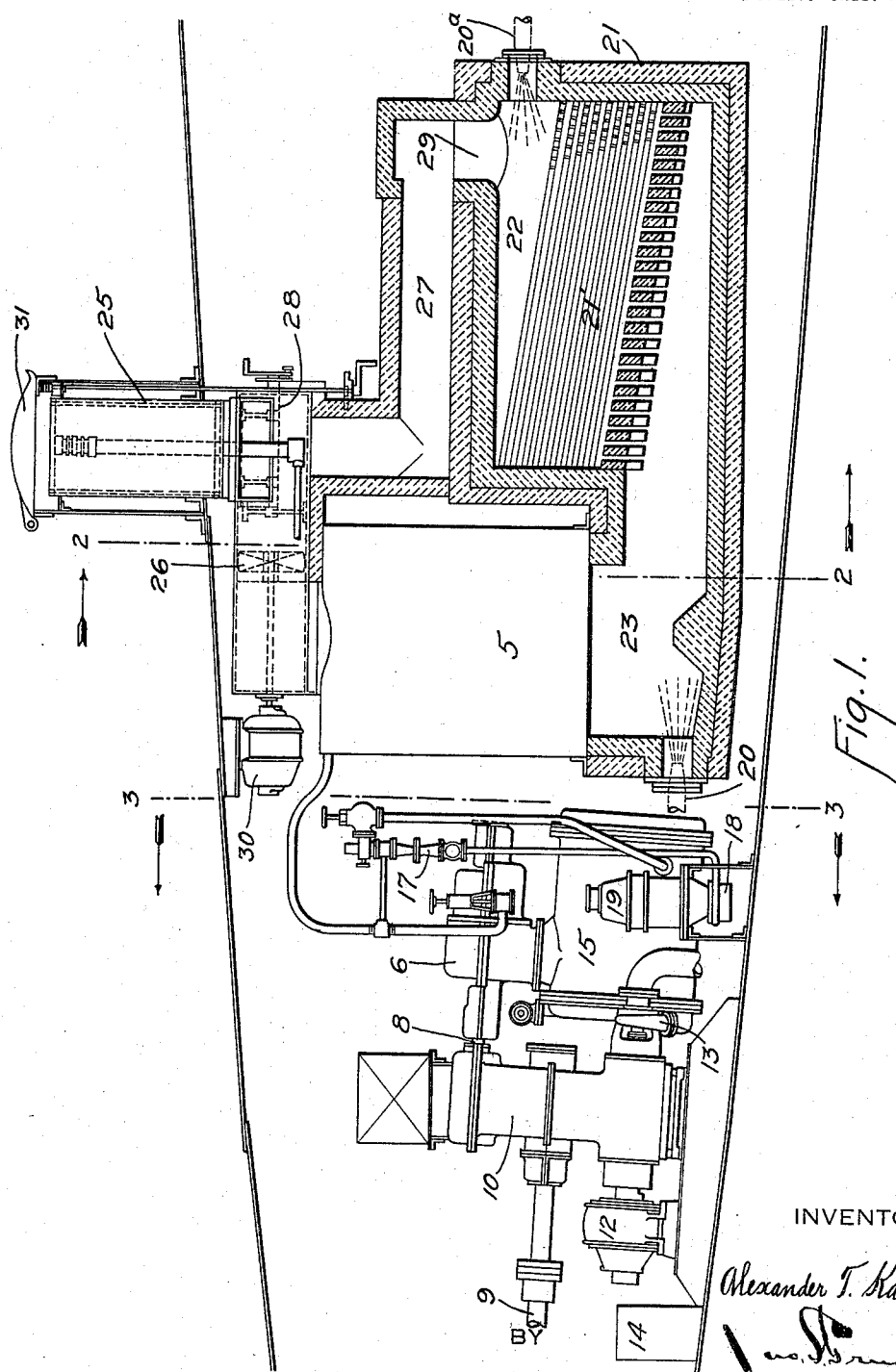


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POWER DEVELOPING APPARATUS.  
APPLICATION FILED SEPT. 22, 1915.

Patented May 15, 1917.  
2 SHEETS—SHEET 1.



INVENTOR.

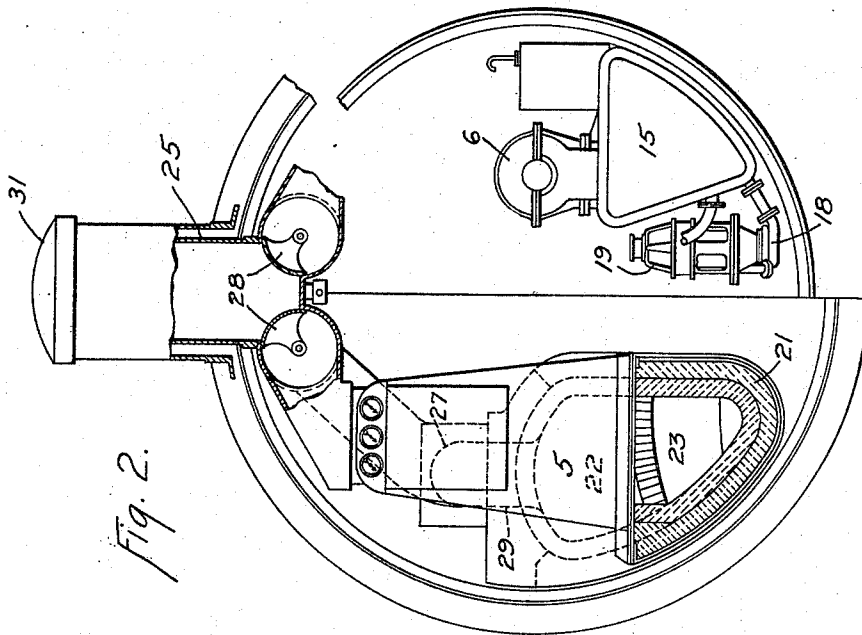
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# UNITED STATES PATENT OFFICE.

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## POWER-DEVELOPING APPARATUS.

1,226,220.

Specification of Letters Patent.

Patented May 15, 1917.

Application filed September 22, 1915. Serial No. 52,042.

*To all whom it may concern:*

Be it known that I, ALEXANDER T. KASLEY, a citizen of the United States, and a resident of Swissvale, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Power-Developing Apparatus, of which the following is a specification.

This invention relates to power developing apparatus and more particularly to such apparatus which may be employed in propelling a submarine both on the surface and submerged.

An object of the invention is to produce improved means for the utilization of fuel in developing power or generating steam or other fluid under pressure.

A further object is to produce improved means for storing heat resulting from the combustion of fuel and for transmitting the stored heat to apparatus for utilizing it in the production of power.

A further object is to produce an improved method of utilizing fuel which may be employed in developing power in a submarine or similar vessel for the purpose of propelling the vessel both on the surface and below the surface of the water.

In submarines it is impractical to develop power by the combustion of fuel while the vessel is submerged. The primary reason for this is that it is impossible, or at least impractical, to store sufficient oxygen or air within the vessel to support combustion for an extensive period of time. Even though this could be satisfactorily accomplished, the disposal of the products of combustion or of the exhaust gases would be difficult, since they could not be retained within the vessel while it was submerged, and, if discharged from it, would indicate the location of the vessel by producing bubbles on the surface of the water.

It is well known that storage batteries are ordinarily employed in propelling submarines while submerged. Storage batteries are, however, costly, bulky, heavy and inefficient, and are objectionable because of the fumes which are given off while the batteries are in operation. In addition to this, the maximum discharge rate of such batteries is limited.

My invention contemplates propelling submarines by steam or fluid under pressure while operating both on the surface

and submerged. While operating on the surface the steam or fluid pressure may be generated in the ordinary manner, and while submerged the steam or fluid pressure is generated by means of stored up heat. The heat is stored while the vessel is at the surface, and preferably while it is maneuvering on the surface. This is accomplished by abstracting a portion of the sensible heat, resulting from the combustion of fuel, prior to its delivery to the steam or fluid pressure generators. In this way nearly all the heat rendered available by the combustion of the fuel is abstracted prior to delivering the products of combustion to the stack. The apparatus illustrated is adapted to employ liquid fuel, such for example as oil, and is provided with an oil burner which is so located and arranged that the products of combustion or burned gases are first delivered to a heat storing apparatus and are then passed to the steam or fluid pressure generators from which they are delivered to the stack. At the beginning of the heat storing operation the major portion of the heat resulting from the combustion of the fuel is abstracted from the products of combustion prior to their delivery to the steam or fluid pressure generators, and for this reason, I find it desirable to employ a second furnace or liquid fuel burner so arranged that the products of combustion or flue gases do not traverse the heat storing apparatus, prior to being delivered to the steam generator. As the heat storing operation progresses, the temperature of the gases delivered from the heat storing apparatus increases and consequently considerable heat would be lost if the gases were not delivered to the steam generator or to some other apparatus for conserving heat. At the time of submerging, the combustion of the fuel is stopped and communication between the boiler room and the interior of the fuel burners or furnaces is closed. The stack is also closed and consequently the only heat available, for power purposes, is the heat which has previously been stored in the heat storing apparatus. In order that this heat may be effectively delivered to the steam or fluid pressure generator, I have included the heat storing apparatus and the steam generator in a closed circulatory system and have provided means, such for example as a fan, for creating a circulation of

air, or other fluid capable of carrying the heat, through the heat storing apparatus, where heat is taken up, then through the flues or tubes of the steam generator, where  
 5 heat is given up, and finally back to the heat storing apparatus, which then operates as a regenerator in that it supplies additional heat to the cooled air or heat-carrying gases. In this way the stored heat is  
 10 conserved and is also rendered available in developing power, and the rate at which the heat is utilized may be varied by varying the velocity of travel of the heat-carrying air or gases through the closed system.

15 The steam generated is utilized in the ordinary manner, in developing power, by being delivered to an engine, such, for example, as a steam turbine, by being condensed after it is exhausted from the turbine and by  
 20 finally being returned to the generator by the feed water pumps. In order to reduce the size and weight of the apparatus as much as possible, per unit of horse power developed, I employ high speed turbines for driving the  
 25 propellers of the vessel, and utilize reduction gearing between the turbines and the propellers. When such an arrangement of apparatus is employed I obtain about 25% saving in weight, in a propelling apparatus  
 30 capable of developing 600 horse power on the surface and 500 horse power submerged, over the weight of a propelling apparatus including Diesel engines and Edison batteries. The initial cost of apparatus embodying my invention is materially less than  
 35 that of other apparatus capable of performing the same functions, and the horse power may be increased while the vessel is submerged by crowding the apparatus without  
 40 the danger of permanently or even temporarily injuring it.

These and other advantages, which will be pointed out throughout the further description of my invention, are attained by means  
 45 of apparatus embodying the features herein described and illustrated in the drawings accompanying and forming a part hereof.

In the drawings, Figure 1 is a fragmental, sectional elevation of a submarine equipped  
 50 with apparatus embodying my invention, a portion of the apparatus being shown in section for convenience of illustration; and

Fig. 2 is a transverse sectional view of the submarine shown in Fig. 1, and a transverse  
 55 sectional view along lines 2—2, and 3—3 of the power developing apparatus illustrated in Fig. 1.

The apparatus illustrated includes a steam generator 5, which may be of any type  
 60 (preferably a flash boiler) and which is adapted to supply steam to a steam turbine 6 through a header 7. The turbine shaft 8 is shown operatively connected to a propeller shaft 9 by means of a reduction gear-  
 65 ing 10. The gearing may be of any type,

but as illustrated is provided with a pinion coupled to the turbine shaft 8 and a large gear coupled to the propeller shaft 9. The large gear may be so constructed as to operate as a thrust bearing if desired, or the pro-  
 70 peller shaft may be provided with a separate thrust bearing. The reduction gearing 10 is also provided with a second pinion, to one end of the shaft of which an electric generator 12 is coupled and to the other end  
 75 of which a pump 13 is directly connected. The generator 12 is employed in connection with a storage battery 14 for furnishing light within the submarine and for driving auxiliaries located at some distance from the  
 80 turbine. The pump 13 is a circulating pump for cooling water and operates in connection with a condenser 15 which communicates with the exhaust of the turbine 6. As illustrated, the air offtake port of the condenser  
 85 communicates with the inlet port of an air ejector 17, which receives actuating steam from the header 7, through a branch pipe, and which exhausts into a hot well 18. The hot well is provided with a pump 19 which  
 90 may be either steam driven or electrically driven and which operates to return water from the hot well to the steam generator 5.

In the apparatus illustrated the generator 5 may receive heat from either or both of  
 95 two sources while the submarine is on the surface. One of the sources consists of a furnace, shown as an oil burner 20 directly below the generator 5 and having a combustion chamber 23 so constructed that the prod-  
 100 ucts of combustion or the burning gases are delivered directly to the heating tubes or flues of the generator. The other source of heat is similarly illustrated as an oil burner 20<sup>a</sup> but it is so located that the products of  
 105 combustion or burning gases pass through a heat storing apparatus 21 prior to being delivered to the generator.

The heat storing apparatus illustrated includes an insulated chamber 22, into which  
 110 burning gases from the oil burner 20<sup>a</sup> are discharged. Within this chamber, but below the point of admission of the burning gases from the burner 20<sup>a</sup>, is located a checker brick or similar arrangement of heat stor-  
 115 ing material 21' through which the gases resulting from combustion, must pass prior to being delivered to the generator 5. I preferably employ silica or graphite, arranged in checker brick formation, as the  
 120 heat storing material 21'.

As illustrated, the chamber 22 communicates directly with the combustion chamber 23, which is shown located immediately  
 125 below the generator 5. With this arrangement both chambers 22 and 23 are served by the same stack 25 and a forced draft is induced by providing a fan 26 or equivalent apparatus between the smoke box or offtake  
 130 of the generator 5 and the stack. In this

way, two converging currents of hot gases are delivered to the heating tubes or flues of the generator 5, one traversing the chamber 23 and the other traversing the chamber 22 and commingling with the gases in the chamber 23.

It will be apparent that the burner 20<sup>a</sup> may be of such size that it will furnish all the heat necessary for generating steam while the submarine is maneuvering on the surface. With such an arrangement the generator could not be operated without storing heat and a certain amount of heat would have to be stored before the generator could generate the desired steam pressure. For both of these reasons it is desirable to employ the two furnaces or oil burners so that heat can be delivered directly to the generator without first storing heat in the heat storing apparatus 21.

It will be apparent that both of the burners 20 and 20<sup>a</sup> may be operated simultaneously for the purpose of storing heat and generating steam, while the submarine is maneuvering on the surface, or that the generator may be operated without storing heat.

In order that the generation of steam may be continued when the vessel is submerged and consequently when the combustion of fuel has ceased, I provide means for creating a flow of air, or other fluid capable of carrying heat, through the heat storing apparatus 21, then through the generator 5, and eventually back to the heat storing apparatus so that the heat transmitting fluid is circulated in a closed system and is first subjected to the heating influence of the checker brick 21' and then to the cooling influence of the flues or tubes of the generator. In the illustrated embodiment this is accomplished by providing a passage 27 which communicates with the off-take of the generator 5 by means of a 2-way valve 28, and with the chamber 22 by means of a port 29. The 2-way valve 28 also forms a means of communication between the off-take of the generator and the stack 25, and is so arranged that it is capable of either establishing communication between the stack and the off-take and cutting off communication between the passage 27 and the off-take, or of establishing communication between the passage 27 and the off-take and cutting off communication between the off-take and the stack. The fan 26 is so arranged that it operates to either discharge the products of combustion through the stack or to maintain the circulation of heat-carrying fluid through the inclosed system above described.

Prior to submerging, the oil burners 20 and 20<sup>a</sup> are shut off and the air inlet ports to each burner are closed. The stack is then closed by means of the trap 31 and the valve

28 is turned so as to open communication between the off-take of the generator 5 and the passage 27. The fan 26 then causes a circulation of air or heat-carrying fluid through the passage 27, the chamber 22, the checker brick 21', the chamber 23, the flues or tubes of the generator 5 and through the off-take of the generator back to the passage 27.

The fan 26 may be driven by a turbine receiving steam from the generator 5, or it may be driven by a motor 30, such as illustrated, receiving current from the storage battery 14, or from the generator 12. It may, however, be desirable to provide a coupling between the gearing 10 and the generator 12 so that the generator may be disconnected while the vessel is submerged.

Among the advantages obtained by apparatus embodying my invention over apparatus now employed for propelling submarines, is that less space is occupied by the heat storing apparatus than is occupied by the storage batteries employed while propelling the vessel submerged. In addition to this, it is not necessary to provide the propelling motor and consequently a greater amount of space is provided within the submarine for air to breathe. The apparatus is also simple, both in construction and in operation, and consequently the crew of the submarine can be materially decreased. The boiler room, which includes the heat storage apparatus, may be closed and heat insulated from other portions of the vessel, since there is no necessity for an attendant in the boiler room, while the vessel is submerged.

Heat may also be stored in the heat storage apparatus while the vessel is developing full power at the surface and the vessel may be crowded for a short time so that it will develop substantially full power while operating submerged without a decrease in efficiency or injury to the apparatus. There is also the possibility for employing steam ejectors for pumping water out of the vessel in emergency. The only disadvantage of the apparatus, as compared with the usual propelling apparatus of submarines, is that there will be a certain amount of loss in stored energy due to heat radiation while the vessel is submerged. This, however, may be reduced to a very low minimum by insulating the steam generator 5, the heat storage chamber, and all of the communicating passages. The kind of insulating material used and the extent of insulation will determine the amount of heat loss. The heat loss may also be materially reduced by insulating the boiler room and by keeping it closed.

While I have described but one embodiment of my invention, it will be apparent to those skilled in the art that various changes, modifications, additions, omissions

and substitutions may be made in the apparatus illustrated, without departing from the spirit and scope of the invention as set forth by the appended claims.

5 What I claim is:

1. In an organized apparatus of the character described, a power developing apparatus, refractory heat storing material in open communication with the power developing apparatus and means for creating a continuous flow of heat carrying fluid through the refractory material, the power developing apparatus, and back to the refractory material.

15 2. In an organized apparatus of the character described, a pressure generator, a furnace for delivering heat to said generator, a heat storing apparatus between the furnace and said generator, and means for creating a flow of gases from the furnace through the heat storing apparatus and to the generator.

3. In an organized power developing apparatus for submarines, a heat conserving device, a furnace for delivering heat to said device, a heat storing apparatus between the furnace and the device, means for creating a flow of the products of combustion from the furnace through the heat storing apparatus and to the device while the furnace is in operation and for creating a continuous flow of heat carrying fluid through the heat storing apparatus, the device, and back to the heat storing apparatus when the furnace is not in operation.

4. In a power developing apparatus for submarines, a fluid pressure generator, a furnace for delivering heat to said generator, a heat storing apparatus located between said furnace and said generator and means for creating a continuous flow of heat carrying fluid from said heat storing apparatus, to said generator, and back to said heat storing apparatus when said furnace is not in operation.

5. In a power plant for submarines, a fluid pressure generator, a furnace for delivering heat to said generator, a second furnace, and a heat storing apparatus between said second furnace and said generator, and through which the products of combustion from the second burner pass in passing to the generator.

6. In a power plant for submarines, a fluid pressure generator, two furnaces for delivering heat to said generator, a heat storing apparatus located between one of said furnaces and the generator, a stack for serving both furnaces, and means for creating a continuous flow of heat carrying fluid through the storing apparatus, the generator and back to the storing apparatus while the stack is closed and the furnaces are inoperative.

7. In a power plant for submarines, a fluid pressure generator, two furnaces for delivering

heat to said generator, one located immediately below the generator, and the second located at a distance from the generator, a heat storing apparatus located between the second furnace and the generator and through which the products of combustion from the second furnace pass prior to entering the generator, a stack serving both furnaces, a passage for connecting the generator to the apparatus in a closed circulatory system, means for shutting off communication between the stack and said furnaces, and means for creating a current of heat carrying fluid through the closed circulatory system.

8. In a power plant for submarines, a fluid pressure generator, a heat storing apparatus, means for simultaneously delivering heat to said generator and said apparatus, and means for transferring heat from said heat storing apparatus to said generator when said heat delivering means are not in operation.

9. In a power plant for submarines, a fluid pressure generator, a heat storing apparatus, means for delivering heat to said generator and to said apparatus, means for transferring heat to said generator from said apparatus when said heating means are not in operation, and means operating on the fluid pressure generated by said generator.

10. In a power plant for submarines, a fluid pressure generator, a furnace having a combustion chamber in proximity with said generator, a second furnace having a combustion chamber remote from said generator, a heat storing apparatus located between and forming a means of communication for said combustion chambers, a stack communicating with the off-take of said generator and serving both furnaces, means of communication between the off-take and said apparatus, and means for shutting off communication between the stack and the off-take and for establishing communication between the off-take and the apparatus for the purpose of delivering heat from the apparatus to the generator, and means for creating a continuous flow of heat carrying fluid, through the heat storing apparatus, the generator, the off-take and back to said apparatus.

11. A method of generating fluid pressure, which consists in burning fuel, delivering a portion of the heat resulting from the combustion of the fuel to heat storing material, and a portion of the heat to a fluid pressure generator, stopping the combustion of the fuel, and creating a continuous flow of heat carrying fluid over the heat storing material, through the flues or tubes of the generator and back to the heat storing material.

12. A method of generating steam pres-

sure, which consists in burning fuel, delivering a portion of the heat resulting from the combustion of the fuel to a heat storing material, and a portion of the heat to a steam generator, stopping the combustion of the fuel, inclosing the flues or gas passages of the generator and the refractory material in a closed circulatory system and then creating a continuous flow of heat carrying fluid through the flues or gas passages of the generator over the heat storing material and back to the generator.

13. In a power plant for submarines, a fluid pressure generator, refractory heat storing material, means for delivering heat to the generator and to the material, and means for delivering heat from the heat

storing material to the generator when the heat delivering means is not in operation.

14. In a power plant for submarines, a fluid pressure generator, a refractory heat storing material, means for delivering heat to the material and to the generator, means for inclosing the refractory material and the generator in a closed circulatory system, and means for creating a continuous flow of heat carrying fluid over the refractory material, through the heating tubes or flues of the generator and back to the heat storing material.

In testimony whereof, I have hereunto subscribed my name this 20th day of September, 1915.

ALEXANDER T. KASLEY.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents. Washington, D. C."