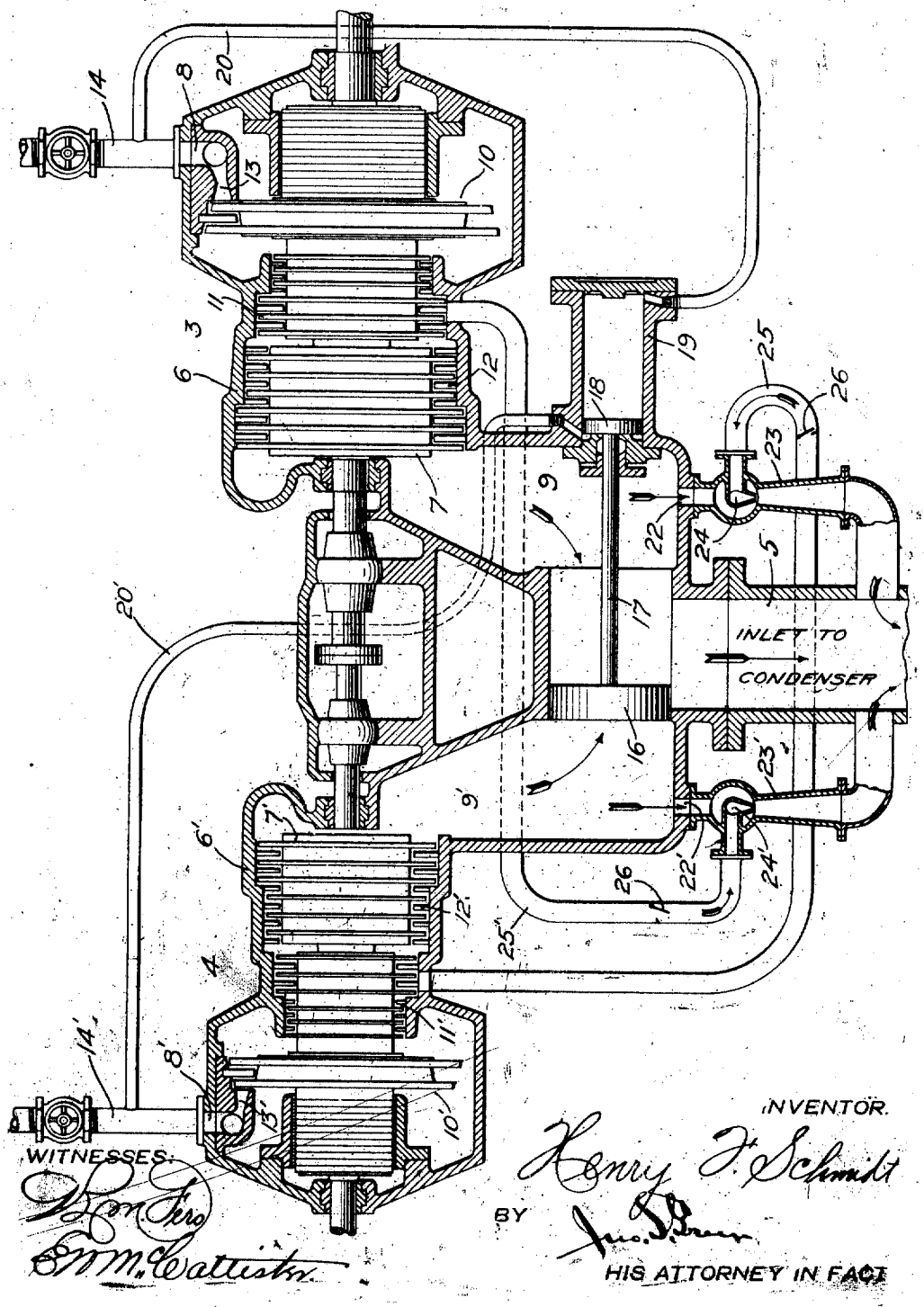
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TURBINE APPARATUS.

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1,252,956. Patented Jan. 8, 1918.



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TURBINE APPARATUS.

1,252,956. Specification of Letters Patent. Patented Jan. 8, 1918.

Application filed October 17, 1914. Serial No. 867,139.

To all whom it may concern:

Be it known that I, HENRY F. SCHMIDT, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Turbine Apparatus, of which the following is a specification.

This invention relates to turbines, and particularly to organized apparatus including two or more power developing elements or sections, which are adapted to operate independently, or in which separate elements at times are employed in developing power, while the others are inoperative or running idle.

The propelling apparatus of a turbine driven vessel may be referred to as an example of the character of apparatus to which my invention relates. Such turbine installations include at least one ahead turbine, or power developing element and one astern, or reversing turbine, or power developing element. It is customary in such installations to divide the ahead turbine into two or more power developing sections or elements, each of which is capable—during emergencies—of operating as an independent turbine, but which, under certain power or speed conditions, operate together as the separate sections or stages of the ordinary multi-stage turbine. For example, the ahead turbine, of such an installation, may include a main power developing element or section, which operates independently of the other sections as a power developing agent only when the vessel is being driven at full speed ahead or when the turbine apparatus is developing full power. Such an installation would also include separate sections or power producing elements, directly or operatively connected to the propeller shaft of the vessel and adapted to operate in conjunction with the main power developing agent during light load conditions, or while the vessel was being propelled at low or cruising speeds. When such sections or elements are employed, they run idle while the ahead turbine apparatus is developing full power, and one of the objects of my present invention is to produce means for reducing losses in efficiency and other disadvantages which result from driving the sections or elements of the turbine apparatus which are not developing power.

The reversing turbine of a marine installation is an example of an independent turbine element, forming a part of an organized apparatus, and the losses occasioned by it are most apparent, since it is ordinarily operatively connected to the propeller shaft and consequently is a drag on the apparatus almost all the time the apparatus is in operation, because it is seldom operated as a power producing agent, and when it is so operated all the separate sections of the ahead turbine apparatus run idle and consequently absorb energy.

In the single sheet drawing accompanying and forming a part hereof, I have diagrammatically illustrated an organized apparatus embodying my invention, portions being shown in section and portions in elevation for convenience of illustration and description.

The apparatus selected for the purpose of illustrating my invention includes an ahead turbine or power developing element 3, and a reversing turbine or power developing element 4. As illustrated, these separate elements are located in separate casings and are provided with separate rotors; the shafts of the two elements are, however, coupled together and both elements are adapted to be operatively connected to a driven shaft, such for example, as the propeller shaft of a vessel. In addition to this, both the elements are adapted to be placed in communication with the same condensing apparatus and are shown connected to the inlet 5 of a condenser.

As illustrated, the ahead turbine element 3, is provided with a casing 6, which incloses the blade carrying rotor 7, and which is provided with an inlet port 8, and a discharge or exhaust passage 9. The element is also illustrated as having three stages, an initial stage 10, an intermediate stage 11, and a low pressure stage 12. The initial stage receives motive fluid from one or more divergent or expansion nozzles 13, which communicate with the inlet port 8, and delivers fluid to the intermediate stage 11. After the fluid has traversed the blades of the stage 11, it is delivered to the low pressure stage, from which it is discharged into the exhaust passage 9.

The reversing turbine or power developing element illustrated, is similar in construction to the element 3, and is provided

with a casing 6′, having an inlet port 8′, and a discharge passage 9′, and it incloses a rotor 7′. This turbine element, like the element 3, is also divided into three stages 10′, 11′ and 12′, which may be respectively designated the initial, intermediate, and low pressure stages of the turbine element, and through which motive fluid delivered from the nozzle or nozzles 13′ successively passes.

A pipe or passage 14 is shown communicating with the inlet port 8 of the turbine 3 and through it motive fluid, such for example as steam, may be delivered from any suitable source to the element 3. The inlet port 8′ of the element 4 is shown communicating with a supply pipe 14′, through which motive fluid is delivered to the element.

In the embodiment of the invention, I have shown the exhaust passages 9 and 9′ of the two elements communicating with the condenser inlet 5. By this arrangement, both of the power developing elements may be served by the same condenser, although such an arrangement is not essential.

I have also provided means for closing communication between the inoperative element and the condenser inlet, which, as illustrated, is automatic in its operation and shifts in response to the pressure of the motive fluid delivered to the operative element to place that element in communication with the condenser inlet and to close communication between the other element and the condenser inlet. The means illustrated consist of a piston 16, having a valve stem 17, on which an operating plunger 18 is mounted. The plunger operates in a cylinder 19, one end of which communicates with the main supply pipe 14 of the element 3, through a pipe 20, while the other end communicates with the main supply pipe 14′ of the element 4, through a pipe 20′. With this arrangement, motive fluid will be delivered to one end of the cylinder 19, when fluid is delivered to the element 3, through the supply pipe 14, and will be delivered to the other end when motive fluid is delivered to the element 4, through the supply pipe 14′. The plunger 18 will therefore shift the piston valve 16 to close communication between the element 4 and the condenser inlet and establish communication between the element 3 and the condenser, when motive fluid is delivered to the element 3, and will shift the valve 16 to close communication between the element 3 and the condenser inlet and establish communication between the element 4 and the condenser, when motive fluid is delivered to the element 4.

I employ the piston valve 16 in conjunction with means for producing a better vacuum in the casing of the inoperative element than is maintained in the exhaust passage of the operating element, or at the point of junction of the exhaust passage of the inoperative element and the condenser inlet 5. The means illustrated consists of an ejector or evacuating agent, which may receive motive fluid from any suitable source, such for example, as the discharge passages of the auxiliaries or, in fact, from the source of motive fluid communicating with the pipes 14 and 14′. In the drawing, the ejecting apparatus operating in conjunction with each element, is shown connected so as to receive motive fluid from the other element after it has been partially expanded. It will be understood by those skilled in the art that instead of providing each element 3 and 4 with a separate evacuating device, a single device may be employed which is provided with means for placing it in communication with one or the other of the elements 3 and 4. It will also be understood that the specific type of ejector or evacuating apparatus illustrated need not necessarily be employed, and that any device capable of removing rarefied air or vapor from an inclosed receptacle may be utilized.

At a suitable point in the casing 6 of the turbine element 3, I have provided a port 22, with which an ejector 23 communicates. The ejector is shown provided with an ordinary discharge nozzle 24, which receives motive fluid through a pipe 25, from an intermediate stage of the element 4. The point of communication between the ejector and the interior of the casing 6 of the element to be evacuated is immaterial and, if desired, the port 22 may be located at or near the high pressure end of the turbine. In this connection, attention is called to the fact that it is desirable to so locate the port 22 that it will aid in draining the casing of the turbine element in case there is any tendency for water or condensate to collect at any point within its working passages. This avoids the necessity of removing water or condensate from the casing by evaporation, and consequently reduces the length of time necessary for obtaining the desired high vacuum within the casing.

As illustrated, the casing 6′ of the element 4 is provided with a port 22′, and an ejector 23′ is shown communicating with this port and receiving motive fluid from an intermediate stage of the element 3, through a pipe 25′. Each of the pipes 25 and 25′ is provided with a separate non-return valve 26, which permits of the flow of fluid through the pipe toward the ejector, but prevents a flow in the opposite direction.

The operation of the apparatus is as follows: When motive fluid is delivered to the element 3, the plunger 18 and the piston valve 16 are shifted to the positions illus-

trated in the drawing. This places the element 3 in direct communication with the inlet to the condenser, but closes communication between the element 4 and the inlet to the condenser. Motive fluid, after it has been partially expanded in the working passages of the element 3, is delivered through the pipe 25′ to the ejector 23′, and the ejector, therefore, operates to evacuate the casing 6′ of the element 4. With this arrangement I can maintain a higher or better vacuum within the casing of the element 4 than would be maintained therein if that element were in open communication with the condenser and, in fact, by properly proportioning the ejector, I can maintain a pressure of from one to two-tenths of a pound absolute, whereas the ordinary pressures obtained in condensers range from one to two pounds absolute. It will, therefore, be apparent that, inasmuch as the energy absorbed by rotating an element—such for example as the rotor of a turbine—in an atmosphere of steam or air is directly proportional to the absolute pressure of the surrounding medium, my invention materially reduces the losses occasioned by windage and also reduces or practically eliminates the attendant disadvantages. When the supply of motive fluid is shut off to the turbine element 3, the actuating pressure of the plunger 18 within the cylinder 19 is, of course, reduced, and the delivery of motive fluid to the ejector 23′ ceases. Now, if motive fluid is delivered to the element 4, pressure will be delivered to the opposite end of the cylinder 19, and the plunger 18 and the valve 16 will shift to establish direct communication between the element 4 and the inlet to the condenser and close communication between the element 3 and the inlet 5 to the condenser. In addition to this, motive fluid from the working passage of the element 4 will be delivered to the ejector 23, and the casing 6 of the element 3 will be evacuated, or exhausted by that ejector.

It will be understood that the ejectors may discharge directly into the condenser and, if feasible, at the zone of minimum pressure in the condenser, thereby reducing the work of compression of the ejectors over what it would be with an arrangement of apparatus similar to that illustrated. As a matter of fact, the economy of an ordinary apparatus, such as illustrated, may be materially increased by closing direct communication between the casing of the idle element and the condenser inlet and by connecting the casing with a region of low pressure, such for example, as the zone of minimum pressure in the condenser. This will be apparent when it is remembered that there is always a considerable difference in pressure between the inlet of the condenser and the region within the condenser at which the condensation is substantially complete.

While the turbine 4 illustrated is essentially a reversing turbine, it will be apparent to those skilled in the art, that my invention may be employed with equal success in connection with any of the separate elements of an organized turbine apparatus, whether the elements are primarily designed to operate independently of each other, or to operate in conjunction with other elements, and at times to run idle, such as is the case with cruising elements of some marine installations. In addition to this, my invention may be employed in connection with apparatus in which the separate power developing elements are located within a single casing, or in which the separate elements coöperate with each other, or are operatively connected to each other through the agency of gears or gearing which drive the driven shaft or agent. I do not, therefore, limit myself in any way to the specific form of apparatus illustrated, or the specific application of my invention to that apparatus, but my invention broadly contemplates means for closing communication between the idle power developing element and the condenser inlet or region of normal exhaust, whether the element is,—under normal operating conditions—directly connected to the condenser inlet or to the region of exhaust or not, and means for reducing the pressure within the casing of the idle element, below that obtainable by connecting the exhaust passages of the idle element to the condenser inlet or to the region of normal exhaust, as is now customary.

What I claim is:

1. In an apparatus of the character described, two power developing elements, operatively connected together and capable of developing power independently of each other, and means for reducing the pressure within the working passage of one element when said element is inoperative as a power developing agent to a point below the pressure normally existing at the exhaust of either element.

2. In combination with a power developing element having its working passages adapted to be connected to a condenser, means for cutting off communication between said element and the condenser, and means for reducing the pressure within the casing of said element below the pressure at the inlet tc the condenser, when the element is inoperative as a power developing agent.

3. In combination with a power developing element having its working passages adapted to be connected to a condenser, means for cutting off communication between a working passage of the element and the condenser and means for reducing the

pressure within the working passage so cut off, below that existing at the condenser inlet.

4. In an organized turbine apparatus, a turbine element having an inlet port and an exhaust port, and means for closing the exhaust port and for reducing the pressure within a working passage of the element, when the working passage is inoperative as a power producing agent, below the pressure normally existing at the exhaust of the organized apparatus.

5. In an apparatus of the character described, an ahead turbine, a reversing turbine, means responsive to the delivery of motive fluid to said apparatus for placing the operating turbine in communication with the exhaust, and means for withdrawing fluid from the casing of the inoperative turbine.

6. An apparatus of the character described, comprising separate fluid driven power developing sections, means for establishing communication between the operative section and the exhaust, and means for exhausting the casing of the inoperative section.

7. In an apparatus of the character described, a turbine element adapted to communicate with a condenser while in operation, means for closing communication between the turbine element and the condenser when the element is inoperative as a power developing agent, and means for reducing the pressure within the working passage of the element below that existing at the inlet to the condenser when its exhaust is closed.

8. In an apparatus of the character described, two turbine elements, operatively connected to each other and each adapted to communicate with a condenser, means for closing communication between the inoperative turbine element and the inlet to the condenser, and means for reducing the pressure within the working passage of the inoperative element below that existing at the inlet to the condenser.

9. In combination with a turbine, means for closing the exhaust port of the turbine when the turbine is inoperative as a power developing agent, and means for evacuating the casing of the turbine when the exhaust port is closed.

10. In combination with a turbine section, means for closing the exhaust port of the turbine section when the turbine section is not developing power, and a fluid ejector communicating with the working passage of the turbine section for evacuating the casing when the exhaust port is closed.

11. In combination with a turbine element adapted to communicate through its exhaust port with a condenser, means for closing the exhaust port of th turbine element and means for reducing the pressure within the casing of the turbine element below that existing at the inlet to the condenser.

12. In combination with a turbine element adapted to run idle while not developing power, and adapted to communicate with a condenser during normal operation, a condenser, means for closing communication between the exhaust port of the element and the inlet of the condenser, and means for establishing communication between the interior of the casing and the condenser, while the exhaust port is closed.

13. In an apparatus of the character described, two turbine elements operatively connected together and adapted to operate independently as power developing agents, a condenser communicating with the exhaust ports of both elements, a valve for controlling communication between both of the elements and the condenser, and means for evacuating the casing of the turbine element between which and the condenser inlet communication is cut off.

14. In combination with an ahead turbine section, a reversing section operatively connected thereto and adapted to run idle while the ahead section is developing power, means for closing communication between the working passage of the reversing section and the region of exhaust therefor, and means for reducing the pressure within the working passage of the reversing section below the pressure of the region of exhaust when said first mentioned means is operative.

15. A power developing apparatus comprising an ahead section having a fluid inlet and exhaust, a reversing section having a fluid inlet and exhaust, each of said sections being adapted to run idle while not delivering power, means for closing the exhaust of the reversing section when said section is not developing power and means for evacuating said section when the exhaust is closed.

16. An organized turbine apparatus, comprising an ahead section, a reversing section, said reversing section adapted to run idle when the ahead section is developing power, means for closing the exhaust of the reversing section and an ejector for evacuating the reversing section when the exhaust is closed.

17. An organized apparatus of the character described, comprising an ahead turbine element, a reversing turbine element, each of said elements being adapted to run idle while the other is developing power, means for closing the exhaust of the turbine element running idle, and an ejector for reducing the pressure within the working passage of the turbine element, the exhaust of which is closed.

18. An organized apparatus of the character described, comprising an ahead tur-

bine element, a reversing turbine element, each of said elements being adapted to run idle while the other is developing power, a valve for closing the exhaust of the idle turbine element, and a fluid actuated ejector for exhausting the working passage of the turbine, the exhaust of which is closed.

19. An organized apparatus of the character described, comprising an ahead turbine element, a reversing turbine element, a condenser with which both of said turbines communicate, means for closing communication between each of said turbine elements and the inlet to the condenser, and an ejector for exhausting the working passage of the turbine which is closed off from the inlet to the condenser.

20. An organized apparatus of the character described, comprising an ahead turbine element, a reversing turbine element, each of said elements adapted to run idle while the other is developing power, means for closing the exhaust of the element running idle, and means for withdrawing fluid from the working passage of the turbine element, the exhaust of which is closed.

21. In an apparatus of the character described, independent power developing elements, each adapted to run idle while not developing power, means such as a valve for closing the exhaust end of the element running idle, and a fluid ejecting device for exhausting the working passage of the element running idle.

22. In an apparatus of the character described, independent power developing elements, each being adapted to communicate with a condenser and to run idle while not developing power, means for closing communication between the working passage of the idle element and the inlet to the condenser, and means for actuating said first mentioned means to establish communication between each element and the condenser when motive fluid is delivered to the element.

23. In an apparatus of the character described, two power developing elements, each adapted to run idle while the other is developing power, and each adapted to be connected with the condenser, a valve for closing communication between the working passage of the idle element and the condenser inlet, fluid actuated means for actuating said valve to establish communication between each element and the inlet to the condenser when motive fluid is delivered to the element, and means for exhausting the working passage of the idle element.

24. In an apparatus of the character described, two power developing turbine elements, each adapted to run idle while the other is developing power and each adapted to communicate with a condenser, a valve for closing communication between the working passage of one or the other of said elements and the inlet to the condenser, fluid actuated means responsive to the delivery of motive fluid in actuating said valve to establish communication between the element receiving motive fluid and the condenser inlet, and means responsive in operation to the delivery of motive fluid to one element for exhausting the working passages of the other element.

25. In an apparatus of the character described, a power developing element, a condenser, the inlet of which communicates with the exhaust of the element, a quick acting valve for closing communication between said element and the condenser, and means responsive in operation to the delivery of fluid to said element for actuating said valve to establish communication between said element and the condenser.

26. In an apparatus of the character described, a power developing element, a condenser, the inlet of which communicates with the exhaust of the element, a quick acting valve for closing communication between said element and the condenser, means responsive in operation to the delivery of fluid to said element for actuating said valve to establish communication between said element and the condenser, and means for reducing the pressure within the working passage of the element when the exhaust is closed to the condenser below that normally existing at the inlet to the condenser.

In testimony whereof, I have hereunto subscribed my name this 15th day of October, 1914.

HENRY F. SCHMIDT.

Witnesses:
C. W. McGHEE,
E. W. McCALLISTER.