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(54) **SOLAR POWER CONCENTRATING SYSTEM**

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(57) **ABSTRACT**

An outer side of a receiver is covered with a housing, so that the receiver is not exposed to the open air and no heat of the receiver is taken by winds, to improve thermal efficiency. Although the outer side of the receiver is covered with the housing, a lower side thereof has an opening, so that sunlight reflected by heliostats is introduced through the opening to the inside of the receiver and is surely received by an inner face of the receiver.

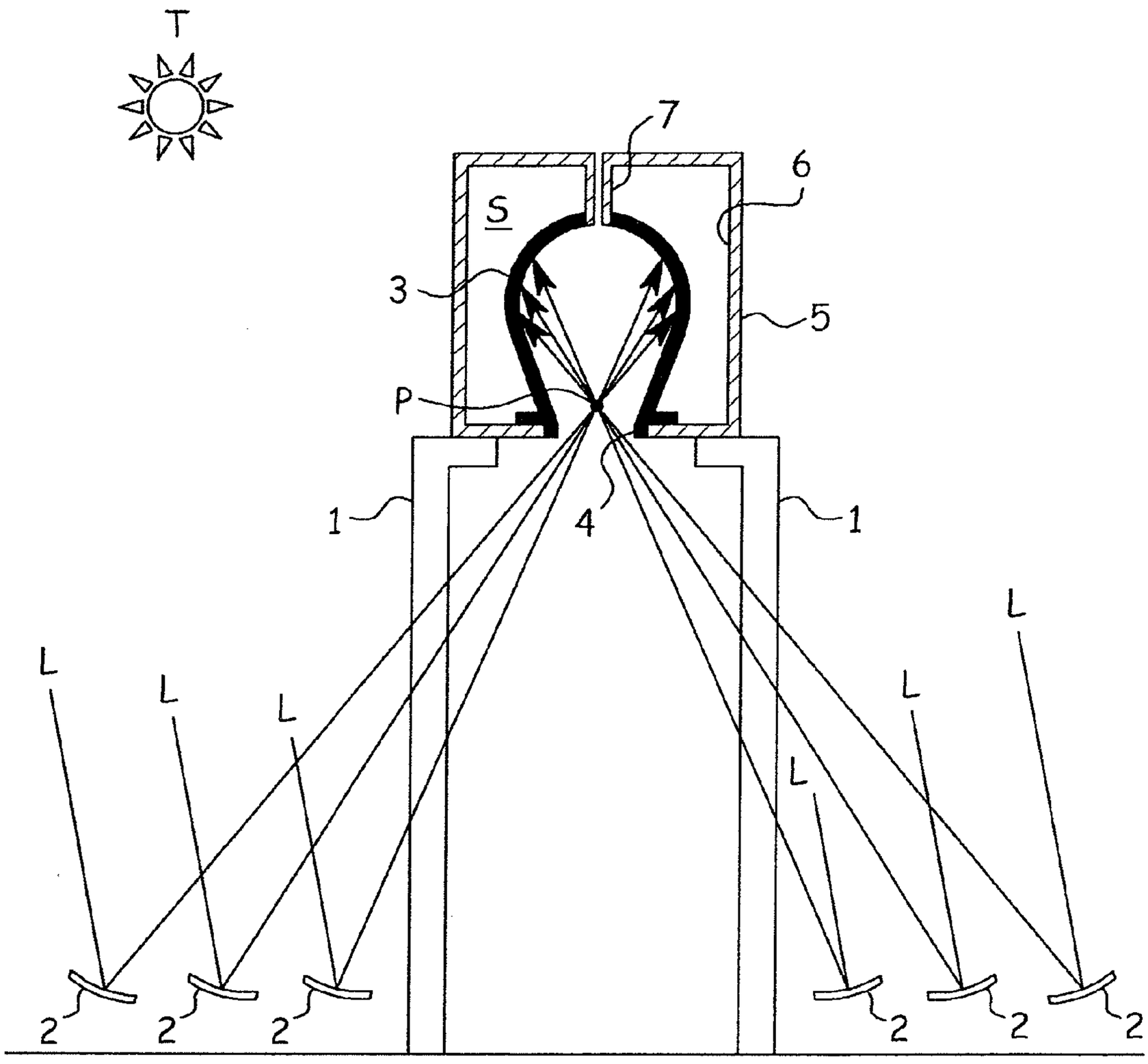


FIG. 1

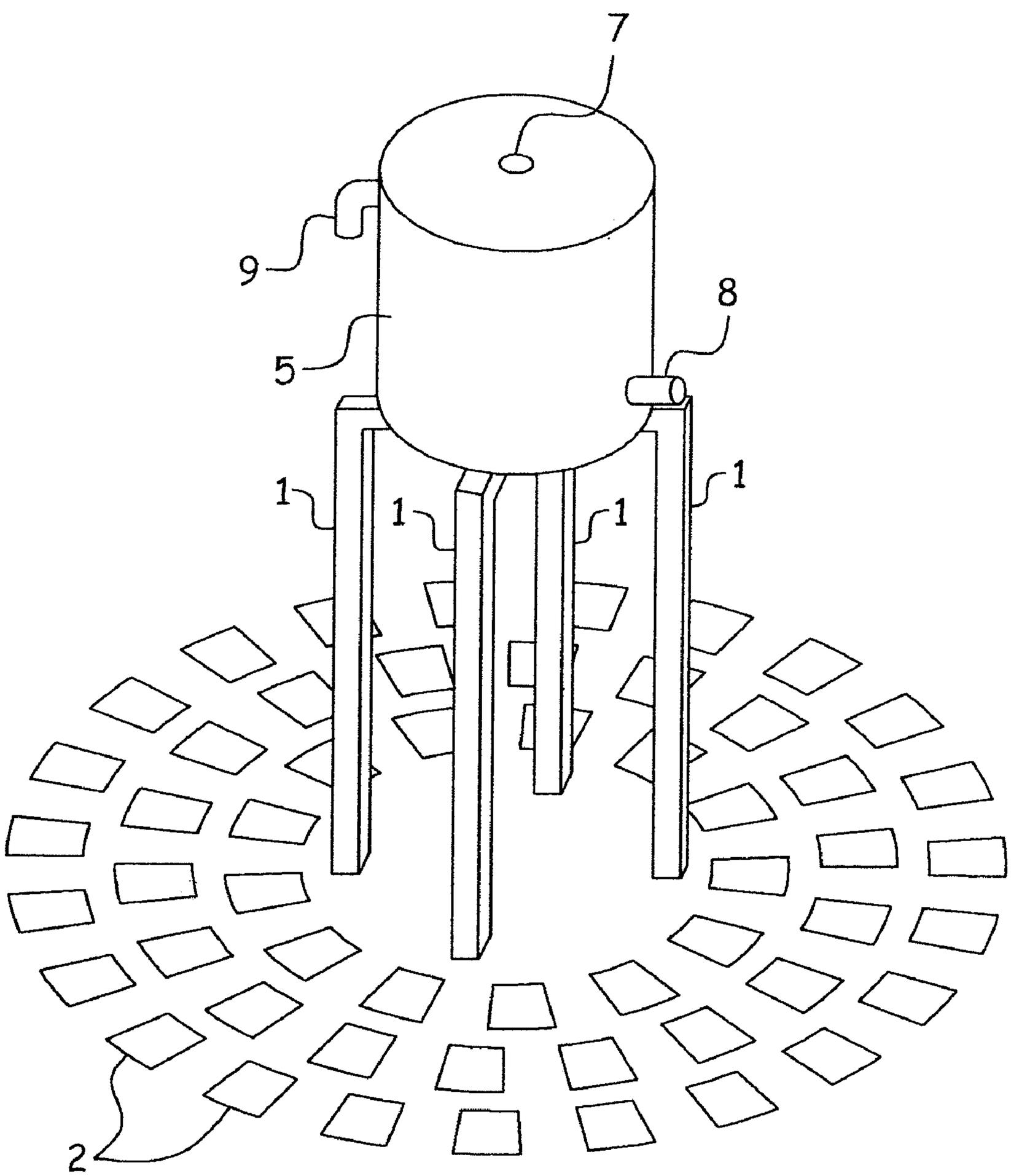


FIG. 2

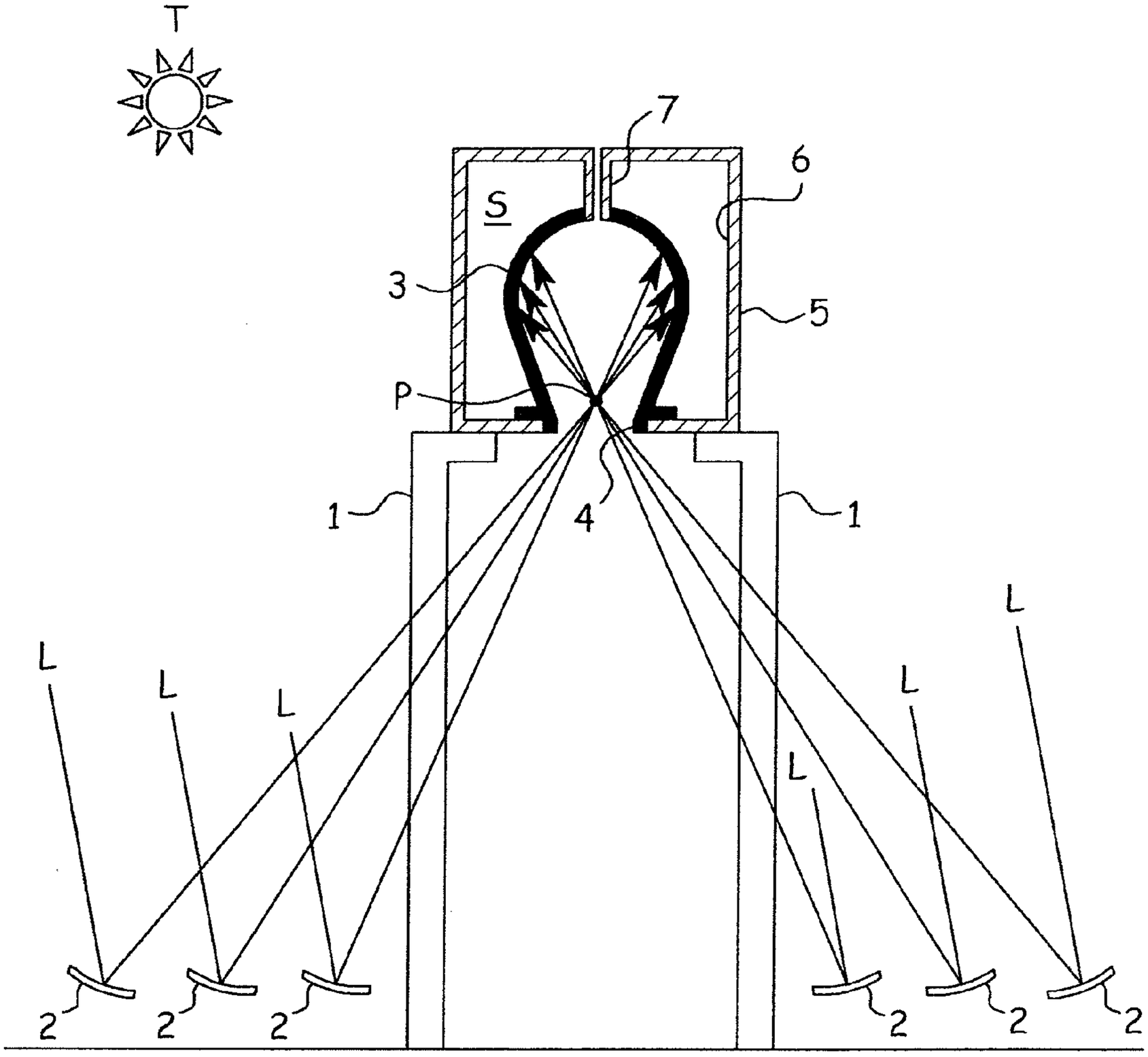


FIG. 3

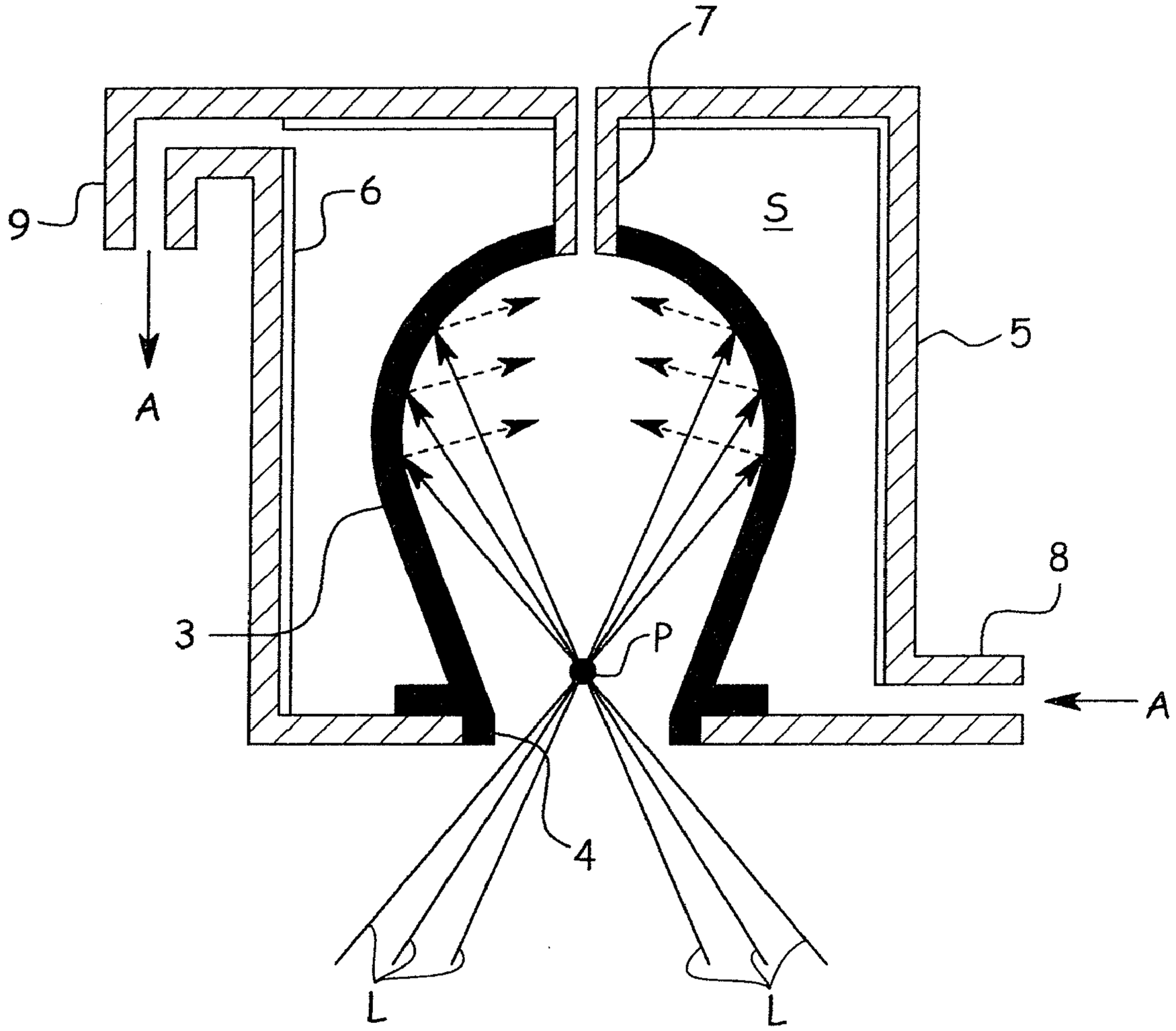


FIG. 4

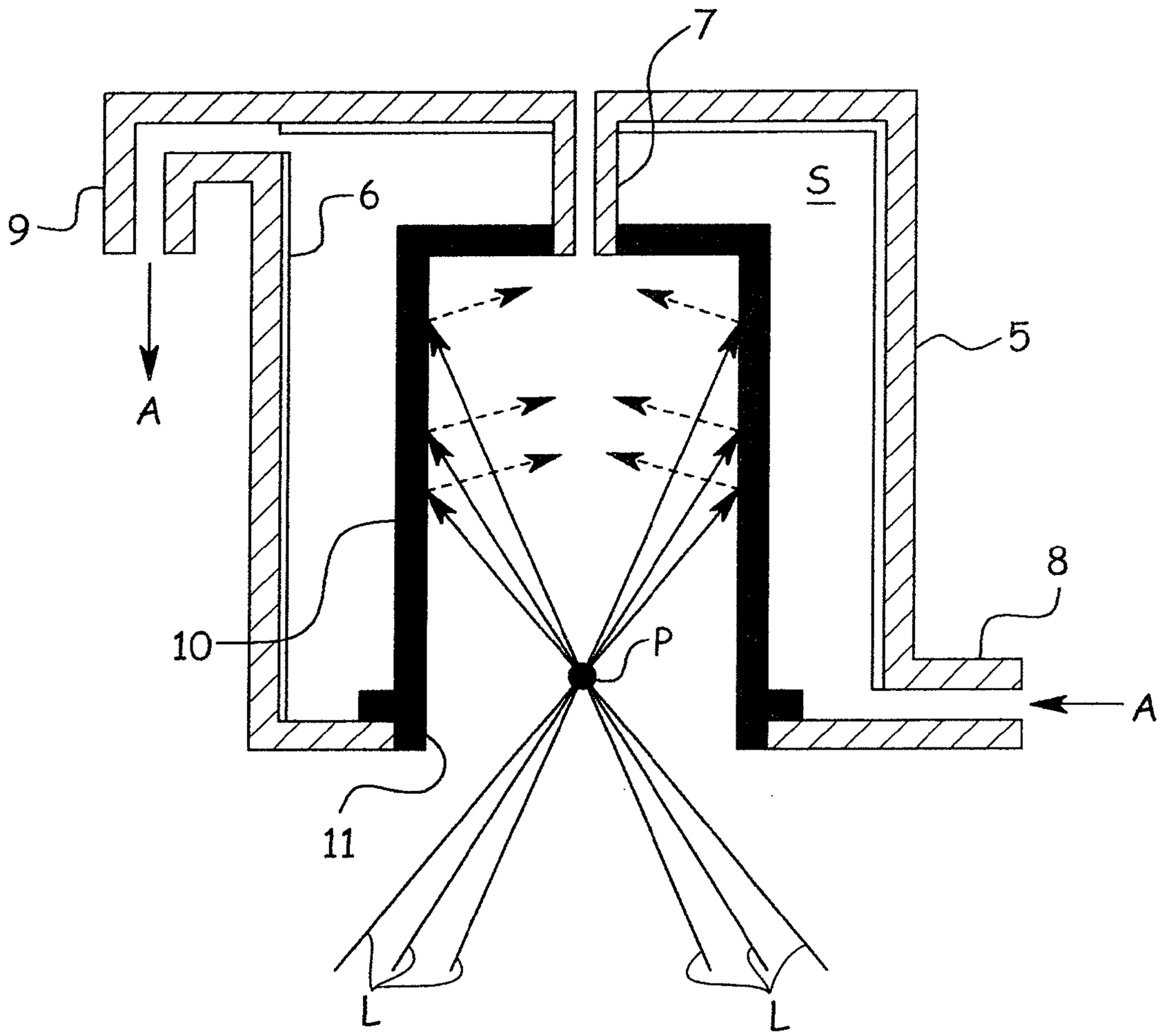
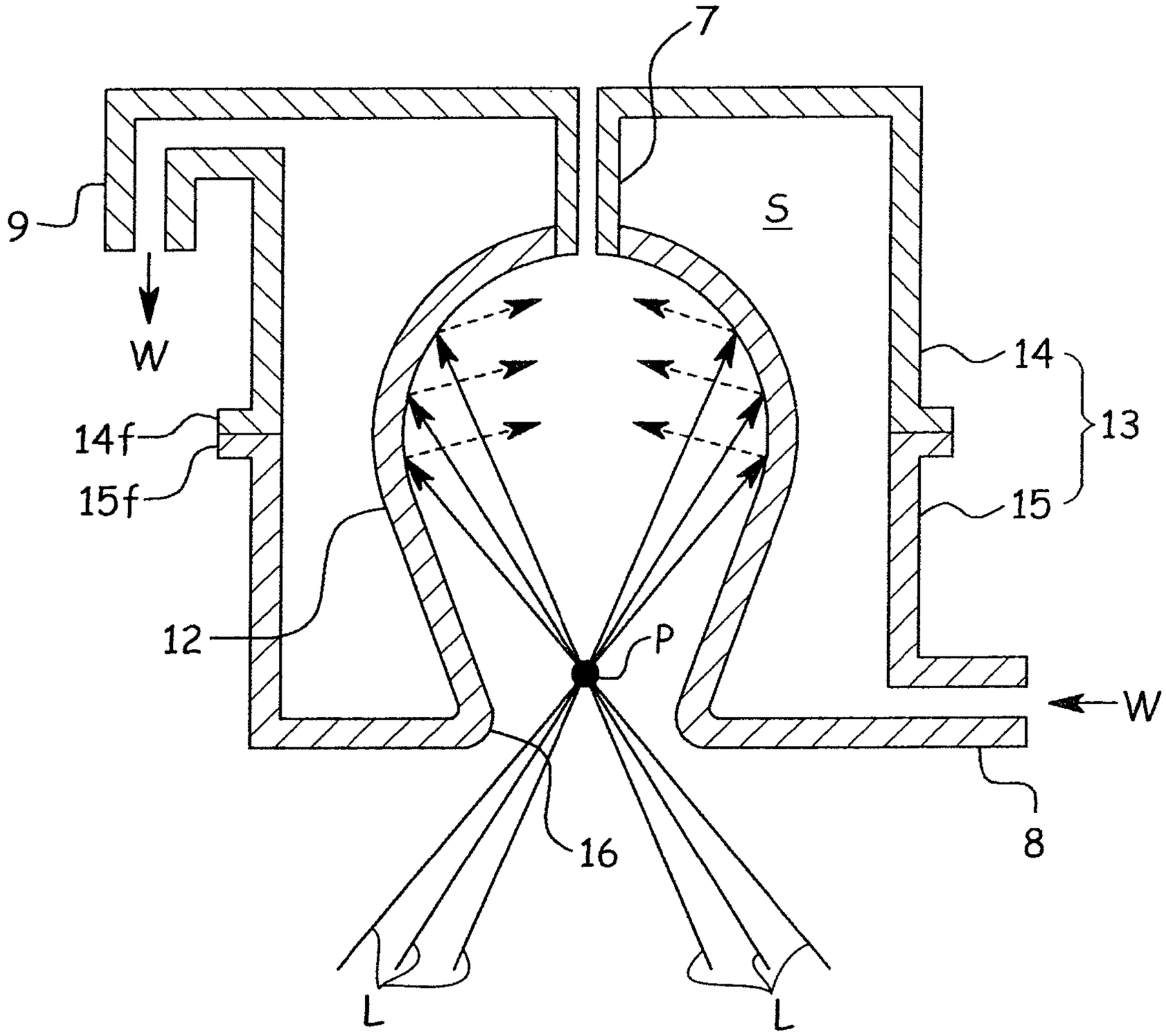


FIG. 5



SOLAR POWER CONCENTRATING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to a solar power concentrating system.

BACKGROUND TECHNOLOGY

[0002] A known solar power concentrating system arranges a receiver at the top of a tower installed on the ground, and on the ground around the tower, sets a plurality of heliostats that follow the sun. The heliostats follow the sun and reflect sunlight toward the stationary receiver. The sunlight reflected by the plurality of heliostats concentrates in the receiver to make the receiver high temperature. Inside the receiver, there is a path to pass a heating fluid (for example, molten salt). Passed through the inside of the receiver, the heating fluid becomes high temperature. The high-temperature heating fluid is circulated through a place that needs heat (for example, a steam generator). In this way, the heating fluid transfers the heat of the receiver. A related document is, for example, U.S. Pat. No. 4,227,513.

SUMMARY OF INVENTION

[0003] According to the related art, the receiver is exposed to the open air at the tall position, and therefore, winds take heat from the receiver. In addition, the high-temperature receiver radiates heat, to deteriorate thermal efficiency.

[0004] In consideration of the related art, the present invention provides a solar concentrating system capable of improving thermal efficiency.

Means to Solve the Problems

[0005] According to an aspect of the present invention, the solar concentrating system has a receiver installed at a predetermined height and heliostats arranged on the ground around the receiver, to reflect sunlight toward the receiver. The receiver has an inverted container shape having at a lower side thereof an opening to introduce sunlight. A housing is arranged on an outer side of the receiver, surrounds the receiver except the opening, and defines a space for a heating fluid defined between the housing and the receiver

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. **1** is a general perspective view illustrating a solar concentrating system according to a first embodiment of the present invention

[0007] FIG. **2** is a sectional view illustrating the solar concentrating system

[0008] FIG. **3** is a sectional view illustrating a receiver

[0009] FIG. **4** is a sectional view illustrating a receiver according to a second embodiment of the present invention

[0010] FIG. **5** is a sectional view illustrating a receiver according to a third embodiment of the present invention

MODE OF IMPLEMENTING INVENTION

First Embodiment

[0011] FIGS. **1** to **3** are views illustrating the first embodiment of the present invention. At the center of a solar concentrating system according to the present embodiment, four supports **1** having a predetermined height (about 10 m) are uprightly arranged. Around the supports **1**, there are a plurality of heliostats **2** to follow the sun T and reflect sunlight L toward a single target position P.

[0012] The tops of the four supports **1** support a stationary receiver **3**. The receiver **3** has an inverted container shape (inverted pot shape) having an opening **4** at a lower side thereof and a predetermined inner space. The receiver **3** is generally made of black carbon material and an inner face thereof is covered with a silicon carbide (SiC) film. Accordingly, the color of the inner face of the receiver **3** is black to realize a very high absorptance for the sunlight L. Nearly at the center of the opening **4** of the receiver **3**, the virtual target P of the heliostats **2** is positioned.

[0013] Formed around the receiver **3** is a cylindrical housing **5** having a top face. The housing **5** is made of metal and has an inner face provided with a mirror coating **6**. The housing **5** and receiver **3** are connected to each other at lower parts thereof and a space S is defined between them to pass air A serving as a heating fluid.

[0014] At the center of the top face of the housing **5**, a cylindrical smoke vent **7** is formed. A lower end of the smoke vent **7** passes through the top of the receiver **3** to make the inside of the receiver **3** and the outside of the housing **5** communicate with each other. The diameter of the smoke vent **7** is small to discharge smoke created inside the receiver **3** to the outside little by little and not to discharge a large amount of air from the inside of the receiver **3** to the outside.

[0015] At a lower part of a side face of the housing **5**, an inlet **8** for the air A is formed. An outlet **9** is formed at a position opposite to the inlet **8**.

[0016] To the inside of the receiver **3** having the above-mentioned structure, the sunlight L reflected by the heliostats **2** is introduced through the opening **4**. The sunlight L is once concentrated at the target P and is diffused to hit the inner face of the receiver **3**. The inner face of the receiver **3** is black to realize a high absorptance for the sunlight L, and therefore, the receiver **3** becomes high temperature. Even if the receiver **3** becomes high temperature, the receiver **3** is made of solid carbon material with the inner face coated with the silicon carbide film, and therefore, the receiver **3** has excellent thermal resistance not to break by heat.

[0017] The inner face of the receiver **3** may partly reflect the sunlight L. However, the diameter of the opening **4** of the receiver **3** is smaller than the diameter of the inner space thereof and a solid angle from each incident point on the inner face to the opening **4** is small, so that the sunlight L hardly escapes outside. Namely, components of the sunlight L scattered by the inner face of the receiver **3** mostly advance toward the depth of the inner space to hit the inner face and be absorbed thereby. When the inside of the receiver **3** becomes high temperature, smoke may sometimes be produced in the receiver **3**. The smoke is discharged through the smoke vent **7**, so that no smoke will present to block the sunlight L, and therefore, the sunlight L surely reaches the inner face of the receiver **3**.

[0018] On an outer side of the receiver **3** that is at high temperature due to absorption of the sunlight L, there is the space S in which the air A serving as a heating medium flows. The air A comes in contact with the outer face of the receiver **3**, is heated thereby, and circulates heat to a place that needs the heat.

[0019] According to the present embodiment, the outer side of the receiver **3** is covered with the housing **5** so that the

receiver **3** is not exposed to the open air. This prevents heat of the receiver **3** from being taken by winds and improves thermal efficiency.

[0020] Although the outer side of the receiver **3** is covered with the housing **5**, the opening **4** is formed at the lower side of the receiver **3**, and therefore, the sunlight L reflected by the heliostats **2** is introduced through the opening **4** to the inside of the receiver **3** and is surely absorbed by the inner face of the receiver **3**.

[0021] The receiver **3** has an inverted container shape having the opening **4** at the lower side thereof, and therefore, air A heated in the receiver **3** stays inside the receiver **3** to maintain the receiver **3** at high temperature. The heated air A tends to move upward, and therefore, if the opening **4** is formed at an upper side of the receiver **3**, the heated air A will cause an upward flow to escape from the receiver **3**, and in place thereof, cold air A will enter the receiver **3** to cool the receiver **3** and deteriorate thermal efficiency. This will not happen according to the present embodiment.

[0022] The inner face of the housing **5** is provided with the mirror coating **6** to form a reflector. As a result, high-temperature radiation from the receiver **3** is reflected toward the receiver **3**, thereby a heat radiation out from the receiver **3** is effectively suppressed.

[0023] According to the present embodiment, only the inner face of the receiver **3** is provided with a silicon carbide (SiC) film. Instead, the receiver **3** may entirely be covered with a silicon carbide (SiC) film.

[0024] To increase a contact area with air A in the space S, the outer face of the receiver **3** may be made undulated.

Second Embodiment

[0025] FIG. **4** is a view illustrating the second embodiment of the present invention. The present embodiment has components that are similar to those of the first embodiment. The similar components are represented with common reference marks to omit a repetition of explanation.

[0026] According to the present embodiment, the shape of a receiver **10** is cylindrical having a top face, like a housing **5**. The receiver **10** that is cylindrical and has the top face is easy to form. The diameter of an opening **11** is larger than that of the preceding embodiment, and therefore, components of sunlight L going outside due to reflection may slightly increase. The larger opening **11**, however, is capable of receiving sunlight L even if an accuracy of collecting sunlight from heliostats is low. The height of the cylindrical shape of the receiver **10** may be increased to decrease a solid angle from an incident point on an inner face of the receiver **10** to the opening **11**, so that sunlight L scattered by the inner face may advance toward the depth of an inner space of the receiver **10**, to improve a sunlight absorbing efficiency.

Third Embodiment

[0027] FIG. **5** is a view illustrating the third embodiment of the present invention. The present embodiment has components that are similar to those of the above-mentioned embodiments. The similar components are represented with common reference marks to omit a repetition of explanation.

[0028] According to the present embodiment, a receiver **12** is integrally formed with a housing **13**. The housing **13** is divided into an upper member **14** and a lower member **15** that are welded together with peripheral flanges **14***f* and **15***f*. The receiver **12** has an inverted container shape with a narrow opening **16**, like that of the first embodiment. The receiver **12** is integrally and continuously formed from a bottom face of the lower member **15** from the same material. A smoke vent **7** is formed from the upper member **14** and is passed through and welded to an upper part of the receiver **12**.

[0029] According to the present embodiment, water W is used as a heating fluid. The water W is supplied into an inlet **8** and is passed through a space S, thus the water W comes in contact with the receiver **12** and is heated thereby and hot water W is taken out of an outlet **9**.

[0030] According to the present embodiment, the receiver **12** is integrally formed as part of the housing **13**, and therefore, no gap is present between them. This is appropriate for passing a liquid such as water W as a heating fluid.

[0031] According to the present embodiment, water W is used as a heating fluid. Instead of the water W, a liquid such as oil is employable. An inner face of the receiver **12** may be coated with a heat-resistant black coating.

Effect of Invention

[0032] According to the present invention, the outer side of the receiver is covered with the housing, and therefore, the receiver is not exposed to the open air. This prevents heat of the receiver from being taken by winds and improves thermal efficiency. Although the outer side of the receiver is covered with the housing, the opening is formed at a lower side of the receiver. Accordingly, sunlight reflected by the heliostats is introduced through the opening to the inside of the receiver and is surely received by the inner face of the receiver. Between the receiver and the housing, the space for a heating fluid is formed so that the heating fluid introduced into the space comes in contact with the outer face of the receiver and is heated thereby. The receiver has an inverted container shape with the opening formed at the lower side thereof, so that air heated in the receiver stays therein to maintain the receiver at high temperature.

[0033] According to another aspect of the present invention, the diameter of the opening of the receiver is smaller than the diameter of the inside of the receiver to reduce a solid angle. Accordingly, sunlight introduced into the receiver and reflected by the inner face of the receiver will rarely escape outside through the opening.

[0034] The receiver is made of solid silicon carbide, or solid silicon carbide entirely covered with a silicon carbide film. The inner face of the receiver is black due to the silicon carbide film, to improve a sunlight absorptance. At least the surface of the receiver is formed with a silicon carbide film, to provide excellent heat resistance.

[0035] Further, the inner face of the housing is provided with a mirror coating. If the heating fluid is a transparent gas such as air, the mirror coating reflects radiation from the high-temperature receiver back to the receiver, thereby preventing heat radiation from the receiver.

[0036] Also, the receiver is integrally formed from part of the housing, to produce no gap between them. This is appropriate when the heating fluid is a liquid.

UNITED STATES DESIGNATION

[0037] In connection with United States designation, this international patent application claims the benefit of priority under 35 U.S.C. 119(a) to Japanese Patent Application No. 2009-99980 filed on Apr. 16, 2009, the entire content of which is incorporated by reference herein.

1. A solar concentrating system having a receiver installed at a predetermined height and heliostats arranged on the ground around the receiver, the heliostats reflecting sunlight toward the receiver, wherein:

the receiver has an inverted container shape having an opening at a lower side thereof to introduce sunlight; a housing is arranged on an outer side of the receiver and surrounds the receiver except the opening; and

a space for a heating fluid is defined by the housing and the receiver.

2. The solar concentrating system according to claim **1**, wherein the diameter of the opening of the receiver is smaller than that of the inside of the receiver.

3. The solar concentrating system according to claim **1**, wherein the receiver is made of solid silicon carbide, or solid carbon material entirely covered with a silicon carbide film.

4. The solar concentrating system according to claim **1**, wherein an inner face of the housing is provided with a mirror coating.

5. The solar concentrating system according to claim **1**, wherein the receiver is made from the same material as the housing so that the receiver is continuous and integral with the housing.

6. The solar concentrating system according to claim **2**, wherein the receiver is made of solid silicon carbide, or solid carbon material entirely covered with a silicon carbide film.

7. The solar concentrating system according to claim **2**, wherein an inner face of the housing is provided with a mirror coating.

8. The solar concentrating system according to claim **3**, wherein an inner face of the housing is provided with a mirror coating.

9. The solar concentrating system according to claim **2**, wherein the receiver is made from the same material as the housing so that the receiver is continuous and integral with the housing.

10. The solar concentrating system according to claim **3**, wherein the receiver is made from the same material as the housing so that the receiver is continuous and integral with the housing.

11. The solar concentrating system according to claim **4**, wherein the receiver is made from the same material as the housing so that the receiver is continuous and integral with the housing.

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