**ABSTRACT OF THE DISCLOSURE**

A novel solar energy collector is disclosed that absorbs radiated sunlight across a wide spectrum of wavelengths through a thermoelectric fluid composed of thermally absorptive micro-structures also exhibiting semiconductor characteristics. More specifically, the micro-structures are contained in the thermoelectric fluid and circulate into the glass tube arrangement of the solar collector. The sunlight radiates through the glass tubes onto the thermoelectric fluid which absorbs the thermal energy and converts a fraction of the sunlight energy into electric energy through the semiconductor micro-structures. The thermoelectric fluid is pumped and the energy is recuperated through a heat exchanger and electrode system.

# THERMAL ELECTRONIC SOLAR COLLECTOR

The present invention relates to the art of methods and apparatus for converting solar energy to thermal and electrical energy through a thermoelectric fluid containing micro-structures for absorbing radiated heat and converting photonic energy into electronic energy. The present invention also relates to the use of solar collector apparatus for conversion of sunlight radiated energy to a thermoelectric fluid and mechanism for pumping and transporting the stored energy to a heat exchanger and electrode system.

## BACKGROUND OF THE INVENTION

Devices for solar energy collection and conversion can be classified into concentrating types and non-concentrating types. Non-concentrating types of solar collectors capture heat from sunlight with a flat array composed of absorbing materials or devices such as photovoltaic cells or fluid conduit, for example. The output is a direct function of the area of the array. Concentrating type of solar collectors focuses the energy rays using a parabolic reflector or a lens system, multiplying the sunlight intensity several times onto a focal point. The sunlight is concentrated to increase the intensity of conversion of solar radiation to higher photovoltaic outputs or to higher temperature of collected heat from the solar radiation to provide for higher temperature applications.

In conventional concentrating and non-concentrating solar energy collectors, the solar radiation is typically absorbed through a metallic conductive conduit or photovoltaic cell array. The solar radiation can be focused at a point from a circular reflector (e.g., a dish-shaped reflector) or along a focal line from a cylindrical shaped reflector. Such apparatus perform efficiently in ideal conditions and climates where a lower energy output less than 700 Wth/M$^2$ heat and 150 Wev/M$^2$ are sufficient throughput.

However, even conventional concentrating solar energy receivers require improvement for two reasons. First, the solar radiated energy conversion in conventional systems occurs at the surface of an absorbing material which conducts thermal energy to a conduit which in turn conducts the thermal energy to a fluid being pumped through the conduit, creating numerous thermal resistances. Secondly, a large portion of the solar radiated energy absorbed initially by the absorbing material is reflected back to the atmosphere during its conductivity path to the conduit.

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| 4388481 | Jun., 1983 | Uroshevich | 136/246. |
| 4943325 | Jul., 1990 | Levy | 136/259. |
| 6020553 | Feb., 2000 | Yogev | 136/246. |
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| 6018123 | Jan., 2000 | Takada. | |

Steadily, the sun delivers energy at the earth's surface at the average rate of 1,000 Watts/M² per hour. This is enough energy to heat and light the whole world on a continuous basis. However, the efficiency of conventional solar collectors in converting radiated solar energy into heat and electricity has been limited. The flat plate solar collectors widely used at the present time provide applications no better than heating dwelling spaces and hot water for domestic uses. The present day technology for collecting solar energy at a significantly elevated temperature is limited to parabolic reflectors and focusing lenses, which are expensive, complex and cumbersome technologies and are neither promising nor encouraging in terms of their present status and their future potential. One of the most typical examples of solar energy application is the use solar energy for air conditioning in the tropical and subtropical regions where the expense of cooling in summer time is far greater than the expense of heating in winter time. Another prosperous application is the generation of steam for power stations.

Solar photovoltaic cells are usually produced as small units, each capable of producing limited electric power in the range of a few watts. For large scale applications, it is necessary to integrate many cells to form a module that can produce higher electric power. Due to mechanical limitations, very close packing of cells is very difficult and in many cases, each cell has a small area with inactive material. When such a module is formed, a portion of the area of the module is inactive and when oriented towards the sun, a fraction of the light that is incident on this area is not utilized. Moreover, when the module is used for converting concentrated solar radiation to electricity, this fraction of concentrated radiation can damage the module.

There is a need to improve and develop new systems that convert solar energy to both thermal and electrical energy efficiently in severe and extreme climates to deliver heat and electric power reliably with minimal losses.

**SUMMARY OF THE INVENTION**

The primary object of the present invention is to provide a solar collector that absorbs radiated solar energy to produce thermal energy at higher efficiency.

Another object of the present invention is to provide a solar collector that absorbs radiated solar energy by means of a thermoelectric fluid composed of micro-structures converting photonic energy into electronic energy.

A further object of the present invention is to provide a solar collector that absorbs radiated solar energy to produce thermal and electrical energy for residential, industrial and commercial needs and into systems that are affordable.

Yet another object of the present invention is to provide a highly efficient solar collector employing translucent conduits allowing solar radiated energy to be captured directly by the thermoelectric fluid and eliminate numerous thermal resistances and conductivity bridges.

These and other objects of the present invention will become clear as the description thereof proceeds.

There is disclosed herein a solar energy collector comprising an array of translucent passages connected at one end to a fluid inlet header and at the other end, to a fluid outlet header and placed in a direct path with sunlight. A opaque thermoelectric fluid composed of homogenous propylene glycol and micro structure semiconductors is processed through the array of translucent passages. Solar energy radiates onto the array of translucent passages allowing the thermoelectric fluid to absorb solar energy directly and causing the thermoelectric fluid to increase in temperature. Fraction of the solar energy absorbed by the thermoelectric fluid is converted from heat and photonic energy to electron energy within the micro structure semiconductors.

The solar radiated thermoelectric fluid circulates by pumping mechanism from the inlet header to the outlet header of the translucent passages and to an energy storage tank through a conversion system composed of a heat exchanger and a planar electrode system where thermal and electrical energies are recuperated. The thermal energy and electrical energy thus recuperated in the conversion module can be used for heat and power applications.

The energy conversion module includes a reception surface composed of planar electrodes and heat exchanger. The planar electrodes act as poles where electrons are collected as voltage. The heat exchanger collects the thermal energy from the fluid through conduction.

The thermoelectric fluid may include up to 30% micro-structure semiconductors in weight of the total component of the fluid solutions which is equivalent to 3 times the surface area of the solar collector if the micro-structure semiconductors were laid down next to each other. Solar absorptivity of the thermoelectric fluid is directly proportional to the content and absorptivity of the micro-structure semiconductors in the solution. However, other mechanical and fluid thermodynamics consideration limits the total content of micro-structure semiconductor into the fluid. Nonetheless, the efficiency of the solar collector is enhanced sharply by use of the opaque thermoelectric fluid.

In an alternate embodiment, there is disclosed a concentrating solar energy collector comprising multiple parabolic reflectors having high reflectivity surface on a concave side of the reflector and having a focal axis extending from a concave side of the reflector which passes through a focal point where a translucent glass tube is placed. A opaque thermoelectric fluid passes through the translucent glass tube and is irradiated by the solar light converging at the focal point. This alternate embodiment allows higher temperatures being reached due to convergence of solar light equivalent to 100 to 1000 suns depending on the geometry and size of the parabolic surface with respect to the glass tube surface.

It is therefore first a broad object of the present invention to ameliorate the disadvantages of the prior art solar collectors.

It is a further broad object of the present invention to provide a solar collector system capable of absorbing radiated solar energy for conversion to thermal energy and electronic energy to supply heat and electricity for a wide range of applications.

It is still a further object of the present invention to provide a solar collector system that eliminates the use pipes and other metallic passages between the absorbing fluid and the radiated sun energy.

In accordance with the present invention, there is therefore provided a high efficiency solar radiation collector, thermal and electronic conversion system, comprising at least one absorbing surface and thermoelectric fluid, said surface being made of a translucent material and said thermoelectric fluid being made of thermal absorbing micro-structure semiconductors, wherein said thermoelectric fluid absorbs solar energy and wherein said conversion system recuperates thermal energy and converts fraction of thermal energy to electric energy.

The present invention was accomplished on the basis of the above-discussed recognition.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying Drawings in which:

FIG. 1 illustrates a typical solar energy system application comprising a solar collector, thermal fluid conduits, thermal reservoir and thermal exchanger.

FIG. 2 illustrates an array of translucent passages comprising a inlet for the pumped thermal fluid entrance and outlet for the thermal fluid exit.

FIG. 3 illustrates the thermoelectric fluid micro-structures and a representation of the thermal absorption, conductivity, convection and thermal radiation.

FIG. 4 illustrates the thermoelectric fluid micro-structures and a representation of the photonic absorption, reaction and representation of the electron transport.

FIG. 5 is a pictorial drawing illustrating the conversion system comprising a thermal exchange section and a electron exchange system.

FIG. 6 illustrates another alternate embodiment of a concentrating solar energy collector wherein a collector tube is installed at the focal area.

While the principles of the present invention have now been made clear by the illustrative embodiments, it will be immediately obvious to those skilled in the art that many modifications of the structure, arrangements, elements, proportions and materials which are particularly adapted to a certain working environment and operating condition in the practice of the invention are possible without departing from those principles of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, there is illustrated a typical solar energy system according to the present invention. The solar collector 2 is installed on a typical building roof 1 and secured. The pipe 3 brings the thermoelectric fluid 12 through the solar collector 2 by pumping mechanism. The thermoelectric fluid absorbs the solar radiated energy 13 incident onto the surface of the solar collector 2. The therefore heated thermoelectric fluid 12 is returned by means of insulated pipe 4 through conversion system 6 to the thermal exchanger 5. The energy contained in the thermoelectric fluid 12 is recuperated as heat and electric energy through the conversion system 6. The electric energy is stored in batteries 14 and heat is stored in reservoir 8 where heat is reabsorbed by thermal coil 7 and ejected in heating devices 11 to supply ambient comfort heat to the building 1. Sanitary water can also be extracted from reservoir 8 and brought to reservoir 9 through insulated pipe 10 for supplying clean warm water.

Referring now to FIG. 2, there is illustrated one embodiment of a solar energy collector 20 according to the present disclosure, comprising an array of translucent passages 21. The solar energy collector 20 includes a inlet pipe 22 and outlet pipe 23 to allow the thermoelectric fluid 12 of figure 1, to flow in and out with pumping action. There is provided onto the inlet pipe 22 and outlet pipe 23, a threaded section 24 an 25 to allow for pipe connections. The array of translucent passages 21 comprises a multitude of channels 27 enhancing laminar flow through the solar collector 20 and increasing solar radiation absorption through surface 26 by the thermoelectric fluid 12.

While referring now to FIG. 3, there is illustrated an enlarged view of the micro-structure semiconductors 32 within the thermoelectric fluid 12 and a single channel 30, part of the multitude of channel 27, illustrating the photon absorption process. The photons contained into light rays 31 are absorbed by micro-structure semiconductor 32. The photons transfer energy to electron 38 to flow freely to find electron holes in the micro-structure. This process creates electric current. The radiated light rays 31 induce heat into the micro-structure 32 which is partly absorbed, partly radiated to nearby elements of the micro-structure 34, partly convected to the fluid 33 and also partly radiated to the fluid 35 and the atmosphere 36. The size x 37 of the micro-structure elements vary from 500 nanometer to 5 micrometers and are composed of multiple elements.

Referring now to FIG. 4, there is illustrated the thermoelectric fluid 41 and micro-structure semiconductors 40. The solar radiated light energy 42 induce photons and photocurrent transients through the electronic process occurring into the micro-structure semiconductors 43. The electron transport to the conversion system electrodes is achieved through the thermoelectric fluid 41 acting as an electrolyte. The shape and the time domain for the current transients are dependent on the conversion system of figure 5 membrane thickness, membrane material and thermoelectric fluid conductivity. The micro-structure semiconductors 45 travel in suspension within the thermoelectric fluid 41 due to the density of the fluid which is mainly composed of propylene glycol, chemically made micro-structure semiconductors 45, 43 and electrolyte. The micro-structure semiconductors 45 have a higher thermal absorptivity than the thermoelectric fluid 41 and exchange heat energy 46, 47 on their way to the conversion system.

Referring now to FIG. 5, there is illustrated the conversion system 50, comprising a thermal exchanger 53 with inlet 51 and outlet 55 for the proper flow of the thermoelectric fluid. A water thermal absorbing section comprising an inlet 52 and outlet 54 allow sanitary water from reservoir 6 to be heated. Electronic energy carried by the micro-structure semiconductors 56 is absorbed through the membrane 58 and thin film electrode 57.

Referring now to FIG. 6, there is illustrated in cross section, a alternate solar multiple parabolic collector embodiment 60 comprising multiple parabolic reflectors 61 shown in cross section. As is well known, this is an efficient shape for receiving incident solar energy radiation. However, the concentrating solar energy receiver 60 of the present disclosure is not limited to any parabolic shape reflector 61 but could be other geometric shapes such as an ellipse, an oval, a rectangle (i.e., a cylindrical reflector), a polygon or an array of regular polygons or any other closed plane figure. Such an array of panel segments could be a composite of contiguous shapes placed edge-to edge or a composite of reflecting elements arranged in proximity to one another or a composite of reflecting elements arranged in predetermined positions though not necessarily close together.

While continuing reference to FIG. 6, Further, the solar multiple parabolic collector comprises a plurality of glass translucent tubes 62 allowing the thermoelectric fluid to flow by pumping mechanism. The solar multiple parabolic collector 60 also comprises insulation 63, seal 65 and glazed plate 64 to enhance its performance.

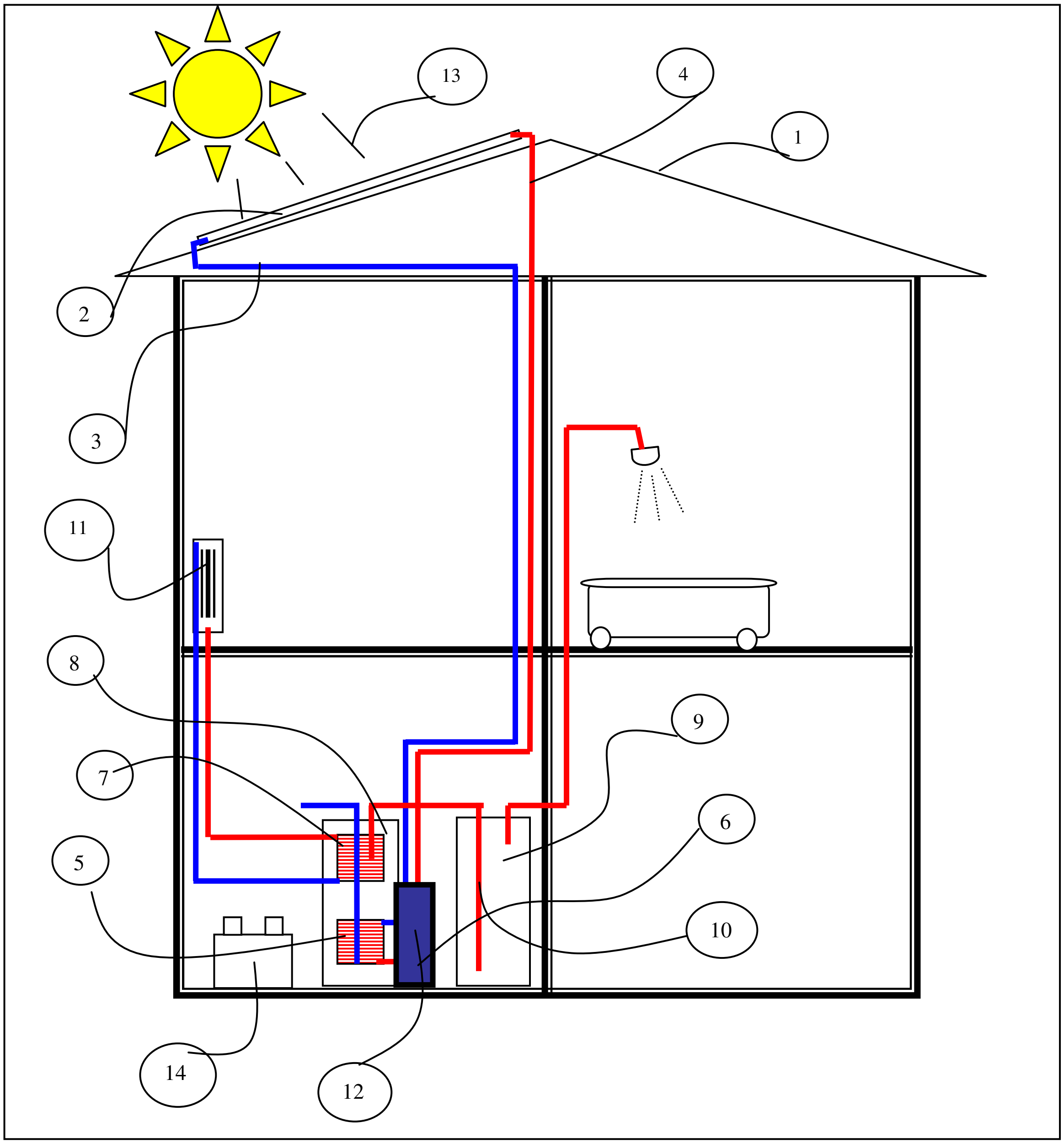


Figure 1, typical solar energy system application

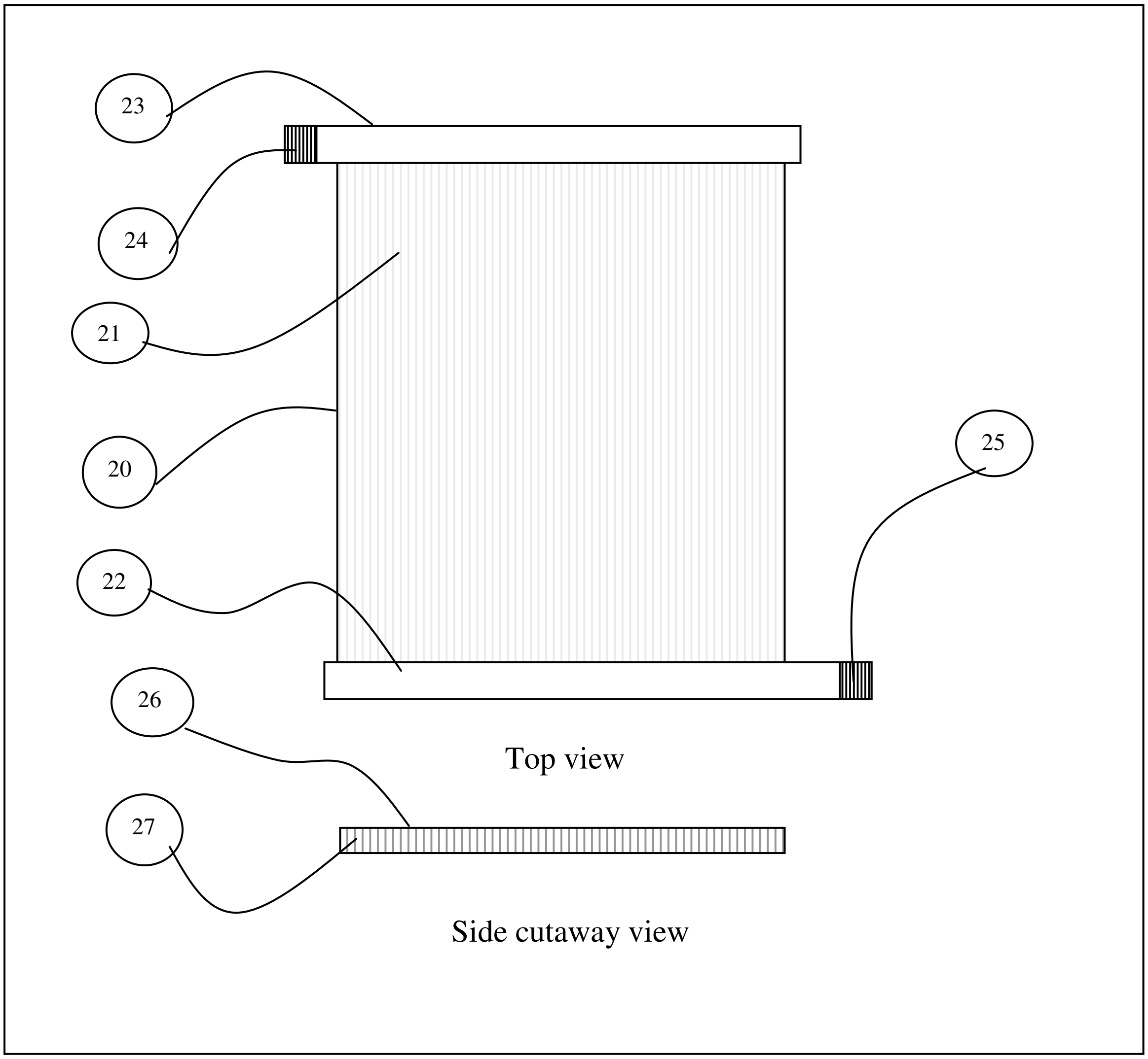


Figure 2, Array of translucent passages

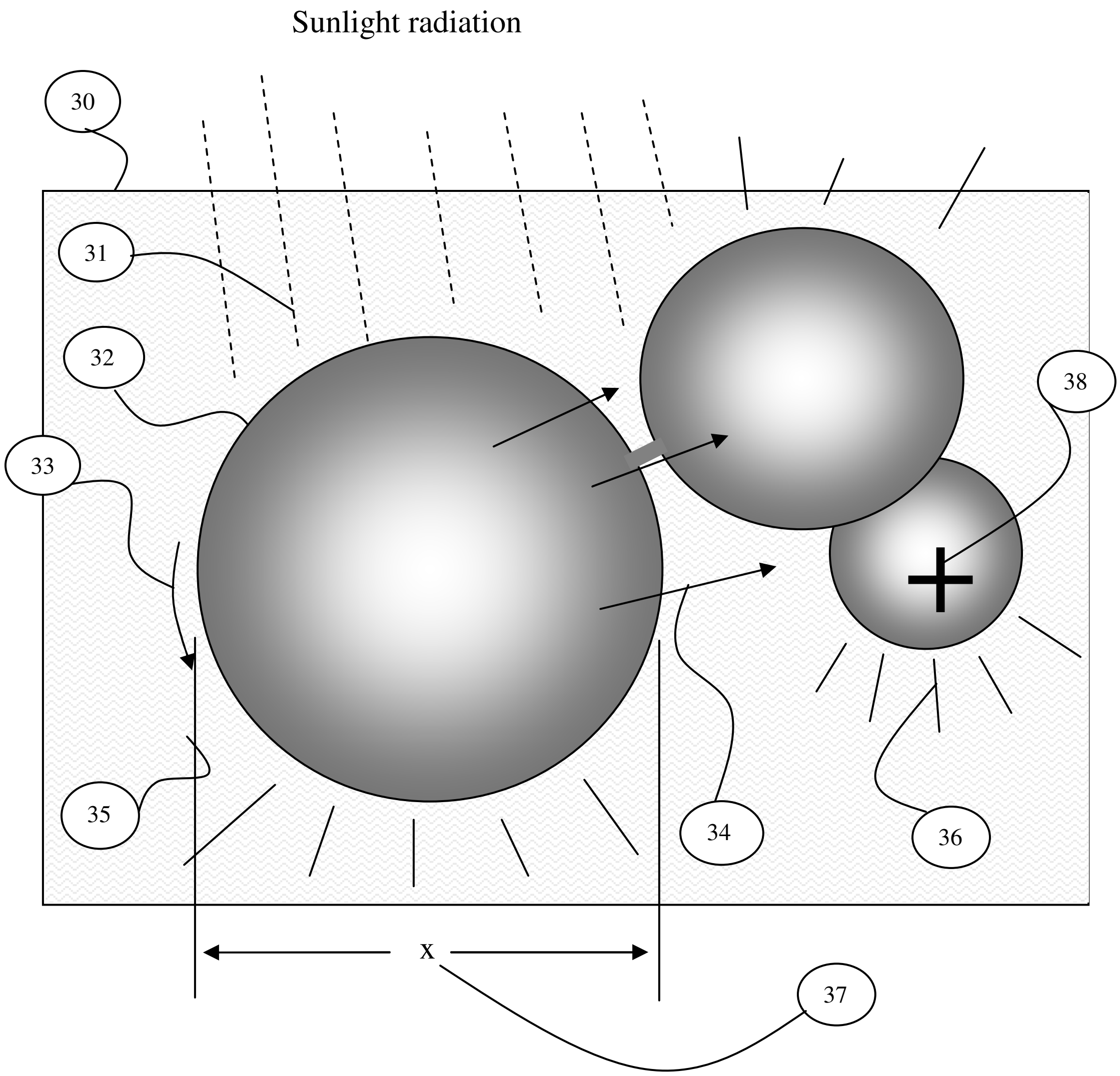


Figure 3, Micro structure semiconductor thermal absorption and rejection process

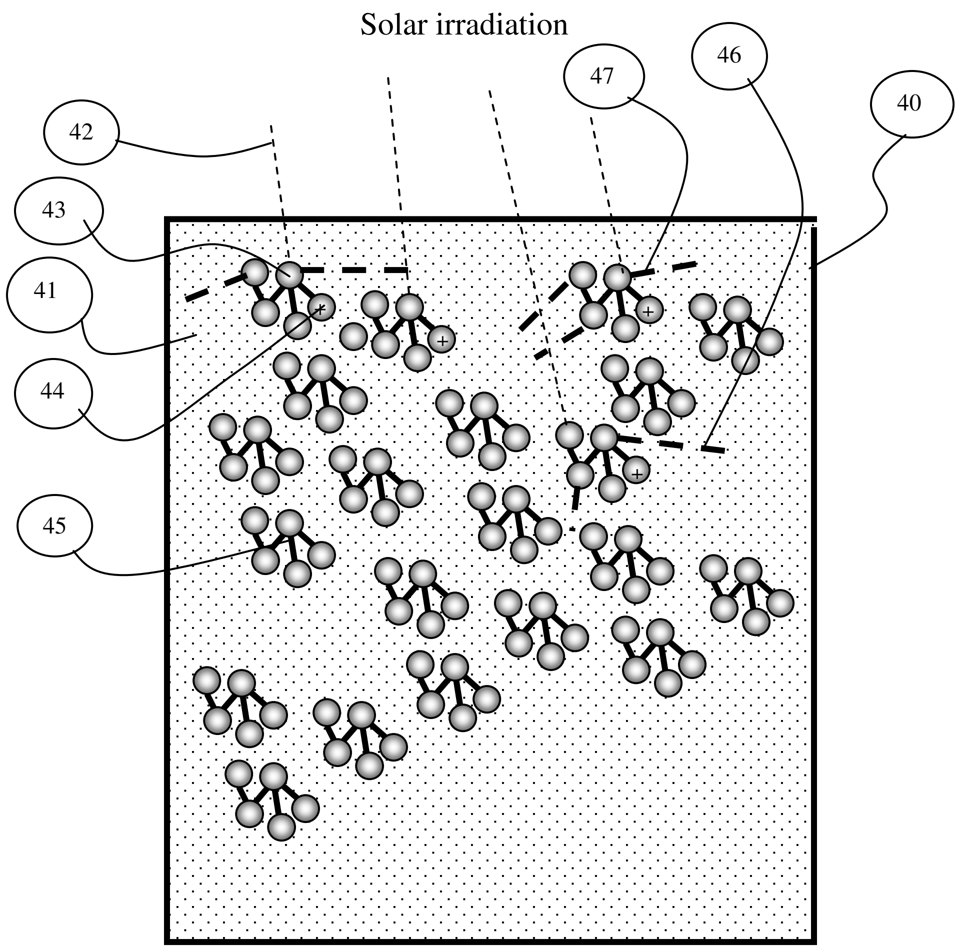


Figure 4, Representation of micro-structures
photonic - electronic conversion

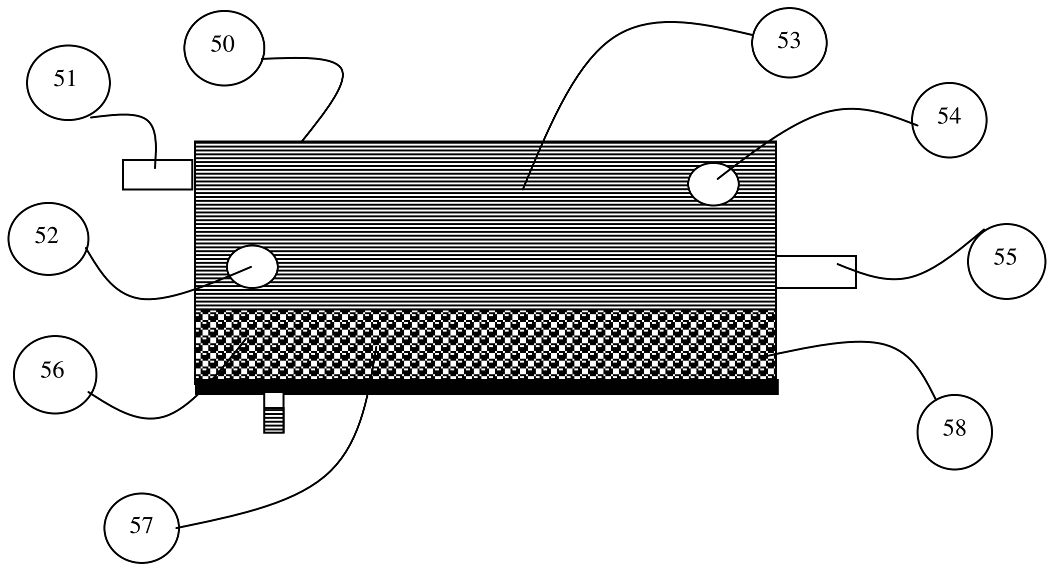


Figure 5, Conversion system

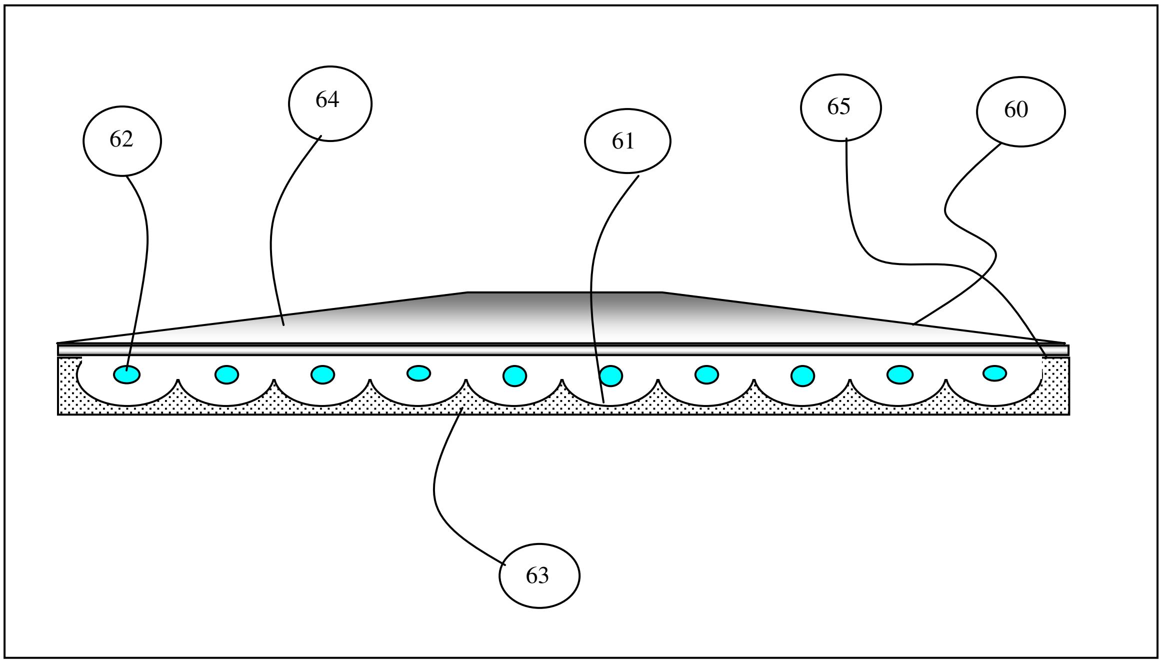


Figure 6, Multiple parabolic embodiment