{condensed phase}} \times \text{Area}_{\text{piston}}}{\text{Speed}_{\text{piston}}} \times \text{Force} = \frac{\text{Pressure}_{\text{condensed phase}} \times \text{Area}_{\text{piston}}}{\text{Speed}_{\text{piston}}} \times \text{Force}_{\text{slow}}
\]

In the present process, a slow-speed piston engine can take more pressure difference and more vapor speed difference and can be designed to have more strength, to be more stably moving at a slower-speed, and have less ball-bearing friction wear on the flywheel. The slow-speed flywheel is connected to a high ratio gear reducer to increase the generator’s rotating speed and meet its power generation requirements at 3,600 rpm. This slow-speed with a strengthened and stable running flywheel attached to a high ratio gear reducer can use this intensive force of the condensed phase to generate more useful power and minimize the disadvantages of running piston in the condensed phase flow (minimize droplet erosions and thermal strength fatigue). Another advantage of the stronger and slow-speed flywheel with a high ratio gear reducer is to make the piston run through the condensed phase with the higher speed difference generating more useful power, more efficiently, and less instability. The vapor (steam) boiler’s outlet cross section area must be much larger than the recycled vapor (steam) returning inlet cross section area. Both components are attached to the same saturated vapor pressure (at boiler’s pressure), but must have different cross-sectional areas, so that both ends have the same pressure. In the middle, similarly a large piston is directly connected to a small piston. The large piston is connected to the left container and the small piston is also connected to the right container. The small piston moves from left to the right, then stops because the larger piston has larger force than the smaller piston does if they are run under the same ending pressure. Reversing the pistons’ piping positions backwards, and reversing the small and large piston positions, they will move backward. Therefore, this strategy makes the piston set moving back and forth and generating power over 50%. This vapor (steam) engine is easier to be built and maintained by today’s matured technologies.

A conventional heat engine with a condenser process needs to be alternated, and the present two-phase compressing/pumping process pumps the waste steam directly back to the boiler through a much smaller vapor returning inlet to the boiler with check valves controlling flow direction to substitute for the conventional cooling condenser’s function by putting waste stream’s power back into the boiler ready for reused in the next cycle.

The present vapor (steam) engine process (using the liquefied oxygen, nitrogen, or air as its working fluid) will have a higher efficiency over 50% and above, and can produce power under temperatures lower than the ambient temperature. This powerful vapor engine process may use liquefied gases (oxygen, nitrogen, or air) for its working fluid transferring energy and extracting work from ambient energy, and the ambient fluid’s temperature drops down to lower than the room temperature as for our new air conditioner and new refrigerator without damaging the environment (without chemical refrigerants leaking, no warm cooling water discharge, no thermal pollution, and no radioactive/hazardous waste discharge from the conventional nuclear power plants’ cooling towers). There is a need for a simpler vapor (steam) engine running in the closed system, taking much higher vapor (steam) pressure than the Stirling engine. The present system can be adapted for use with a nuclear power plant.

The foregoing descriptions of specific innovations are presented for purposes of illustration and applications. They are not intended to be exhaustive or to limit the claimed subject matter to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above disclosure. It is intended that the scope of the present embodiments is defined by the claims appended hereto and their equivalents.

Having thus described the embodiments, it is now claimed:

1. We claim:
   1. A method for heat transfer comprising:
      absorbing ambient/ambient thermal energy to a boiler;
      generating a high pressure saturated vapor stream from the boiler;
      extracting practical work from the high pressure saturated vapor stream via an associated two-phase piston engine, resulting in used gas/liquid phases; and,
pumping the used gas/liquid phases back into the boiler through a smaller passage having check valves using a piston pumping process in a closed system without discharging of heat into a heat sink; and generating electricity through an associated contacting/grinding reaction generator, wherein after extracting working fluid dynamic power, that fluid current loses its dynamic energy.

2. The method of claim 1, wherein, for a closed vapor (steam) engine/pump cycle, selecting a working fluid of the boiler from a group comprising water, liquefied oxygen, nitrogen, or air.

3. The method of claim 1, wherein generating electricity comprises operating a slow-speed piston engine in conjunction with a flywheel and a high ratio gear reducer to increase generator speed to 3,600 rpm.

4. The method of claim 1, wherein the step of compressing/pumping waste gas/liquid phases back into the boiler through a smaller passage and check valves using a piston pumping process further comprises:

   compressing/pumping used gas/liquid streams directly back into the boiler, without discarding heat into the heat sink.

5. A low-temperature vapor (steam) engine device comprising:

   at least one low-temperature liquefied gas boiler;
   at least one two-phase piston engine with a larger vapor inlet cross-sectional area and a smaller condensed phase return outlet passage with check valves controlling the flow direction, and having a concurrent piping position and shape for the returning fluid discharge back into the boiler;
   at least one flywheel attached with a high ratio gear reducer;
   at least one piston pumping process;
   at least one piston engine/pump process; and,
   a generator having at least one contacting/grinding reaction for generating high power DC electricity.

6. The device of claim 5, wherein the piston engine is a slow-speed piston engine and wherein the flywheel and the high ratio gear reducer increases speed of the contacting/grinding reaction high power DC generator to 3,600 rpm.

7. The device of claim 5, wherein the two-phase piston engine has a speed of approximately 36 rpm, and the piston engine has a large piston reaction cross section area.

8. The device of claim 7, wherein the gear reducer has a ratio of approximately 1:100=1:10x10 in two stages.

9. The device of claim 8, wherein the generator has a rotation speed of approximately 3,600 rpm for generating high power DC electricity through contacting/grinding reactions.

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