



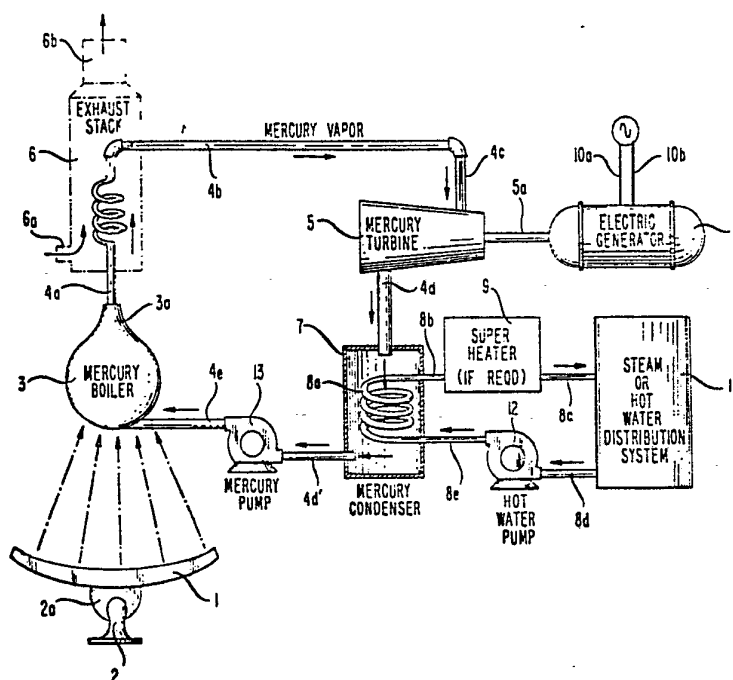
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(54) Title: METHOD AND APPARATUS FOR GENERATING HEAT AND ELECTRICITY BY SOLAR ENERGY

(57) Abstract

A solar energy system that concentrates the sun's rays by means of a concave reflecting surface (1) trained to follow the sun, and disposed to focus the sun's rays on a mercury boiler (3) so that mercury vapor may be employed at relatively high temperatures without encountering the high pressures that occur with steam. Mercury vapor generated by the boiler passes through a conduit system to drive a mercury turbine (5) which is coupled to operate an electrical generator (10). The mercury vapor then passes through a condenser (7) where it is condensed to liquid by heat-exchange with water pumped through an inner coil. In accordance with one alternative, the heated water may be passed through a superheater (9) where it is converted to steam. The hot water, or steam, as the case may be, passes into a distribution system (11) where it may be used for residential, industrial or commercial heating. The partially condensed steam or hot water is returned through the pump (12) to the inner coil (8a) of the mercury condenser. Where there is an auxiliary oil or gas-fired heating system available, the discharge pipe from the mercury boiler may be passed through the fuel exhaust stack (6) to absorb supplemental heat.



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METHOD AND APPARATUS FOR GENERATING
HEAT AND ELECTRICITY BY SOLAR ENERGY

Background of the Invention

This relates in general to solar energy systems;
5 and more particularly, to systems in which the sun's rays are focused for the purpose of vaporizing fluid which is utilized to generate power and supply heat for residential, industrial and commercial consumption.

Many of the prior-art systems utilize steam
10 boilers which require high pressures in order to drive turbine or other power-generating equipment. This requires the use of systems, including boilers, conduits, turbine and condensers, which are of high strength materials and are therefore expensive to construct and
15 maintain.

Further, one of the disadvantages of many types of prior art solar systems is that they are completely dependent on sunlight, and do not function at all during the night, or on cloudy days.

20 It is therefore a principal object of this invention to provide improvements in systems for focusing solar energy to vaporize fluid.

A more particular object of the invention is to provide a solar energy system of the type described which is cheaper to build and maintain than the
25 systems of the prior art. Another object of the invention is to provide a system of the type described which is readily adapted to augment the heat derived from solar



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energy with waste heat derived from other sources.

These and other objects, features and advantages are realized in a system in which solar energy is focused on a mercury boiler by a concave or parabolic mirror, trained to follow the sun, the vapor from which boiler is pumped through a conduit system which leads into a mercury turbine. The exhaust vapor from the turbine passes into a condenser where it is condensed back to liquid by heat-exchange with a coil bearing water.

The water in the coil is heated up and may be converted to steam, being pumped through an independent heat distribution system, the output from which passes back into the condenser coil. As an alternative, the conduit from the mercury boiler may be passed through the exhaust gas stack of a conventional oil, gas or coal heating system, so as to absorb heat from the exhaust gases during periods when no sunlight is available.

A particular advantage of the system of the present invention over prior systems in which solar energy is focused to vaporize water or other low density fluids, is that the pressure of mercury vapor is substantially lower than that of steam at the high temperatures generated at the focal point of the reflector by solar radiation. Hence, the conduit systems and generating and condensing equipment of the present invention need not be constructed of as high-strength material, and are less expensive to build and maintain. Another advantage of the present invention is that, in the alternative, the mercury vapor conduit is constructed to pass through the stack of a conventional heating system to thereby absorb waste heat from an additional energy source, thereby providing an auxiliary energy source for periods when the sun is not shining. Further advantages of the mercury vapor system of the present invention over systems employing water is that there is no danger of the system freezing up in winter; and there is less danger of leakage in the system than with conventional steam systems.

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These, and other objects, features, and advantages of the present invention will be better understood from a detailed study of the specification hereinafter with reference to the attached drawing, Fig. 1, which is a
5 schematic showing of a preferred embodiment of the present invention.

Detailed Description of the Invention

Referring to Fig. 1, there is shown a solar reflector 1 which may, for example, be in the form of
10 a parabolic dish of a type well-known in prior art practice.

The parabolic dish reflector 1 is mounted on a bearing member 2a, which, for example, may take the form of a metal semisphere, preferably of steel which is drilled with a cylindrical bore perpendicular to the
15 plane of the drawing which accommodates and is disposed to rotate or swivel about a rod mounted in the support member 2. In accordance with well-known prior art practice, the reflector 1 may be always trained on the sun, and may be driven to rotate in such a manner that the sun's rays
20 as received, are always substantially perpendicular to its principal axis, and will thus concentrate the rays at the focal area of the reflector.

The solar collector system comprising the parabolic dish 1 and associated driving means is designed to
25 cooperate with a mercury-vapor-steam electric generating system of the general form disclosed in Mechanical Engineers Handbook, 1941 Edition, edited by Lionel S. Marks, published by McGraw Hill Book Company, Sect. 9, Power Generation, Chap. 4, Steam Turbines by F. Hodgkins,
30 Fig. 28, pages 1247, 1248 and 1249.

The mercury boiler 3, which rests at the focal area of reflector 1 on a conventional open support, not shown, comprises, for example, a retort of platinum of general spherical form, the upper end of which takes the
35 form of a neck 3a. The mercury boiler 3 holds a quantity of liquid mercury, which is heated to a temperature of about 975 degrees Fahrenheit, and generates mercury vapor



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at a pressure of about 140 pounds per square inch gauge. These values are indicated in the Mechanical Engineers' Handbook, 1941 Edition, supra, Sect. 4, in the Chapter entitled Thermal Properties of Bodies and Thermodynamics
5 by H. C. Weber, page 336, Table 23.

At top speed, assuming mercury vapor at a pressure of 125 pounds per square inch gauge at the turbine, and 3 inches of mercury absolute at the turbine exhaust, the turbine 5 drives the shaft 5a at the
10 rate of 900 revolutions per minute. Shaft 5a, in turn, is coupled to operate a conventional electrical generator 10 of a form well-known in prior art practice. When the shaft 5a operates at the rate of 900 revolutions per minute, the generator 10 will produce alternating
15 current electricity across the terminals 10a, 10b.

The output vapor from the mercury turbine 5 passes into the condenser 7 through the conduit 4d, which may be of substantially similar cross-section and material as the conduits 4a, 4b and 4c. The mercury condenser 7, may be of any of the forms well-
20 known in prior art practice.

A coil 8a, of stainless steel pipe is centrally disposed in the condenser 7. Water is pumped into coil 8a by a hot water pump 12, which may be of
25 a type well-known in prior art practice.

The water is further heated by a heat-exchange with the mercury vapor, which gives out heat as it is again reduced to liquid mercury. The latter passes from conduit 4d leading from mercury condenser 4d' through
30 the mercury pump 13, out through the conduit 4e, and into the mercury boiler 3 where it is reconverted to mercury vapor. The mercury pump 13 is of a type well-known in prior art practice.

The water from coil 8a of the condenser 7
35 which has been heated in a heat exchange with the condensed mercury vapor, is passed out through the conduit 8b. In a preferred embodiment, this water (or steam if



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it has been heated hot enough) passes into a conventional super-heater 9 which may be of the general form well-known in prior art practice.

The hot water or superheated steam, as the case
5 may be, then passes into a conventional utilization system 11 which may be a residential, industrial or commercial heating plant, the output water (or condensed steam) returning from which passes through the conduit 8d and the hot water pump 12, and back into the condenser coil
10 8a through the conduit 8e.

It will be understood that the invention is not limited to the specific form of system, shown by way of illustration, but only by the scope of the appended claims.



C L A I M S

1. A system for collecting solar energy which comprises in combination:

a concave reflector directed to receive radiation from the sun and to focus said energy on a focal area,

means for driving said reflector to follow the diurnal course of the sun,

a boiler containing a quantity of mercury disposed in said focal area, whereby said mercury is brought to a boil by energy from the sun which is focused in said focal area,

a mercury turbine,

a first conduit system connected between said mercury boiler and said mercury turbine for delivering mercury vapor to drive said turbine to rotate,

an electrical generator coupled in driven relation to said mercury turbine,

a mercury condenser connected by conduit means to receive the mercury vapor output from said mercury turbine,

a fluid coil enclosed in said mercury condenser,

a fluid distribution system,

a second conduit system including pumping means for pumping the output from said fluid distribution system into the fluid coil in said mercury condenser for heat exchange with the condenser vapor in said mercury condenser, and for pumping the heated fluid from said mercury condenser into said distribution system for dissipating the heat from said fluid in said dissipation system.

2. The combination in accordance with claim 1, in which the fluid in the coil in said mercury condenser is water.

3. The combination in accordance with claim 1,



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in which the fluid in the coil in said mercury condenser is steam.

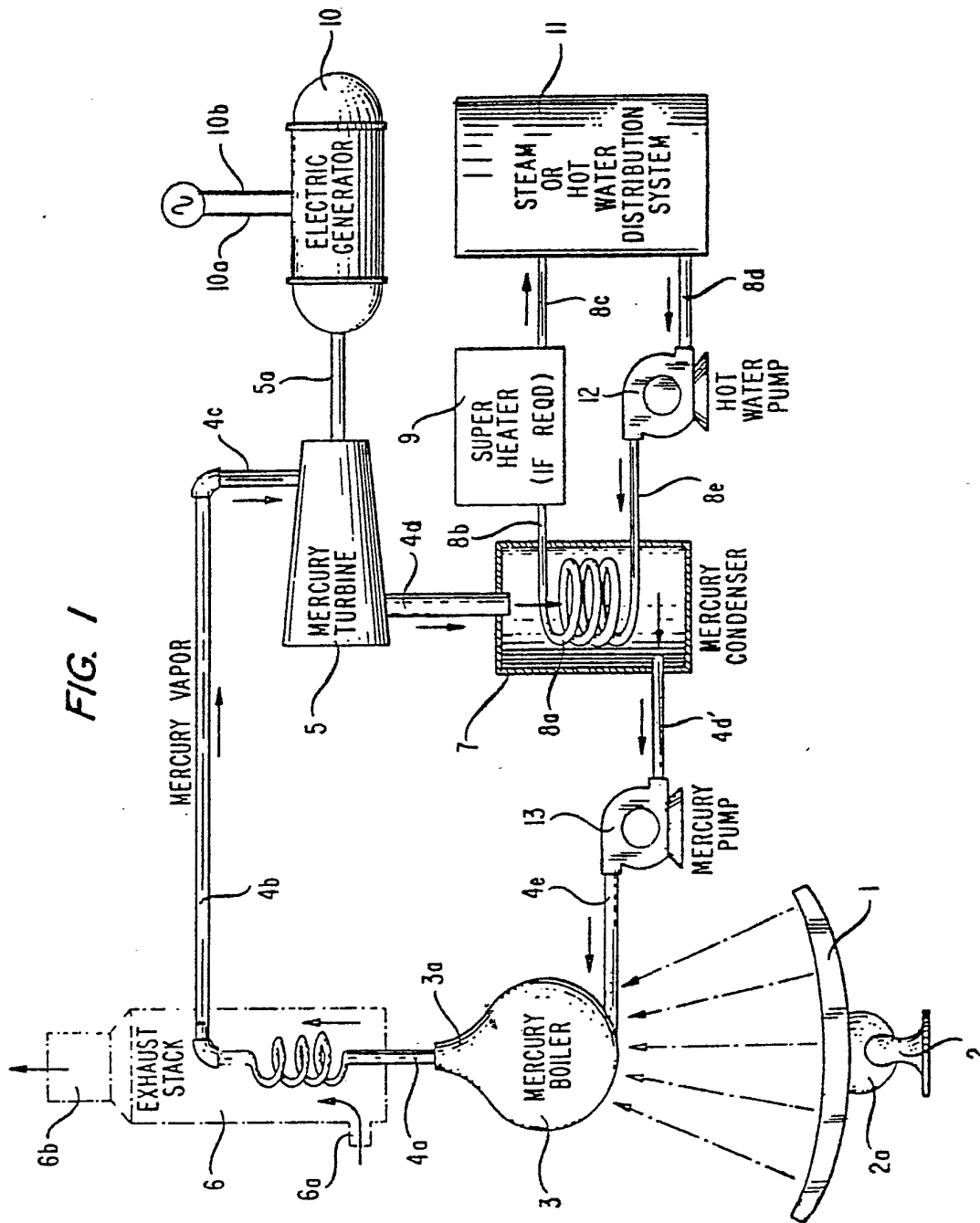
4. The combination in accordance with claim 3, in which a super-heater is connected into said second conduit system between said mercury condenser and said distribution system for super-heating the steam from said condenser before directing it into said distribution system.

5. The combination in accordance with claim 1, which includes a conventional heating system having a stack through which heated waste gases escape to the atmosphere, and said first conduit system is constructed to pass through said stack in heat-exchange relation with said waste gases.

6. The combination in accordance with claim 5, wherein the portion of said first conduit system constructed to pass through said stack includes a coil of pipe in heat exchange with said waste gases.



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INTERNATIONAL SEARCH REPORT

International Application No PCT/US 80/00999

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl. ³ F03G 7/02	U. S. Cl. 290/52	
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
U. S.	60/641,648 126/427,435 290/1A,1R,2,52	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	'Steam Turbines', F. Hodgkins, Fig. 28	1 thru 4 5&6
X	U S,A, 3070703 Published 25 December 1962 Podo1ny	1 thru 4 5&6
X	U S,A, 4159017, Published 26 June 1979, November 1	5&6
A	U S,A, 4116223, Published 26 September 1978, Vasilantone	1-6
A	U S,A, 4079591, Published 21 March 1978, Derby et al	1-6
[*] Special categories of cited documents: ¹⁵ "A" document defining the general state of the art "E" earlier document but published on or after the international filing date "L" document cited for special reason other than those referred to in the other categories "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but on or after the priority date claimed "T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention "X" document of particular relevance		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ²	
6 November 1980	09 DEC 1980	
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