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ELASTIC FLUID TURBINE.

APPLICATION FILED SEPT. 28, 1909.

1,041,121.

Patented Oct. 15, 1912.

3 SHEETS—SHEET 1.

Fig. 2

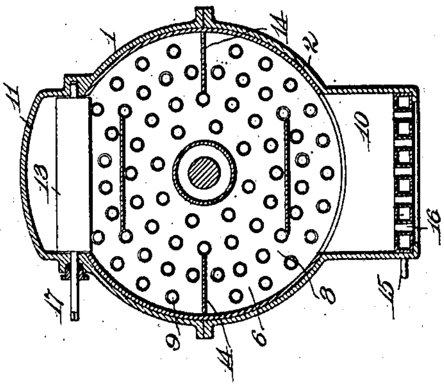
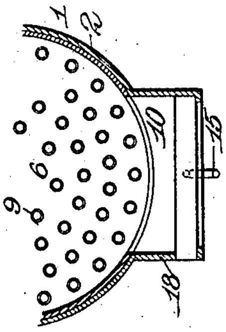


Fig. 4



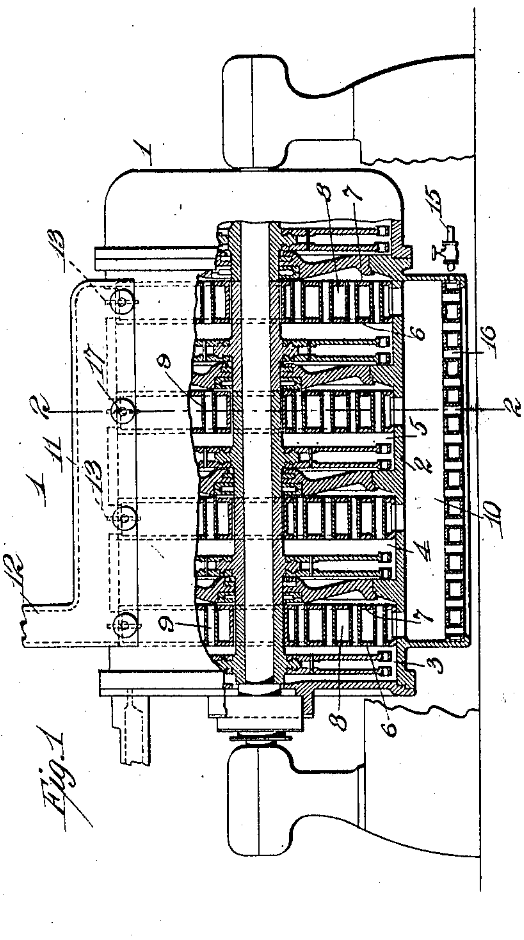


Fig. 1

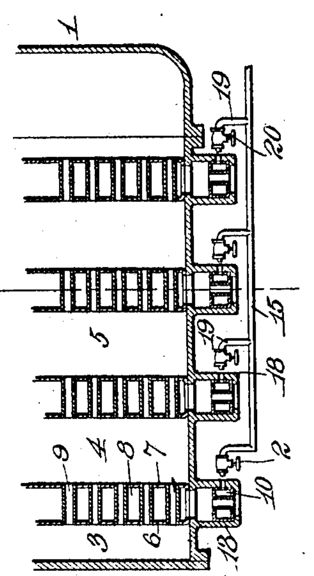


Fig. 3

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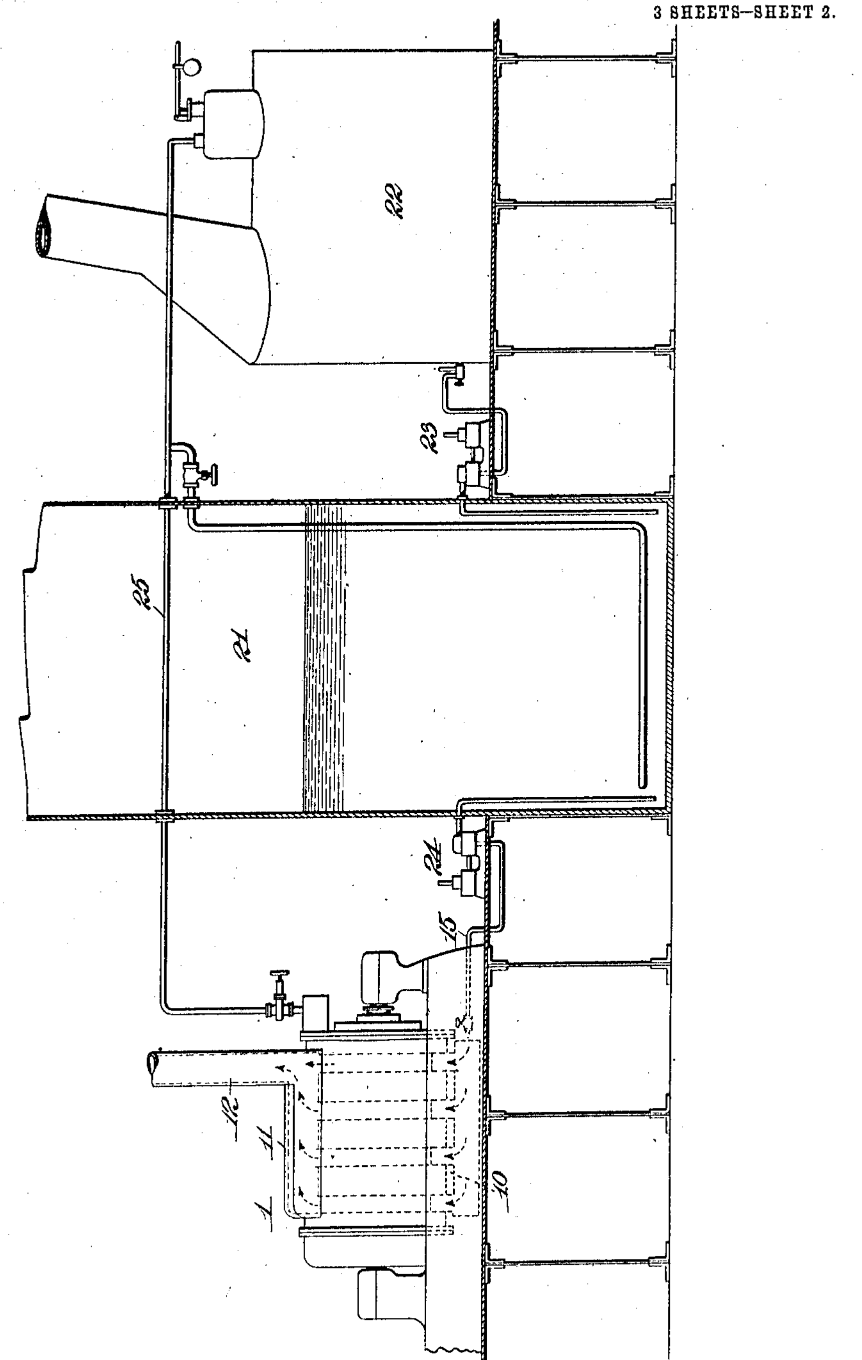
3 SHEETS—SHEET 2.

Fig. 5



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3 SHEETS—SHEET 3.

Fig. 6

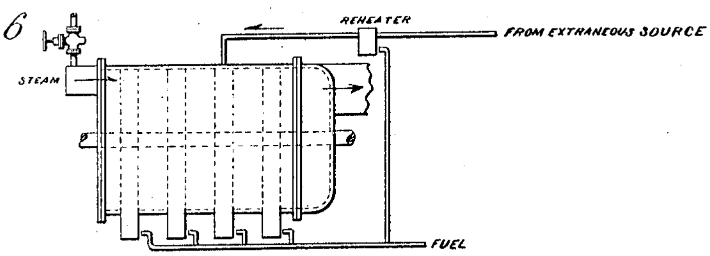


Fig. 7

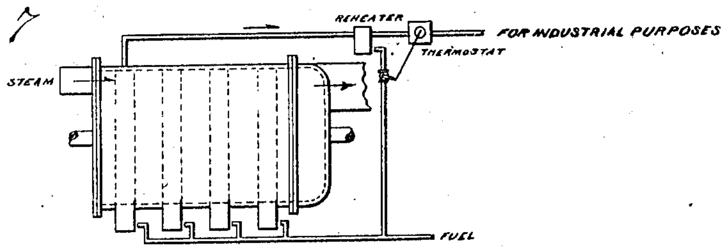


Fig. 8

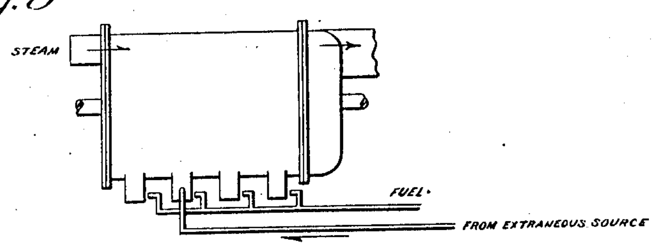
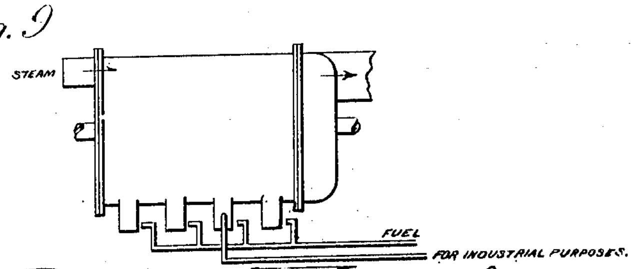


Fig. 9



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UNITED STATES PATENT OFFICE.

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ELASTIC-FLUID TURBINE.

1,041,121. Specification of Letters Patent. **Patented Oct. 15, 1912.**

Application filed September 28, 1909. Serial No. 520,001.

To all whom it may concern:

Be it known that we, LOUIS C. LOEWENSTEIN, a citizen of the United States, and a resident of the city of Lynn, county of Essex, State of Massachusetts, and LEONARD H. DYER, a citizen of the United States, and a resident of the town of Greenwich, county of Fairfield, State of Connecticut, have invented a new and useful Elastic-Fluid Turbine, of which the following is a specification.

This invention relates to turbines which utilize elastic fluid and is particularly applicable to steam turbines, although it is not so limited.

By our invention we seek to increase the efficiency of the plant by reheating the steam between stages, so that we secure a more definite and advantageous steam expansion throughout the turbine,—as for instance, an isothermal expansion, or perhaps a closer approach to true adiabatic expansion as the necessities of any certain case may demand; or the invention may be used for simply avoiding the use of wet steam between stages without the need of primary superheating, which is objectionable owing to the high heat required.

By this invention an increase of efficiency is also obtained by reducing the lengths of the steam connections and making the flues of the reheaters more compact,—thus reducing the radiation and other losses incident to longer flues.

Further objects are to permit the separation of the motor and generator and to connect them by the main steam passage only, without the need of further connecting the two by flues or steam passages for the purpose of reheating between stages by means of the furnace gases.

These and further objects will appear from the following specification and accompanying drawings, considered together or separately.

In the drawings: Figure 1 is a side elevation, partly in section, of a multistage elastic fluid turbine embodying our invention. Fig. 2 is a sectional view thereof on the line 2—2 of Fig. 1. Fig. 3 is a detail section of a modification of the structure shown in Fig. 1. Fig. 4 is a section on the line 4—4 of Fig. 3. Fig. 5 is a diagrammatical view of a marine layout, showing a steam boiler, turbine and an oil fuel tank. Fig. 6 is a diagraphic view of an elastic fluid turbine embodying our invention, showing the application of the invention to an arrangement in which additional steam is introduced into an intermediate stage from an extraneous source. Fig. 7 is a similar view, showing an application of the invention in which the steam is removed from an intermediate stage for industrial or other purposes. Fig. 8 is a view similar to that of Fig. 6, but modified by the omission of the reheater in the pipe connected to the extraneous source, and Fig. 9 is a view similar to Fig. 7, but modified as in Fig. 8.

In all of the views like parts are designated by the same reference characters.

According to one form of our invention, the elastic fluid between stages in a multistage elastic fluid turbine is reheated by a single furnace, the flues being arranged in parallelism with a common combustion chamber and the heat regulation being made by means of dampers.

Referring to Figs. 1 and 2, the turbine 1 has its shell 2 divided into stages 3, 4 and 5 of different pressures. Between each two stages are diaphragms 6 and 7, the space 8 between forming a passage for the hot gases. Connecting these diaphragms are fluid passages 9. These passages are shown as made of a plurality of tubes through which the steam passes from one stage to the next. The elastic fluid is adapted to pass through the fluid passages while the products of combustion of the furnace pass outside of said passages. Below the steam passages (but in connection therewith and substantially within the shell) is a furnace 10. Above the steam passages is a manifold or smoke box 11 which communicates with a stack 12. Within each gas passage 8 is a damper 13. Baffle plates 14 are arranged within the gas passages to properly distribute the hot gases arising from the furnace. The furnace illustrated is an ordinary form of oil burning furnace, fuel being supplied to it from the pipe 15. The air passages 16 permit the entrance of air to the furnace for the purpose of supporting combustion. Each damper is mounted upon a shaft 17, through the agency of which its position may be controlled by means outside of the shell of the turbine. In connection with this portion of our invention, any form of furnace may be employed. By means of the dampers 13 the temperature of the gases in the gas passages 8, and consequently of the fluid passages 9, may be precisely controlled and the desired effects may be secured. This will permit the steam (when such is used as the elastic fluid) to be reheated between stages to the necessary degree to secure the desirable results. One of these results, for instance, would be that the steam could be maintained dry throughout each stage, preventing the erosive effect of wet steam on the buckets and increasing the efficiency of the turbine by utilizing dry steam, although this result we do not regard as the most important.

In the modification shown in Figs. 3 and 4, the reheating is secured by a parallel arrangement of individual furnaces and combustion chambers. The heat regulation, instead of being effected by dampers, is in this embodiment of the invention secured by regulating each separate furnace. In this embodiment of our invention—instead of the furnace 9 lying within a box attached to the shell and communicating therewith—each separate furnace is within its own box 18. The fuel supply pipe 15 is connected by a branch 19 to each separate furnace. The separate valves 20 control the supply of fuel to each furnace. By means of these valves the amount of heat supplied to each gas passage—and, consequently, to each stage—may be controlled within exact limits.

Fig. 5 represents the application of the invention to a marine plant. The parts are shown diagrammatically. In the drawing, the turbine 1, which may be of any form desired, is located aft of the oil fuel tank 21. The boiler or generator 22 is located forward of the tank. For the purpose of illustrating the applicability of the invention to an oil burning plant, the boiler furnace is shown as connected to and supplied from the oil fuel tank, and the fuel is delivered to the furnace through the agency of the pump 23. The furnace (or furnaces) of the turbine, as shown, is supplied by the same tank by means of a pump 24. 25 is the main steam pipe connecting the generator 22 and the turbine 1. This view illustrates the practicability of locating the generator and turbine at convenient points as determined by their own especial needs, and interposing the oil supply tank at an intermediate position connected to the generator, and located at the place in the vessel best suited to it. There is no communication between the generator and the turbine, except by means of the steam supply pipe. If an attempt were made in such a situation to reheat between stages by use of the flue gases of the main boiler furnace, such an arrangement would require the passing of the flues through the oil supply tank,—which would be obviously impossible; or, as an alternative, it would require that the steam from each stage be led to the main boiler flue which would be manifestly uneconomical.

We have shown and described the invention in connection with a multistage steam turbine, and with the separate furnaces arranged to burn liquid fuel, but we desire to have it understood that the invention is not so limited, as any other form of stage expansion elastic fluid motor, whether in one or more shells, or composed of one or more elements, may be used with any kind of elastic fluid, and the furnaces may burn any kind of fuel.

It is apparent from the foregoing description that, by reheating between the stages, we are able to secure a more advantageous steam expansion throughout the turbine; as, for instance, a closer approach to true adiabatic expansion; or perhaps an isothermal expansion, as the necessities of any certain problem may demand. In other words, by regulating the reheating at the various stages, it is possible to secure any theoretical expansion that may be desired, independently of any initial superheat. This we regard as a great advantage because the heat is applied in just the stage where wanted and in the correct quantity, which can be closely regulated by the means described and cannot be obtained by reheating by flue gases. A further advantage appears when it is required to extract steam from any certain stage for manufacturing purposes. This extraction of steam will vary according to the needs of any manufacturing establishment, and it is apparent that in some situations this steam must be superheated, or perhaps may be simply kept dry. The amount of heat added depends upon the amount of steam extracted in that particular stage, and by our invention it can be closely regulated automatically.

Another advantage of our invention when applied to a turbine which has partial extraction at any stage is that the steam passing through the remaining stages, after a certain amount has been extracted, can also be reheated to any amount needed for economical operation. This is shown in Figs. 7 and 9, Fig. 7 showing a reheater interposed in the conduit through which the extracted steam passes, for reheating, while Fig. 9 shows the connection for the steam, which is removed, as connected with one of the reheaters. In the latter structure the burner for that particular reheater may be adjusted so as to secure the desired amount of reheating. An automatic device can be installed so that, when the quantity of extracted steam changes, the amount of fuel fed to this particular furnace may be increased or decreased to a certain and definite amount. A diagraphic view of a thermostat connected to the steam pipe and controlling the valve on the fuel pipe is shown in Fig. 7.

Another advantage of our invention is that it may be applied to multistage turbines, particularly in marine plants, in which the steam is introduced in intermediate stages from an extraneous source. In this situation the steam in the stage where introduced, and in the succeeding stages, may be raised to the necessary temperature. Figs. 6 and 8 illustrate embodiments of this idea, Fig. 6 showing the reheater in the conduit from which the steam is introduced into the turbine, from extraneous sources, such as auxiliary machinery in marine work, and Fig. 8 illustrating the connection made directly with one of the interstage reheaters, the temperature being controlled by the furnace of that reheater.

In accordance with the provisions of the patent statutes, we have described the principle of our invention, together with the apparatus which we now consider to represent the best embodiment thereof; but we desire to have it understood that the apparatus shown is merely illustrative and that the invention can be carried out in other ways.

Having now described our invention, what we claim as new and desire to secure by Letters Patent, is:—

1. A multistage elastic fluid turbine, having a furnace within its shell for reheating elastic fluid between stages.

2. In a power plant, in combination with the source of steam supply and a multistage turbine, of means for reheating steam between stages, such means being independent of the source of steam supply.

3. A power plant which comprises a generator and furnace and a multistage motor, of means for reheating steam between stages, such means being independent of the generator furnace.

4. A multistage steam turbine, with a main generator, and having means for reheating steam between stages, such means comprising a furnace with independent firing.

5. A multistage steam turbine, having means for reheating steam between stages, such means comprising a separate furnace for each stage.

6. A multistage steam turbine divided into stages with a furnace within each stage for reheating the steam therein.

7. A multi-stage elastic fluid turbine, having a main generator and heating furnace therefor, and means for re-heating fluid between stages, said means comprising a separate furnace located at a distance from the main generator furnace.

8. A multi-stage elastic fluid turbine, in combination with a main generator and heating furnace therefor, a storage receptacle for fuel located between the generator and turbine, and a separate re-heating furnace located on the same side of the receptacle as the turbine.

This specification signed and witnessed this 23 day of Sept., 1909, and 30th day of August 1909 respectively.

LOUIS C. LOEWENSTEIN.
LEONARD H. DYER.

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