United States Patent

[11] 3,576,424

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] **METHOD AND APPARATUS FOR MELTING A SALT BED IN A STEAM GENERATOR**
2 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **219/275,** 60/59, 114/16, 122/32, 219/300, 219/325, 219/378
[51] **Int. Cl.** **F22b 1/28**
[50] **Field of Search** ..... 126/400; - 60/(Inquired), 59; 122/32, 33; 219/300, 325, 378, 275, 271; 237/81; 114/16

[56] **References Cited**
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ABSTRACT: A steam generator which includes a container, a meltable and electrically nonconductive salt disposed in the container to form a salt bed, and a high electrical resistance steam generating coil disposed in the slat bed so that an electric current can be passed through the coil to heat the salt bed and then the heat of the salt bed can be used to generate steam in the coil.

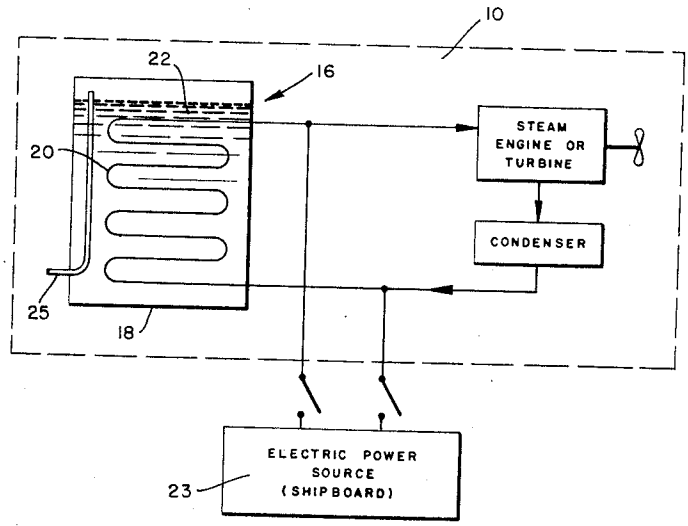
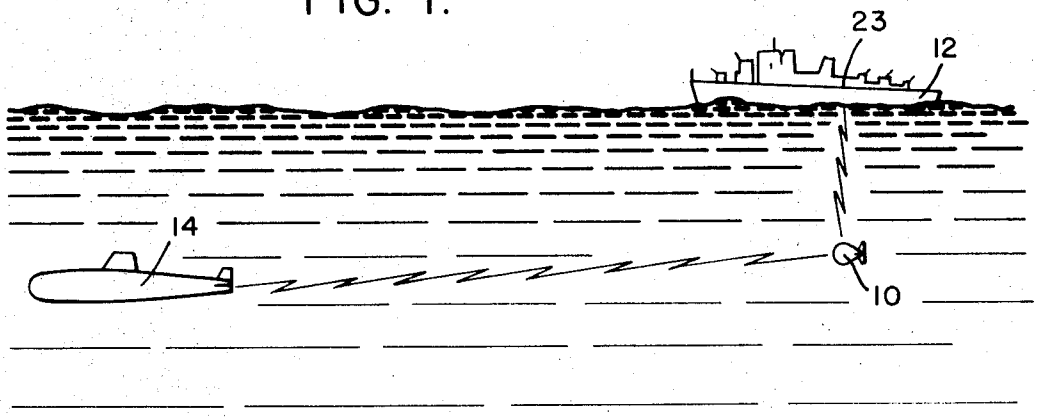


FIG. 1.



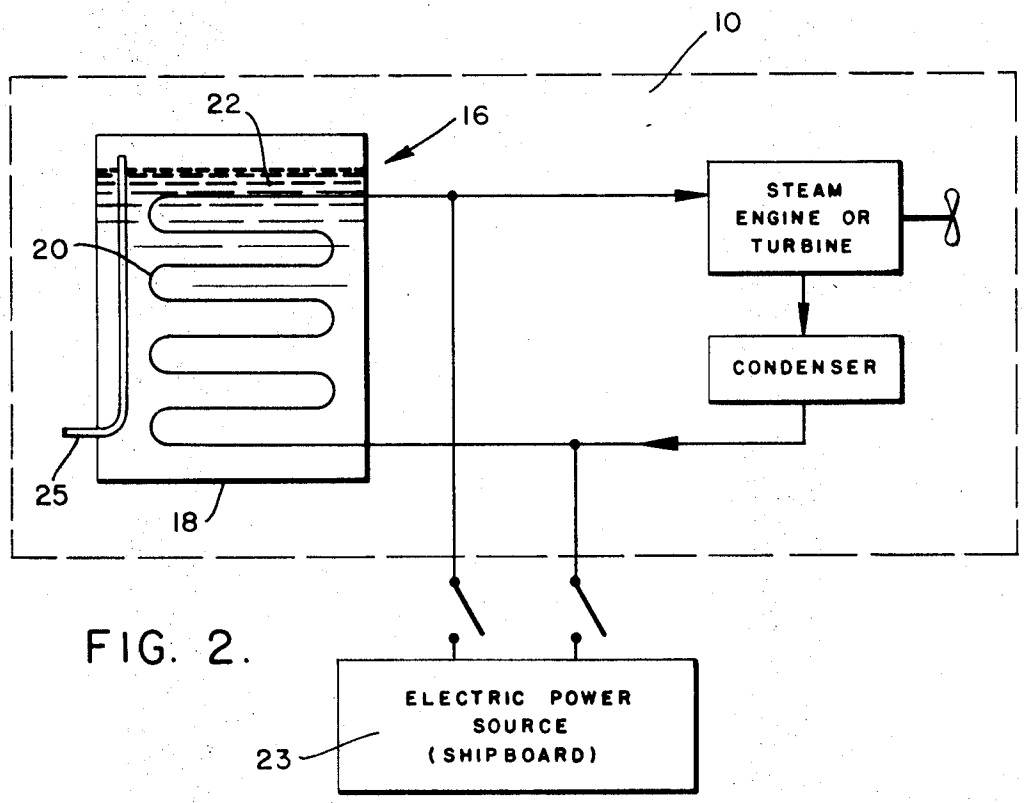


FIG. 2.

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METHOD AND APPARATUS FOR MELTING A SALT BED IN A STEAM GENERATOR

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

In the copending application of Horace E. Karig et al., Ser. No. 500,389, filed Oct. 21, 1965, an underwater molten salt heat storage boiler is disclosed which generates steam for propelling an underwater vehicle which is periodically raised to the surface of the water for remelting the salt bed, the remelting being effected by passing superheated steam, available on the surface ship, through the steam coil. In the copending application of Gerrit DeVries et al., Ser. No. 584,062, filed Sept. 30, 1966, there is disclosed a boiler for use in the same environment wherein the novelty resides in the specific configuration of the steam coil.

The present invention relates to a boiler for use in the environments referred to and in which the steam coil may be of any desired configuration.

One of the objects of the invention is to provide method and apparatus for melting a salt bed without the use of superheated steam.

Another object is to provide method and apparatus for transferring heat to the entire bed uniformly to thereby uniformly raise its temperature and melt it substantially at the same time.

Still further objects, advantages, and salient features will become more apparent from the description to follow, the appended claims, and the accompanying drawing in which:

FIG. 1 illustrates an environment for the invention, and

FIG. 2 diagrammatically illustrates the vehicle propulsion system and ship apparatus for melting the boiler salt bed.

Referring now to the drawing, FIG. 1, as in the application to Karig et al., illustrates an underwater drone vehicle **10**, controlled from a surface ship **12** which detects a submarine **14** by sonar.

The boiler **16**, as illustrated in FIG. 2, comprises a container **18** and a steam generating coil **20** within the container, the coil being submerged in a salt mixture **22**. When the drone is submerged, feed water is fed from the condenser to the steam coil which generates steam for operating the steam engine, all as more fully described in the application to Karig et al.

It has been discovered that a salt bed of the composition disclosed by Karig et al., which is 60 to 90 percent LiOH and 40—10 percent LiF, by weight, is electrically nonconductive and that the steam coil, when formed of inconel, provides a high resistance to flow of current which may thus be employed as a heating coil to melt the mixture. In the melting process, the vehicle is brought to the surface ship and the ends of the coil are connected to an electric power source **23**, such as a generator, current being passed through the coil until the salt bed has been melted and raised to desired temperature. The melting process differs from melting by steam since the coil is at uniform temperature throughout its length rather than at the variable temperature when supplied with superheated steam.

As the vehicle descends in the water the container may be subjected to increasing water pressure. If it is desired to use thin-wall construction for the container the pressure within the container may be equalized with ambient water pressure by a conduit **25** which extends through the container and is open at an exterior end to the water and is open at an interior end to the top of the container **18**.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. In an underwater vehicle of the type including apparatus for generating steam for propelling same, said apparatus comprising a closed thin-wall container having a void space at its upper end, a meltable salt mixture filling said container below said space, said mixture having substantially zero coefficient of expansion at its solidifying temperature, the solidifying temperature being in excess of 212° F., the outside of said container being in contact with and subjected to water at ambient pressure, means for pressurizing said space to ambient water pressure, whereby the salt mixture, when melted, subjects the inside of said container to ambient water pressure, a steam generating coil within said salt mixture having a water inlet at its lower end and a steam outlet at its upper end adapted to extract heat from the salt mixture and cause it to solidify, first at the bottom of the container, and thereafter in succeeding layers thereabove, the improvements, in combination, comprising:
   a. a source of electric power for melting said salt mixture disposed at the surface of the water and means for connecting ends of said coil to same,
   b. said coil having high electrical resistance, whereby it serves as a heating coil,
   c. said salt mixture being electrically nonconductive, whereby electric current flows only through the coil and maintains it at uniform temperature throughout its length, whereby the entire salt mixture is uniformly raised in temperature.

2. A method for use with an underwater vehicle of the type including apparatus for generating steam for propelling same, said apparatus comprising a closed thin-wall container having a void space at its upper end, a meltable salt mixture filling said container below said space, said mixture having substantially zero coefficient of expansion at its solidifying temperature, the solidifying temperature being in excess of 212° F., the outside of said container being in contact with and subjected to water at ambient pressure, means for pressurizing said space to ambient water pressure, whereby the salt mixture, when melted, subjects the inside of said container to ambient water pressure, a steam generating coil within said salt mixture having a water inlet at its lower end and a steam outlet at its upper end adapted to extract heat from the salt mixture and cause it to solidify, first at the bottom of the container, and thereafter in succeeding layers thereabove, said coil having high electrical resistance, whereby it serves as a heating coil, said salt mixture being electrically nonconductive whereby current will flow only through the coil and maintain it at uniform temperature throughout its length, whereby said entire salt mixture may be uniformly raised in temperature, said method comprising the step of
   a. passing an electric current through said coil when the vehicle is at the surface of the water until the salt mixture is melted and raised to a desired temperature.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,576,424 Dated April 27, 1971

Inventor(s) Joseph P. Strapp, et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet [72] "John P. Strapp, Glendale;" shou read -- Joseph P. Strapp, Glendora; -- .

Signed and sealed this 24th day of October 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patent