

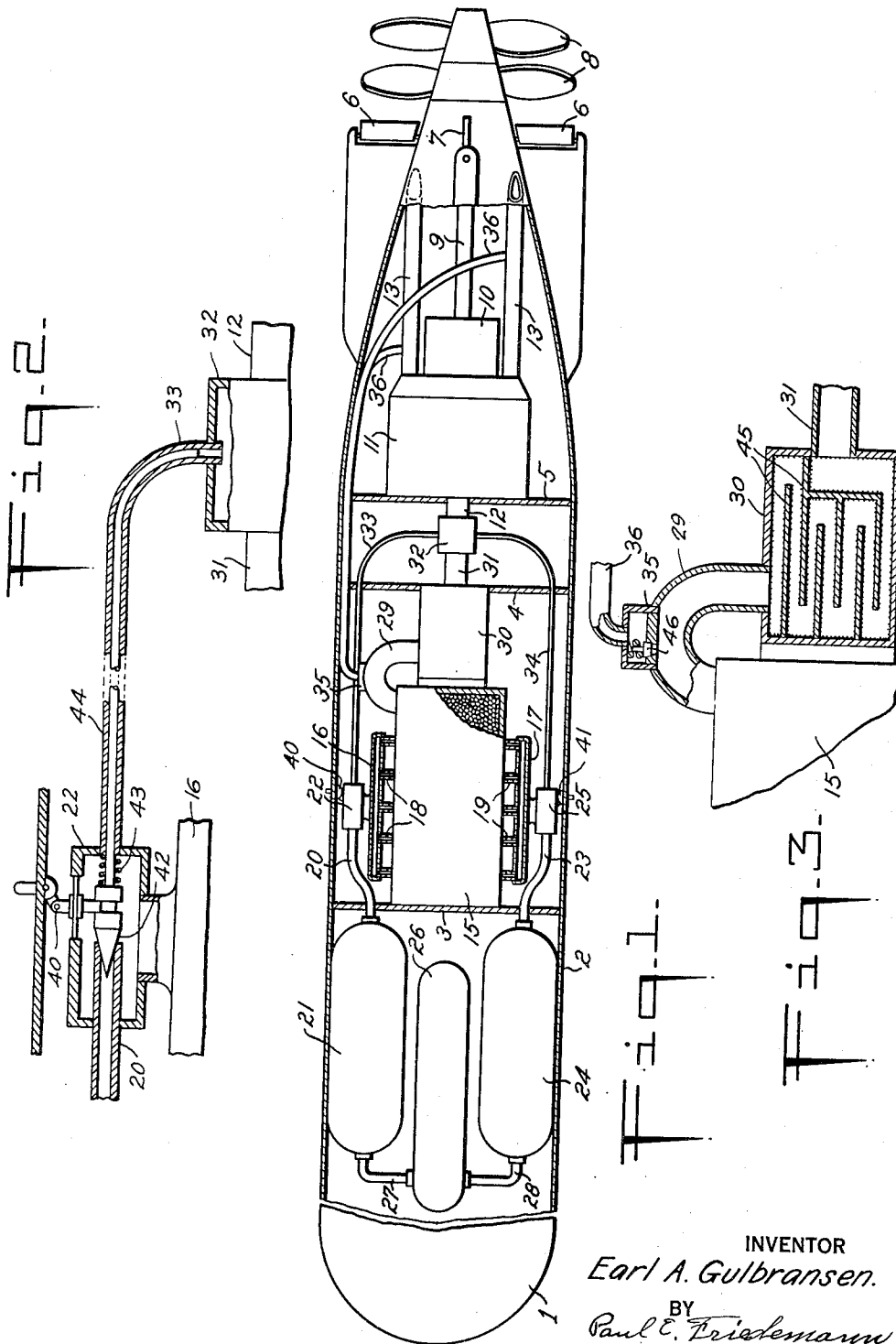
Oct. 11, 1949.

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2,484,221

CHEMICAL TYPE POWER PLANT FOR TORPEDO PROPULSION

Filed June 25, 1946



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2,484,221

CHEMICAL TYPE POWER PLANT FOR
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Application June 25, 1946, Serial No. 679,304

5 Claims. (Cl. 60—50)

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My invention relates to methods and means for producing steam under pressure and operating a steam prime mover. In one of its more specific aspects, my invention relates to the propulsion plant of a torpedo, hydrobomb, or the like missile or craft and involves the use of a novel steam boiler for operating the propulsion plant.

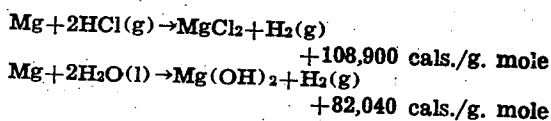
It is an object of my invention to provide methods and means for producing a relatively large quantity of steam under pressure by exothermic reaction of comparatively small quantities of chemicals.

Another object of the invention is to devise a chemical reaction steam boiler whose waste products are soluble in water.

A further object, in conjunction with those above-mentioned, is to provide a steam-operated propulsion plant of small size which is suitable for torpedoes and the like craft.

A well known method of producing hydrogen gas is to apply hydrochloric acid to finely divided magnesium. The reaction is accompanied by the evolution of large quantities of heat.

My invention involves a somewhat similar method but includes also the use of means for utilizing the heat of reaction to form steam from water in a boiler at definite pressure and temperature conditions. Magnesium in finely divided form, especially in the form of salt cake with about 75 to 90% Mg, also reacts with water at a much slower rate. Both the hydrochloric acid and the water reaction are combined according to the invention to obtain steam under pressure, and this pressure, or the quantity of steam evolved by the reactions, is controlled by regulating the supply of hydrochloric acid with or without regulation of the water supply. The reactions involved in this method in steam production are as follows:



The heat evolved in these reactions is used to heat the products of reaction to the boiling point and then to vaporize the water.

When using commercially available salt cake ($\text{Mg} + \text{MgCl}_2$) of about 75% Mg, and supplying hydrochloric acid, the liberated heat suffices to vaporize about 5 pounds of water per pound of salt cake at a pressure of 150 pounds and a temperature of 180.5° C. Corresponding quantities of water are vaporized at other pressures and temperatures. The reaction is controlled, pref-

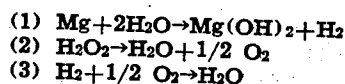
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erably in dependence upon the pressure of the steam thus produced, by regulating the supply of hydrochloric acid to the cell or boiler containing the magnesium containing substance, while the input of water may be kept at a constant rate in accordance with the desired steam rate. However, it is possible to also regulate the supply of water.

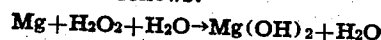
The reaction cell or boiler, as will be described more in detail hereinafter, consists preferably of a lagged chamber charged with a given amount of salt pellets. Concentrated acid and water are fed into the boiler through separate ducts or conduit lines and jets which include the necessary regulating valves.

A torpedo-type hydrobomb, equipped with a steam propulsion plant operating according to the above-mentioned features of my invention and having a drag of 3360 pounds, a speed of 70 miles per hour and a cruising time of 30 seconds requires for safe performance about 80 pounds of H_2O ; 40 pounds of concentrated HCl , and 20 pounds of magnesium salt cake ($\text{Mg} + \text{MgCl}_2$) in pellet form. The reaction of the hydrochloric acid and water with the magnesium is governed by the temperature, pressure, pellet size, and outlet steam pipe size. Hence, aside from the control of acid and water supplies, a proper choice of these other variables is also determining for the rate of steam available for the propulsion motor.

According to another feature of my invention, a reaction of the above-described kind is combined with the decomposition of hydrogen peroxide to result in completely water soluble gaseous reaction products. This decomposition is preferably carried out by introducing hydrogen peroxide into the magnesium reaction cell so that the following exothermic reactions occur simultaneously:



The magnesium reacts with water according to Equation 1. The hydrogen peroxide decomposes according to Equation 2 and is combined with the hydrogen according to Equation 3. The overall equation is as follows:



The three exothermic reactions contribute large quantities of heat for the production of steam from the water introduced and evolved in the reaction. The devices needed to perform this method are similar to those above-mentioned

except that a sufficient amount of H_2O_2 must also be supplied to the reaction cell. This can be done by adding a separate, i. e. third container and supply conduit for the hydrogen peroxide, or by storing and supplying the water and peroxide together. In the latter case, an aqueous solution of hydrogen peroxide may be used in which commercially available peroxide (30 to 50% H_2O_2) can be employed.

A further improvement according to the invention consists in the provision of a catalytic reaction chamber between the reaction cell or boiler and the steam turbine or engine to be driven. The catalysts, such as platinum, palladium, or oxides of iron or cobalt, take care of combining the residual amounts of hydrogen and oxygen to water in the form of steam.

The invention will be more fully understood from the following description of a torpedo equipped with a steam operated propulsion plant according to the invention and represented in:

Figure 1 by a part-sectional axial section showing the parts in operative relation;

Fig. 2 by a somewhat schematic showing on a larger scale of certain details; and

Fig. 3 by another schematic showing of other details also on a larger scale.

The drawing, though showing at 1 part of the war head of the torpedo, is substantially limited to an illustration of the steam boiler and propulsion devices essential to the invention. The interior of the torpedo shell 2 is subdivided by partitions or bulkheads 3, 4 and 5 and carries at its tail end rudders 6 and elevators 7 close to the propeller 8. The propeller shaft 9 is driven through a reduction gear box 10 from a steam turbine 11 mounted on the bulkhead 5. The steam inlet pipe of the turbine is denoted by 12 and the exhaust pipes by 13.

The steam producing devices of the propulsion plant include a reaction cell or boiler proper at 15. This cell is filled with the above-mentioned pellets of magnesium salt cake. Two manifolds 16 and 17 have numerous outlet ducts, such as those denoted by 18 and 19, which open into the cell 15 at places distributed over the cylinder surface of the cell. The manifold 16 is connected by a pipe 20 with a pressure container or flask 21 filled with hydrochloric acid of suitable concentration. A valve 22 serves to regulate the supply of acid from pipe 20 to manifold 16. A similar pipe 23 leads to a flask 24 and is connected with a regulating valve 25. A pressure flask 26, containing, for instance, compressed air, is connected by pipes 27 and 28 with the flask 21 and 24, respectively, to drive the acid and water into the reaction cell when the valves 22 and 25 are open. The flask 24 contains water, or water and hydrogen peroxide as set forth in the foregoing. Before the torpedo is launched, the two valves 22 and 25 are closed. When launching the torpedo, both valves are released and open to an extent determined by the control performance of the pressure gauge described below. The release is effected mechanically, by inertia responsive switches or other time delayed controls that become automatically effective by the launching movement or acceleration of the torpedo. These releasing devices are not illustrated because they are not part of the invention proper and, in type, are known for releasing the operation of the propulsion plant of torpedoes.

Immediately after the opening of valves 22 and 25, the above-mentioned reactions take place in the reaction cell 15. The gaseous and vapor-

ous reaction products pass through a connecting pipe 29 into a catalytic cell 30 whose outlet conduit 31 leads to the inlet conduit 12 of the turbine 11. A manometric gauge 32, inserted between conduits 31 and 12 is connected, mechanically or electrically, through respective conduits or conductors 33, 34 with the valves 22 and 25 respectively so that the effective flow areas of these valves are automatically controlled by the steam pressure at the inlet side of the turbine in order to maintain this pressure within the desired limit values. A safety valve 35 communicates with pipe 29 or some other part of the boiler and catalytic assembly. The appertaining exhaust pipe 36 communicates with the turbine exhaust pipes 13.

In accordance with well-known practice, a trigger apparatus is actuated upon launching of a torpedo. This trigger apparatus initiates the operations of a number of devices in a torpedo. In the torpedo shown the trigger apparatus includes valve unlatching means 40 and 41.

As shown in Fig. 2 the valve unlatching means 40 releases the valve 42 from its closed position—the position shown. The valve 42 has a backing spring 43 and is coupled to a flexible Invar rod 44 disposed in the guide tube 33. The rod 44 ends in a flat piston-like end in the device designated the manometric gauge 32. The rod 44 is thus pressure responsive and as the pressure in 32 builds up, controls the flow of the material from tank 21 into the manifold 16. The valve 25 is similar in structure and function to the valve 22, and is similarly controlled from the pressure in 32.

Since, as already stated, there may be a possibility that the reaction is not completed with the degree of completeness desired, in the reaction chamber, or cell, 15, the products are transmitted to the catalytic cell 30. This cell 30 is provided with a circuitous path for the material as shown by the baffles 45 shown in Fig. 3. The baffles are preferably of ceramic material, or metal baffles coated with sand or gravel as shown and the sand in turn is covered with an extremely fine coating of platinum.

If, for any reason, an excess pressure develops in pipe 29 and the associated parts then the pressure relief valve 46 is actuated to relieve the pressure. The excess steam and gases passing through valve 46 are transmitted to pipes 13 and are thus of aid in propelling the torpedo by means of a jet thrust.

It will be understood from the foregoing that steam and power plants according to the invention can be modified and altered in design and construction and may be used for purposes other than exemplified by the above-described propulsion drive without departing from the principles of the invention and within its essential features as set forth in the claims annexed hereto.

I claim as my invention:

1. A power plant, comprising a reaction cell containing magnesium substance in finely divided form, a pressure container having a duct connected to said cell for supplying hydrochloric acid thereto, at least one other pressure container having a duct connected to said cell for supplying thereto water and hydrogen peroxide, a catalytic cell in communication with said reaction cell and containing a catalyst for hydrogen oxygen reaction, an outlet conduit in communication with said catalytic cell to derive steam from said reaction and catalytic cells, and pressure-responsive control means associated with said outlet

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conduit and connected with at least one of said ducts for controlling the steam-producing reaction in said cell in dependence upon the steam pressure in said conduit.

2. A power plant, comprising a reaction cell containing magnesium substance in finely divided form, a container for hydrochloric acid having a duct connected to said reaction container, a container for water having a duct connected to said reaction container, pressure means connected with said container to drive their contents into said reaction cell, pressure control valves disposed in said respective ducts, a catalytic cell in communication with said reaction cell and containing a catalyst for hydrogen oxygen reaction, an outlet conduit in communication with said catalytic cell to derive steam from said reaction and catalytic cells, and means disposed in said outlet conduit and connected with said valves for controlling the supply of hydrogen and water to said reaction cell in dependence upon the steam pressure.

3. A power plant, comprising a lagged cell containing magnesium salt cake and having separate distributor means for supplying hydrochloric acid and water, a pressure container for hydrochloric acid connected to one of said distributor means, a pressure container for water connected to the other of said distributor means, a catalytic cell in communication with said reaction cell and containing a catalyst for hydrogen oxygen reaction, an outlet conduit in communication with said catalytic cell to derive steam from said reaction and catalytic cells, and control means for regulating the supply from at least one of said containers to said cell.

4. A propulsion plant, comprising a steam turbine, a lagged cell for magnesium salt cake and having distributor means for supplying hydrochloric acid, water and hydrogen peroxide, a

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pressure container for hydrochloric acid connected to said distributor means, at least one other container for water and hydrogen peroxide separately connected to said distributor means,

5 a catalytic cell in communication with said reaction cell and containing a catalyst for promoting hydrogen oxygen reaction, a conduit connecting said catalytic cell with said turbine to supply steam to the latter, a pressure-responsive means disposed in said conduit, and control valves disposed between said reaction cell and said respective containers and connected to said means to be controlled by the latter in dependence upon steam pressure.

5. The method of producing steam under pressure, which comprises the steps of supplying concentrated hydrochloric acid and separately supplying water and hydrogen peroxide to magnesium salt, passing the vapory and gaseous reaction products over a catalyst for hydrogen oxygen reaction to obtain steam, and controlling the supplied quantities in accordance with the steam pressure.

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