W. L. R. EMMET.

SYSTEM OF SHIP PROPULSION.

APPLICATION FILED DEC. 12, 1916.

1,297,130. Patented Mar. 11, 1919.

Fig. 1.

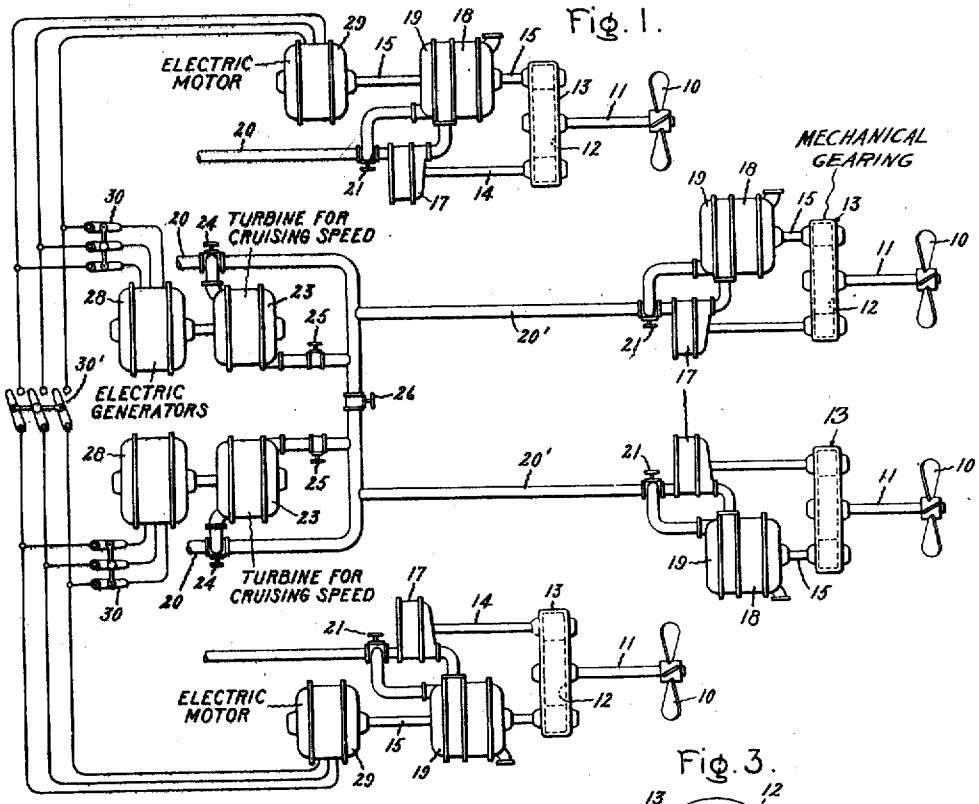


Fig. 2.

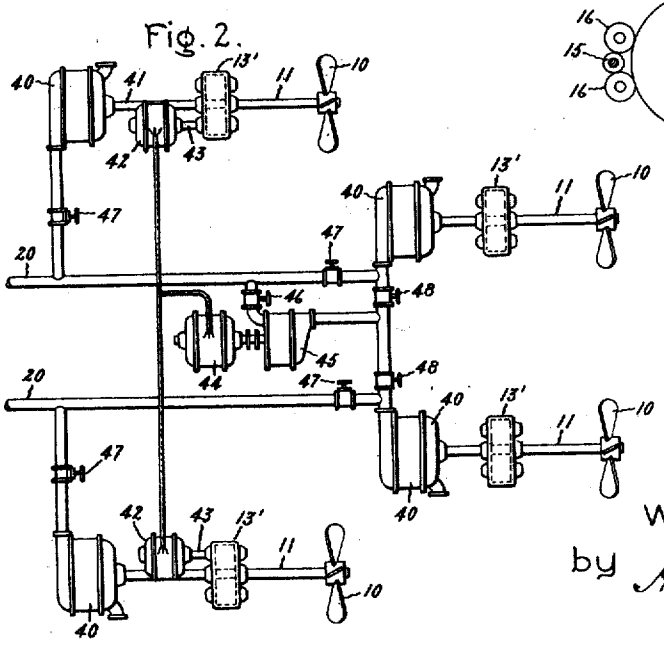


Fig. 3.

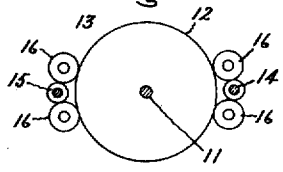
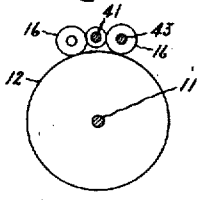


Fig. 4.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF SHIP PROPULSION.

1,297,130. Specification of Letters Patent. Patented Mar. 11, 1919.

Application filed December 12, 1916. Serial No. 136,431.

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 Systems of Ship Propulsion, of which the following is a specification.

My invention relates to systems of ship propulsion, and has for its object the provision of an improved system for the propulsion of ships. More particularly, the object of the present invention is to provide an improved system of ship propulsion particularly adapted for the economic propulsion of a large vessel over a wide range of speeds.

The power required for the propulsion of a ship varies substantially as the cube of the ship's speed, and it is, therefore, obvious that the power demands for propulsion purposes are very materially different for different speeds of the ship. Thus, for low and cruising speeds a very much smaller amount of power is required for propulsion than is required for full or high speeds. For full and relatively high speeds, the entire capacity of the propelling equipment is generally required, whereas for lower speeds only a relatively small proportion of the total capacity of the equipment is necessary, and the principal aim of my present invention is to provide an equipment which not only operates economically for high speed navigation, but in which the relatively small power demands for the lower speeds of navigation are also economically obtained. In carrying out the invention, I provide a combined mechanical and electrical equipment by which the ship can be economically propelled over a wide range of speeds.

The novel features of the invention, which I believe to be patentable, are definitely pointed out in the appended claims. The invention itself, together with the arrangement of apparatus in a system embodying the same and the operation thereof, will be understood from the following description taken in conjunction with the accompanying drawings, in which—

Figure 1 is a diagrammatic view of a ship propulsion equipment embodying the invention; Fig. 2 is a modified embodiment of the invention, and Figs. 3 and 4 are diagrammatic detail views indicating the arrangement of the mechanical gearing in the equipments of Figs. 1 and 2 respectively.

The equipment diagrammatically illustrated in Fig. 1 is for a vessel having four propellers 10. The shafts 11 of these propellers are connected to the low speed gear 12 of a flexible speed reducing gearing suitable for marine purposes. The type of gear described in U. S. patent to Alquist No. 1,165,830, patented December 28, 1915, may be advantageously employed, and in Fig. 1 of the accompanying drawings I have generally indicated such a type of gearing by reference numeral 13. In Fig. 3 of the accompanying drawings, I have diagrammatically represented the operative relation of the high speed shafts 14 and 15 and the low speed shaft 11 and their associated gears, including the flexible idlers 16.

The rotor of the high pressure elastic fluid turbine 17 is mounted on the high speed shaft 14, while the rotor of a low pressure elastic fluid turbine 18 is mounted on the other high speed shaft 15. Each high pressure turbine 17 is arranged to exhaust into the admission of its coöperating low pressure turbine 18. Each turbine 18 is provided with a reversing section 19 which is adapted to receive high pressure fluid from a main supply pipe 20. The pipes 20 are connected to the source of elastic fluid, such for example as the steam boilers of the ship. A valve 21 serves to control the admission of motive fluid to the turbine 17 and to the reversing section 19 of each generating unit.

It will be observed from the drawings that each of the four propellers of the ship is provided with an arrangement of apparatus such as hereinbefore described. In the case of the apparatus for the inward propeller on each side of the ship, the intermediate supply pipe 20′ for the high pressure turbine 17 may be connected to the exhaust of an auxiliary high pressure cruising turbine 23, or to the main supply pipe 20. Valves 24 are provided for controlling the admission of high pressure fluid to the cruising turbines 23 or directly to the intermediate supply pipes 20′. A valve 25 is also provided in the exhaust of each of the cruising turbines 23, while a valve 26 serves to permit

of the flow of exhaust fluid from either of the cruising turbines 23 to both of the turbines 17.

An electric generator 28 is directly coupled to each of the cruising turbines 23. An electric motor 29 has its rotor mounted on the high speed shaft 15 of the mechanical gearing for the outward propeller on each side of the ship. Electric switches 30 and 30′ are provided whereby the generators 28 may independently feed the motors 29, or either generator 28 may feed both motors 29 in parallel.

The operation of the equipment illustrated in Fig. 1 is as follows: For the purposes of explanation, I will assume that the ship has a full speed of 35 knots. For full and relatively high speeds, say, for example, for speeds from 35 knots down to about 20 knots, each propeller is mechanically driven by its coöperating high and low pressure turbines. For this range of speeds, the electrical switches 30 are in their open positions and the valves 24 are positioned so as to admit high pressure motive fluid direct to the supply pipes 20′. The cruising turbines and their generators are thus idle. Variations of the ship's speed within this speed range are obtained by varying the admission of elastic fluid to the turbines, substantially as described in my U. S. Letters Patent No. 1,137,308, patented April 27, 1915. For intermediate speeds, say, for example, from 20 knots down to about 12 knots, the valves 21 of the generating units for the outward propellers are closed, while the valves 24 and 25 are adjusted so as to admit high pressure fluid to the cruising turbines 23 and to permit the exhaust from these turbines to enter the intermediate supply pipes 20′ and the generating units connected thereto. The valve 26 will be closed under this condition of navigation. The electric switches 30 will be closed while the switch 30′ will be open. The generators 28 are thus driven by the turbines 23 and operate to supply electric energy independently to the motors 29 geared to the outward propellers 10. The exhaust fluid from the generator-turbines 23 operate to drive the turbines 17 and 18 of the inward propellers at the desired intermediate speeds. It will thus be evident that the outward propellers are electrically driven, while the inward propellers are mechanically driven. In the drawings, I have represented the generators 28 as polyphase alternating current generators and the motors 29 as polyphase induction motors, but it will, of course, be understood that my invention may be carried out with other types of electric generators and motors. For the lowest speeds of the ship, say, for example, from about 12 knots down to the lowest speed at which it is desired to operate the ship, only one turbo-generator 23—28 is operated. For this low range of speeds, the valve 26 is open, while the valves 24 and 25 of one of the cruising turbines 23 are closed. It will be understood that the valves 21 of the generating units for the outward propellers are also closed. The electric switch 30 of the operating generator will be closed, while the other switch 30 will be open, and the switch 30′ will be closed. The two outward propellers are thus electrically driven from the one operating generator 28, while the two inward propellers are each mechanically driven by the exhaust fluid from the one operating turbine 23. The turbines for the two inward propellers are thus operated in parallel from the exhaust of one turbine 23, while the electric motors 29 of the two outward propellers are operated in parallel from the one generator 28. Reversing of the propellers and hence of the ship is effected in the equipment represented in Fig. 1 by manipulation of the valves 21 to admit high pressure fluid to the reversing turbine sections 19. For severe reversing conditions, all four reversing sections 19 may be required, whereas for ordinary maneuvering about harbors and wharves all of the reversing turbine sections 19 may not be required.

In Fig. 2, I have indicated a modified arrangement of apparatus embodying my present invention for a vessel having four propellers 10. The shaft 11 of each of these propellers is mechanically geared by suitable marine gearing 13′ to an elastic fluid turbine 40. In Fig. 4 of the drawings, I have diagrammatically indicated a suitable arrangement of gearing for connecting the high speed turbine shaft 41 to the low speed propeller shaft 11. As shown in this figure, the small gear on the turbine shaft 41 is connected by the flexible idlers 16 to the main gear 12 on the propeller shaft 11. An electric motor 42 has its rotor mounted on the shaft 43 of one of the flexible idlers 16 of the outward propeller on each side of the ship. The motors 42 are adapted to be supplied with electric energy from a generator 44 which is directly coupled to an auxiliary high pressure cruising turbine 45. A valve 46 serves to admit high pressure fluid from one of the main supply pipes 20 to the turbine 45. The exhaust fluid of the turbine 45 is adapted to be supplied to the admission of the turbines 40 of the inward propellers. Valves 47 control the admission of elastic fluid to the main turbines 40, while valves 48 control the admission of the exhaust fluid of the turbine 45 to the turbines 40 of the two inward propellers.

The operation of the equipment illustrated in Fig. 2 is as follows: For full and high speeds of the ship, the valves 46 and 48 are closed, while all of the valves 47 are open. Variations in the ship's speed are

obtained by varying the amount of elastic fluid admitted to the turbines 40. For economical operation at relatively low speeds, all of the valves 47 are closed, and the valves 46 and 48 are open. Under this condition, high pressure fluid is admitted to the cruising turbine 45 and exhausts into the main turbine 40 of the two inward propellers. The generator 44 is simultaneously driven by the cruising turbine 45 and delivers electric energy in parallel to the motors 42. The outward propeller on each side of the ship is thus electrically driven, while the inward propeller of each side of the ship is mechanically driven. Suitable speed variation for this condition of operation is obtained by controlling the amount of elastic fluid admitted to the cruising turbine 45.

The auxiliary cruising turbine, or turbines, as the case may be, are proportioned to economically deliver the relatively small amount of power required in propelling the ship at low speeds. Up to the limit of this low speed range, all of the steam enters the auxiliary turbine and its power is distributed as hereinbefore described. A larger power can be obtained by admitting steam to the main turbines which are not arranged to communicate with the exhaust of the cruising turbine. Such an addition of steam will increase the power propelling the vessel without increasing the load upon the generator and motors. A small cruising turbine, or turbines, can thus be made a means of improving the economy of the equipment through a considerable range of load. Except at the highest speeds of the vessel, it is not important that the four propellers deliver equal power, if the power delivered is divided equally between the two sides of the ship. Accordingly, the power delivered to one propeller may be greater or less than the power delivered to the other propeller on the same side of the ship, provided the total power delivered to all the propellers on the same side of the ship is substantially equal to the total power delivered to all the propellers on the other side of the ship.

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. A system of ship propulsion comprising in combination, a plurality of main elastic fluid turbines, a propeller coupled to each of said turbines and adapted to be mechanically driven thereby when the ship is to be propelled at her higher speeds, an auxiliary elastic fluid turbine having its exhaust arranged to communicate with the admission of certain of said main turbines, an electric motor operatively arranged to electrically drive each of the propellers whose main turbines are not arranged to communicate with the exhaust of said auxiliary turbine, an electric generator coupled to said auxiliary turbine and adapted to deliver electric energy to said motors, and means whereby the propellers provided with the aforementioned electric motor drive are electrically driven and the other propellers are mechanically driven when the ship is to be propelled at relatively low speeds.

2. A system of ship propulsion comprising in combination, a plurality of propellers on each side of the ship, a main elastic fluid turbine for each propeller, mechanical speed reducing gearing operatively connecting each propeller to its driving turbine, an electric motor operatively arranged to electrically drive one or more of the propellers on each side of the ship, an auxiliary elastic fluid turbine directly coupled to an electric generator, means for supplying the exhaust fluid of said auxiliary turbine to the admission of only the main turbines whose propellers are not provided with the aforementioned electric motor drive, and means adapted to electrically connect one or more of said motors to said generator.

3. A system of ship propulsion comprising in combination, a plurality of propellers, a main elastic fluid turbine for each propeller, mechanical speed reducing gearing operatively connecting each propeller to its driving turbine, an electric motor operatively connected to the mechanical gearing of certain of said propellers, an auxiliary elastic fluid turbine having its exhaust communicating with the admission of only the turbines whose propellers are not provided with the aforementioned electric motor drive, an electric generator coupled to said auxiliary turbine and adapted to be electrically connected to said motors, and means for mechanically driving each propeller by its main turbine when the ship is to be propelled at her high speeds and for electrically driving those propellers provided with the aforementioned electric motor drive and mechanically driving the remaining propellers when the ship is to be propelled at relatively low speeds.

4. A system of ship propulsion comprising in combination, a plurality of main elastic fluid turbines, a propeller coupled to each turbine and adapted to be mechanically driven thereby, an electric motor arranged to electrically drive certain of said propellers, an auxiliary elastic fluid turbine having its exhaust communicating with the

admission of only those turbines whose cooperating propellers are not provided with the aforementioned electric motor drive, an electric generator coupled to said auxiliary turbine and arranged to deliver electric energy to said motors, and means for supplying elastic fluid to all of said main turbines for mechanically driving each of said propellers when the ship is to be propelled at her higher speeds and for supplying elastic fluid to said auxiliary turbine and mechanically driving the propellers whose turbines are in communication with the exhaust of the auxiliary turbine and electrically driving the other propellers when the ship is to be propelled at relatively low speeds.

In witness whereof, I have hereunto set my hand this 11th day of December, 1916.

WILLIAM L. R. EMMET.