

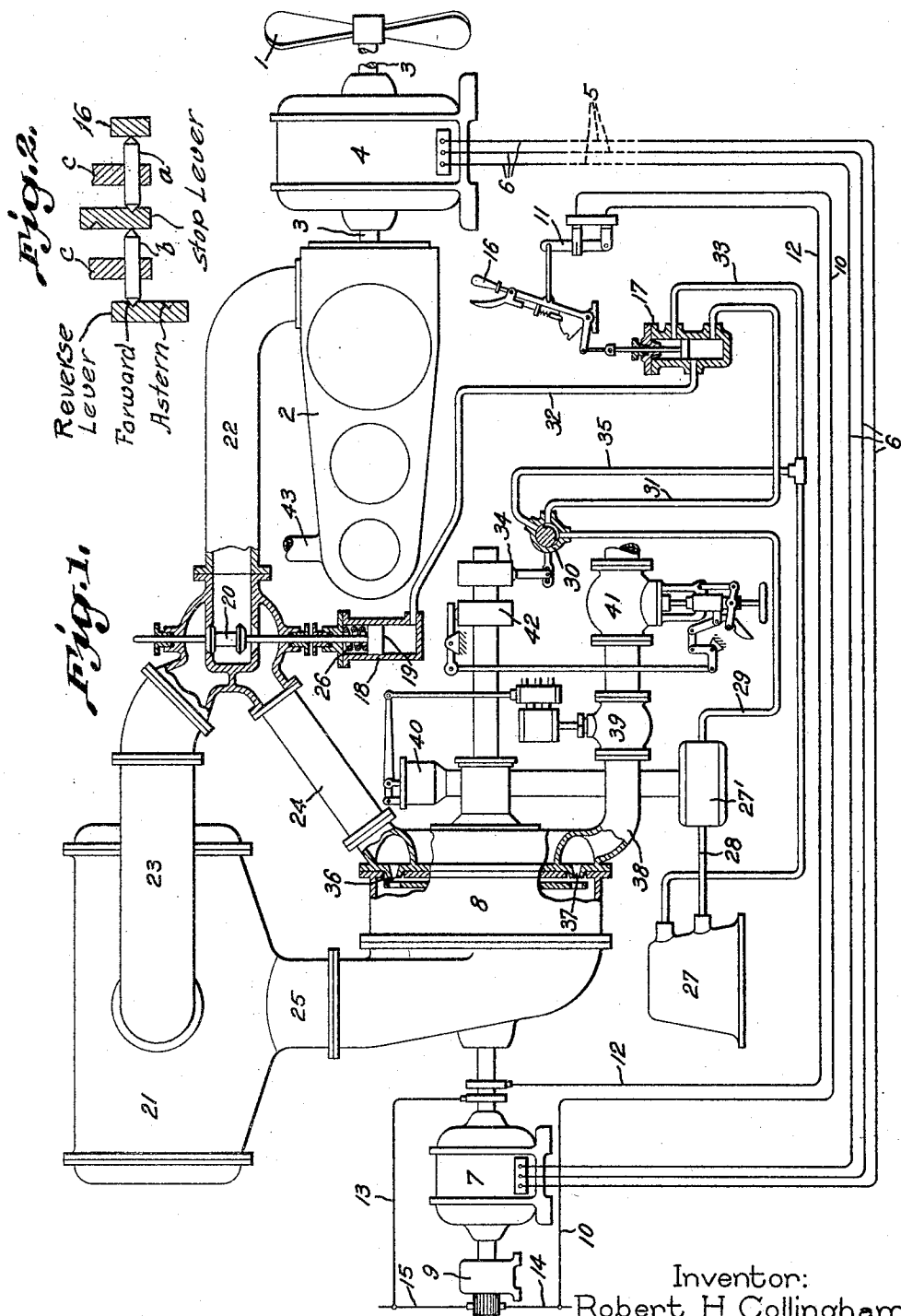
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SHIP PROPULSION SYSTEM

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UNITED STATES PATENT OFFICE

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SHIP PROPULSION SYSTEM

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My invention relates to systems of power distribution intended more especially for the propulsion of ships, wherein a plurality of prime movers, one of which normally receives and is driven by the exhaust of another, is used to propel a ship.

An object of my invention is to improve the construction and arrangement of the parts of such a system and to provide an improved method of operation whereby the speed of the vessel may be changed and the ship maneuvered without interrupting the supply of electric current furnished by a generator used for lighting and supplying current to auxiliaries about the ship which is driven by one of the prime movers normally used in propelling the ship.

Further objects of my invention will be apparent to those skilled in the art from the following description and appended claims.

In the accompanying drawing Fig. 1 diagrammatically represents circuits, machinery, and control apparatus according to one embodiment of my invention and Fig. 2 is a sectional view of the control levers showing one form of interlocking mechanism for these levers.

Referring to the drawing, the ship's propeller 1 is shown as directly connected to a prime mover 2 by means of a shaft 3 on which is also mounted a motor 4. This motor may be connected by switching means, not shown, but indicated by the dotted lines 5 and conductors 6 to generator 7 driven by a second prime mover 8 normally receiving and driven by exhaust from the first prime mover 2. This second prime mover also drives a second generator 9 used to supply the ship's lighting load, auxiliaries, etc., and to furnish excitation to generator 7. In the drawing prime mover 2 is shown as a reciprocating steam engine and prime mover 8 as a steam turbine.

The excitation of generator 7 is supplied through conductor 10, switch 11, and conductors 12 and 13 from busses 14 and 15 connected to generator 9 to which also are connected the ship's lights, auxiliaries, etc. Switch 11 is operated by a lever 16 which is interlocked with the stop valve and reversing

levers of engine 2 and the reversing switches indicated at 5. The interlocking arrangement is such that before engine 2 can be maneuvered to control the ship, generator 7 is deenergized and cannot again be energized until maneuvering of engine 2 has been completed and switches 5 have been closed. By way of example one form of mechanical interlock has been shown in Fig. 2, but it will of course be understood that any suitable interlocking mechanism may be employed which will impose upon the operator the desired sequence of operations; that is, movement of lever 16 to open switch 11 before movement of the stop and reversing levers to maneuver the ship and locking of lever 16 in its open position until maneuvering of the main engine has been completed through the agency of the stop and reversing levers. In the particular arrangement illustrated lever 16 is shown in the position it occupies when switch 11 is closed, the stop lever is shown in the position it occupies when the stop valve of engine 2 controlled by it is in its open position and the reversing lever is shown in its forward position. The stop lever is locked in its illustrated position by a locking bar *a* held in locking engagement with the stop lever by means of lever 16, and the reversing lever is locked in its forward position by a locking bar *b* held in locking position by the stop lever. Locking bars *a* and *b* are supported in stationary portions *c* of the lever stand. When the lever 16 is operated to open the switch 11, the locking bar *a* is released and the stop lever may then be moved to valve closing position in which the right-hand end of locking bar *b* is opposite the left-hand notch in the stop lever. In this position the locking bar *b* is released and the reversing lever may be moved to the astern position if this is desired. When the reversing lever is in either the forward or astern position the stop lever may again be operated to valve opening position. When the stop lever is in the valve opening position the locking bar *a* is free to move and no longer prevents operation of the lever 16 which may then be returned to the position illustrated in Fig. 2 in which it moves the locking

bar *a* into engagement with the stop lever holding it in its open position.

Lever 16 also operates a valve 17 through which fluid under pressure such as oil is supplied to a cylinder 18 and to the under side of a piston 19 in that cylinder. Piston 19 is connected to a valve 20 which controls the flow of exhaust from engine 2 to a region of low pressure such as condenser 21 or turbine 8 through conduits 22 and 23 or 22 and 24. Turbine 8 is also connected to a region of low pressure and is shown as exhausting into condenser 21 through conduit 25. Valve 20 is biased to its lower position by a spring 26 acting on piston 19 in which position engine 2 exhausts directly into condenser 21. Valve 20 is moved against this bias to the position illustrated in the drawing by fluid pressure applied to piston 19 through valve 17. When lever 16 is moved to close switch 11 oil under pressure is supplied from a well 27 by means of a pump 27' driven by turbine 8 as follows: from well 27, through pipe 28, pump 27', pipe 29, valve 30, pipe 31, valve 17, and pipe 32. Oil may be exhausted from cylinder 18, through pipe 32 to valve 17 and pipe 33 into well 27.

Valve 30 is under the control of a governor 34 sensitive to overspeed of turbine 8, the arrangement being such that when turbine 8 overspeeds valve 30 is moved to interrupt the passage from pipe 29 to 31 therethrough and to complete a passage from pipe 31 to pipe 35 and thence by pipe 33 to well 27, thereby allowing valve 20 to move to its lower position under the influence of its biasing means independently of the control of valve 17 operated by the field control lever 16.

Exhaust from engine 2 is supplied to turbine 8 through low-pressure nozzles 36. Turbine 8 is also provided with a group of nozzles 37 which are supplied with high pressure steam through a pipe 38 in which there is a governing valve 39 under the control of a governor 40 and an emergency valve 41 under the control of an emergency governor 42 which is sensitive to overspeed of turbine 8. Steam is supplied to engine 2 through pipe 43 under the control of valve means previously referred to but not shown in the drawing.

When turbine 8 is supplied with exhaust steam from engine 2 through low-pressure nozzles 36 and when the generator 7 is locked electrically with motor 4, the speed of turbine 8 is controlled by the speed of main engine 2. High pressure steam is not admitted by the throttle valve 39 to the nozzles 37 because the centrifugal governor 40 is designed not to come into operation unless the speed of turbine 8 drops considerably below the normal running speed fixed by engine 2 and all the power generated by generator 7 and generator 9 is derived from the low pressure steam from engine 2. This condition

holds as long as the ship is steaming normally. When maneuvering of the ship is required the lever 16 which is interlocked with the main engine stop valve and reversing levers is moved to open the field switch 11 of the generator 7 and to release the oil pressure under piston 19 of the by-pass valve 20. By means of valve 17 the oil under piston 19 is discharged back into well 27 and valve 20 descends to its lower position under the action of its own weight and the force of spring 26. By this means steam from engine 2 is by-passed to condenser 21 through pipes 22 and 23 and turbine 8 is cut off from engine 2.

If due to windage loss, bearing loss of generator 7 and the load on the generator 9, the speed of turbine 8 falls to some predetermined value, which brings the spring load of the centrifugal governor 40 into operation high pressure steam is then admitted by throttle valve 39 to turbine 8 and the turbine then runs at practically constant speed to deal with the varying load on generator 9, the high pressure steam after doing work in the turbine being exhausted into condenser 21 through conduit 25. The lever 16 having been moved to open the field switch 11 and to release the interlocks on the main stop valve and reversing levers of engine 2, maneuvering of the ship by the main engine 2 will then be carried out. The lever 16 cannot be moved to close the generator field switch 11 until maneuvering of the main engine has been completed. When the lever 16 is moved to close the generator field switch 11 valve 17 is simultaneously moved and admits oil pressure under the piston 19 which raises valve 20 against the weight of the valve and the compressive force of spring 26. The exhaust steam from engine 2 now passes to turbine 8 through pipes 20 and 24 and nozzles 36. The turbine then commences to run up in speed and the spring loaded governor 40 cuts off the high pressure steam supply to nozzle 37 by means of throttle valve 39. The field switch 11 being closed, the speed of turbine 8 and generator 7 increases until the generator locks in with the motor 4 when the speed of turbine 8 will again be controlled by the speed of engine 2.

If while engine 2 is driving the ship with the assistance of motor 4 supplied by power obtained from the exhaust steam of engine 2 through turbine 8 and generator 7, for some reason all the load should be removed from the generator 7 so that the speed of turbine 8 and generator 7 is not controlled by the speed of engine 2, then turbine 8 would tend to speed up until such a speed had been reached that the emergency governor 34, sensitive to overspeed of turbine 8, would operate and release the oil pressure under piston 19. Valve 20 would then descend due to its own weight and the action of spring 26 and exhaust steam

from engine 2 would then be by-passed through pipes 22 and 23 to condenser 21 and the flow through pipes 22 and 24 to turbine 8 would then cease. The speed of the turbine would then fall until the spring loaded centrifugal governor 40 functioned and admitted high pressure steam through throttle valve 39, pipe 38 and nozzles 37 to turbine 8 which would then run on high pressure steam maintaining practically constant speed and preventing failure of power supplied by generator 9 which may be used for ship lighting and auxiliary power as before noted. Excessive overspeeding of turbine 8 under high pressure steam due to failure of governor 40 is prevented by the emergency governor 42 which on overspeed operates the emergency valve 41 to cut off the supply of high pressure steam to turbine 8.

In the particular embodiment adopted for describing the invention the prime movers 2 and 8 have been referred to as receiving steam as their motive fluid. It is, of course, apparent that other motive fluids may be used and that these prime movers need not necessarily be steam machines as illustrated. Furthermore, it is apparent that the generator 7 and motor 4 illustrated as alternating current machines, one of which is a synchronous unit in order to establish a synchronizing connection between engine 2 and turbine 8, may be direct current machines suitably controlled in order to enable turbine 8 to deliver its power to the propeller 1 and to enable prime mover 2 to regulate the speed of turbine 8 under normal operating conditions. Furthermore, it is apparent that more than one generator 9 may be used for furnishing auxiliary power and that by providing suitable switching arrangements generator 7 may also be used to supply power to auxiliaries and elsewhere about the ship during maneuvering of the propeller 1 by control of prime mover 2.

I have explained my invention by illustrating and describing a certain specific embodiment thereof, but it will be readily understood by those skilled in the art that the invention may be embodied in many other forms than that shown and described. I, accordingly, do not wish to be restricted to the particular form or construction disclosed herein by way of example for the purpose of setting forth my invention in accordance with the patent statutes. The terms of the appended claims are, therefore, not restricted to the precise structure disclosed, but are intended to cover all changes and modifications within the true spirit and scope of my invention.

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

1. In a power system including a main prime mover and a second prime mover which normally receives and is driven by exhaust from said main prime mover, means for con-

necting both of said prime movers to a common load device, and a generator adapted to be driven by said second prime mover at a substantially constant speed for supplying power to auxiliaries, the method of operation which includes the steps of disconnecting said second prime mover from said load device, diverting the exhaust of said main prime mover from said second prime mover to a region of low pressure, admitting motive fluid from another source to said second prime mover in sufficient quantity to maintain the speed of said prime mover and its connected generator, controlling the speed of said main prime mover in order to control said load device, and reestablishing the steam and load connection between said main prime mover and said second prime mover, and interrupting the direct supply of motive fluid to said second prime mover when the speed of said main prime mover is again substantially normal.

2. In a ship propulsion system comprising a main prime mover for driving a propeller, an auxiliary prime mover receiving and driven by exhaust from said main prime mover, and a generator adapted to be driven by said auxiliary prime mover at a substantially constant speed for supplying power to auxiliaries, the method of operation which includes the steps of disconnecting said auxiliary prime mover from the exhaust of said main prime mover, connecting said main prime mover to a region of low pressure, supplying motive fluid from an independent source to said auxiliary prime mover, controlling the supply of said motive fluid to maintain the speed of said auxiliary prime mover and its connected generator, maneuvering the ship by controlling said main prime mover, and after maneuvering has been completed, again connecting said auxiliary prime mover to the exhaust of said main prime mover and interrupting the independent supply of motive fluid to said auxiliary prime mover.

3. In a ship propulsion system comprising a main prime mover for driving a propeller, an auxiliary prime mover receiving and driven by exhaust from said main prime mover, a generator adapted to be driven by said auxiliary prime mover at a substantially constant speed for supplying power to auxiliaries, and means for connecting said auxiliary prime mover to the propeller, the method of operation which includes the steps of disconnecting said auxiliary prime mover from the propeller, interrupting the supply of exhaust from said main prime mover to said auxiliary prime mover, connecting said main prime mover to a region of low pressure, supplying motive fluid from an independent source to said auxiliary prime mover, controlling the supply of said motive fluid to maintain the speed of said auxiliary prime mover and its connected generator, maneu-

vering the ship by controlling said main prime mover, and connecting said auxiliary prime mover to the propeller and to the exhaust of said main prime mover, and interrupting the independent supply of motive fluid to said auxiliary prime mover when the speed of said main prime mover is again substantially normal.

4. A plurality of prime movers, one of which normally receives and is driven by exhaust from the other, means for connecting the exhaust of one of said prime movers to the other of said prime movers or to a region of low pressure, valve means in said connecting means biased to a position for completing the connection from said first prime mover to said low pressure area, means for moving said valve means against said bias to a position for completing a connection between said prime movers, and a governor associated with said exhaust receiving prime mover sensitive to overspeed for rendering said last-described means inoperative in order to allow said valve to assume its biased position.

5. A main prime mover, a second prime mover normally receiving and driven by exhaust from said first prime mover, condensing means for said prime movers, conduit means for conducting exhaust from said first prime mover to said second prime mover and to said condensing means, valve means biased to a position for completing the connection from said first prime mover to said condensing means, means for moving said valve against said bias to a position for completing a connection between said first prime mover and said second prime mover, and a governor associated with said second prime mover sensitive to overspeed for rendering said last means inoperative in order to allow said valve to assume its biased position.

6. A power system comprising a prime mover, a second prime mover which normally receives and is driven by the exhaust from said first prime mover, a generator driven by said second prime mover, a governor for said second prime mover, means controlled by said governor for admitting motive fluid to said second prime mover independently of said first prime mover when its speed falls below a predetermined value, means for connecting said prime movers to a common load, means for controlling said first prime mover, means for interrupting the connection of said second prime mover to said common load, and means actuated by said last-mentioned means for interrupting the supply of exhaust from said first prime mover to said second prime mover to place said second prime mover under the control of its governor in order to maintain the speed of said generator while maneuvering said first prime mover.

7. A power plant comprising a main prime mover, a second prime mover, means for con-

ducting exhaust motive fluid from said main prime mover to said second prime mover, a governor for said second prime mover, means controlled by said governor for admitting motive fluid to said second prime mover independently of said main prime mover when its speed falls below a predetermined value, means for controlling the admission of motive fluid to said first prime mover, means for interrupting the supply of said motive fluid from said main prime mover to said second prime mover and for directing the exhaust motive fluid from said main prime mover to a region of low pressure and means for preventing the operation of said controlling means to a low speed position until said last-mentioned means has been operated and said second prime mover has been placed thereby under the control of its governor, receives motive fluid from said independent source and continues to run at a predetermined speed.

8. A power plant for propelling ships comprising a propeller, a shaft therefor, a prime mover connected to said shaft, an electric motor connected to said shaft, a second prime mover, means for supplying exhaust motive fluid from said first prime mover to said second prime mover, a generator connected to said second prime mover, means for electrically connecting said generator to said motor, means for controlling the energization of said generator, a governor for controlling the admission of motive fluid to said second prime mover from a source independent of said first prime mover when its speed falls below a predetermined value, means for controlling said first prime mover, and means interlocked with said controlling means for operation prior thereto for deenergizing said generator and interrupting the supply of exhaust motive fluid from said first prime mover to said second prime mover and diverting it to a region of low pressure so that said second prime mover under the control of its governor receives motive fluid from said independent source and continues to run at a predetermined speed while said first prime mover is being maneuvered.

9. A power plant for propelling ships comprising a propeller, a shaft therefor, a prime mover connected to said shaft, a second prime mover, means for supplying exhaust motive fluid from said first prime mover to said second prime mover, an alternating current synchronous machine connected to one of said prime movers, a second alternating current machine connected to the other of said prime movers, means for connecting said machines electrically for synchronous operation, means for controlling the energization of one of said machines, a governor for controlling the admission of motive fluid to said second prime mover from a source independent of

said first prime mover when its speed falls below a predetermined value, means for controlling said first prime mover, and means interlocked with said controlling means for operation prior thereto for deenergizing said generator and thereafter interrupting the supply of exhaust motive fluid from said first prime mover to said second prime mover and diverting it to a region of low pressure so that said second prime mover under the control of its governor receives motive fluid from said independent source and continues to run at a predetermined speed while said first prime mover is being maneuvered.

10. A power system comprising a main prime mover, an auxiliary prime mover which normally receives and is driven by the exhaust from said main prime mover, a generator driven by said auxiliary prime mover, a governor for said auxiliary prime mover for admitting motive fluid to said auxiliary prime mover independently of said first prime mover, means for connecting said prime movers to a common load, means for interrupting the connection of said auxiliary prime mover to said common load, means actuated by said last-mentioned means for interrupting the supply of exhaust from said main prime mover to said auxiliary prime mover to place said auxiliary prime mover under the control of its governor in order to maintain the speed of said generator while maneuvering said main prime mover to control the load, and means responsive to overspeed of said auxiliary prime mover operating independently of said last two mentioned means for interrupting the supply of exhaust from said main prime mover to said auxiliary prime mover and for placing said auxiliary prime mover under the control of its governor.

11. A power system comprising a main prime mover, an auxiliary prime mover which normally receives and is driven by the exhaust from said main prime mover, a generator driven by said auxiliary prime mover, a governor for said auxiliary prime mover for admitting motive fluid to said auxiliary prime mover independently of said first prime mover, means for controlling said main prime mover, means for controlling the supply of exhaust motive fluid from said main prime mover to said auxiliary prime mover, and means preventing operation of said main prime mover controlling means until said exhaust controlling means has been operated to interrupt the supply of exhaust from said main prime mover to said auxiliary prime mover and for preventing operation of said exhaust controlling means to supply exhaust from said main prime mover to said auxiliary prime mover until said main prime mover controlling means is in one of its operating positions, so that during maneuvering of said main prime mover said auxiliary

prime mover under the control of its governor receives motive fluid from said independent source and continues to drive said generator at a predetermined speed.

12. A power plant for propelling ships comprising a propeller, a shaft therefor, a main prime mover connected to said shaft, an electric motor connected to said shaft, an auxiliary prime mover, means for supplying exhaust motive fluid from said main prime mover to said auxiliary prime mover, generating means connected to said auxiliary prime mover, means for electrically connecting said generating means to said propeller motor and to the ship's auxiliaries, a governor for controlling the admission of motive fluid to the auxiliary prime mover from a source independent of said main prime mover, means for controlling said main prime mover, means for controlling the supply of exhaust motive fluid from said main prime mover to said auxiliary prime mover, means for controlling the connection of said motor to said generating means, means for preventing operation of said main prime mover controlling means until said exhaust controlling means has been operated to interrupt the supply of exhaust from said main prime mover to said auxiliary prime mover and said motor controlling means has been operated to disconnect said motor from said generating means and for preventing operation of said exhaust controlling means to supply exhaust from said main prime mover to said auxiliary prime mover and operation of said motor controlling means to connect said motor to said generating means until said main prime mover controlling means is in one of its operating positions, and means responsive to overspeed of said auxiliary prime mover operating independently of said last-mentioned means for interrupting the supply of exhaust motive fluid from said main prime mover to said auxiliary prime mover.

In witness whereof I have hereunto set my hand this 9th day of October, 1929.

ROBERT H. COLLINGHAM.