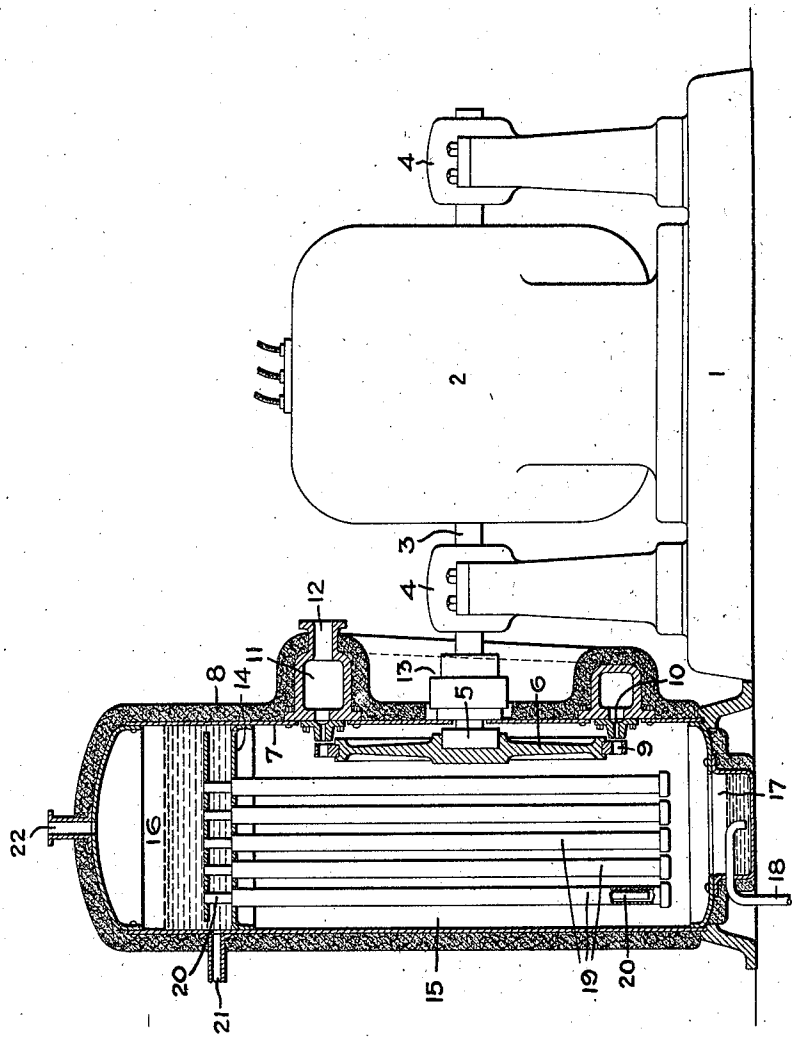
W. L. R. EMMET.

COMBINED TURBINE AND VAPOR GENERATOR.

APPLICATION FILED NOV. 26, 1913. RENEWED NOV. 30, 1915.

1,192,775. Patented July 25, 1916



Witnesses:
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UNITED STATES PATENT OFFICE.

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COMBINED TURBINE AND VAPOR GENERATOR.

1,192,775. Specification of Letters Patent. Patented July 25, 1916.

Application filed November 26, 1913, Serial No. 803,179. Renewed November 30, 1915. Serial No. 64,386.

To all whom it may concern:

Be it known that I, WILLIAM L. R. EMMET, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Combined Turbine and Vapor Generators, of which the following is a specification.

The present invention relates to turbines which are driven by vapors obtained from liquids having high boiling points, as mercury for example, and to means whereby the exhaust of such turbines can be economically utilized to vaporize a liquid having a lower boiling point, as water for example, the vapor thus formed being employed for some useful purpose, as driving an ordinary steam turbine for example. The great advantage of such a system or apparatus resides in the fact that the total range of temperature through which it operates can be made very great without, however, dealing with such high pressures as would be the case if steam alone were used. In an organization of this kind, however, the high temperatures dealt with introduce problems not found in ordinary steam turbine installations. As an example of the temperatures involved, mercury vaporizes at atmospheric pressure at about 677° F. and condenses in a vacuum of 28″ at about 457° F. This means that after the mercury vapor has done work in the turbine it still contains a large amount of heat that is available for generating steam or other vapor, and upon the effective utilization of this heat and the avoidance of heat losses depends the efficiency of the apparatus as a whole. These high temperatures give rise to very considerable expansion of the parts which, unless specifically taken care of, will cause serious distortions. Further, in order to prevent losses by radiation of the exhaust all of the parts should be heavily lagged.

The object of my invention is to provide improved apparatus for carrying out the process of generating power above referred to.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and claims appended thereto.

In the accompanying drawing is shown one embodiment of my improved apparatus in vertical section.

1 indicates a base and mounted thereon is an alternating current three-phase generator 2. Its rotor is carried by the shaft 3 and the latter is supported by bearings 4. The left hand end of the shaft is provided with a head 5 that fits into a socket in the bucket wheel or rotor 6. It will be noted that the usual axial hole for the shaft is omitted. By omitting said hole the wheel can be made much lighter for the necessary strength, it being well understood that an axial hole in a high speed rotating body weakens it very materially. Owing to the decrease in weight the wheel can be "overhung" with respect to the adjacent bearing on the shaft 3.

Instead of providing separate casings for the turbine wheel and exhaust receiving means, I mount the rotor directly within the casing or shell 7 of what may be conveniently termed a condenser-boiler thereby saving one casing. By thus arranging the wheel the use of an exhaust conduit is avoided and also all losses incident to its use. The arrangement also causes an active circulation of the high temperature vapor in the condenser-boiler, thereby increasing the effectiveness of its action. Further, since the parts are in the same casing the distance that the exhaust has to traverse after leaving the wheel and before reaching the condenser-boiler tubes is very short, the losses due to radiation will be substantially avoided, and the vapor caused to directly strike said tubes, an arrangement that facilitates the transfer of heat to the liquid undergoing vaporization in the tubes. Since the condenser also acts as a steam boiler and operates at a high temperature it is desirable to conserve the heat as fully as possible, and to this end it is entirely surrounded by heavy lagging 8. Locating the wheel as shown, besides making one casing or shell serve the purpose of two, obviates the necessity for a separate lagging for the turbine casing and for an exhaust conduit leading from the turbine to the condenser. It also avoids the necessity of any expansion joint between the turbine casing and the condenser with its lagging which, with the high temperatures contemplated, would be a matter of some inconvenience and considerable cost.

The rotor is provided with one or more rows of buckets 9 of any suitable construc-

tion, and mercury vapor is discharged against them by nozzles 10 which may extend wholly or partially around the circumference of the wheel. Mercury vapor under relatively low pressure is admitted to the nozzles from the chest 11, the latter having an inlet 12 connected to a suitable vapor generator. This chest is also well lagged to reduce radiation losses. In effect the chest and shell form one structure and the lagging on the shell also covers the chest. To prevent any vapor from escaping through the shaft opening in the shell a packing 13 of suitable construction is provided. By overhanging the wheel on the shaft and locating it inside of the shell of the condenser-boiler only one packing is necessary as against two with ordinary turbine constructions where the shaft passes through the wheel and is supported by two bearings located outside of the wheel casing.

In the upper part of the shell of the condenser-boiler is a partition 14 which divides the interior into two principal chambers 15 and 16, chamber 15 containing liquid mercury and its vapor, and chamber 16 water and steam. In the bottom of the chamber 15 is formed a pocket 17 from which liquid mercury is drained by the pipe 18. The rotation of the wheel will cause a most active circulation of the vapor in the shell, and as a result it will be efficiently condensed by the tubes 19, which in turn give up their heat to the water, said tubes depending from the partition which also forms a tube sheet. The tubes 19 are closed at their lower ends and located inside of each of them is a second and smaller tube 20 open at both ends and so positioned that there will be a small annular space for steam and water between the two. In other words, the tubes are in telescopic relation. The water will flow down the center tube and issue as steam and superheated water from said annular space. The number of these tubes will, of course, depend upon the amount of vapor to be condensed on the one hand, and the amount of steam to be delivered on the other. This arrangement of tubes is well adapted for the purpose owing to the freedom from stresses tending to loosen the joints in the tube sheet through expansion by variations in temperatures, and to its simplicity of construction. Since the heat delivered to all parts of the surface will be very uniform, the construction will afford ample water circulation and release of steam, even if the tubes are made very long as might be desirable for reasons of economy, simplification in construction, and saving in floor space. The arrangement also makes possible removal or cleaning of the tubes from the top without any access to the bottom of the boiler which can be placed directly on the floor foundation. I can, however, use other tubing arrangements as will be appreciated. The tubes will ordinarily be staggered so as to further increase the effective action of the hot mercury vapor on the outer tubes. Water is admitted to the chamber 16 by the pipe 21, the latter being connected to a pump or other suitable source of supply. Steam is discharged from the chamber by the pipe 22, which communicates with steam consuming apparatus, such as a turbine for example.

To simplify the illustration I have omitted the man-hole or equivalent arrangement by means of which access may be had to the boiler tubes and also the means whereby the turbine wheel can be taken out of the casing, since these form no part of the invention and can be of any suitable construction.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In an apparatus of the character described, the combination of a casing that is divided into two principal chambers between which there is a free exchange of heat, one of said chambers containing a liquid of high boiling point and its vapor, and the other a liquid of lower boiling point and its vapor, a turbine rotor mounted in the first named chamber and exhausting into it, means for discharging vapor derived from a fluid having a high boiling point to the rotor, a conduit for draining off the liquid due to condensation of said exhaust, a conduit for supplying a liquid of lower boiling point to the other part of said casing, and a conduit leading therefrom for carrying off the vapor of the last named liquid.

2. In an apparatus of the character described, the combination of a casing that is divided into two principal chambers between which there is a free exchange of heat, one of said chambers containing a liquid of high boiling point and its vapor, and the other a liquid of lower boiling point and its vapor, a shaft that extends into the casing, a bearing for the shaft located outside of the casing, a turbine rotor mounted on one end of the shaft and within the first named chamber and exhausting into it, means for discharging the vapor of a fluid having a high boiling point against the buckets on the rotor, a conduit for draining off the liquid due to condensation of said exhaust, a conduit for supplying a liquid of lower boiling point to the other chamber of

said casing, and a conduit leading therefrom for carrying off the vapor of said liquid.

3. In an apparatus of the character described, the combination of a casing, a turbine rotor located therein and driven by the vapor of a liquid having a relatively high boiling point, tubes located in the casing and containing a liquid having a lower boiling point than the first, said tubes acting to condense the vapor discharged against them by the wheel and to vaporize the liquid contained in them, means for draining off the liquid of higher boiling point as it is condensed, a conduit for feeding the liquid to the tubes, and a conduit for carrying off the vapor generated by said tubes.

4. In an apparatus of the character described, the combination of a casing, a partition therein for dividing it into two principal chambers, tubes supported by the partition and extending into one of the chambers, a turbine rotor mounted in one of the chambers in the casing and discharging its exhaust against the outer surfaces of the tubes, means for discharging a vapor derived from a fluid having a high boiling point against the buckets on the rotor, a conduit for carrying off the liquid condensed by the tubes, a conduit for supplying water to the other chamber and to the interior of the tubes, and a conduit for conveying steam from the last named chamber.

5. In an apparatus of the character described, the combination of a casing that is divided into two principal chambers, the walls of one of said chambers acting as a boiler, a turbine rotor mounted in the other chamber and discharging its exhaust directly against said walls, means for supplying a vapor to the rotor which condenses at a temperature above that of boiling water, a conduit for draining off the liquid condensed by said walls, a conduit for supplying a liquid to the other chamber which is vaporized by the exhaust from the rotor, and a conduit located in a part of the last named chamber and above the level of the liquid therein for carrying off vapor.

In witness whereof, I have hereunto set my hand this 25th day of November, 1913.

WILLIAM L. R. EMMET.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.