Concentrated Solar Power Generation Using Solar Receivers- A Review

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Abstract- *This paper presents various aspects of concentrated solar power generation with the focus on solar receivers. In this paper, the principles underlying the operation of desiccant concentrated solar power generation with the focus on solar receivers are recalled and their actual technological applications are discussed. Some commented examples are presented to illustrate how the concentrated solar power generation with the focus on solar receiver scan be a perfective.*

Keywords- Solar, generation, receivers

I. INTRODUCTION

Inventive concentrated solar power systems using solar receivers, and related devices and methods, are generally described. Low pressure solar receivers are provided that function to convert solar radiation energy to thermal energy of a working fluid, e.g., a working fluid of a power generation or thermal storage system. In some embodiments, low pressure solar receivers are provided herein that are useful in conjunction with gas turbine based power generation systems.

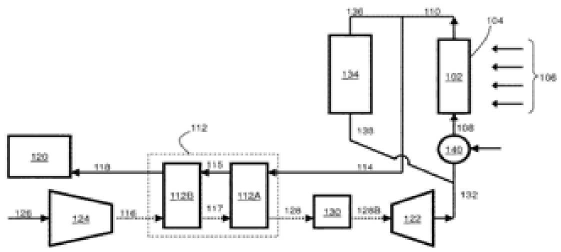
II. FIELD OF INVENTION

Systems, devices, and methods related to concentrated solar power generation using solar receivers are generally described. Mounting concerns over the effect of greenhouse gases on global climate have stimulated research focused on limiting greenhouse gas emissions. Solar power generation is particularly appealing because substantially no greenhouse gases are produced at the power generation source. Concentrated solar power (CSP) generation using solar receivers is known in the art. Briefly, concentrated solar power systems use lenses, minors, or other elements to focus sunlight incident on a relatively large area onto a small area called a solar receiver. The concentrated sunlight can be used to heat a fluid within the solar receiver. The fluid heated within the solar receiver can be used to drive a turbine to generate power.

III. SUMMARY OF THE INVENTION

Inventive concentrated solar power systems using solar receivers, and related devices and methods, are generally described. In some embodiments, the concentrated solar power systems include a low pressure solar receiver. In addition, inventive heat recovery systems and methods for use in concentrated solar power generation systems using solar receivers are generally described. Inventive solar receivers for use in concentrated solar power systems, and related systems, devices and methods, are also generally described. In some embodiments, low pressure solar receivers are provided that function to convert solar radiation energy to thermal energy of a working fluid, e.g., a working fluid of a power generation or thermal storage system. In some embodiments, the low pressure solar receivers have lower cost of production and significantly larger collection capacity than typical currently available solar receivers. Inventive concentrators for use in concentrated solar power systems, and related systems, devices and methods, are also generally described. In some embodiments, the concentrators include integrated cooling systems to maintain components of the concentrator at predetermined and/or desired temperatures. In other embodiments, methods for producing concentrators having integrated cooling systems to maintain components parts at predetermined and/or desired temperatures are provided.

In some aspects of the invention, systems are provided that comprise a solar receiver constructed and arranged to heat a gas at a pressure of less than or equal to 2 atmospheres; a thermal storage system fluidic ally connected to the solar receiver; and a heat exchange system fluidic ally connected to the solar receiver. In some embodiments, the heat exchange system is constructed and arranged to transfer thermal energy from the gas heated by the solar receiver to a second gas. In some embodiments, the system is constructed and arranged such that a first portion of the gas heated by the solar receiver can be transported to the low pressure thermal storage system and a second portion of the gas heated by the solar receiver can be transported to the heat exchange system. In some embodiments, the thermal storage system is constructed and arranged to be operated (e.g., heated with a fluid) at a pressure of less than or equal to 2 atmospheres.

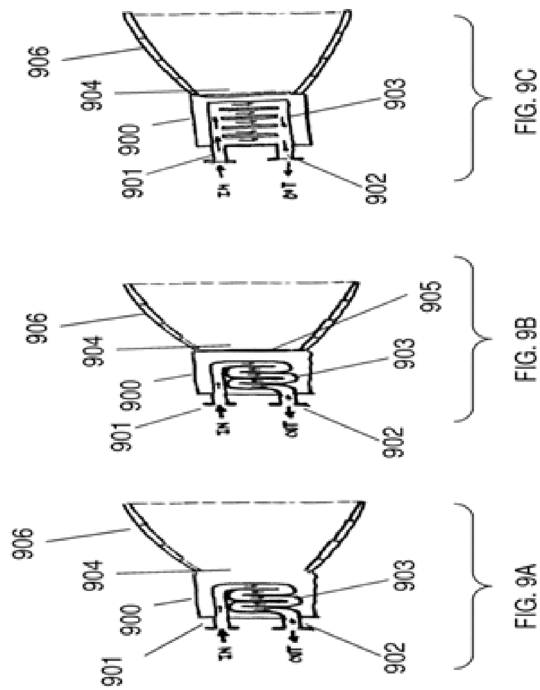


IV. DETAILED DESCRIPTION

Inventive concentrated solar power systems using solar receivers, and related devices and methods, are generally described. In some embodiments, the concentrated solar power systems include a solar receiver used to heat a fluid at a relatively low pressure. Heat from the low-pressure fluid heated by the solar receiver can be transferred to a relatively high-pressure fluid, which can be used to power a gas turbine as part of, for example, a Braxton cycle. The heat exchange between the low- and high-pressure fluids can be accomplished via the use of a heat exchange system.

In some embodiments, the exhaust of the gas turbine can be transported to the solar receiver and used as the low-pressure heated fluid. Optionally, a blower can be used to provide additional ambient air to the low-pressure solar receiver, which can be useful, for example, for regulating the flow of fluid through the system. In some embodiments, a controller can be used to regulate the flow rate of the gas from the blower. The controller can be constructed and arranged to adjust the flow rate of the gas transported from the blower to the solar receiver based at least in part on a condition of the gas transported from the gas turbine to the solar receiver. For example, the controller can be constructed and arranged such that the flow rate of the gas transported from the blower to the solar receiver depends on one or more of the temperature, pressure, and/or flow rate of the gas transported from the gas turbine to the solar receiver.

The low-pressure fluid from the solar receiver, in addition to providing heat to the high-pressure working fluid within the Braxton cycle, can be used to provide heat to a thermal storage system, which can operate, for example, by storing sensible heat from the low-pressure fluid. The thermal storage system can be useful for operating the power cycle during periods of low sunlight, for example, by providing heat to the low-pressure fluid in addition to or in place of the heat provided by the solar receiver. In some embodiments, the thermal storage system can be operated at the high pressure of the turbine, for example, by transporting a pressurized fluid through the thermal storage unit to heat the pressurized fluid prior to, for example, transporting the pressurized fluid to a



turbine. In some embodiments, the airflow from the solar receiver can be switched between the thermal storage system and the heat exchange system used to transfer heat from the low-pressure fluid to the high-pressure Braxton cycle fluid. In some embodiments, a blower can be connected to transport heated air from the thermal storage system into the solar receiver.

V. EFFICIENCY OF A SYSTEM

The overall efficiency of the system can be improved, in some cases, by recovering heat from the low-pressure fluid exiting the heat exchange system used to transfer heat to the high-pressure fluid. For example, in some cases, the low-pressure fluid exiting the heat exchange system can be used to generate steam to power a steam turbine in a Rankin cycle. In some instances, the low-pressure fluid exiting the heat exchange system can be used to provide heat to an absorption chiller, which can be used, for example, to produce chilled water for an air conditioner. The low-pressure fluid from the heat exchange system can also be used to provide heat for general space heating purposes (e.g., via an air to liquid heat exchanger).

Some embodiments of the invention can be used in coordination with solar power tower systems (also known as central tower solar power plants or heliostat solar power plants). Such systems include a plurality of heliostats arranged to redirect sunlight toward the top of a collector tower, sometimes called a central tower, on which one or more solar receivers are mounted. In some such embodiments, the gas turbine and/or the compressor can be mounted, along with the solar receiver, at the top of the solar tower. Other components, such as a thermal storage system can also be mounted at the top of, or within other parts of, the tower.

In some embodiments, low pressure solar receivers are provided that may be used in conjunction with the power generation systems disclosed herein. The solar receivers function, at least in part, to convert solar radiation energy to thermal energy of a working fluid, e.g., a working fluid of a power generation or thermal storage system. The solar receivers typically comprise a low pressure fluid chamber that is designed and constructed, at least in part, to provide an insulated casing that acts to reduce or eliminate thermal losses from the solar receiver, to contain a low pressure working fluid and/or to provide a support structure for a solar absorber. The low pressure solar receivers also typically comprise a transparent object (e.g., window) positioned adjacent to an opening in the receiver for receiving solar radiation. The transparent object functions, at least in part, to contain the low pressure working fluid, to permit solar radiation to pass into the solar receiver (where the radiation impinges the solar absorber) and to eliminate or reduce thermal losses associated with re-radiation from the solar absorber.

REFERENCE

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