REVERSIBLE THERMOELECTRIC CONVERTER WITH POWER CONVERSION OF ENERGY FLUCTUATIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to devices for directly converting thermal energy to useful electric energy, wherein the invention may also be utilized for directly pumping heat from a colder source to a higher temperature sink. More specifically, the invention relates to a device for utilizing with high efficiency the electric fluctuation energy of small circuits thermally insulated from other small circuits at a different temperature so as to produce useful electric energy. The same device also efficiently pumps heat from lower to higher temperature regions.

2. Description of the Prior Art

Devices for converting thermal energy directly into electric energy have been extensively investigated and the most commonly utilized devices have been the thermionic converters working from high temperature sources and silicon cells utilizing the input thermal energy of solar radiation. The present state-of-the-art has been limited to achieving efficiencies of 15% for thermionic converters and 16% for silicon solar cells. In addition to these limitations on efficiencies, the temperature range over which these devices can work efficiently has been limited to high temperatures in the range of 1400° to 2200° K for the emitter and 500° to 1200° K for the collector of the thermionic converters and to moderate operating temperatures in the range of less than 400° K for the temperature of the silicon solar cells.

The present invention removes these limitations along with providing other improvements in the performance of the direct conversion of thermal energy to electric energy. The thermal converter of this invention eliminates the electron cooling, radiation losses and lead losses of thermionic diode converters and operates reversibly as a heat pump over a wide temperature range. The efficiency for each working temperature range is determined by the physical dimensions of the circuits. The small circuits of this invention yield increased efficiency and power output or heat pump output. The efficiency of the small circuit devices of this invention also improves the efficiency when the input thermal energy is in the form of thermal radiation from a heated source such as solar radiation from the sun which is to be converted to useful power. The Carnot cycle efficiency obtainable from a heat source at solar temperature working with a heat sink at the ambient temperature on earth is over 90%. This invention achieves this efficiency as it is not limited by the heat losses resulting from the diffusion and thermal conduction processes of solar cells. The invention also improves on the efficiency obtainable from the small circuits of the prior art. A typical prior art device is disclosed in U.S. Pat. No. 3,760,257 issued Sept. 18, 1973, which discloses a device used with a directional wide band antenna system to convert radiation energy to useful output power. The improvement of the invention herein over the prior art results generally from minimizing or eliminating the losses resulting from eddy current losses on the receiving antenna surfaces. Also, the efficiency of converting the wide bandwidth radiation such as solar radiation is increased in the instant invention by minimizing or eliminating the losses that occur from impinging stray radiation from other directions and the losses resulting from incompletely utilized voltages from antenna element spacings approaching one wavelength, or from antenna element spacings less than one half wavelength.

OBJECTS OF THE INVENTION

A primary object of the instant invention is to provide an improved apparatus for directly converting thermal energy to electric energy.

Another object of the invention is to improve the efficiency of conversion of heat to electricity.

Still another object of the invention is to increase the power output from the thermal energy converter to a high power level.

It is a further object of the invention to increase the operating temperature range of the thermal energy converter so that efficient conversion over a wider range of temperatures is obtained.

It is a further object of the invention to provide an alternate mode of operating the device as a heat pump or a refrigerator with an improved coefficient of performance over a wide temperature range.

It is a yet further object of the invention to increase the types of heat sources with which the thermal converter operates to include solar, fossil, nuclear and geothermal heat sources.

It is still a further object of the invention to lower the temperature at which efficient operation is achieved so as to use the waste heat from other power plants as input heat sources for this thermal energy converter.

Yet another object of this invention is to decrease the weight and size of the thermal converter so as to increase the power output per unit volume and per unit weight of the thermal converter.

These and other objects and advantages of the invention will become apparent from the following description taken in accordance with the accompanying drawings which form a part of this application.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1*a* is a sectional schematic view of one embodiment of the invention working in a power conversion mode.

FIG. 1*b* is a sectional schematic view of another embodiment of the invention working in a heat pump mode.

FIG. 2 is a sectional schematic view of still another embodiment of the invention in which two stages of thermal cycles enable higher efficiencies to be obtained.

FIGS. 3*a*, 4, 5 and 6 are schematic views of the transducing modules that may be used in the invention for the conversion of the electric energy fluctuation to useful power output, or for refrigeration by pumping the electric energy fluctuations of a cold source to a hot sink.

FIG. 3*b* is a schematic of the series-parallel circuit for combining the output power from all the transducing modules.

FIG. 3*c* is a sectional view of an embodiment for a component of the modules of FIGS. 3*a*, 4, 5 and 6.

FIG. 7 is a sectional view of a layer for collecting radiation from the sun or other radiation sources for efficient conversion by the power conversion circuits of the invention.