DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the invention, both the conversion of electric energy fluctuations to useful power output and the refrigeration cycle embodiments have increased efficiency over a wide range of working temperatures. The small microcircuits of the transducer modules convert electric energy fluctuations into a useful output with a high efficiency. This efficiency is over 90% for some applications. The lead conduction losses, electron cooling and radiation losses are minimized. This increase in efficiency is accomplished in part by using a vacuum or equivalent thermal barrier between the circuits at different temperatures and by providing an electrical path for the electric fluctuation energy. This is achieved by coupling the electric fluctuating energy using capacitors having a vacuum or equivalent thermal barrier between the capacitor plates and by separating the adjacent areas of the circuits of the modules **7** and **8** of FIGS. 1*a*, 1*b* and 2 by a vacuum or equivalent thermal barrier.

Referring now to FIG. 1*a* of the drawings, incoming heat **50** from some heat source shown on the left side of the drawings is converted into electrical power for an electrical load **6** shown on the right side of the drawing. Thermal conduction layer **37** is the heated thermal conducting film which may typically be a metal or carbon film that is in thermal contact with layer **1** of the invention. This thermal conduction layer **37** is also thermally exposed by conduction, radiation or convection to the heat **50** from some heat source (not shown) and conducts this thermal energy to the layer **1** of the device. In this embodiment and for this application, the layer **1** is comprised of an assembly of modules **7** (to be more fully described infra) for transducing the incoming heat at the temperature of the source to electric energy fluctuations across potential barriers or electrical resistors. A low loss dielectric substrate **34** typically but not limited to sapphire supports the modules **7**.

This fluctuating electrical energy is transmitted across a thermal barrier **2** from each module **7** of layer **1** to a corresponding conversion module **8** of layer **3**. (The conversion module **8** will be more fully described infra). The thermal barrier **2** may be, but is not limited to, a vacuum thermal barrier in which the separation distance between layers **1** and **3** is maintained by spacing support **47**. This separation distance is less than the dimensions of modules **7** and **8** in the plane of the layers **1** and **3**. For the vacuum thermal barrier, the vacuum is maintained over a convenient area of the layers by making the spacing support **47** in the form of walls to enclose convenient areas between the layers **1** and **3**. The separation walls **47** may typically be of a low thermal conductivity material such as glass but are not limited to this material. As will be described infra, the walls of the substrate **34** and **35** containing the vacuum may typically be plated with a metallic coating with a low net effective thermal emissivity such as gold. The layer **3** is maintained at a lower temperature by thermal contact with thermal conducting layer **58** which may typically be a metal or carbon film which is thermally exposed to the cooler reservoir sink at the lower temperature by conduction, convection or radiation. The modules **8** are supported on the low loss dielectric substrate **35** of layer **3** which may be of similar material to substrate **34**. The conversion modules **8** of layer **3** for this power conversion mode rectify the fluctuating electrical energy to provide a direct current power output from each module **8**.

The output power from all the modules **8** of layer **3** is combined in a series parallel network, to be described infra, to supply the total available output power of all the modules at the required voltage to the electrical load **6**. The series-parallel circuit is connected to electrical leads **4** and **5** and the total available output power is conducted by leads **4** and **5** to the electrical load **6**. Layers **1**, **2**, **3**, **37** and **58** may be flexible and may extend in shape and area to conform to the application.

An alternate embodiment of the invention is schematically shown on FIG. 1*b*. This embodiment utilizes the invention as a heat pump or refrigerator. Input power from a power source **27** is supplied to leads **30** and **31** to the series parallel network and to the modules **8**. This reverses the direct current in each module **8** so that heat **56** is pumped across thermal conducting film **58** from the low temperature reservoir to the low temperature of the modules **8** and across the thermal barrier **2** to the higher temperature of the modules **7** of the layer **1** and to the thermal conducting film **37**. From the thermal conducting film **37**, the heat output **57** is transferred by conduction, convection or radiation to the higher temperature reservoir.

FIG. 2 shows another embodiment of the invention wherein the embodiments of FIGS. 1*a* and 1*b* are combined so that modules **7** in layer **1** and modules **8** in layer **3** operate as in FIG. 1*a* to provide output power through leads **4** and **5**, whereas modules **8** of layer **28** and modules **7** of layer **29** are to work in the heat pump or refrigeration mode as shown in FIG. 1*b* with the input power being transmitted by conductive leads **30** and **31**. Layer **28** is in thermal contact with layer **3** and is thermally insulated from layer **29** by a thermal barrier layer **32** that may be similar to the thermal barrier **2** between layers **1** and **3**. The addition of layers **28**, **29** and **32** operating in the refrigeration mode to layers **1**, **2**, and **3** lowers the temperature of layer **3** so that for some components and designs of the rectifying modules **8**, the overall efficiency of the power conversion of the two stages is improved.

FIG. 3*a* shows a schematic view of one embodiment of a circuit for the transducing module **7** and the conversion module **8**. In this schematic view the circuit to the left of condenser plates **22** and **23** is the circuit of module **7** and, as stated supra, layer **1** of FIGS. 1*a*, 1*b*, and 2 is comprised of an assembly of modules **7**. In this schematic view, condenser plates **22**, **23**, **10** and **18** are part of layer **2** of FIGS. 1*a*, 1*b*, and 2 as will be shown infra. Finally, in this schematic view the circuit to the right of condenser plates **10** and **18** is the circuit of module **8** and, as stated supra, layer **3** is comprised of an assembly of modules **8**. In FIG. 3*a* the transducing modules **7** use a diode **9** as the source of the electric energy fluctuations which are transmitted by electrical leads **13** and **14** to the condenser plates **22** and **23**. The other plates of the condensers **10** and **18** are on the other side of the vacuum or equivalent thermal barrier and are connected to the rectifying module **8**. The condenser plate **10** is connected by lead **17** in module **8** to the high impedance inductance **11** and to the rectifying diode **12**. The condenser plate **18** is connected by lead **19** to the other lead of the inductance **11**, to the low impedance capacitor **20**, and to the power output lead **15**. The rectified output power from the diode **12** is conducted by connecting lead **21** to power output lead **16** and through the inductance **11** and lead **19** to