8-14-1934

Apparatus for Absorbing Solar Energy

Robert Goddard
WPI Class of 1908

Aug. 14, 1934. R. H. GODDARD 1,969,839

APPARATUS FOR ABSORBING SOLAR ENERGY

Filed Oct. 30, 1930

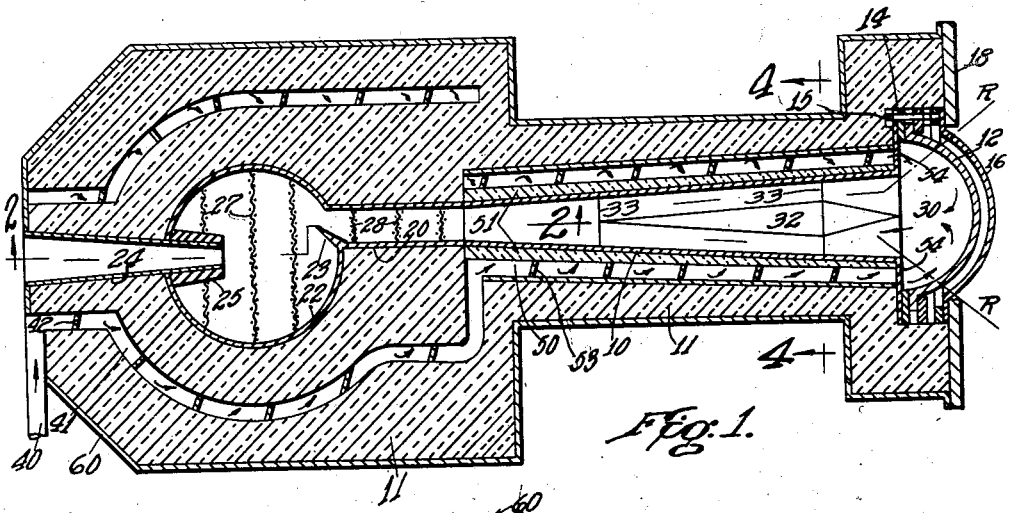

Fig. 1.

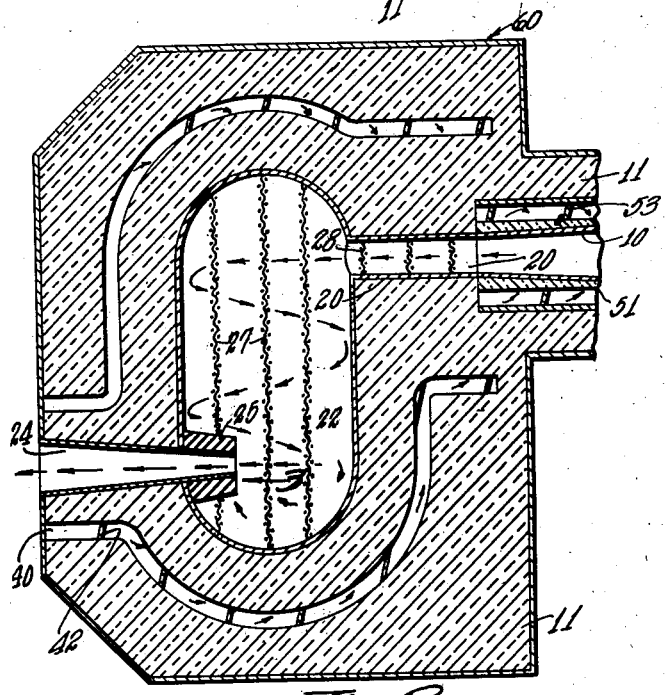

Fig. 2.

Fig. 3.

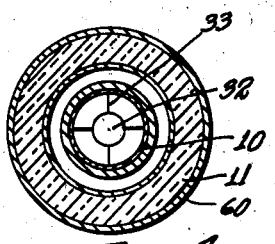

Fig. 4

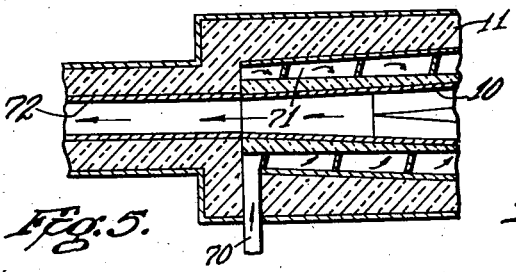

Fig. 5.

Witness
W. D. McKeon

Inventor
Robert H. Goddard

Southgate Fayr Hawley
Attorneys

Patented Aug. 14, 1934 1,969,839

UNITED STATES PATENT OFFICE

1,969,839

APPARATUS FOR ABSORBING SOLAR ENERGY

Robert H. Goddard, Worcester, Mass.

Application October 30, 1930, Serial No. 492,267

17 Claims. (Cl. 126—271)

This invention relates to apparatus by which solar energy may be effectively utilized in the heating of water, the production of steam or the raising of any fluid to a higher temperature.

It is the general object of my invention to provide apparatus for such purposes so designed that a relatively large heating action may be attained by use of a relatively small apparatus.

A further object of my invention is to provide apparatus which is simple in construction, reliable and efficient in operation and which involves the use of no moving parts.

My improved apparatus produces rapid and complete vaporization of a liquid at high temperatures, with a minimum loss of heat during the vaporizing operation.

My invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawing, in which

Fig. 1 is a longitudinal sectional view of my improved apparatus;

Fig. 2 is a partial sectional view, taken along the line 2—2 in Fig. 1;

Fig. 3 is an end view of a detail part, looking in the direction of the arrow 3 in Fig. 2;

Fig. 4 is a sectional elevation, taken along the line 4—4 in Fig. 1; and

Fig. 5 is a fragmentary sectional view of a modified structure.

Referring to the drawing, my improved heating apparatus comprises a relatively long and preferably conical tube 10, suitably supported in a casing 11 of insulating material. The length of the tube 10 should be substantially greater than twice its longest diameter. A substantially hemispherical window 12 of quartz or very transparent glass is mounted at the large end of the conical tube 10 and is held in position by clamping rings 14 and bolts 15. When the apparatus is exposed to strong winds, a second and outer similar window 16 is preferably mounted in spaced relation to the window 12. A refractory disc 18 may be secured to the front of the apparatus, protecting the edge portions of the windows from excessive heat.

The conical tube 10 is connected at its rear end through a passage 20 to a mixing and drying chamber 22 which is preferably of substantially cylindrical form. A barrier 23 at the rear end of the passage 20 restricts the outlet of the passage from the chamber 22 and causes the vapor to flow in a substantially tangential direction as it enters the chamber 22.

A discharge passage 24 projects in through the side of the chamber which is opposite to the passage 20 and provides for the discharge of highly heated vapor from the mixing and drying chamber.

The projecting inner end of the discharge passage is preferably coated or built up to a substantially streamlike section, as indicated at 25 in Fig. 3, thus reducing the interference with the rapid circulation of the liquid and vapor within the mixing chamber.

Fine mesh metal screens 27 are preferably provided in the chamber 22 to effect the breaking up and complete vaporization of any liquid entrained in the vapor entering the mixing chamber. Similar screens 28 may be provided in the passage 20 for a similar purpose.

The discharge passage 24 is preferably in the form of an outwardly enlarged conical nozzle through which the highly heated vapors are discharged for heating or other desired purposes.

The conical tube 10 is preferably formed of relatively thin metal and is highly polished on its inner surface. The window 12 encloses a substantial fluid-circulating space 30 in front of the large end of the conical tube 10.

Assuming that this space and the interior of the tube 10 have been supplied with water or other fluid in a manner to be described, the action of this part of the apparatus, when exposed to the heat of the sun, is as follows:—

Ultra violet or heat rays R traverse the fluid-circulating space 30 and are concentrated at a point inside of the large end of the conical tube 10. These heat rays traverse the liquid in the tube 10 and are repeatedly reflected back and forth by the polished internal conical surface of the tube, which, however, is of such slight inclination that the rays are not to any substantial extent reflected back into the space 30.

The heat of the rays R is thus rapidly absorbed by the liquid in the space 30 and tube 10, raising the temperature thereof and causing vapor to be formed, which vapor is discharged rearward through the passage 20 to the mixing chamber 22 in which the vaporization is completed, the dry vapor being discharged through the nozzle 24.

The action within the tube 10 may be facilitated by mounting a spreading member 32 therein, said member 32 being centrally located in the tube 10 by guy wires 33, (Figs. 1 and 4). The member 32 may be of hollow metal construc-

tion and is preferably formed with two abutting conical portions, as clearly shown in Fig. 1.

In order to still further conserve heat, I feed the liquid to be vaporized through an inlet pipe 40 to a space or passage 41 formed in the insulating material of the casing 11 but substantially spaced both from the chamber 22 and its connecting passages and also from the outer wall of the apparatus. This space or passage 41 is provided with spirally arranged partitions 42 which cause the entering liquid to traverse a helical path and to repeatedly encircle the nozzle 24, the chamber 22 and the connecting passage 20.

The liquid then enters a space or passage 50 which surrounds the conical tube 10 but is spaced therefrom by a portion of insulating material 51 which is of increased thickness toward the small end of the tube where the temperatures are higher.

The passage 50 is also provided with spiral partitions 53 forming a second helical path through which the liquid is conducted to the front end of the tube 10 where it is discharged in a tangential direction through openings 54 into the circulating space 30 previously described.

The outside of the apparatus is preferably provided with a metal casing 60, impervious to air and particularly designed to protect the more or less porous insulating material from the action of wind.

Experiments with the apparatus indicate that its high efficiency is due in part to the fact that vaporization of the liquid takes place throughout the entire body of the liquid in the conical tube 10 and is not confined to those portions of liquid in contact with the tube itself, which, due to its reflecting surface, does not absorb an appreciable amount of heat.

The liquid traversing the passages 41 and 50 enclosing the inner heating portions of the apparatus serves to absorb such heat as may escape through the insulating material of the walls, but it is still at relatively low temperature when it enters the circulating space 30 and thus serves to prevent the window 12 from becoming overheated.

It will also be noted that as the liquid enters the conical tube 10, the cooler portions of the liquid tend to move to the outside of the cone in contact with the reflecting metal, so that heat losses through the tube 10 are reduced and the temperature of the tube 10 ordinarily remains below that of the liquid and vapor flowing therethrough. The provision of the inner conical member 32 makes the action of the apparatus more definite and rapid.

It may be noted that the ultra-violet rays transmitted by the window 12 when quartz is used are highly concentrated in the tube 10 and have a strong sterilizing action which is of great importance under certain circumstances.

In cases where it is not essential that the liquid be completely vaporized, as where the liquid is to be used for heating only, the mixing chamber and nozzle may be dispensed with, as shown in Fig. 5, in which case the liquid enters directly through a pipe 70 to a helical passage 71 surrounding the conical tube 10. In this construction, the vapor formed in the tube 10 may be discharged directly through an outlet passage 72.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:—

1. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, and means to conduct heated fluid from the smaller end of said tube, said transparent window being substantially semi-spherical and inclosing a fluid-circulating space of substantial volume in front of said conical tube.

2. Heat-absorbing apparatus as set forth in claim 1, in which the conduit opens directly and freely into said fluid-circulating space.

3. Heat-absorbing apparatus as set forth in claim 1, in which the conduit is mounted and connected to deliver the heat-absorbing fluid directly into said fluid-circulating space in a tangential direction.

4. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, and means to conduct heated fluid from the smaller end of said tube, said transparent window consisting of two concentric semi-spherical portions mounted in spaced relation to each other.

5. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, and means to conduct heated fluid from the smaller end of said tube, said means for conducting away heated fluid including a mixing and drying chamber.

6. Heat-absorbing apparatus as set forth in claim 5, in which an outwardly-enlarged conical discharge nozzle is included, having its inner end open to said chamber and said nozzle extending outwardly therefrom.

7. Heat-absorbing apparatus as set forth in claim 5, in which an outwardly-enlarged conical discharge nozzle is included, said nozzle having its inner end projecting into said mixing and drying chamber and said inner end having a streamline external surface.

8. Heat-absorbing apparatus as set forth in claim 5, in which a plurality of fine wire screens are mounted in said chamber and effect the breaking-up and more complete vaporization of liquid entrained in the heated vapor which enters said chamber.

9. Heat-absorbing apparatus as set forth in claim 5, in which the mixing and drying chamber is of substantially cylindrical cross section and is provided with a discharge outlet and with an inlet connection from said conical tube, said inlet connection being so disposed that vapor enters said chamber from said connection in a substantially tangential direction.

10. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, and means to conduct heated

fluid from the smaller end of said tube, said means for conducting away heated fluid including a mixing and drying chamber and a discharge nozzle, a thick heat-insulating covering for the external surfaces of said apparatus, and an outer casing for said apparatus and insulating covering, which is substantially impervious to air.

11. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, means to conduct heated fluid from the smaller end of said tube, said means for conducting away heated fluid including a mixing and drying chamber and a discharge nozzle, a thick heat-insulating covering for the external surfaces of said apparatus, said apparatus having a fluid inlet passage therefor, positioned between the inner and outer surfaces of said insulating covering and substantially spaced from said surfaces.

12. Heat-absorbing apparatus as set forth in claim 11, in which said fluid inlet passage provides a helical path for the fluid.

13. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, and means to conduct heated fluid from the smaller end of said tube, said means for conducting away heated fluid including a mixing and drying chamber, and inlet and outlet connections to said chamber, which connections are positioned substantially out of alignment with each other.

14. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, means to conduct heated fluid from the smaller end of said tube, and a directing member mounted within said conical tube and spaced from the internal conical wall thereof, said member directing fluid entering said tube outwardly toward said internal conical wall.

15. Apparatus for absorbing solar energy comprising a conical tube having an internal reflecting surface, a transparent window through which solar heat rays are admitted to the larger end of said tube, a conduit through which a heat-absorbing fluid is delivered to said tube through its larger open end, means to conduct heated fluid from the smaller end of said tube, and a reversely tapered tubular conical member axially centered in spaced relation to the internal surface of said conical tube and outwardly deflecting fluid entering said tube.

16. Heat-absorbing apparatus comprising a heating tube, means to direct solar heat rays into said tube, a mixing chamber, means to conduct heated vapor from said tube to said chamber, means to conduct vapor from said chamber, and means to direct said vapor to enter said mixing chamber in a substantially tangential direction.

17. Heat-absorbing apparatus comprising a heating tube, means to direct solar heat rays into said tube, a mixing chamber, passages encircling said mixing chamber and heating tube, means to conduct heated vapor from said tube to said chamber, means to conduct vapor from said chamber, and means to feed a fluid to be heated to said heating tube, said fluid traversing said encircling passages before entering said tube.

ROBERT H. GODDARD.