March 24, 1931. H. F. SCHMIDT 1,797,841

SCOOP CONDENSER APPARATUS

Filed May 31, 1928

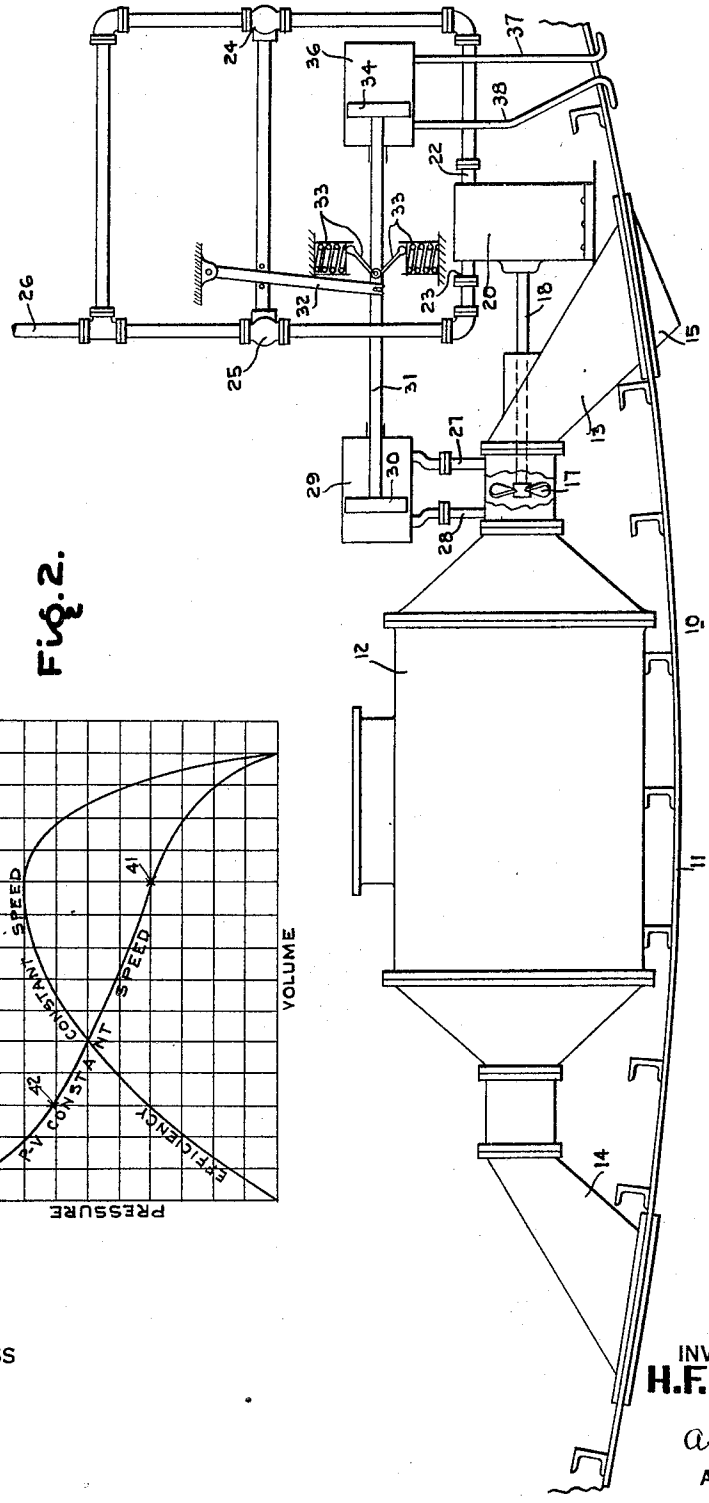


Fig. 1.

Fig. 2.

WITNESS
E. Lutz.

INVENTOR
H. F. Schmidt
A. B. Reavis
ATTORNEY

Patented Mar. 24, 1931 1,797,841

UNITED STATES PATENT OFFICE

HENRY F. SCHMIDT, OF LANSDOWNE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

SCOOP-CONDENSER APPARATUS

Application filed May 31, 1928. Serial No. 281,933.

This invention relates to scoop condensers and it has for an object to improve the efficiency of condensers of this type.

In the operation of this class of equipment, it has been the practice to provide auxiliary circulating pumps for accelerating the rate of flow of the circulating water when the vessel is traveling at reduced speed, where the scoop is ineffective, and for opposing the velocity head of water from the propellers when running astern. The auxiliary pumps require the attention of an operator who is guided, in controlling them, by the vacuum gauge.

The operation of such a system is attended with difficulties which have been overcome only at the expense of considerable losses in efficiency. For example, a ship, due to its headway, may continue on a forward course after the main engines are reversed and after the wash from the propellers becomes effective to oppose the circulation which might otherwise be produced by the forward motion of the ship. Also, after the vessel has lost its forward headway and is gaining headway astern, the back pressure created by the wash from the propellers and the astern motion of the ship is, likewise, effective, either in greatly reducing, or even in reversing the flow of circulating water.

It will readily be seen, therefore, that the conditions just described produce variations in the differential pressure across the condenser. While an attendant may ascertain from the vacuum gauge that the circulation should be improved, he has no means of determining the direction in which the circulating water may be passed with the least resistance. Moreover, since, in the reversal of a ship, the loss of vacuum and also the accumulation of an excessive pressure in the condensers may take place almost instantaneously, the only course of procedure, which has been considered safe, is for an attendant in charge of the auxiliary pump to see that this pump is operated to capacity at the first indication of a falling off of the vacuum.

Consequently, merely reversing the circulating pump will not overcome these difficulties, since no means have been provided for ascertaining the proper time to change the direction of flow.

Since the circulating pump in the usual installations must be able to discharge water against the back pressure created by the astern motion of the ship and the wash from the propellers, an unduly large driving turbine would be required for the circulating pump if it were designed to handle the full amount of circulating water required by the condensers. However, the auxiliary circulating pumps are generally made of very much reduced capacity and power, and in the case of destroyers and high speed naval vessels, great care has to be exercised in going astern at full power, in view of the relatively small capacity and power of the auxiliary circulating pump, to avoid building up an excessive steam pressure in the condenser when the vessel is coming to rest.

Furthermore, in some cases, the amount of steam required for operating the circulating pump becomes quite large. In fact, the quantity of steam required for this purpose may amount to as much, or more, than that required by the main engines. It may thus occur, that, in suddenly changing from forward to astern, the auxiliary circulating pump throttle valve may be opened so quickly that the demand for steam by the circulating pump may cause a reduction in the boiler pressure sufficient to interfere with the maneuvering of the main engines. On the other hand, if advantage is taken of the ahead motion of the ship, or of the astern motion and the wash of the propellers, a relatively small amount of power is sufficient to handle the full volume of circulating water required.

More particularly, therefore, an object of my invention is to provide for assisting the flow of circulating water, in a scoop condenser, by means of fluid translating apparatus which is, preferably, reversible in response to the attainment of predetermined differential pressures, whereby the translating forces developed by the translating apparatus may be combined, either with the translating forces due to the ahead motion of the ship, or with those due to the astern motion and to the wash from the propellers, the par-

ticular combination of forces depending, preferably, upon the attainment of a pressure difference which is sufficient to produce the required flow through the circulating system.

This and other objects is effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which

Fig. 1 is a diagrammatic view of apparatus illustrative of principles of my invention, and

Fig. 2 is a graph showing characteristics of a pump which may be used with apparatus of the type described.

In accordance with a preferred form of my invention, the fluid translating apparatus takes the form of a propeller pump, which is mounted in one of the scoops, and which is adapted to be operated by a reversible motor, such, for example, as a reversible turbine, or an induction motor. In this connection, it is noted that my novel arrangement of condenser, scoop system and auxiliary circulating pump is disclosed and claimed in my copending application, Serial No. 515,759, filed February 14, 1931, entitled "Condenser circulating system" and assigned to the Westinghouse Electric and Manufacturing Company.

The direction of rotation of the motor is controlled, preferably, by a piston in a working cylinder. The pressure difference across the propeller tends to actuate the piston in a manner similar to the functioning of a pilot valve in a fluid pressure relay. Means are provided for restraining the movement of the piston, and hence, the reversal of the motor, until the proper pressure difference prevails across the propeller of the pump.

Means are also provided for preventing the reversal of the motor due to a pressure difference, which though of the proper value, might be due to clogging of the circulating system, instead of to a reduction of speed, or to running astern.

Referring now to the drawing for a better understanding of my invention, I show a ship's hull 10, having a bottom 11, and a condenser 12 supported in any suitable manner by the ship's hull. The condenser is of the scoop type and it has conduit, or scoop portions 13 and 14 arranged at the forward and astern ends, respectively, the conduit portion 13 terminating at its forward end in a projecting lip or scoop construction 15 of any suitable design.

In order that the objection of loss of power and consequent possible serious reduction of boiler pressure, due to the necessity heretofore, of overcoming the velocity head of cooling water when running astern, may be overcome, I provide a reversible propeller 17 in the forward conduit 13, the reversible propeller being carried by a shaft 18, whose outer end is connected to a suitable motor, at 20. In the form shown, the motor at 20, takes the form of a reversible steam turbine, although any reversible motor may be used for this purpose, a reversible induction motor being well adapted to this service. The casing of the motor is provided with suitable steam inlet passages, 22 and 23, adapted to be alternatively connected, by way of the valves 24 and 25, to the steam supply line 26.

In order that the valves 24 and 25 may be operated to supply steam through either the passage 22 or the passage 23 so that the turbine may be operated either in one direction or the other, I show pressure responsive means for controlling such valves, this pressure responsive means preferably taking the form of apparatus which is responsive to a predetermined differential pressure in either direction across the propeller 17. To this end, I show conduits 27 and 28 opening into the conduit 13 at opposite sides of the propeller 17, the other ends of these conduits being connected to the cylinder 29 adjacent to the ends of the latter, the clyinder 29 containing a piston 30 connected to a rod 31, which cooperates with a lever 32 for actuating the valves 24 and 25 in order that steam may be supplied alternatively through the passages 22 and 23 to secure operation of the turbine in either direction.

In order that the lever 32 may be moved sufficiently in either direction to fully close one valve and open the other, as well as to impose sufficient resistance on the piston rod 31 so that the latter will not be moved until a predetermined differential pressure is attained across the propeller 17, I provide a spring toggle mechanism, 33, which, not only serves to afford this resistance, but also secures a positive snap-over action in either direction in order to fully close one valve and to fully open the other. Due to the resistance of the spring toggle mechanism, it is assured that minor fluctuations in differential pressure across the propeller, such as may occur when a ship is being maneuvered for docking, shall not result in reversal of the turbine. For example, the spring toggle mechanism may be so designed that a speed of 10 knots will be necessary to secure reversals.

The method of proportioning my pump to operate in the desired manner is determined, for example, as follows: Assuming that, in a single-pass scoop condenser, a pressure difference of 10 feet of water is required between the two ends of the condenser to provide the necessary flow of water to condense full power steam, I would then design my pump to be capable of delivering the required water against a pressure difference of, say 12 feet, and so proportion the valve operating mechanism that when the pressure difference across the pump exceeds 12 feet for any reason, the valves would come into oper-

ation and reverse the direction of rotation and flow through the condenser.

The building up of pressure in excess of the necessary 10 feet would be caused, either by reversal of direction of the ship, or by the clogging of the condenser tubes with seaweed, or other foreign matter.

It is further obvious, that should seaweed, fish, rubbish, or other débris be caught on the tube sheets, the reversal of flow will wash such obstructions overboard and automatically keep the condenser clean.

As shown on the drawing, the vessel is proceeding forward, or to the right, the scoop 13 being the forward scoop. Under these conditions the velocity of flow through the conduit or scoop portion 13 is relatively high and the pressure difference between the front and rear sides of the propeller is relatively small. The piston 30 is at the left end of its stroke in the cylinder 29, and although the pressure in the passage 28 under these conditions is greater than that in the passage 27, the difference of pressure across the propeller is so small as to be ineffective against the toggle mechanism, and as long as these conditions prevail the toggle mechanism will hold the piston 30 in this position.

In the graph shown in Fig. 2, the pressure volume characteristic and the efficiency curves for a propeller type pump are shown. At the point 41 on the pressure volume curve the pump is operating at its maximum efficiency. This is, preferably, the point at which the pump is operating as shown in the drawings for normal forward speeds of the vessel.

Since the ordinates of the pressure-volume curve are the pressure-differences across the propeller, it will be clear that as the quantity, or volume, of water delivered decreases, the pressure difference will increase. Hence, as the forward speed of the vessel is reduced, the forward scoop 13 becomes less effective and supplies a smaller quantity of water and the burden on the pump increases. It will be clear therefore, that at some point on the pressure volume curve, such as at the point 42, the pressure difference across the propeller will be great enough to overcome the resistance offered by the toggle mechanism and to move the piston 30 to the right and thus, to reverse the pump.

It will also be obvious that the reversal of the pump is effected, when changing from astern to ahead operation, in the same manner as that just described, such reversal resulting in the various parts returning to the positions in which they are shown on the drawing.

It will be understood, of course, that at high speeds, very little work need be done by the pump and in fact at such speeds the scoop effect may be so great that the flow of water will actually run the pump as a water turbine. Under these conditions, the pressure difference across the propeller would be very small and the toggle mechanism would hold the piston 30 in the proper position.

In changing from ahead to astern operation, a vessel may have considerable forward headway even after the main engines have been reversed and after the wash from the propellers has become effective to oppose the flow of circulating water through the astern scoop and through the condenser tubes. Hence, it is desirable that the flow through the condenser tubes be reversed before the vessel has completely lost its forward headway, as otherwise the circulating pump would have to oppose the pressure head due to the wash from the propellers.

It will be apparent that the apparatus thus far described is capable of attaining these advantageous conditions of operation automatically and that the motor 20 and the pump 17 are controlled in accordance with the actual translating effects due to the navigation of the ship and irrespective of whether the ship is actually proceeding ahead or astern.

With the apparatus thus far described, there is a possibility of the circulating system becoming so clogged with débris, and the like, and thus offering sufficient resistance to the flow of the circulating water to produce the pressure difference required to reverse the pump while the vessel is proceeding forward under considerable headway. Should this occur, the pump would be operating against the velocity head due to the forward motion of the ship.

In order to prevent an occurrence of this kind, I connect the piston rod 31 to the piston 34 in the working cylinder 36. The actuating medium is introduced and discharged from the cylinder 36 by means of the Pitot tubes 37 and 38, which extend through the hull 11, to the ports of the cylinder, the tube 37 being pointed forward, while the tube 38 is pointed aft. During forward motion of the ship, the velocity head of the water will be available through the tube 37 to move the piston 34 to the left and to hold it there until the speed is considerably reduced. Should the vessel be proceeding astern, the velocity head due to the wash from the propellers and to the astern motion will act through the tube 38 to move the piston 34 to the right and to hold it in this position.

It will be apparent, therefore, that a pressure difference due to the accumulation of débris in the circulating system, cannot effect a reversal of the pump in such a way as to cause it to oppose the pressure head due to any appreciable speed of the ship.

Moreover, should a pressure difference, due to clogging or the like, occur at a low speed where the velocity head is of little effect in the cylinder 36, the reversal of the pump

could do no harm and, at the same time, this would be an effective means of back washing the condenser and, thus, to rid it of the débris.

From the foregoing, it will be apparent that I have devised a marine condenser of the scoop type wherein the objection of the circulating pump opposing the velocity head of cooling water when running astern is avoided, advantage being taken of the propulsion speed in either direction to secure passage of cooling water through the condenser in either direction, depending upon pressures prevailing at the scoops. Another advantage of the present construction is that the condenser system may be readily evacuated of seaweed, fish, rubbish, etc., which may possibly accumulate at the ahead end of the condenser.

It will also be seen that my apparatus is responsive to pressures which are produced by the various velocities of the ship relative to the body of water through which the vessel is proceeding. In this way it is assured that the condenser will be capable of producing the required vacuum under all conditions of operation.

In addition to producing the required vacuum under the various conditions of service, my apparatus is arranged to operate with minimum consumption of power. As previously pointed out, neither the direction of motion of a vessel, nor the point at which that direction is reversed, may be taken as an indication of the condition of flow in the circulating system of a scoop condenser. For these reasons, it has been the practice to provide auxiliary circulating pumps of very large capacity so that water may be forced through the tubes in the same direction whether proceeding ahead or astern, the reason for this practice being that regardless of which way the water is forced through the tubes, there is a point at which the pump must be capable of opposing the velocity head due to the motion of the vessel, since the apparatus of the prior art is not adapted to function in response to variations, or changes in the actual conditions of flow. Since my pumping apparatus is arranged to operate in phase with any appreciable change in head, it will be clear that I may use a much smaller pump than has heretofore been considered adequate, and consequently, I may thereby effect a saving in power consumption as well as in the first cost of equipment.

Furthermore, it will be obvious that my pumping apparatus may be operated continuously, or only at reduced speeds and when running astern.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:—

1. The combination with a condenser of the marine type having conduit portions communicating with the ends thereof, a propeller arranged in one of the conduit portions, a reversible motor for driving the propeller, and means depending upon the differential pressure across the propeller for controlling the direction of rotation of the motor.

2. The combination with a marine condenser of the scoop type having conduit portions communicating with the ends thereof, a propeller arranged in one conduit portion, a reversible motor for driving the propeller, conduits communicating with the conduit containing the propeller at each side of the latter, a pressure responsive device connected to said conduits, controlling means for the reversible motor, and means for actuating the controlling means from said pressure responsive device.

3. The combination with a marine condenser having cooling water conduit portions communicating with the ends thereof, a propeller arranged in one cooling water conduit portion, a reversible motor for driving the propeller, passageways communicating with the cooling water conduit portion containing the propeller at each side of the latter, a cylinder communicating with said passageways, a piston in the cylinder, and controlling mechanism for the motor operatively connected to said piston.

4. The combination with a marine condenser of the scoop type having cooling water conduit portions communicating with the ends thereof, of a propeller arranged in one conduit portion, a reversible motor for driving the propeller, controlling means for the motor, and means responsive to a predetermined differential pressure in either direction across the propeller for rendering effective the controlling means.

5. The combination with a marine condenser and scoop means for circulating cooling water therethrough, of auxiliary pumping means for circulating cooling water through the condenser, means for reversing the direction of flow of the water circulated by said auxiliary pumping means, and means responsive to a characteristic of the water of circulation for controlling the direction of flow of the water circulated by said auxiliary pumping means.

6. The combination with a marine condenser and scoop means for circulating cooling water therethrough, of auxiliary pumping means for circulating cooling water through the condenser, means for reversing the direction of flow of the water circulated by said auxiliary pumping means, means responsive to a characteristic of the water of circulation for reversing the direction of flow

of the water circulated by said auxiliary pumping means, and means for restraining the reversing means, whereby frequent reversals due to slight changes in the characteristic of the water of circulation are avoided.

7. The combination with a marine condenser and scoop means for circulating cooling water therethrough, of an auxiliary pump for circulating cooling water through the condenser, said auxiliary pump being reversible so as to effect a direction of flow through the condenser in either an ahead or an astern direction, and means responsive to a characteristic of the water of circulation for controlling the pumping direction of the auxiliary pump.

8. The combination with a marine condenser and scoop means for circulating cooling water therethrough, of an auxiliary pump for circulating cooling water through the condenser, said auxiliary pump being reversible so as to effect a direction of flow through the condenser in either an ahead or an astern direction, means responsive to a characteristic of the water of circulation for controlling the pumping direction of the auxiliary pump, and means for restraining the reversing movements of the auxiliary pump, whereby frequent reversals due to slight changes in the characteristic of the water of circulation are avoided.

9. The combination with a marine condenser, of a reversible pump for circulating cooling water therethrough in either an ahead or an astern direction, and means responsive to a characteristic of the water of circulation for controlling the pumping direction of said pump.

10. The combination with a marine condenser, of a reversible pump for circulating cooling water therethrough in either an ahead or an astern direction, means responsive to a characteristic of the water of circulation for controlling the pumping direction of said pump, and means for restraining the reversing movements of the pump, whereby frequent reversals due to slight changes in the characteristic of the water of circulation are avoided.

11. The combination with a condenser of the marine type having conduit portions communicating therewith for supplying cooling water thereto, of a propeller arranged in one of the conduit portions for effecting a circulation of cooling water through the condenser, a reversible motor for driving the propeller, and means responsive to a characteristic of the water of circulation for controlling the direction of rotation of the motor.

12. The combination with a condenser of the marine type having conduit portions communicating therewith for supplying cooling water thereto, of a propeller arranged in one of the conduit portions, a reversible motor for driving the propeller, and means responsive to a pressure characteristic of the water of circulation for controlling the direction of rotation of the motor.

In testimony whereof, I have hereunto subscribed my name this 29th day of May, 1928.

HENRY F. SCHMIDT.