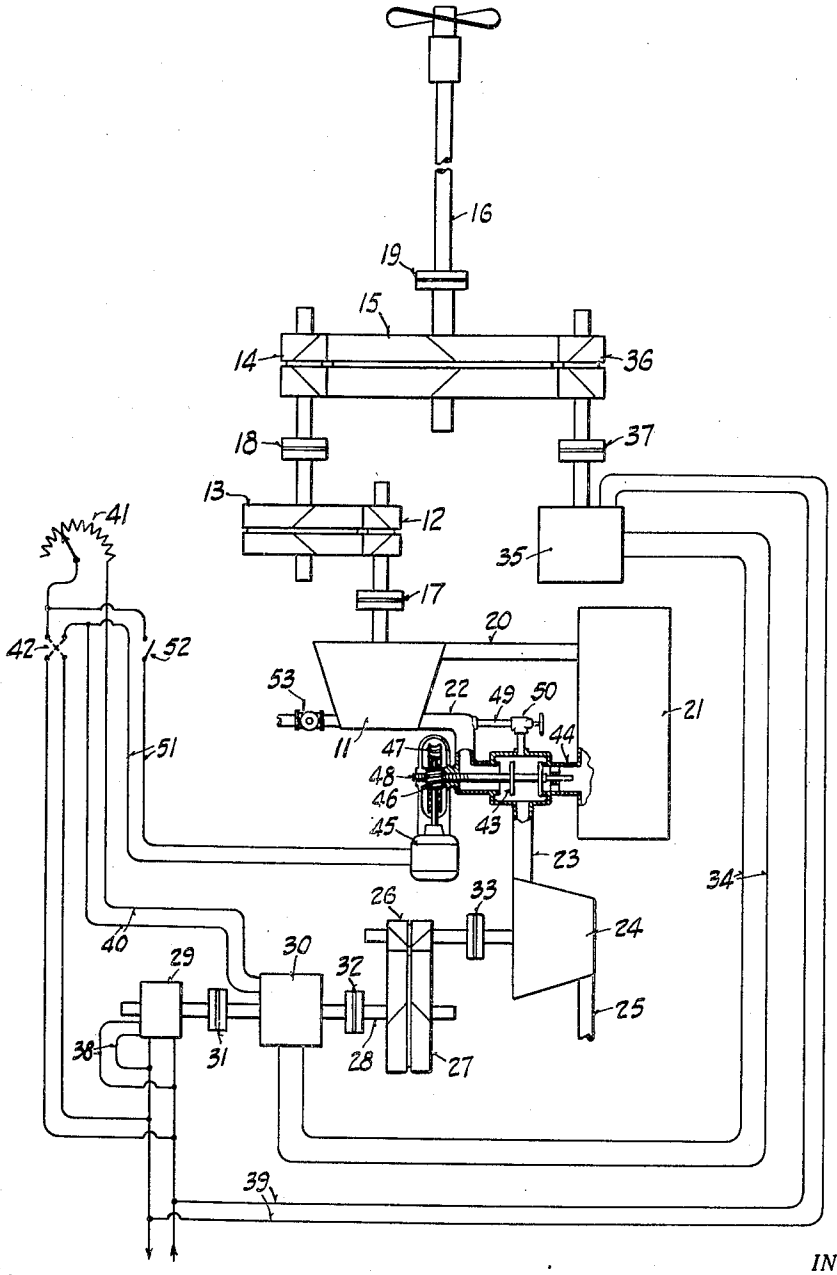
Nov. 7, 1939. P. C. DAY 2,179,370

MARINE PROPULSION SYSTEM

Filed April 29, 1937



INVENTOR.
Percy C. Day

BY

ATTORNEY.

Patented Nov. 7, 1939

2,179,370

UNITED STATES PATENT OFFICE

2,179,370

MARINE PROPULSION SYSTEM

Percy C. Day, Brookfield, Wis., assignor to The Falk Corporation, Milwaukee, Wis., a corporation of Wisconsin

Application April 29, 1937, Serial No. 139,649

16 Claims. (Cl. 290—4)

This invention relates to marine propulsion systems, particularly for merchant vessels.

A propulsion system for a merchant vessel has for its chief consideration the matter of average fuel economy for all purposes. The drive necessarily must be such that there will be developed under ordinary cruising conditions the greatest possible power for the amount of fuel consumed. To accomplish this, such propulsion systems now commonly consist of a high pressure steam turbine exhausting into a low pressure steam turbine, both geared directly to the propeller shaft. Reduced speeds for maneuvering are ordinarily secured by reducing the amount of steam supplied to these turbines, and maneuvers are carried out by valves manually controlled in the engine room upon orders telegraphed from the bridge of the vessel. Since turbines are non-reversible, however, a separate steam turbine, likewise manually controlled, must be provided for reversing the vessel. Likewise a separate steam auxiliary turbine of large capacity must be provided to generate the large amounts of power which are needed for auxiliary purposes, both at sea and in port.

The use of turboelectric generators and motors for driving a ship, in place of the direct connected turbines above mentioned, which has solved some of these problems in other cases, has not been deemed generally practicable for merchant vessels because of the lessened economy of such a drive under normal cruising conditions.

An object of the present invention is to provide a marine propulsion system combining a directly geared turbine drive with an electric drive to secure advantages and eliminate disadvantages of each.

Another object is to simplify the propulsion systems of merchant vessels.

Another object is to reduce the number of turbines required for such a vessel.

Another object is to increase the economy of such a propulsion system when operated at other than optimum speeds.

Another object is to increase the flexibility of control of such a vessel.

Another object is to provide a propulsion system which may be controlled solely by electric means from the bridge of the vessel or from any desired location.

Another object is to provide a propulsion system having two means for propelling the vessel, which may be operated independently in case of emergency.

Other objects and advantages will appear, either expressed or implied, from the following description of an illustrative embodiment of the present invention.

The single figure of the drawing is a diagrammatic illustration of a marine propulsion system embodying the present invention.

The propulsion system shown includes a low pressure steam turbine 11 which preferably furnishes the greater part of the power for propelling the vessel and which is preferably mechanically connected to the propeller shaft 16 through appropriate speed reduction gearing. In this instance a pinion 12, directly driven by the turbine 11, meshes with a gear 13 which in turn drives a pinion 14, which meshes with a main propeller gear 15. Suitable couplings 17, 18, and 19 provide for ready disconnection of the parts and also permit necessary articulation.

The turbine 11 is driven by steam supplied through an inlet pipe 22 from the exhaust pipe 23 of a high pressure turbine 24, the latter being driven by steam supplied from the boilers through pipe 25. The amount and condition of the steam supplied to the turbine 11 is thus normally controlled by the turbine 24. The turbine 11 exhausts through a pipe 20 into a condenser 21.

The turbine 24 is of a well known type governed to operate at constant speed by automatic regulation of its steam supply. It contributes to the driving power of the ship through an appropriate power transmission system, preferably electrical, which is regulatable to vary the rate and direction of operation of the propeller shaft.

In this instance the power transmission system shown comprises a main generator 30 and an electric motor 35 driven thereby through appropriate connections 34. The generator 30 is driven at constant speed by the turbine 24 preferably through speed reduction gearing, including pinion 26 and gear 27, and suitable couplings 32 and 33. The motor 35 is geared to the propeller shaft 16 preferably through a pinion 36 engaged with the main gear 15, the pinion 36 being preferably connected to the motor 35 through a separable coupling 37.

The torque and speed of the motor 35 may be regulated in various ways, but in this instance a type of control system, commonly known as the Ward-Leonard system is preferably employed. For this purpose an auxiliary generator 29 is provided which is driven at constant speed preferably through a coupling 31 from the constant speed generator 30. Generator 29 serves to excite its own field through connections 38,

to excite the field of the motor 35 through connections 39, and to excite the field of the main generator 30 through connections 40. The connections 40 include a rheostat 41, adjustable to regulate the field strength of the generator 30, and also a reversing switch 42 operable to reverse the generator field. By thus varying the strength and direction of its field, the generator 30 may be made to deliver electric current to the motor 35 in either direction and varying in voltage from zero up to the maximum capacity of the generator, although the generator 30 itself is driven at a constant speed.

By this system, both the direction and speed of the driving motor 35 may be controlled merely by the rheostat 41 and the reversing switch 42. These controls may of course be placed in any desired location on the ship, and may be placed upon the bridge of the ship to give direct control of the movement of the vessel from the bridge.

The generator 29, operating at constant speed and generating constant voltage current, is preferably utilized as a source of electric energy for the auxiliary power and lighting equipment of the ship.

Since the low pressure turbine 11 is a non-reversing turbine, and since the turbine 11 and the driving motor 35 are both geared to the propeller shaft 16, it may be necessary to cut out the turbine 11 when it is desired to reverse the driving motor 35, or to operate the ship at reduced speed under the control of the driving motor 35 alone, as when maneuvering. For this purpose there has been provided a valve 43 between the exhaust 23 of the high pressure turbine 24 and the inlet 22 of the lower pressure turbine 11. By means of this valve steam from the high pressure turbine 24 may be passed either through the low pressure turbine 11 or exhausted through the port 44 directly into the main condenser 21, the inlet 22 of the low pressure turbine being then closed. Although this valve might of course be manually operated, it is advantageous to operate it electrically. For this purpose there is shown a motor 45 operating through a worm gear 46 to turn a gear 47 upon the screw threaded shaft 48 of the valve 43.

A by-pass 49 is provided around the valve 43, controlled by a valve 50 which is adjustably set to continuously admit a small quantity of steam to the low pressure turbine 11, sufficient to keep that turbine warm and to allow it to turn freely in a simple atmosphere of steam when not in use.

It will be found greatly advantageous to couple the valve motor 45 directly to the reversing switch 43, through connections such as 51, so that the valve 43 will automatically close to disconnect the turbine 11 whenever the switch 42 is operated to reverse the driving motor 35. The valve motor 45 may be equipped with some means, such as a limit switch, to cut off the current when movement of the valve is complete, or may be of a well known type which will stall upon reaching its limit of movement, without overheating or other harm.

There should also be provided, however, means, such as the manually operated switch 52, by which the circuit 51 may be interrupted to keep the valve 43 closed entirely regardless of the direction of the driving motor 35, when a close control of the ship's movement at reduced speed is desired, as when maneuvering. The electrical connections 51 and the switch 52 are not intended to show a complete control system for the motor 45, but are intended to be suggestive only.

By a propulsion system, such as that herein described, direct electric control of the ship may be had from the bridge by using the driving motor 35 alone when operating at reduced speed or when reversing. The driving motor 35 may be made capable of producing all of the power necessary for maneuvering the ship or for reversing. At normal cruising speeds, however, power will be provided both by the driving motor 35 and by the low pressure turbine 11. Even with such joint operation, control of the speed of the ship may be had directly from the bridge, through variations in the torque of the low pressure turbine 11 as well as in the driving motor 35. As has been stated above, the high pressure turbine 24 is of an automatically controlled type which maintains itself at a constant speed by varying the amount of steam passing therethrough as the load upon the turbine varies. For this reason, when the torque of the driving motor 35 is reduced by adjustment of the rheostat 41, thus reducing the field strength of the generator 30 and the load upon the turbine 24, the amount of steam passing through the turbine 24 reduces automatically. This of course results in a reduction in the supply of steam to the turbine 11, with a consequent reduction in the torque thereof, all in response to adjustment of the rheostat 41 upon the bridge of the ship.

It will be noted that the high pressure turbine 24 which furnishes a substantial part of the propelling power for the ship, operates constantly at the single speed of its maximum efficiency. It will be noted also that the low pressure turbine 11, although it may be called upon for some variation of speed, nevertheless operates normally in a speed range close to its maximum efficiency, and need not be used at all if greatly reduced, less efficient speeds are required. The net result is to improve the efficiency of the entire propulsion system under varying conditions.

To care for a possible emergency, provision is made for operation of the low pressure turbine 11 by steam direct from the boilers, admitted through a manually operated emergency valve 53.

When the ship is lying in port, and auxiliary power demands may be many times heavier than when at sea, the generator 30 may of course be disconnected from the driving motor 35 and used to produce auxiliary power at constant voltage. In this way the need for an extra turbo-generator system of large capacity is eliminated. The valve 43 of course will then be set to disconnect the low pressure turbine 11, and exhaust the high pressure turbine 24 directly into the condenser 21.

It will be noted that by the system herein disclosed, all auxiliary turbines and all reversing turbines may be eliminated, thus greatly simplifying the power system of the ship.

Various changes may be made in the embodiment of the invention hereinabove specifically described without departing from or sacrificing the advantages of the invention defined in the appended claims.

I claim:

1. In a marine driving system the combination of a constant speed turbine, an electric generator driven by said turbine, a driving motor driven by said generator, means for varying the speed of said motor, a second turbine receiving steam

from said first named turbine, and a shaft driven by said system, said second turbine and said driving motor being each connected in driving relation to said driven shaft.

2. In a marine driving system the combination of a steam turbine governed to operate at constant speed, an electric generator driven by said turbine, a driving motor driven by said generator, a second turbine receiving steam from said first named turbine, means for shutting off the supply of steam from said first named turbine to said second turbine, and a driven shaft, said second turbine and said motor being each connected in driving relation to said driven shaft.

3. In a marine driving system the combination of a steam turbine, a constant speed, nonreversible electric generator driven by said turbine, a driving motor driven by said generator, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said motor being connected in driving relation to said driven shaft, means for reversing and for varying the speed of said driving motor, and means for shutting off the supply of steam from said first named turbine to said second turbine.

4. In a marine driving system the combination of a steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, means for reversing said driving motor, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said motor each being connected in driving relation to said driven shaft, and means for shutting off the supply of steam to said second turbine automatically upon operation of said reversing means.

5. In a marine driving system the combination of a steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, means for reversing said driving motor, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said motor each being connected in driving relation to said driven shaft, a valve for shutting off the supply of steam to said second turbine, means for associating said valve with said reversing means to effect operation of said valve automatically in response to operation of said reversing means, and means for dissociating said valve from said reversing means to permit maintenance of said valve in one position independently of said reversing means.

6. In a marine driving system the combination of a constant speed steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, a second turbine receiving steam from said first named turbine, a driven shaft to which said second turbine and said driving motor are connected in driving relation, and means for varying simultaneously the torque of said second turbine and said driving motor.

7. In a marine driving system the combination of a steam turbine, a second turbine receiving steam from said first named turbine, an electric generator driven at constant speed by one of said turbines, a driven motor driven by said generator, means for varying the torque of said driven motor, the other of said turbines being automatically variable in torque in response to variations in torque of said driving motor, and a driven shaft, said motor and said last named turbine being connected with said driven shaft in driving relation with said driven shaft.

8. In a marine driving system the combination of a constant speed steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, means for varying the torque of said driving motor, a second turbine receiving steam from said first named turbine and variable in torque in response to variations in torque of said driving motor, and a driven shaft, said driving motor and said second turbine each being connected in driving relation to said driven shaft.

9. In a marine driving system the combination of a steam turbine maintained at constant speed by varying the steam consumption thereof in response to load variation, an electric generator driven by said turbine, a driving motor driven by said generator, means for varying the power output of said generator to vary the torque of said driving motor, a second turbine receiving steam from said first named turbine and thereby varying in torque in response to variations in load upon said first named turbine induced by variations in the power output of said generator, and a driven shaft, said second turbine and said driving motor each being connected in driving relation to said driven shaft.

10. In a marine driving system the combination of a constant speed turbine, an electric generator driven by said turbine, a driving motor driven by said generator, electrical control means for varying the speed of said motor, a second turbine receiving steam from said first named turbine, and a driven shaft, said second turbine and said driving motor each being connected in driving relation to said driven shaft.

11. In a marine driving system the combination of a steam turbine, a constant speed, nonreversible electric generator driven by said turbine, a driving motor driven by said generator, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said motor each being connected in driving relation to said driven shaft, electrical control means for varying the speed and the direction of rotation of said motor, and electrically controlled means for shutting off the supply of steam to said second turbine.

12. In a marine driving system the combination of a steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, an electrical control switch for reversing said driving motor, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said driving motor each being connected in driving relation to said driven shaft, a valve for shutting off the supply of steam to said second turbine, and electrical means for operating said valve automatically upon operation of said control switch.

13. In a marine driving system the combination of a steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, an electrical control switch for reversing said driving motor, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said driving motor each being connected in driving relation to said driven shaft, a valve for shutting off the supply of steam to said second turbine, electrical means for operating said valve automatically upon operation of said control switch, and means for dissociating said valve operating means from said control switch to thereby main-

tain said valve in position independently of the direction of rotation of said driving motor.

14. In a marine driving system the combination of a constant speed steam turbine, an electric generator driven by said turbine, a driving motor driven by said generator, a second turbine receiving steam from said first named turbine, a driven shaft, said second turbine and said driving motor, electrical control means for varying the torque of said driving motor each being connected in driving relation to said driven shaft, and means for varying the torque of said second turbine in response to said electrical control means.

15. In a marine driving system the combination of a driven shaft, a low pressure turbine connected to drive the same, a constant speed high pressure turbine controlling the supply of steam to said low pressure turbine, and a variable speed transmission through which said shaft is driven by said second turbine.

16. In a marine driving system the combination of a driven shaft, a prime mover connected to drive the same, a second prime mover operating at constant speed, a variable speed transmission through which said shaft is driven by said second prime mover, and means by which the torque of said first named prime mover is varied in response to variations in load upon said second prime mover.

PERCY C. DAY.