



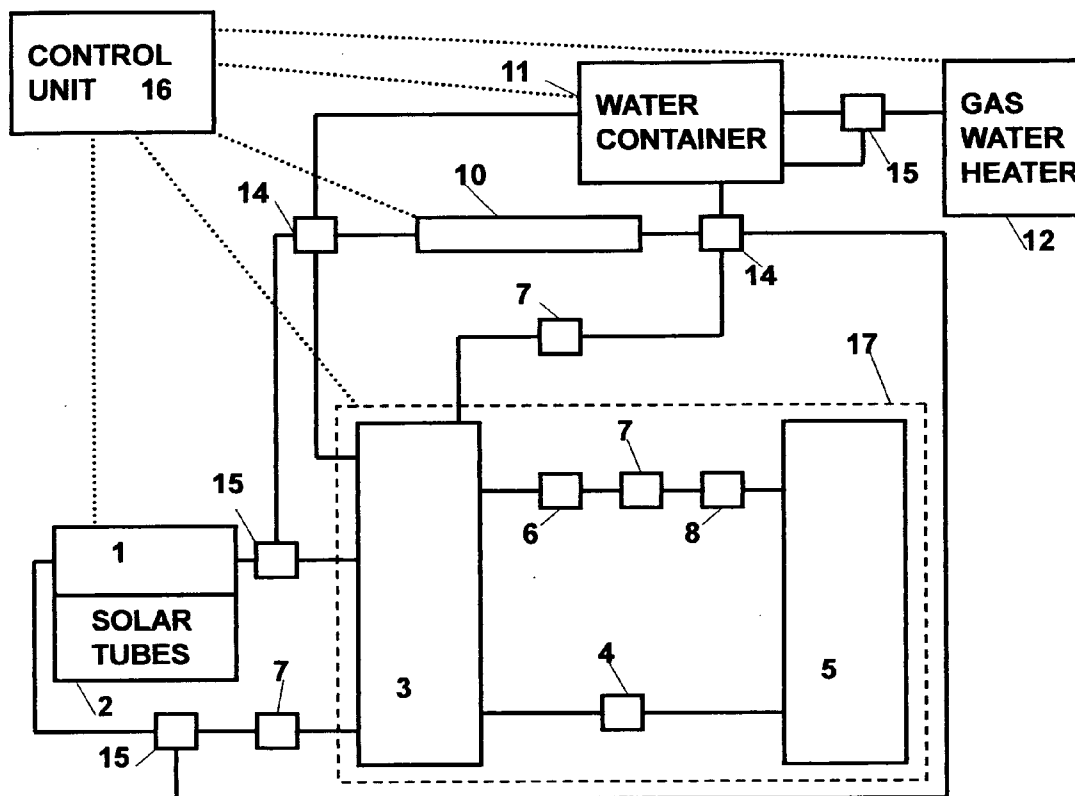
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GAS AND ELECTRICITY AS
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F24J 2/42 (2006.01)(52) **U.S. Cl.** **126/615**(57) **ABSTRACT**

A solar energy saving system composed of solar collectors, a custom built heat pump and a conventional gas heater, a centralized computer control system, a group of sensors, pumps and valves, and the mechanical and electrical connections, is disclosed herein along with the processes and methods for applying the system.

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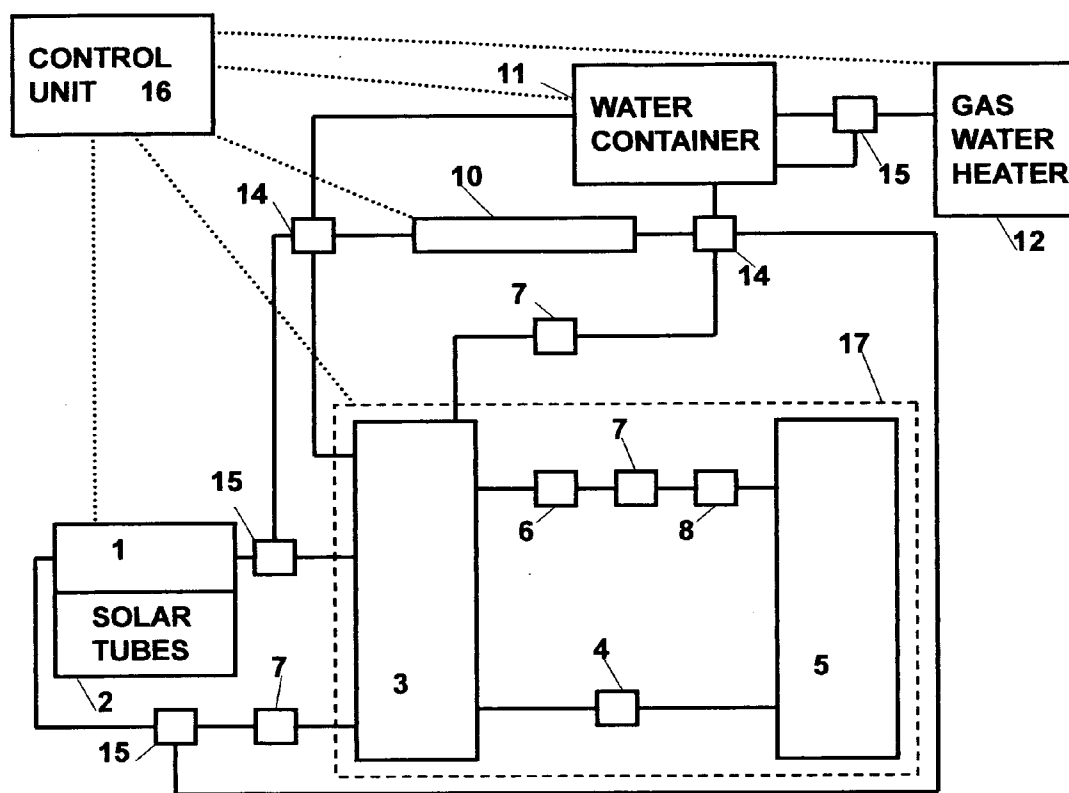


FIG. 1

SOLAR ENERGY SAVING SYSTEM USING GAS AND ELECTRICITY AS COMPENSATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. §119 based on Chinese Patent Application No. 200710171487.X, filed Nov. 30, 2007 and is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention generally relates to energy-saving system, process and method. In particular, this invention relates to a solar heating/cooling system with heat pump and uses common gas or electrical energy as supplementary supply. This solar system comprises solar thermal collectors and heat storage container connected with a heat pump, wherein a common gas water heater is intelligently connected via pipes and controlling signals.

[0004] 2. Background of the Related Art

[0005] Being known as clean and inexhaustible energy, there is a huge challenge for human to make use of solar energy, which could largely reduce the conventional energy consumption protecting environmental and reducing greenhouse effects, it has been great efforts for all the nations to make the most use of solar energy heating system for hot water and airconditioning for our normal families and business. However, solar energy application is affected seasonally and by weathers, and it cannot guarantee satisfaction for all application requirements. For the reason above mentioned, there are lots of solutions to overcome the shortage of solar energy only systems, such as using mixed power of solar energy with electrical, for example: water heater or space heating or airconditioning heat pump technology is existing. While there is no practical system, process and method exist to apply solar energy together with existing appliance of heat pump and common gas water heater to provide an energy effective system that make the most use of the solar energy for water heating and airconditioning. It is normal that people have to remove conventional gas water heater, or airconditioning heat pump, before taking advantage of installing the clean solar energy system, even the conventional appliances are still in good working condition, which prevent the renewable solar energy system from being widely used.

SUMMARY OF THE INVENTION

[0006] This invention is provided for overcoming the shortage of aforementioned present arts, and disclosed a system and method thereof applying solar system with widely used fuel gas water heater or electrical heat pump as compensation energy. With this invention, solar thermal system could be cost-effectively used together with common gas water heater and heat pump providing a solution applying for solar energy while minimizing the consumption of non-renewable energy.

[0007] In embodiment, the solar energy saving system with conventional gas and electricity as compensatory, comprising a solar thermal system, a heat pump, and a conventional gas water heater. It is connected together by a group of pipes, valves, sensors and pumps with a central computer control

unit intelligently controlling the most application of the solar energy and the least compensation of the conventional energy.

[0008] In the condition of adequate sunshine and the solar system outputs enough energy, the central intelligent control system detects the energy level and remains the solar thermal circulating to store as much as energy in the system while keeps heat pump and gas water heater halt. In the condition of lacking sunshine, the central intelligent system detects the solar system exporting less or no energy, and also detects the needs for energy usage, for example: pre-set water temperature or space temperature, to decide whether to turn on energy compensation components: the heat pump or the gas heater. The commonly used gas heater is preferably applied as a complementary energy source herein the solar system and it is programmed to turn on in the worst environment situation where both the solar system and the heat pump lose their working efficiency.

[0009] The said heat pump used in the system includes compressor, vaporizer, condenser, expansion valve, refrigerant storage, phase change separator, filter and water container, wherein the condenser and vaporizer are custom built to integrated into heat-exchanger/condenser and heat-collector/vaporizer to accommodate the system needs.

[0010] The heat pump in the system is performing supplementary function for water heating and space heating, while it is the heat pump that performs the space cooling for airconditioning function, when the opposite heat energy created by the refrigerant condensing loop is recovered by the heat-exchange/condenser and stored in the water container.

[0011] The solar energy saving system preferably apply water as the heating and cooling medium for the heat pump, which is convenient for solar energy to add and store energy in, and it is convenient for connecting the existing gas water heater in the system. In the system, the hot water or the chilled cycles inside coiled conduit in the air handler, and fans blow the conduit to provide warm or cool air.

[0012] The solar system collector may be arranged in vacuum tube, or heat pipe vacuum tube where the collector provide primary energy for heating water directly into the water storage container, or into the heat pump condenser—the “energy sourcing” for the heat vaporizing loop of heat pump.

[0013] Furthermore the solar heating system with fuel gas and electrical compensation includes sensor, pipes, valves and power supply, wherein: the said sensor including temperature sensor, water-level sensor and photometric sensor sated in the outlet of the said solar collector, water container, condenser of heat pump, coiled conduit, inlet of gas water heater for testing the temperature, water-level and intensity of illumination and transferring the signals to control unit; the said pipes using for connecting all the devices as the running way of water, refrigerant and thermal medium, and the said valves using for controlling flow rate and direction; the said power supply providing electric power for each device.

[0014] Optionally, electrical water heater could replace the said gas water heater.

[0015] Owe to the above-mentioned invention, it solves the problem of the current situation of only using gas or electricity as heating energy for residential, industrial and commercial users. It takes solar energy as the main energy to provide heating for water and space, and uses gas and electricity as the supplementary energy. This invention can be used in any hot

water supply and airconditioning system to save energy and reduce emission and decrease the greenhouse effect.

BRIEF DESCRIPTION OF THE DRAWING

[0016] So that those having ordinary skill in the art to which the invention pertains will more readily understand how to make and use the systems and methods of the invention, embodiments thereof will be described in detail herein below with reference to the drawings, wherein:

[0017] FIG. 1 shows the structure diagram of a preferred embodiment of a solar energy saving system connected with a conventional gas water heater and an electrical air-to-water heat pump.

[0018] The FIG. 1 gives features of this invention, which now be described with reference to the drawing of preferred embodiment, it is intended to illustrate and not to limit the other embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The advantages of systems and methods of the invention will become more readily apparent to those having ordinary skill in the art from the following detailed description of certain preferred and exemplary embodiment taken in conjunction with the drawing, which are not intended to limit the scope of the invention.

[0020] FIG. 1 schematically depicts a typical solar energy saving system with gas and electrical energy as compensation in accordance with the preferred embodiment. This solar system includes solar collectors 1 connected with heat pump 17 and a water container 11; the system further includes a conventional gas water heater 12 and a computer control unit 16. The control unit 16 controls each component of the system to work in the priority or the program logical of solar collectors 1 collecting solar heat first, the heat pump 17 second and the gas water heater 12 third to meet the heating requirements. In the environment of adequate sunshine, when the control unit 16 detects enough solar energy is available, it controls the solar collectors 1 continually working to store energy into the storage container; the heat pump 17 works to meet the cooling requirement, and it only works when the control unit 16 detects no enough energy stored in the container to meet the heating requirement; the common gas water heater 12 only works to compensate the energy shortage in the situation of insufficient sunshine and the ambient temperature is really low, for example: lower than -5 degree centigrade (in this situation, no matter how the compressor of heat pump is working, the energy efficiency ratio is poor), when the gas heater 12 is opened up by the control unit.

[0021] In the described embodiment, the heat pump 17 is composed by condenser 3, compressor 4, vaporizer 5, expansion valve 8, refrigerant storage 6, filter 7 and water container 11, wherein the condenser is custom built with a coiled pipe heat-exchanger/condenser placing in the water container 11 and the solar thermal energy can feed into the heat-exchanger/condenser, in which the heat energy is recovered when the heat pump runs in cooling loop, and the air, solar and gas are its combined heat energy sources.

[0022] In the preferred embodiment, the heat pump 17 works for airconditioning, it heats or cools the cycling water inside the water conduit 10 located at the air handler, the fans blow the water conduit 10 sending out warm or cool air.

[0023] In other embodiments, the heat pump 17 could be composed of specifically wherein the condenser 3 and vapor-

izers exchange their functions when the heat pump runs in "cooling loop" and "heating loop" respectively to provide airconditioning function as well as water heating function.

[0024] The solar collectors 1 could choose solar vacuum tube, solar vacuum heat superconductivity tube 2, or solar metal flat panel, the solar collectors use water or other liquid as thermal medium.

[0025] Furthermore, the solar energy saving system comprises temperature sensors, water-level sensors, photometric sensors, pipes, the valve group (three-way valve 15 and four-way valve 14) and power supply. The temperature sensors, water-level sensors and photometric sensors are sated in the outlet of solar collectors, water container, the condenser of heat pump, the water conduit of air-conditioner and inlet of gas water heater. They are settled at the relevant working places for testing and detecting the temperature, water-level and the intensity of illumination from the sun, and translating the corresponding signals to the control unit. The pipes and valve group (three-way valve 15 and four-way valve 14) are used for connecting devices and directing/controlling water, refrigerant and thermal medium flow.

[0026] The solar collectors 1 use heat circulating pump to transfer thermal energy. It is temperature difference controlled heat transferring circle: when the solar collectors 1 outlet temperature reaches a certain higher figure than a preset stored water temperature, the circulating pump opens, when the temperature difference reaches the preset minimum figure, the circulating pump stops.

[0027] In preferred embodiment, a water-pure system is applied preventing inside scaling for longer system life time.

[0028] The power supply provides electric power for each device.

[0029] One advantage of this invention is it could be easily integrated with the existing gas heating and air-conditioner system providing a simply solution to use the green solar energy for residential, industrial and commercial needs.

[0030] This solar system and method has unlimited usage for different climates and different latitude areas. Take a normal family for example, if the family consumes gas (produced by burning 50 kilograms coal) for water and space heating, and airconditioning in 300 days one year; if the gas usage is replaced by this invention, it will save about 15,000 kilograms of coal burning in one year. Presumably, one thousand kilograms of coal burning generates 5 kilogram of sulfur dioxide, carbon dioxide and other noxious emissions, using this solar system, one normal family will decrease at least 15 kilograms of noxious emissions one year.

[0031] In over two third of territories in China, the amount of sun insulation is more than 2200 hours per year, and the total solar energy quantity is greater than $(502\sim670)\times 10000$ kJ/m². The table below illustrates the energy-saving effect by applying solar water heater for one year in the example environment, it shows that 10 million square meters collecting areas of solar system can save 40-50 million tons of standard coal burning; and can save 4.5-5.0 billion Wh of electricity.

	One square meter solar heating system	Gas only water heater	Gas only heating	Electrical Only water heater
Standard coal	0 kilogram	150-180 kilograms	200-250 kilograms	
Electricity	<10 Wh			450-500 Wh

[0032] With satisfying the need of hot water supply, heating and airconditioning for residential and commercial, this invention provides the highest and the best utilization using solar energy, electricity and gas. The initial investment and operating cost in the first five years applying this invention are far below the cost of using any conventional energy: electricity or gas only, for hot water supply and airconditioning.

[0033] The table below illustrates the emission reduction by using the solar system comparing to use gas and electrical water heater for one year:

Emission reduction	1 square meter collecting area solar system	Gas only water heater (emission ratio)	1 square meter collecting area solar system in its serviceable lifetime	10 million square meter collecting area solar system
Sulfur dioxide	0 kilogram	0.02	3.96 kilograms	39,600 tons
Nitrate dioxide	0 kilogram	0.01	1.68 kilograms	16,800 tons
Dust	0 kilogram	none	3.66 kilograms	36,600 tons
Carbon dioxide	0 kilogram	1.79	322 kilograms	3,220,000 tons

[0034] The table below illustrates the potential economic benefit of this invention:

Heating water temperature	1 square meter solar system	Electrical water heater	Propane gas water heater	Coal burning boiler
The beginning temperature is 15° C., for heating 90 kg water to 50° C.	Absorbing solar energy 13.23 MJ per day	Electrical consumption 3.657 kWh, (if conversion efficiency is 98%, the total consumption is 3.732 kWh)	If the heating energy ratio is 42 MJ/kg, and the conversion efficiency is 70%, 13.23 MJ energy burns 0.45 kg propane gas	A boiler producing 2 tons hot water in 50° C., burns coal 300 kg, it equals to save coal 13.5 kg per day using solar system.
Costing	Initial investment almost 2500	If the price is 0.47/kWh, solar system saves 1.75 electricity cost per day and 640 per year.	For 15 kg per cylinder, the price is 45, and it cost 1.35 to heat the water and saves 493 per year.	For coal price of 250/ton, it saves 1232 per year.

[0035] While the particular embodiments as shown and disclosed herein are fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as described in the appended claims.

What is claimed is:

1. A solar energy saving system with conventional gas and electricity as compensatory, comprising
 a heat pump composed of condenser, compressor, vaporizer, expansion valve, refrigerant storage, phase change filter, wherein the condenser forms part of the solar collectors and water heating exchanger, or the refrigerant-water vaporizing/condenser, or refrigerant-air vaporizing/condenser, the condenser forming the heat pump "energy source" gets the energy from the air, solar, electricity and gas;
 a conventional gas water heater is intelligently connected with the system via pipes and controlling signal;
 a computer control unit loaded with controlling softwares controls thermal circulation of the solar collectors, with

or without heat pump and gas heater working in conditions of using the most of solar energy and the least of conventional energy;

a group of sensors, pipes, valves and pumps applied in the system.

2. The solar energy saving system of claim 1, wherein the heat pump includes air-to-water, or air-to-air, or water-to-water, or water-to-air differing types, in which the condenser and evaporator are fabricated differently and performed functions of heating and cooling.

3. The solar energy saving system of claim 1, wherein the conventional gas water heater is intelligently integrated with

connection to the heat pump water-vaporizing/condenser or direct connection to the air-handler water conduit providing supplementary heating function when solar energy is absent and ambient environment temperature is really low.

4. The solar energy saving system of claim 1, wherein a heat exchanger as part of the water-vaporizing/condenser exists providing heat recovery function when the heat pump is working for cooling.

5. A solar energy saving system, comprising
 the solar collector, thermal circulating medium and energy storage container, wherein the collector could be solar vacuum tube, solar vacuum heat superconductivity tube or solar metal flat panel; the thermal circulating medium is water or other anti-freeze liquid.

6. A computer software system performs the intelligent control function in the system, where it accepts inputs from sensors and outputs controlling signals to valves and pumps in the system in the logic of using the solar energy in all possible situation, while provide conventional electricity or gas energy only in the necessary conditions.

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