Y. WADAGAKI.

SYSTEM FOR UTILIZING EXHAUST STEAM.

APPLICATION FILED OCT. 7, 1908.

913,330.

Patented Feb. 23, 1909.

2 SHEETS—SHEET 1.

FIG. 1

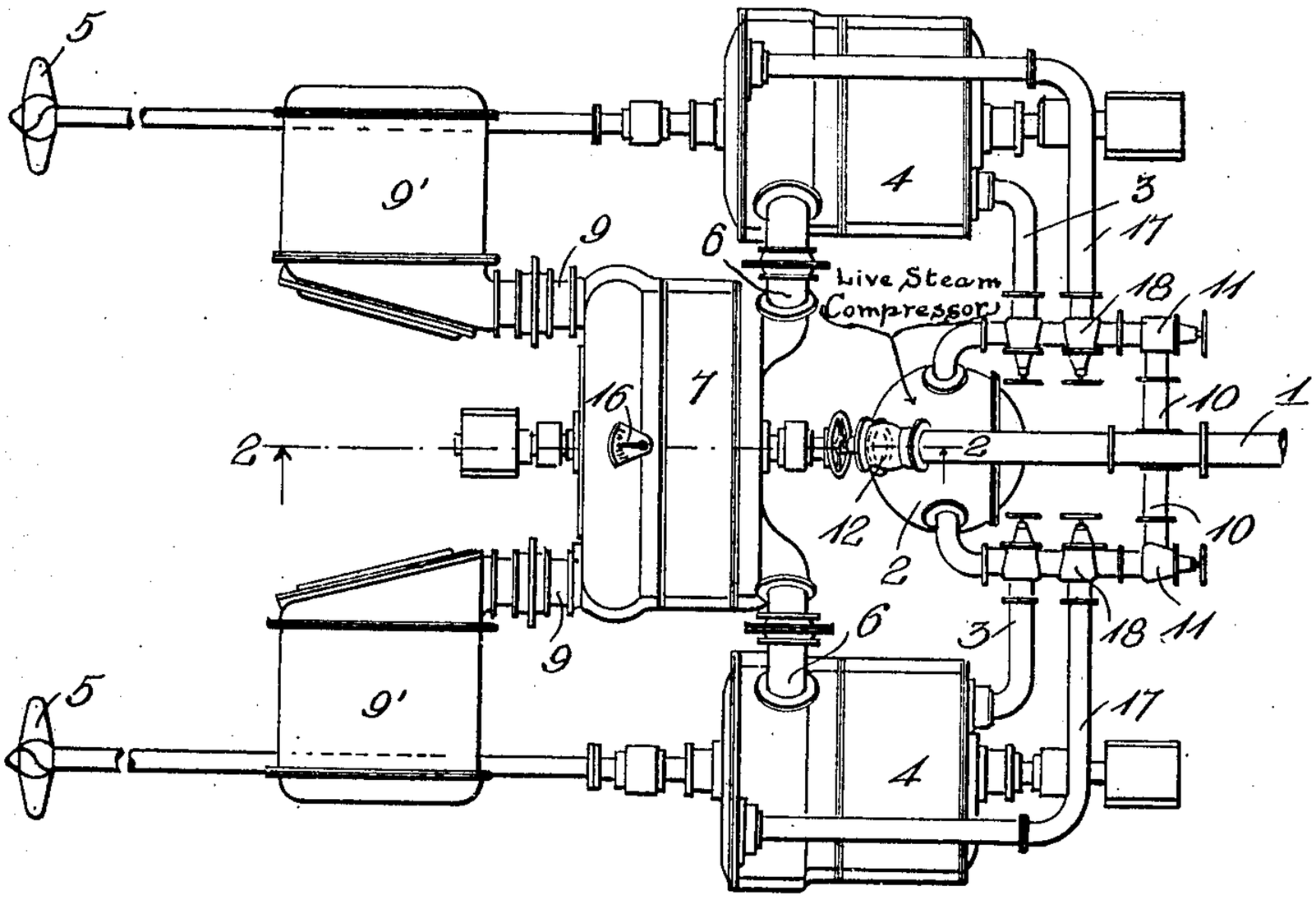
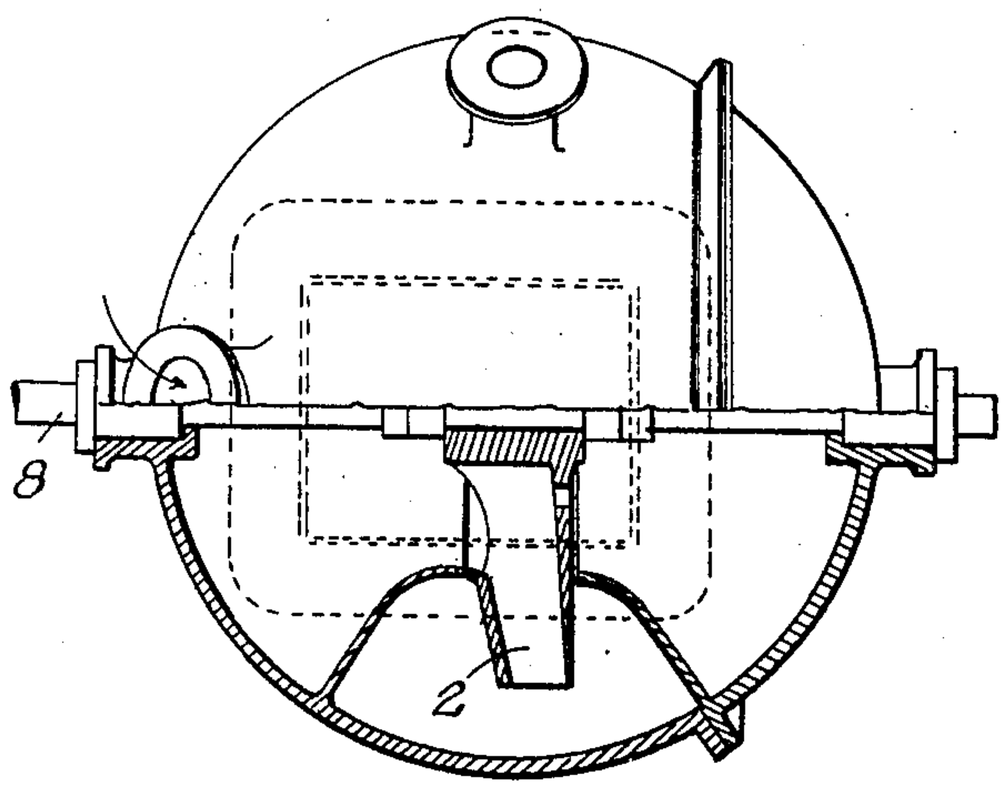


FIG. 2



Witnesses

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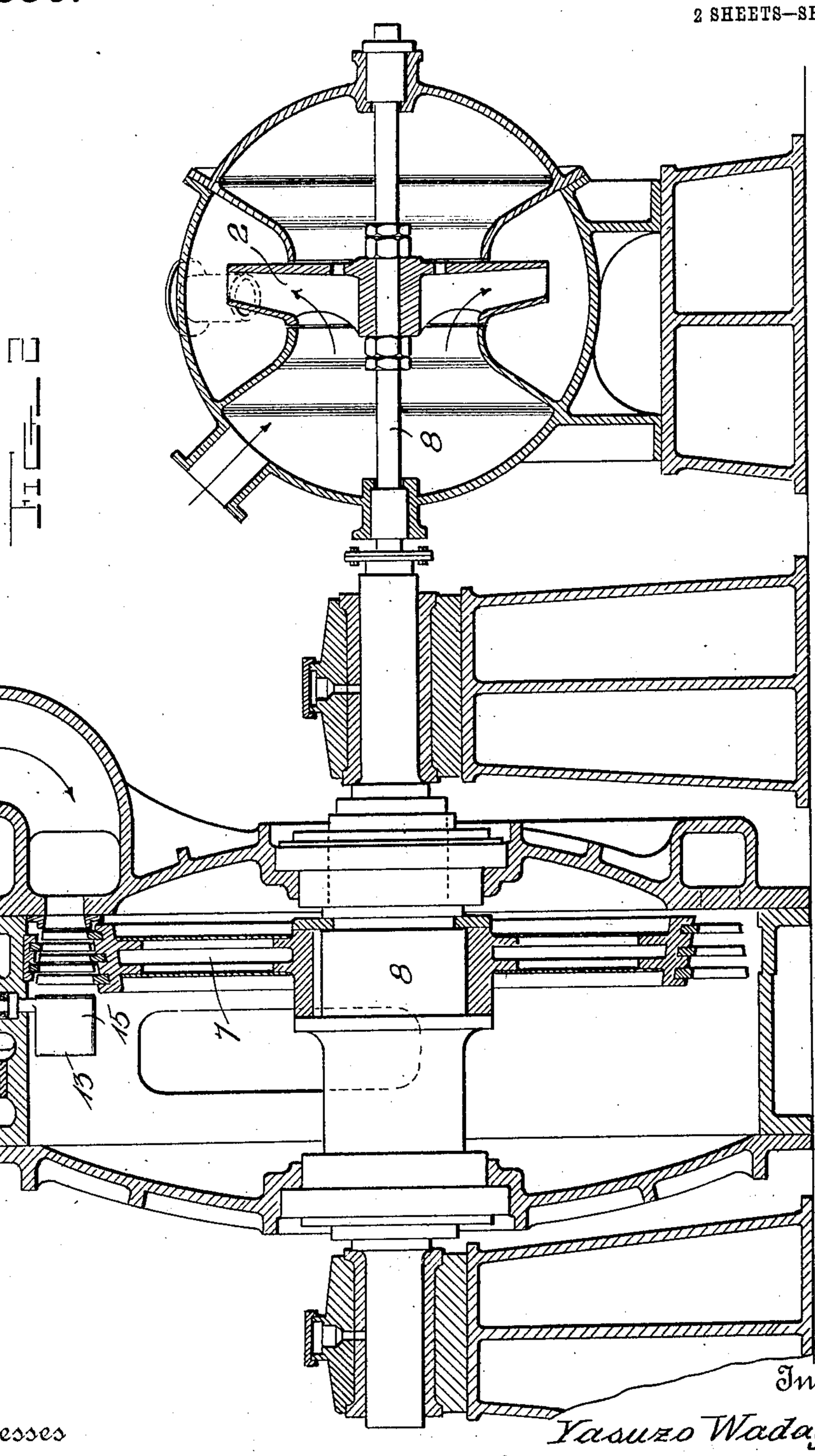

Witnesses

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UNITED STATES PATENT OFFICE.

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SYSTEM FOR UTILIZING EXHAUST-STEAM.

No. 913,330. Specification of Letters Patent. Patented Feb. 23, 1909.

Application filed October 7, 1908. Serial No. 456,594.

To all whom it may concern:

Be it known that I, YASUZO WADAGAKI, a subject of the Emperor of Japan, and a citizen of Nojeo village, Kinosaki, Hyogo Ken, residing at Sasebo, in the county of Hizen, Japan, have invented certain new and useful Improvements in Systems for Utilizing the Exhaust-Steam of Marine or other Engines for Producing Greater Power; and I do 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 an improved system for utilizing the exhaust steam of marine or other engines for producing greater power.

The object of this invention is to utilize, as far as possible, the heretofore necessary waste of available energy which is ordinarily carried away with the exhaust steam from a marine engine cylinder or turbine by utilizing said exhaust steam to compress the main supply of live steam led to the main engine cylinders, to a greater pressure.

With this and other objects in view, the invention consists of certain novel features of construction, combination and arrangement of parts, as will be more fully described and particularly pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a plan view of the invention as arranged in connection with the main propelling machinery of a vessel of the turbine type; Fig. 2 is a longitudinal sectional view on line 2—2 of Fig. 1; and Fig. 3 is a plan view partly in horizontal section of the compressor..

Referring more particularly to the drawings which are for illustrative purposes only and therefore not drawn to scale, the numeral 1 indicates the main steam pipe which conveys the live steam from the boilers to the propelling machinery, 2 indicates a rotary compressor of any suitable design, capable of compressing the main supply of live steam to a still higher pressure and temperature before its admittance to the engine cylinders, 3 the high pressure steam pipes conducting the steam compressed in the rotary compressor to the main engine high pressure cylinders, 4, and 5 the screw propellers.

In carrying the invention into effect, an auxiliary turbine 7 of any suitable type is arranged between the turbines 4 and is driven by the exhaust steam which is led from the main turbines 4 into the auxiliary turbine 7 by the eduction pipes 6. The steam taken from the boilers by the main steam pipe 1 is partly or wholly admitted to the rotary compressor 2 wherein it is compressed to a still higher pressure and temperature. The steam so superheated in the rotary compressor 2 is then conducted by way of the high pressure pipes 3 to the main turbines 4. After doing the principal work in the turbines 4 in driving the screw propellers 5, the steam is next led to the auxiliary turbine 7 which is coupled to the shaft 8 to which is fixed both the rotating vanes of auxiliary turbine 7 and the rotary compressor 2. The exhaust steam after operating the turbine 7 is led by the pipes 9 to the condensers 9′.

The regulation of the speed of revolution of the auxiliary turbine is controlled by means of the by-pass pipes 10 and the steam stop valves 11 and 12 fitted on the pipes 10 and at the inner end of steam pipe 1, respectively. By means of these valves the relative amount of steam passed through the by-pass pipes and compressor may be regulated at will. For instance, when it is desired to increase the speed of the auxiliary turbine the stop valve 12 is more nearly closed, while the stop valves 11 are opened to a greater extent and when it is desired to decrease the speed of the turbine 7, the reverse adjustment of these stop valves is effected. In order to work the auxiliary turbine 7 at the most economical speed of revolution it is necessary to know the absolute direction in which the exhaust steam is finally discharged from the last row of rotating vanes in the turbine. To make this statement clear, it may be said that in any steam turbine there is a particular speed of revolutions corresponding to a given supply of steam which gives the maximum efficiency. With the speed of revolution giving the maximum efficiency, the exhaust steam is discharged from the last row of rotating vanes in a direction parallel to the axis of the turbine shaft. In order that an engineer may ascertain at all times the absolute direction in which the exhaust steam is finally discharged from the last row of rotating vanes and to enable him to run the turbine at the most economical speed, I provide an automatic indicator 13 consisting of a stem or spindle 14 which passes through a steam tight stuffing box on the top of the turbine casing as clearly shown in Fig. 2 in a position immediately behind the last row of rotating

vanes, this stem being provided at its inner end with a flat floating vane or body 15 and at its outer end with an index 16 to indicate the angular position of the floating vane 15 and consequently the direction or course of the exhaust steam discharged from the last row of rotating vanes and the consequent speed of the turbine.

Steam pipes 17 and stop valves 18 are provided for the requirement of going astern as will be understood. When there is ample space in the engine room, the go-astern turbines are preferably made and fitted in separate cylinders from those of the go-ahead turbines, although in Fig. 1 they are shown placed in the same cylinders of the going ahead turbines as a matter of convenience of illustration. Now in naval vessels, the rate of expansion of steam in engine cylinders cannot be carried high enough as might be desired, simply because the naval engines have at times in the course of their service to develop the highest possible amount of power for each ton of weight allowed to them. On the other hand, if, at the expense of extra weight, the engine cylinders are made sufficiently large so as to obtain the desired rate of steam expansion, then the loss due to initial condensation of steam in the engine cylinders and the mechanical friction of engines, when working at reduced rate of power, would offset any advantage that would be derived from greater expansion of steam. Again, in the case of vessels fitted with turbine engines and cruising at a moderate rate of speed, the propelling turbines are not capable of working at a sufficiently high rate of revolution per minute, for the reason that the efficiency of too small a propeller would become seriously affected when the ship is required to go at full speed. In all these cases, a large amount of otherwise available heat is unavoidably carried away with the exhaust steam. By means of my invention, however, an opportunity is afforded to save at least a part of this large waste of energy by the employment of the auxiliary turbine and the rotary steam compressor. Also, as the auxiliary turbine and the rotary steam compressor have no direct mechanical connection with the propeller shafting, they may be operated at any desired rate of speed or revolution, irrespective of any consideration of propeller efficiency. And since their center line need not coincide with any of the center lines of the propeller shafting, they may be installed at any convenient position in the engine room at the option of the designer. There is therefore almost no practical restriction regarding the choice of diameter of the vane wheel for the auxiliary turbine and hence any desired peripheral velocity may be obtained for its vanes, likely to give the most economical result. Also by the employment of my invention means is provided not only whereby it may be certainly determined when the auxiliary turbine is working at the most economical speed of revolution per minute, but also an infallible means is provided for automatically controlling and indicating the speed, whatever may be the power and speed of the main propelling engines 4 at the instant in question. In other words this invention provides for extracting the maximum amount of available energy still possessed by steam at the last stage of its expansion in the engine cylinders or turbines and for restoring the energy to the main supply of live steam, in the shape of extra pressure or superheated temperature. The result will doubtless be productive of considerable steam-economy in working the main propelling machinery in either reciprocating engines or turbines.

From the foregoing description, taken in connection with the accompanying drawings, the construction and operation of the invention will be readily understood without requiring a more extended explanation.

Various changes in the form, proportion and the minor details of construction may be resorted to without departing from the principle or sacrificing any of the advantages of this invention as defined in the appended claims.

Having thus described and ascertained the nature of the invention, what I claim as new and desire to secure by Letters-Patent is:

1. In combination with the propelling mechanism of a marine vessel, means for utilizing the exhaust steam to compress the supply of live steam to a greater pressure before being admitted to the engine cylinders.

2. In combination with the main engines of a marine vessel propelling mechanism, an auxiliary turbine driven by the exhaust steam from the main engines and a compressor driven by said auxiliary turbine, said compressor being arranged to compress the supply of live steam to a greater pressure before the admittance thereof to the main engines.

3. In combination with main stationary fluid-operated engines and a main steam supply pipe, a compressor communicating with the supply pipe, an auxiliary turbine driven by the exhaust steam from the main engines and operating the compressor and means for regulating the relative amount of steam passed through the compressor before its admittance to the main engines.

4. An arrangement for utilizing the exhaust steam from main engines to create greater power comprising an auxiliary turbine driven by the exhaust steam of the main engines, a rotary compressor driven by the auxiliary turbine for compressing the supply of steam to a greater pressure before

admittance to the main engine cylinders and an indicator for indicating the direction of flow of the exhaust steam after passing through the last row of rotating vanes in the auxiliary turbine.

5. In a system including an auxiliary turbine for utilizing the exhaust steam from marine engines to create greater power, an indicator for indicating the direction of flow of the exhaust steam after passing through the last row of rotating vanes in the turbine comprising a stem extending through the turbine casing and provided at its outer end with an index and at its inner end with a flat floating vane.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

YASUZO WADAGAKI.

Witnesses:

TSUNEZO SHIGIO,

CARLETON MILLER.