(No Model.) 2 Sheets—Sheet 1.

F. A. RICH.

ELECTRIC STEAM AND GAS ENGINE.

No. 572,449. Patented Dec. 1, 1896.

FIG. 1.

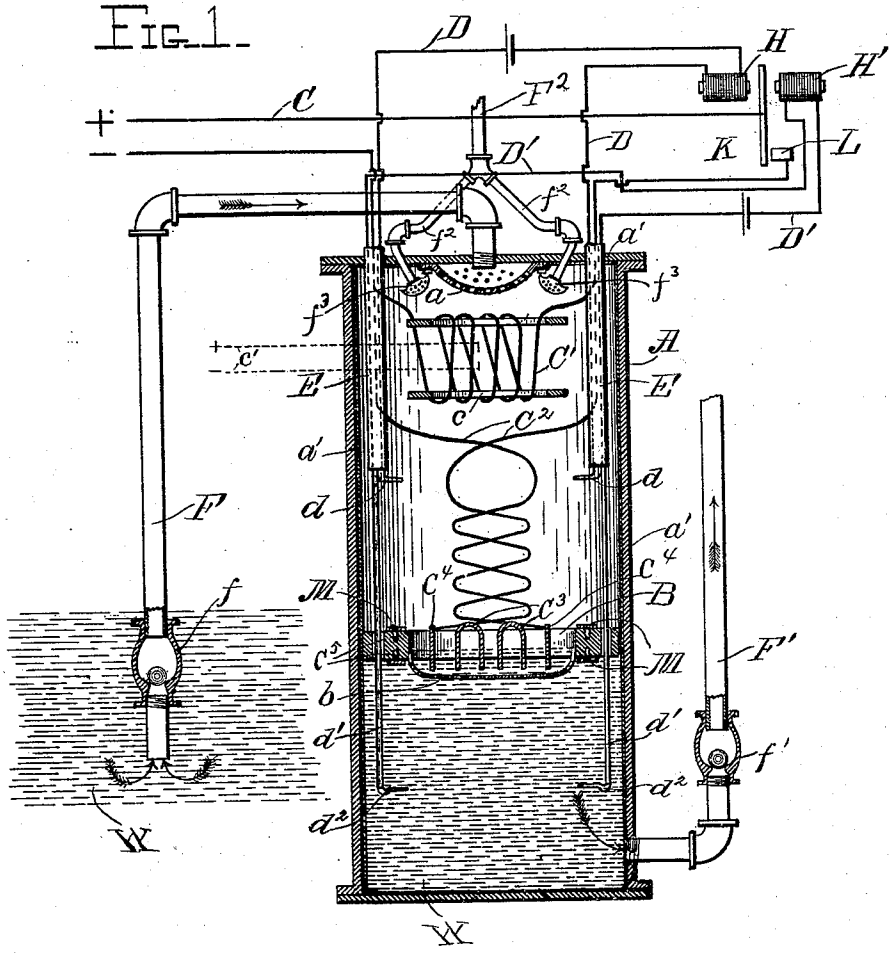


FIG. 2.

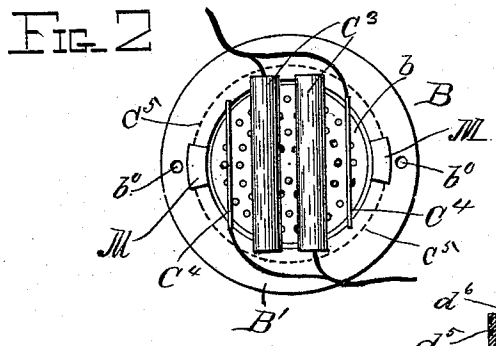
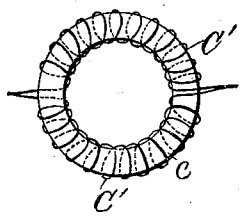


FIG. 3.



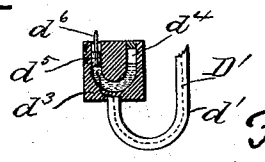


FIG. 4.

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(No Model.) 2 Sheets—Sheet 2.

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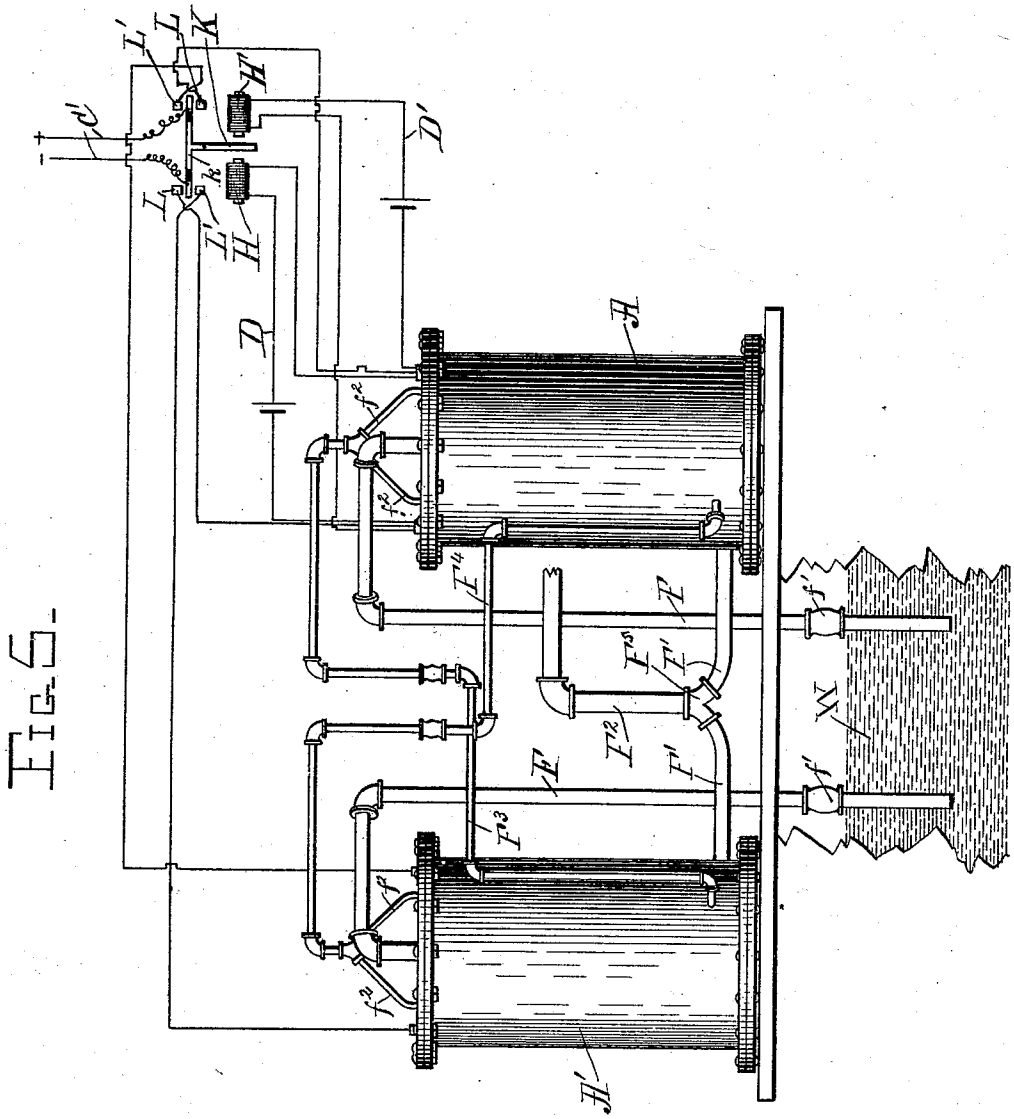

FIG. 5.

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UNITED STATES PATENT OFFICE.

FRANCIS ARTHUR RICH, OF TELLURIDE, COLORADO.

ELECTRIC STEAM AND GAS ENGINE.

SPECIFICATION forming part of Letters Patent No. 572,449, dated December 1, 1896.

Application filed May 9, 1896. Serial No. 590,904. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS ARTHUR RICH, a citizen of the United States, residing at Telluride, in the county of San Miguel and State of Colorado, have invented certain new and useful Improvements in Electric Steam and Gas Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in electric steam and gas engines, and more particularly to such as are employed as pumping-engines, and has for its object the providing of an apparatus by which steam is generated, superheated, and then condensed, or a liquid is resolved into gases by an electric current and by chemical union returned again to its former liquid state and caused to do work by the action of a current of electricity. The result is accomplished by certain novel structures and arrangement of parts, as will be hereinafter described and claimed.

Reference is had to the accompanying drawings, in which—

Figure 1 represents a vertical central section of the apparatus embodying my invention. Fig. 2 is a detail plan view of the electric steam-generator. Fig. 3 represents a detail plan view of the superheating-coil. Fig. 4 represents a form of contact-maker which may be substituted for the one shown in Fig. 1, and Fig. 5 represents two pumping-engines connected together in side elevation.

Similar letters refer to similar parts throughout the several views.

A represents a cylinder of boiler-plate, iron piping, or any metal sufficient to withstand ordinary steam-pressure, lined in its upper parts with asbestos or other non-conductor of heat to prevent heat loss, and being porous increases both steam generation and condensation alternately by raising water in a finely-divided state by its capillarity.

The cylinder A is provided with an inflow-pipe F, which enters the top of the cylinder, and an outflow-pipe F′, which enters the cylinder near its bottom. These inflow and outflow pipes are provided with valves f and f', respectively.

At the top of the cylinder and directly under the mouth of the inflow-pipe is a spreader a, consisting of a perforated plate, which acts to spread the liquid as it enters from the pipe.

In the upper part of the cylinder is suspended a heating-coil C′. This coil consists of a wire or tape of comparatively high resistance wound on two rings c, which rings may be of vulcanite fiber or any other suitable material.

In the upper portion of the cylinder are two sprayers f^3, inserted at such an angle as to direct the spray against the coil C. These sprayers are attached to small pipes f^2, which unite with the pipe F^2.

The steam-generator B consists of metallic plates C^3 and C^4, forming the plus and minus terminals of an electric circuit and carried by a float B′. The said float being made of some light material will readily support the weight of the plates or terminals and float on the surface of the liquid. This float is made in the form of a ring and supports the plates C^3 and C^4 in such a manner that they are kept in contact with the liquid.

An almost water-tight plate b is attached to the float, but not touching the terminal plates. This plate allows only a small quantity of water to circulate around the terminals at one time, thereby preventing heat from escaping to the main body of water and securing a normal water-level within the float. By this arrangement steam can be generated much more rapidly, and as fast as the steam is so generated water enters from below to take its place.

M are small metal plates or contact-pieces, four in number, two on the upper side and two on the bottom of the float, the top pair being connected together by a conductor c^5, which is preferably buried below the surface of the float and the lower pair are similarly connected together.

C represents an electric circuit leading to and from the source of electricity, which circuit after branching traverses the heating-coil and steam-generator. This current may be either a direct current or an alternating current of any phase or frequency. Inserted in the circuit C is a switch consisting of a pivoted arm K and a contact-piece L, said switch being adapted to be operated by elec-

tromagnets, as will hereinafter be described. The circuit C enters the cylinder A through the tubes E. The current in the circuit C is made to separate into two branch circuits, one conveying a portion of the current through the superheating-coil C′ and the other branch conveying the rest of the current through the steam-generator B.

D and D′ are two separate electric circuits. The one D traversing the electromagnet H, passes into the tubes E and terminates at the bottom of those tubes in the contact-pieces d. D′ traverses the electromagnet H′, enters the tubes E, and then passes into the tubes d', terminating at the lower extremity of those tubes in the contact-pieces d^2.

The tubes d', leading from within the tubes E, fulfil the twofold function of providing guides for the steam-generator B and insulation and protection for the wires D′. If the liquid being pumped is acidulated or in any way a good conductor of electricity, the leakage of the current across the terminals d^2 will be so great as to render the apparatus inoperative. To provide against this contingency, the device shown in Fig. 4 is employed. d^3 is a block of non-conducting material carried at the end of the tube d'. This block is provided with a passage d^4, which is stopped at one end and partially filled with oil, while a small tight piston d^5, provided with the piston-rod d^6, is inserted in the other end. The conductor D′, passing through the tube d', enters the oil-passage and occupies a position directly under the small metal piston, so that when the piston is depressed contact will be made between the conductor D′ and the said piston, the latter forcing the oil which formerly supported it into the vacant space on the other side. There are two such devices necessary.

The operation of the pumping-engine is as follows: When the cylinder A has been filled with a liquid to such an extent that the generator B, floating on the said liquid, will bring the metal pieces M in contact with the terminals d, the apparatus will be in a position to begin its operation. When the pieces M are so brought in contact with the terminals d, the electric circuit D, through the electromagnet H, is made complete, and the said magnet is thereby made to attract the upper end of the pivoted arm K, bringing the lower end in contact with the piece L, which completes the circuit C. Immediately that the circuit C is completed a current begins to flow therein. This current, as stated before, divides, a part passing through the superheating-coil C′ and a part through the steam-generator B. Now the terminal plates C^3 and C^4 of the steam-generator being kept in contact with the water, the water included between opposite terminals becomes intensely heated by the electric current, as does also the water surrounding them by connection and conduction. The heat converts the surrounding water into steam, which rises and coming in contact with a heating-coil C′ above becomes superheated, thereby expanding. The pressure of the steam so generated and expanded is sufficient to force the body of water supporting the steam-generator out through the pipe F′; but it is obvious that as the column of water in the cylinder is forced out by the expanded steam, the floating generator B will descend and its descent will continue until the metal pieces M on the lower side of the float come in contact with the terminals d^2. The contact between the said terminals and pieces M being made, another circuit D′, traversing the electromagnet H′, will be closed. The magnet then attracts the arm K and breaks the circuit V, which causes the current in the heating-coils to cease to flow. A spray of cold water from the sprayers f^3 is now directed against the heating-coil c, which will greatly hasten the cooling of that coil, and therefore the condensation of the steam. At this juncture a sufficient amount of steam will have condensed in the chamber to cause a partial vacuum, and immediately that such a vacuum is formed the water W will begin to flow in through the pipe F, and accumulating in the cylinder A will cause the floating steam-generator to again rise to the point where the electric-heating circuits will be again closed, and the operation above described will be repeated.

The resistance of the circuit traversing the electromagnet H′ is so high that the small leakage which might take place across the liquid between the terminals d^2, if the said liquid is water, will not be sufficient to operate the magnet. If, however, it becomes necessary to provide against such leakage, the device shown in Fig. 4 will suffice to overcome any leakage between the terminals d^2.

The metal pieces M on the lower side of the float B′, coming down on the small piston-rod d^6, will cause it to connect with the circuit D′, as before explained, and when the weight of the float is released from the piston d^5 the said piston assumes its initial position by virtue of the column of oil which supports it.

The foregoing description has been confined to an apparatus in which only one cylinder was employed. Such an apparatus may, however, be more advantageously employed if two or more are connected together. Such an arrangement is shown in Fig. 5.

By connecting two or more cylinders together, as shown, not only is a steadier stream obtained, but a portion of the mechanism used in making and breaking the electric circuits may be abolished in all but one cylinder. The outflow-pipes F communicate with a common main F^2 through the double check-valve F^5.

The operation when two cylinders are connected together is as follows: When the steam in A is being generated and water forced out through the outflow-pipe F′, a portion of the water under pressure is also forced out

through the small pipe F^4, which communicates with the lower portion of the cylinder. The water thus forced through the pipe F^4 will enter the spray-pipes f^2 at the top of the cylinder A′ and thus hasten condensation in that cylinder, as before explained, by cooling the heating-coil. Now when the circuit is completed through the magnet H′, which will be when the water has been pumped out of the cylinder A, the armature K will be attracted by the magnet H′, which will connect the terminals of the main circuit C with the terminals L′, which connect with the heating-coils in the cylinder A′, thus causing that cylinder to commence its pumping operation. A little later the steam-generator in A will rise and operate the magnet H, as before explained, which will now attract the armature K and break the circuit through the contacts L′ and make it through the contacts L, thereby switching the current first from one cylinder to the other.

It will be seen that as the contact-pieces M, d^2, and d are not used in controlling the current in A′ they may be done away with in that cylinder when worked with another, as shown; but when the generator B in the cylinder A comes down on the contacts d^2 the electric circuit is broken through the heating-coils of that cylinder and the circuit through similar parts in the cylinder A′ is made complete, that is, the heating-coils in A′ are traversed by a current when the current through the heating-coils in A is cut off. When the current is so switched, the steam begins to generate in A′, forcing a column of water through a small pipe F^3, which branches into the spray-pipes f^2, entering the cylinder A and hastening condensation by spraying the heating-coil C with cold water.

It will be seen that water is sprayed into the cylinders alternately from one to the other at such intervals as to cause condensation of the steam at the proper time, promote the formation of vacuum, and also that the heating-current is alternately switched from one cylinder to the other, which will cause the generator to work in unison and thus pump a steady stream of water.

The switching of the heating-current alternately from one cylinder to the other is accomplished by the use of an electromagnet-operated switch which differs somewhat from that shown in Fig. 1. In its simplest form it consists of a pivoted armature K, mounted between two electromagnets H H′. This armature is provided with a cross-arm k, with its ends insulated from the main body and each end connected to one of the wires from the source of heating-current.

L represents the terminals from the cylinder A, and L′ those from the cylinder A′.

It is also obvious that many modifications of the above-described invention could be made without departing from the spirit of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In an apparatus of the character described, the combination with a vessel having inlet and outlet pipes and partially filled with a liquid, of a steam-generator supported by the said liquid, a heating-coil within said vessel, an electric conductor connecting said heating-coil and steam-generator with the source of electricity, and means for alternately opening and closing the said electric circuit, substantially as described.

2. In an apparatus of the character described, the combination with a plurality of vessels having inlet and outlet pipes and partially filled with a liquid, of a steam-generator supported by the said liquid in each vessel, a heating-coil within each of said vessels, electric conductors connecting said heating-coils and steam-generators with the source of electricity, and means for alternately opening and closing the said electric circuits, substantially as described.

3. In an apparatus of the character described, the combination with a vessel lined with a porous non-conductor of heat and partially filled with a liquid, of an electric steam-generator supported by said liquid, a heating-coil within the said vessel and above the said steam-generator, means for cooling said heating-coil, an electric conductor connecting the said heating-coil and steam-generator with the source of electric current, means for alternately making and breaking the said electric circuit, and means for conducting the aforesaid liquid to and from the said vessel, substantially as described.

4. In an apparatus of the character described, the combination with a plurality of vessels partially filled with a liquid, of an electric steam-generator in each of said vessels supported by said liquid, a heating-coil within each of said vessels and above the said steam-generators, electric conductors connecting the said heating-coils and steam-generators with the source of electrical current, means for alternately making and breaking the said electric circuit, and means for conducting the aforesaid liquid to and from the said vessels, substantially as described.

5. In an apparatus of the character described, the combination with a plurality of closed vessels, of inlet and outlet pipes connected to the said vessels, an electric steam-generator carried within each of the said vessels, an electric heating device also carried within each of the said vessels, means for periodically cooling the said coils; electric connection between the source of electric current and the said steam-generators and heaters and means for alternately switching the current from one vessel to another, substantially as described.

6. In an apparatus of the character described, the combination with a plurality of vessels partly filled with a liquid, of inlet and outlet pipes connected to the said vessels, a

steam-generator within each of the said vessels and supported by the said liquid, a heating-coil within each of the said vessels, means for periodically spraying the said coils; electric conductors connecting said heating-coils and steam-generators with the source of electricity, and means for alternately switching the said electric current from one heating-coil and steam-generator to another, substantially as described.

7. In an apparatus of the character described, the combination with a plurality of vessels partly filled with a liquid, of an electric steam-generator in each vessel consisting of a float carrying a plurality of conducting-plates and supported by said liquid, a heating-coil in each vessel above said generators, electric conductors connecting the said generators and heating-coils with the source of electric current; means for alternately opening and closing the aforesaid electric circuits, and inflow and outflow pipes connected with the aforesaid vessels by which the liquid is conveyed to and from the same, and a pipe passing from the lower portion of each cylinder to the upper portions of the others, substantially as described.

8. In an apparatus of the character described, the combination with a plurality of vessels partly filled with a liquid, of an electric steam-generator in each vessel and floating upon and partly immersed in said liquid, a heating-coil within each of the said vessels and above the said steam-generator, electric conductors connecting the said heating-coil and steam-generator of each vessel with the source of electric current, means for alternately switching the current from one of the heating-coils and steam-generators of one vessel to similar parts of another vessel, pipes connecting the lower portion of one vessel with the upper portion of another vessel, and means for conducting the aforesaid liquid to and from the said vessels, substantially as described.

9. In an apparatus of the character described, the combination with a vessel partly filled with liquid, of an electric steam-generator consisting of a float carrying a plurality of conducting-plates and supported by said liquid, a heating-coil above said generator, electric conductors connecting the said generator and heating-coil above said generator with the source of electric current, means for alternately opening and closing the aforesaid electric circuit, and an inflow and outflow pipe each provided with a check-valve, connected with the aforesaid cylinder by which the liquid is conveyed to and from the same, substantially as described.

10. In an apparatus of the character described, the combination with a source of electricity, of a cylindrical vessel lined with a porous non-conductor of heat and adapted to be partially filled with a liquid, an electric steam-generator consisting of a float carrying a plurality of electric conducting-plates and adapted to be periodically supported by the said liquid, a heating-coil within the said vessel and above the steam-generator, an electric conductor connecting the said heating-coil and steam-generator with the source of electric currents, metallic contact-pieces carried by the said steam-generator, guide-rods near the sides of said cylindrical vessel each traversed by an electric conductor and terminating at its lower end in a contact-piece, contact-pieces at the upper ends of said guide-rods and connected to separate electric conductors, means operated by said contact-pieces for opening and closing the circuit, and pipes for conveying the liquid to and from the aforesaid cylindrical vessel, substantially as described.

11. In an apparatus of the character described, the combination with a vessel lined with a porous non-conductor of heat partially filled with a liquid, of an electric steam-generator consisting of a float carrying a plurality of conducting-plates and supported by said liquid, a heating-coil carried above said generator, electric conductors connecting the said generator and heating-coil with the source of electric current, means for alternately opening and closing the aforesaid electric circuit, and an inflow and outflow pipe connected with the aforesaid cylinder by which the liquid is conveyed to and from the same, substantially as described.

12. In an apparatus of the character described, the combination with a closed vessel adapted to be partially filled with a liquid, of an electric steam-generator consisting of a float carrying a plurality of electric conducting-plates and adapted to be periodically supported by said liquid, a heating-coil within the said vessel and above the steam-generator, an electric conductor connecting the said heating-coil and steam-generator with the source of electric currents, metallic contact-pieces carried by the said steam-generator, guide-rods near the sides of said vessel each traversed by an electric conductor terminating at its lower end in a contact-piece, contact-pieces at the upper ends of said guide-rods and connected to separate electric conductors, electromagnets traversed by the said electric circuits, a switch in a separate circuit and operated by said electromagnets, and means for conveying the liquid to and from the aforesaid cylindrical vessel substantially as described.

13. The combination with a source of electricity and a source of liquid supply, of a closed vessel, with a pipe leading from the source of liquid supply into the upper part of said vessel, and an outlet for liquid near the base of said vessel, of an electric steam-generator mounted within said vessel, a heating-coil also within said vessel and above the steam-generator, electric conductors connecting said source of electricity with said heat-

ing-coil and said steam-generator, and means for making and breaking the said electric circuit, substantially as described.

14. In an apparatus of the character described, the combination, with a vessel partly filled with a liquid, of an electric steam-generator floating upon and partly immersed in said liquid, a heating-coil within said vessel and above the said steam-generator, electric conductors connecting the said heating-coil and steam-generator with the source of electric current, means for alternately making and breaking the said electric circuit, and a source of liquid supply, with pipes leading therefrom to said vessel, and a delivery-pipe for conducting the aforesaid liquid from the the said vessel, substantially as described.

15. The combination with a source of electricity and a source of liquid supply, of a closed vessel, lined with a porous non-conductor of heat with a pipe leading from the source of liquid supply into the upper part of said vessel, and an outlet for liquid near the base of said vessel, of an electric steam-generator mounted within said vessel, a heating-coil within said vessel and above the steam-generator, and means for periodically cooling the same, electric conductors connecting said source of electricity with said heating-coil and steam-generator, and means for making and breaking the said electric circuit, substantially as described.

16. In an apparatus of the character described, the combination with a vessel lined with a porous non-conductor of heat and partly filled with a liquid, of an electric steam-generator floating upon and partly immersed in said liquid, a heating-coil within the said vessel and above the said steam-generator, electric conductors connecting the said heating-coil and steam-generator with the source of electricity, means for alternately making and breaking the said electric circuit, and a source of liquid supply, with pipes leading therefrom to said vessel, and a delivery-pipe for conducting the aforesaid liquid from the said vessel, and a sprayer for cooling the aforesaid heating-coil, substantially as described.

17. In an apparatus of the character described, the combination with a plurality of cylindrical vessels partially filled with a liquid, and lined with a porous material, of an electric steam-generator in each vessel consisting of a float carrying a plurality of conducting-plates and supported by said liquid, heating-coils carried above said generators, electric conductors connecting the said generators and heating-coils with the source of electric current, means for alternately opening and closing the aforesaid electric circuits, and inflow and outflow pipes connected with the aforesaid cylinders by which the liquid is conveyed to and from the same, substantially as described.

18. In an apparatus of the character described, the combination with a closed vessel adapted to be partly filled with a liquid and lined with a porous non-conductor of heat, of an electric steam-generator consisting of a float carrying a plurality of electric conducting-plates and adapted to be periodically supported by the said liquid, a heating-coil within the said vessel and above the steam-generator, sprayers for cooling said coil, an electric conductor connecting the said heating-coil and steam-generator with the source of electric currents, metallic contact-pieces carried by the said steam-generator, guide-rods near the sides of said vessel each traversed by an electric conductor terminating at its lower end in a contact-piece, contact-pieces at the upper ends of said guide-rods and connected to separate electric conductors, electromagnets traversed by the said electric circuits, a switch in a separate circuit and operated by said electromagnets, and means for conveying the liquid to and from the aforesaid cylindrical vessel, substantially as described.

19. The combination with a source of electricity and a source of liquid supply, of a plurality of closed vessels, with pipes leading from the source of liquid supply into the upper part of said vessels, and outlets for liquid near the base of said vessels, of an electric steam-generator mounted within each of the said vessels, a heating-coil also within each of the said vessels and above the steam-generator, sprayers for cooling the said heating-coils, electric conductors connecting said source of electricity with said heating-coils and steam-generators, and means for making and breaking the said electric circuits, substantially as described.

20. In an apparatus of the character described, the combination with a plurality of vessels partly filled with a liquid, of an electric steam-generator within each vessel floating upon and partly immersed in said liquid, a heating-coil within each of the said vessels and above the said steam-generators, means for cooling the said heating-coils, electric conductors connecting the said heating-coils and steam-generators with the source of electric current, means for alternately making and breaking the said electric circuits, and a source of liquid supply, with pipes leading therefrom to said vessels, and delivery-pipes for conducting the aforesaid liquid from the said vessels, substantially as described.

21. The combination with a source of electricity and a source of liquid supply, of a plurality of closed vessels lined with a porous non-conductor of heat, with pipes leading from the source of liquid supply into the upper part of said vessels, and outlets for liquid near the base of said vessels, of electric steam-generators mounted within said vessels, heating-coils also within the said vessels and above the steam-generators, electric conductors connecting said source of electricity with said heating-coils and steam-generators, and means for making and breaking the said electric circuits, substantially as described.

22. In an apparatus of the character de-

scribed, the combination with a plurality of vessels partly filled with a liquid and lined with a porous non-conductor of heat, of an electric steam-generator floating upon and partly immersed in said liquid of each vessel, a heating-coil within each of the said vessels and above the said steam-generators, means for cooling the said heating-coils, electric conductors connecting the said heating-coils and steam-generators with the source of electric current, means for alternately making and breaking the said electric circuits, and a source of liquid supply, with pipes leading therefrom to said vessels, and a delivery-pipe communicating with each vessel for conducting the aforesaid liquid from the said vessels, substantially as described.

23. In an apparatus of the character described, the combination with a source of electricity, of a cylindrical vessel lined with a porous non-conductor of heat adapted to be partially filled with a liquid, an electric steam-generator consisting of a float carrying a plurality of electric conducting-plates and adapted to be periodically supported by the said liquid, a heating-coil within the said vessel and above the steam-generator, a sprayer for cooling the said heating-coil, an electric conductor connecting the said heating-coil and steam-generator with the source of electric currents, metallic contact-pieces carried by the said steam-generator, guide-rods near the sides of said cylindrical vessel each traversed by an electric conductor and terminating at its lower end in a contact-piece, contact-pieces at the upper ends of said guide-rods and connected to separate electric conductors, means operated by said contact-pieces for opening and closing the circuit, and pipes for conveying the liquid to and from the aforesaid cylindrical vessel, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

FRANCIS ARTHUR RICH.

Witnesses:

WALDO FULLER,

CHAS. P. CASLETT.