R. N. EHRHART.

ELASTIC FLUID TURBINE.

APPLICATION FILED MAR. 31, 1906. RENEWED SEPT. 28, 1909.

953,521. **Patented Mar. 29, 1910.**

2 SHEETS—SHEET 1.

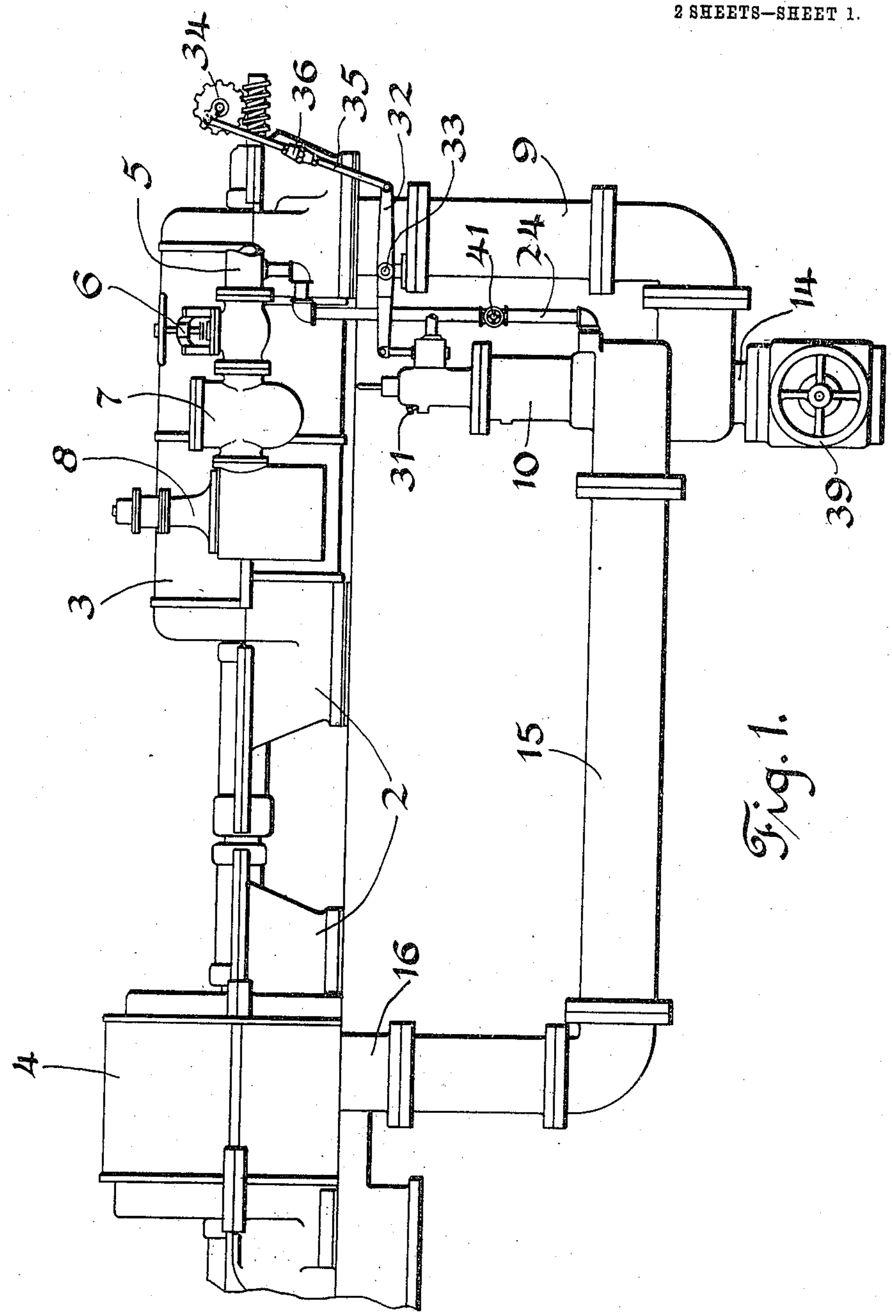

Fig. 1.

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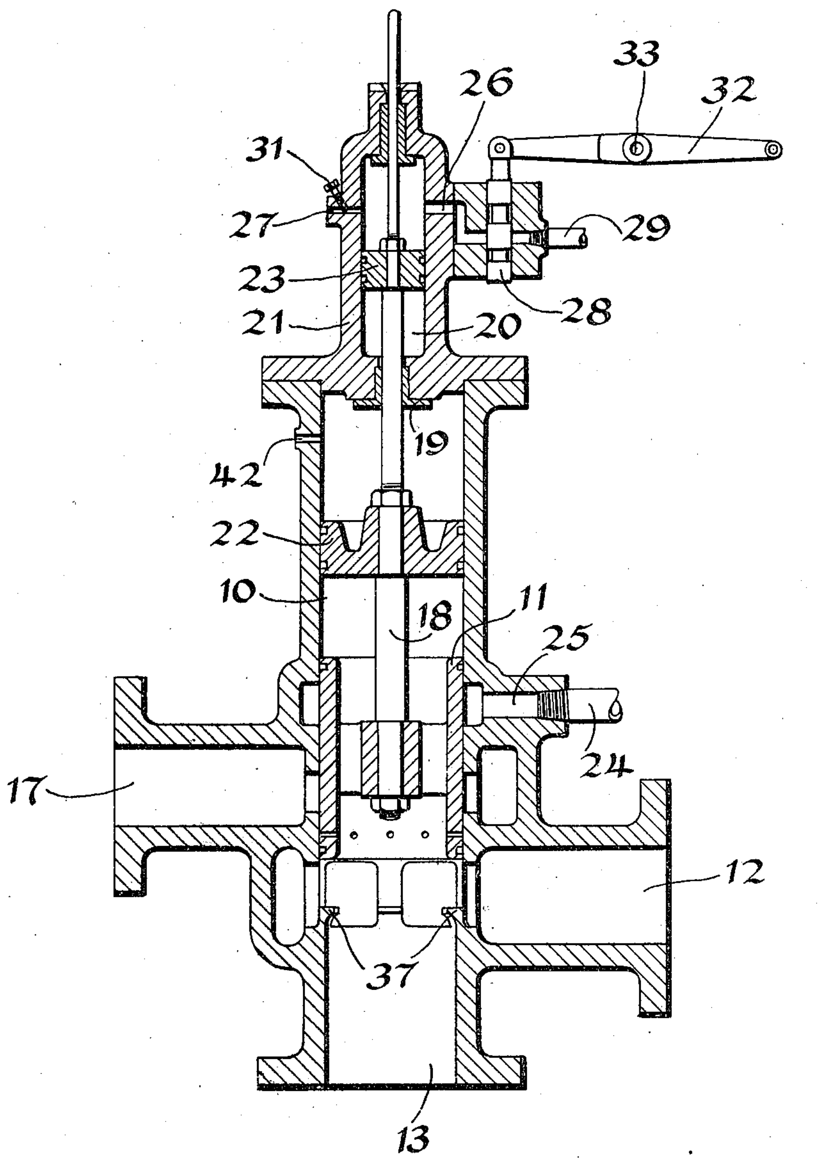

Fig. 2.

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ELASTIC-FLUID TURBINE.

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To all whom it may concern:

Be it known that I, RAYMOND N. EHRHART, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Elastic-Fluid Turbines, of which the following is a specification.

This invention relates to elastic fluid turbines and has for an object the production of means for utilizing the fluid discharged from turbines as a heating agent.

A further object of this invention is the production of a heating system which may be utilized in connection with a turbine, in which means are employed for proportioning the flow of fluid from the turbine to the heating system so as to maintain therein a constant pressure.

A further object is the production of a heating system in which motive fluid discharged from a high-pressure stage of a turbine is delivered to the heating system and connected with which means are employed for delivering the excess fluid to a stage of lower pressure.

The embodiment of my invention herein described includes a multi-stage turbine, which is divided into high and low pressure sections, and a heating system which receives steam from a high pressure section. The arrangement is such that all or a portion of the steam discharged from the high pressure section is delivered to a valve, which communicates with the heating system, before it is delivered to the low pressure section. A special valve is utilized between the high and low pressure sections which is adapted to supply fluid from the high-pressure section in regulable amounts to the heating system so as to maintain therein a constant pressure. The valve is arranged to automatically admit high-pressure steam to the heating system when the fluid discharged from the high-pressure section of the turbine is insufficient to maintain a predetermined pressure therein, and is also arranged to by-pass steam around the heating system and into the low-pressure section of the turbine when the pressure in the heating system exceeds a predetermined amount.

In the drawings accompanying this application and forming a part thereof, Figure 1 is a side elevation illustrating a system of fluid passages which communicate with a heating system; and Fig. 2 is a sectional elevation of a valve forming a detail of my invention.

A turbine 2 is divided into high and low pressure sections which are inclosed within separate cylinders 3 and 4. The high-pressure section is provided with a motive fluid supply pipe 5 which is provided with a hand-operated throttle valve 6, an automatic cut-off valve 7 and a governor-controlled admission valve 8, which admits motive fluid (hereinafter called steam, for the sake of brevity) to the turbine. The cylinders 3 and 4 of the turbine are so arranged that the steam entering the high-pressure section flows in one direction toward the exhaust and through suitable passages to the admission port of the low-pressure cylinder through which it flows in an opposite direction and is discharged into a condenser or the atmosphere. The steam discharged from the high-pressure cylinder of the turbine enters a conduit, or passage 9, which communicates with a casing 10 of an automatically-actuated valve through port 12. The casing 10 is provided with a port 13 which communicates with a heating system through a valved pipe 14 and with a conduit or passage 15, which communicates with the admission port of the low-pressure section of the turbine, through a valve port 17. The valve 11 comprises a hollow piston and reciprocates within the casing 10 to control the flow of steam through the ports 12 and 17. The valve stem 18 is rigidly secured to the valve 11 and extends through a suitable bush 19, located in the casing 10, and into a cylindrical chamber 20, the walls 21 of which are formed integrally with the head portion of the casing 10. A piston 22, rigidly mounted on the valve stem 18, operates within the casing 10 and a piston 23, also rigidly mounted on the valve stem, operates within the chamber 20.

A pipe or passage 24 communicates with a port 25, formed within the casing 10, and is adapted to admit high-pressure steam to the interior passages of the casing 10. The chamber 20 is provided with a steam admission port 26 and an exhaust port 27. The admission port is provided with a valve 28 which is adapted to periodically admit steam from a pipe 29 to the upper portion of the chamber 20. The exhaust port 27 is provided with a needle valve 31, which is adapted to restrict and regulate the amount of steam exhausted from the chamber 20. The valve 28 is pivotally connected to a lever 32, which is fulcrumed at 33 and which is periodically oscillated by an eccentric 34 through an eccentric rod 35. The eccentric 34 is driven by the shaft of the turbine and the eccentric rod 35 is provided with a sleeve nut 36, which may be utilized in adjusting its length. The flow of steam from the chamber 20 is restricted by the valve exhaust port 27 and consequently the piston 23 is periodically subjected to fluid pressure admitted by the valve 28, which tends to close the ports 12 and 17 by moving the valve 11 downwardly toward its seat, which is formed on lugs 37, formed integrally with the valve casing 10. The lugs 37 are so located that the piston valve 11 will never entirely close the admission port 12 and the valve 11 is hollow and so constructed that when it is in its lowest position the port 17 is closed and the port 25 is open. The arrangement is such that the pressure in the heating system is transmitted through the port 13 and through the piston valve 11 to the under side of the piston 22 and tends to open the ports 12 and 17 by raising the piston valve 11 in opposition to the fluid pressure admitted by the valve 28 to the upper portion of the chamber 20.

By properly proportioning the areas of the pistons 22 and 23, and by adjusting the flow of steam through the upper portion of the cylinder 20, a predetermined pressure may be maintained in the heating system. When the pressure in the heating system exceeds a predetermined amount, due to the valve 8 supplying extra amounts of steam to the high pressure portion of the turbine, or to the fact that the heating system is not condensing all of the steam supplied, the piston 22 is raised, in opposition to the periodic pressure on the piston 23, and lifts the valve 11, thereby admitting steam from the port 12 to the low-pressure cylinder of the turbine through the port 17. The fluctuations of pressure in the chamber 20 cause the valve 11 to pulsate and to periodically open the port 17 amounts proportional to the existing pressure in the heating system. As the pressure in the heating system continues to increase, the valve 11 is raised to such positions that it will not close the ports 12 and 17 during its reciprocations and steam is, therefore, admitted to the low-pressure cylinder of the turbine in a continuous and unthrottled stream. When the pressure in the heating system falls below a predetermined pressure, the valve 11 is periodically forced by the pressure in the chamber 20 to such positions that the port 17 is periodically closed, and the port 25 is periodically uncovered and high-pressure steam is admitted in puffs through the hollow valve 11 to the heating system. As the pressure continues to fall in the heating system, the pulsations of the valve 11 decrease until, at a predetermined pressure, the valve is held by the pressure in the chamber 20 against the lugs 37 and high-pressure steam is admitted in a continuous stream in conjunction with the steam admitted through the partially closed port 12.

The pressure maintained in the heating system may be varied by adjusting the throw of the valve 28, by lengthening or shortening the eccentric rod 35 or by adjusting the needle valve 31 with which the exhaust port 27 is provided.

When the heating system is not in use, a valve 39 in the pipe 14 is closed and the valve 11 in reciprocating admits steam direct to the low-pressure section of the turbine. Means may be utilized for securing the valve 11 in such a position that the port 17 is always open. A valve 41 is provided in the pipe 24 which admits high-pressure steam to the interior of the valve casing 10, that may be closed when the heating system is not in use, or may be utilized in adjusting the flow of steam through the pipe during the operation of the heating system.

It is apparent that with such a construction the efficiency of the turbine will not be materially affected, since the low-pressure section will be operating in a vacuum if connected to a condenser, during light loads, or when the heating system is making large demands for steam. It is apparent also that during the operation of the heating system the motive fluid will be delivered to the low-pressure section of the turbine in accordance with the load demand. As the load on the turbine increases, the valve 11 will respond to the variations of pressure admitted to the interior of the valve casing 10 by the valve 8 and periodically supply motive fluid to the low-pressure section of the turbine. As the load on the turbine still further increases, the valve 11 will increase the periodic supply of steam to the low-pressure section and, at some predetermined load, steam is admitted in a continuous stream. Under such conditions the turbine at all times will answer to the load demand just as effectively as an ordinary turbine and the pressure in the heating system will be maintained practically constant.

The valve stem 18 is arranged to project through the casing 10 to form a sight rod, which discloses the position of the piston 11 and, therefore, aids in the adjustment of the needle valve 31 and the sleeve nut 36.

The pressure in the chamber 20 may be so proportioned that the valve 11 will pulsate even when the pressure in the heating system is far below or greatly in excess of the predetermined pressure and for this reason the valve 11 will be effective and accurate in operation, as the sticking of the parts will be overcome by the variations of fluid pressure in the chamber 20. The exhaust port 27 of the chamber 20 may be connected with the low-pressure section of the turbine or with a condenser, and a small port 42, which is adapted to discharge the leakage of steam past the piston 22 and the piston 23 through the bush 19 from the valve casing 10 is located in the upper part of the casing and may be connected with the atmosphere or a condenser.

When a single cylinder turbine is utilized in connection with the heating system, the interior working passages of the turbine are divided into high and low pressure sections and the steam discharged from the high-pressure section is utilized in whole or in part in the heating system substantially as herein described.

Other and various arrangements may be utilized and still fall within the spirit and scope of this invention.

What I claim as new and useful is:

1. In combination with a multi-stage turbine, a heating system, a valve for delivering motive fluid discharged from a high-pressure stage of said turbine to said system and to a low-pressure stage of said turbine.

2. In combination with a multi-stage turbine, a heating system, a valve between said turbine and said heating system adapted to admit motive fluid discharged from a high-pressure section of said turbine to said heating system, and to by-pass the excess of fluid to a low-pressure section of said turbine.

3. In combination with a multi-stage turbine, a heating system, a valve between a high-pressure stage of said turbine and said heating system adapted to maintain a constant pressure in said heating system and proportion the amount of fluid admitted to a low-pressure stage of said turbine.

4. In combination with a multi-stage turbine, a heating system, a valve between a high-pressure stage of said turbine and said heating system and adapted to deliver motive fluid discharged from said high-pressure stage to said heating system and to a low-pressure stage of said turbine and means for maintaining the pressure within said heating system constant.

5. In combination with a multi-stage turbine, a heating system, a valve adapted to deliver motive fluid to a low-pressure stage of said turbine and to said heating system, means for maintaining the pressure within said heating system constant and means for pulsating the fluid delivered by said valve to said low-pressure stage of said turbine.

6. In combination with a multi-stage turbine, a heating system, a valve for said system, a fluid-actuated piston within said valve adapted to proportion the delivery of motive fluid from said turbine to said system and means for causing said piston to pulsate.

7. In combination with a multi-stage turbine, a heating system, means for delivering motive fluid from a high pressure stage of said turbine and from a source other than said turbine to said heating system and means, dependent on the pressure within said system, for controlling the admission of the secondary supply of motive fluid.

8. In combination with a high and low pressure section of an elastic fluid turbine, a heating system, means for delivering motive fluid from said high pressure section to said system and means, dependent on the pressure within said system, for controlling the delivery of fluid to said low pressure section.

9. In combination with a multi-stage elastic fluid turbine, a heating system communicating with a high pressure stage of said turbine, means, dependent on the pressure within said system, for controlling the delivery of fluid to a low pressure stage of said turbine, and means causing the fluid delivered to said low pressure stage to pulsate.

10. In combination with a high and low pressure section of an elastic fluid turbine, a heating system between said sections, a valve receiving fluid from said high pressure section and from an auxiliary source of supply and communicating with said heating system and said low pressure section, a piston within said valve subjected to the fluid pressure of said heating system for controlling the delivery of fluid to said low pressure stage and the delivery of fluid from said auxiliary source to said heating system and means for causing said valve to pulsate.

11. In combination with a high and low pressure section of an elastic fluid turbine, a heating system between said sections, a valve receiving fluid from said high pressure sections and from an auxiliary source of supply and communicating with said heating system and said low pressure section and a piston within said valve subjected to the fluid pressure of said heating system for controlling the delivery of fluid to said low pressure section and the delivery of fluid from said auxiliary source to said heating system.

12. In combination with a multi-stage turbine, a heating system, means between said turbine and said heating system for admitting motive fluid discharged from a high pressure stage of said turbine to said heating system and for by-passing the excess of fluid to a low pressure stage of said turbine.

13. In combination with a multi-stage turbine, a heating system, means between a high pressure stage of said turbine and said heating system for maintaining a constant

pressure within said system and for proportioning the amount of fluid admitted to a low pressure stage of said turbine.

14. In combination with a multi-stage turbine, a heating system, a valve between a high-pressure stage of said turbine and said heating system and adapted to deliver motive fluid to a low-pressure stage of said turbine and said heating system and means for proportioning the delivery of fluid to said low-pressure stage in accordance with the pressure existing in said system.

15. In combination with a multi-stage turbine, a heating system, a valve for delivering motive fluid discharged from a high-pressure stage of said turbine to a low-pressure stage and to said heating system, means for proportioning the delivery of fluid to said low-pressure stage in accordance with the pressure existing in said system and means for pulsating the fluid delivered thereto.

16. In combination with a multi-stage turbine, a heating system, a valve for delivering motive fluid from a high-pressure stage of said turbine and from a source other than said turbine to said heating system and means, denenaent upon the pressure existing within said system, for controlling the delivery of motive fluid to said low-pressure stage of the turbine.

17. In combination with a multi-stage turbine, a heating system, a valve for delivering motive fluid from a high-pressure stage of said turbine and from a source other than said turbine to said heating system, means, dependent upon the pressure existing within said heating system, for controlling the delivery of motive fluid to said low-pressure stage and means for pulsating the fluid delivered to said low-pressure stage.

18. In combination with a multi-stage turbine, a heating system, a valve between a high and a low-pressure stage of said turbine, and means whereby said valve is adapted to proportion the delivery of motive fluid to said low-pressure stage in accordance with the pressure existing in said system and to pulsate the fluid passing it.

19. In combination with a multi-stage turbine, a heating system, means between said heating system and said stage for delivering motive fluid discharged from a high-pressure stage of said turbine to a low-pressure stage and to said heating system and means for proportioning the delivery of motive fluid to said low-pressure stage in accordance with pressure existing in said system.

20. In combination with a multi-stage turbine, a heating system, means for delivering motive fluid discharged from a high-pressure stage of said turbine to a low-pressure stage and to said heating system, means for proportioning the delivery of fluid to said low-pressure stage in accordance with the pressure existing in said system and means for pulsating the fluid delivered thereto.

21. In combination with a multi-stage turbine, a heating system, means for delivering motive fluid discharged from a high-pressure stage of said turbine and from a source other than said turbine to said heating system and means, dependent upon the pressure within said heating system, for controlling the delivery of motive fluid to said low-pressure stage of the turbine.

22. In combination with a multi-stage turbine, a heating system, means for delivering motive fluid discharged from a high-pressure stage of said turbine and from a source other than said turbine to said heating system, means, dependent upon the pressure within said heating system, for controlling the delivery of motive fluid to said low-pressure stage of the turbine and means for pulsating the fluid delivered to said stage.

23. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means intermediate said turbines adapted to absorb energy of the motive fluid exhausted from the first turbine of the series and mechanism for automatically by-passing said means whereby varying proportions of the exhaust motive fluid from the first turbine are delivered to the second turbine without passing through said means.

24. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing work, means adapted to absorb energy of a portion or all of the motive fluid exhausted from the first turbine of the series, a by-pass around said means, a valve in said by-pass and means for automatically controlling the operation of said valve.

25. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means adapted to absorb the energy of a portion or all of the motive fluid exhausted from the first turbine of the series, a by-pass around said means, a valve in said by-pass and means for automatically controlling the operation of said valve in accordance with the pressure of the motive fluid in said means.

26. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means adapted to absorb the energy of a portion or all of the motive fluid exhausted from the first turbine of the series, a by-pass around

said means for placing said turbines in direct communication one with the other and regulating means for automatically varying the effective area of said by-pass.

27. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means adapted to absorb the energy of a portion or all of the motive fluid exhausted from the first turbine of the series, a by-pass around said means for placing said turbines in direct communication one with the other and regulating means for automatically shunting all or a portion of the exhaust motive fluid from said first turbine of the series around said means.

28. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means adapted to absorb the energy of a portion or all of the motive fluid exhausted from the first turbine of the series, a by-pass around said means for placing said turbines in direct communication one with the other and regulating means for automatically controlling the delivery of all or a portion of the motive fluid exhausted from said first turbine to the second turbine of the series.

29. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means adapted to absorb the energy of a portion or all of the motive fluid after it has passed through the first turbine of the series, a by-pass for leading motive fluid exhausted from the first turbine of the series directly to the second turbine, a valve in said by-pass and an agent the operation of which is dependent upon the amount of energy absorbed by said means for automatically controlling the operation of said valve.

30. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing work, means for utilizing a portion of the motive fluid exhausted from the first turbine of the series in performing useful work, a by-pass around said means and a device the operation of which depends upon the energy abstracted by said means for controlling the effective area of said by-pass.

31. In combination, independent turbines working at different pressures and through which the motive fluid passes in series relation in performing useful work, means for abstracting and utilizing the energy of a portion of the motive fluid exhausted from the first turbine of the series and a device the operation of which depends upon the energy abstracted by said means, for automatically proportioning the amounts of exhaust fluid delivered to said means and to the second turbine of the series.

In testimony whereof, I have hereunto subscribed my name this 29th day of March, 1906.

RAYMOND N. EHRHART.

Witnesses:
CHARLES W. McGHEE,
R. P. McINTYRE.