L. C. LOEWENSTEIN & L. H. DYER.

ELASTIC FLUID TURBINE.

APPLICATION FILED SEPT. 28, 1909.

960,357. Patented June 7, 1910.

3 SHEETS—SHEET 1.

Fig. 1

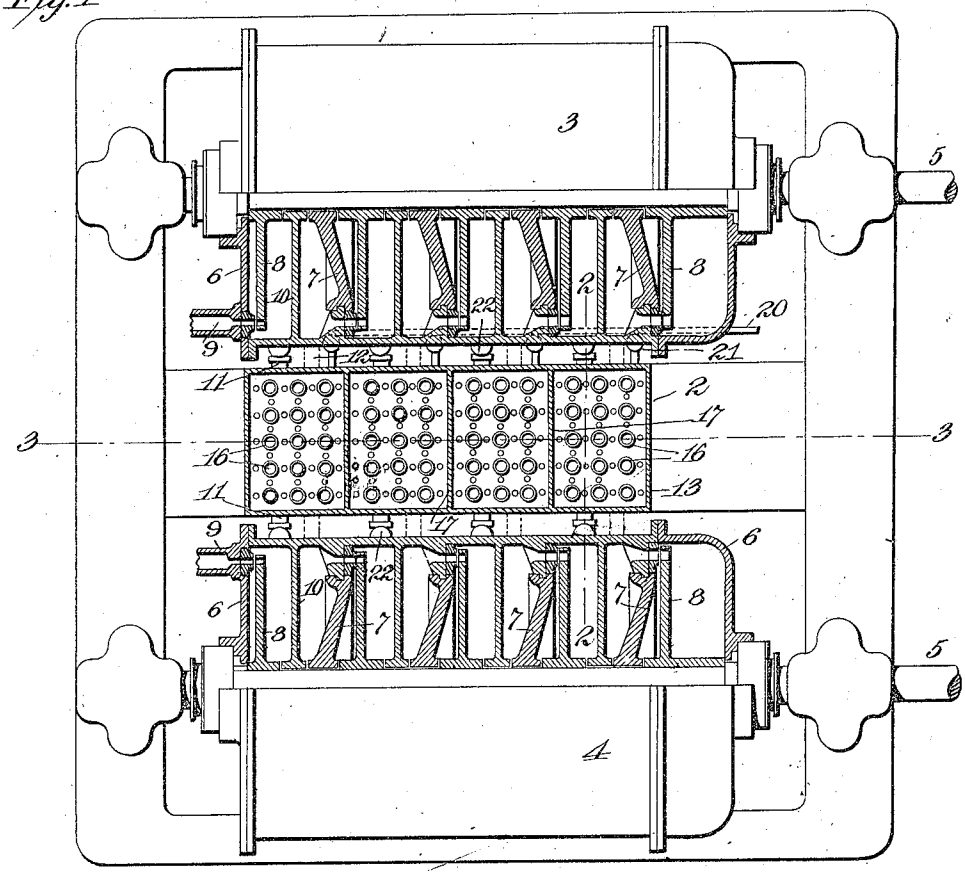
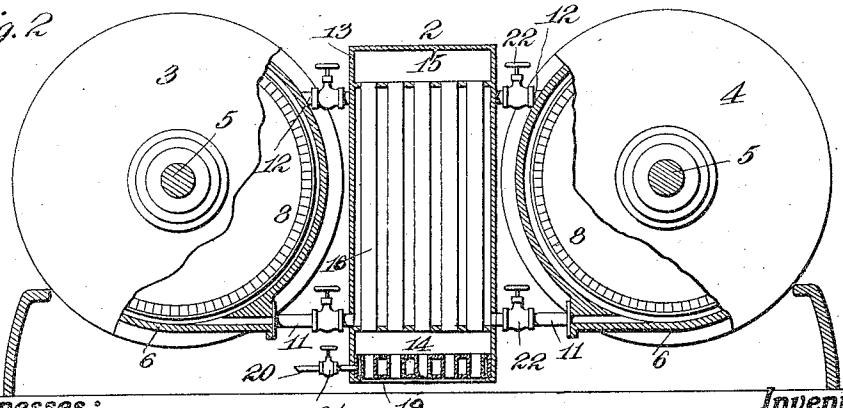


Fig. 2



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3 SHEETS—SHEET 2.

Fig. 3

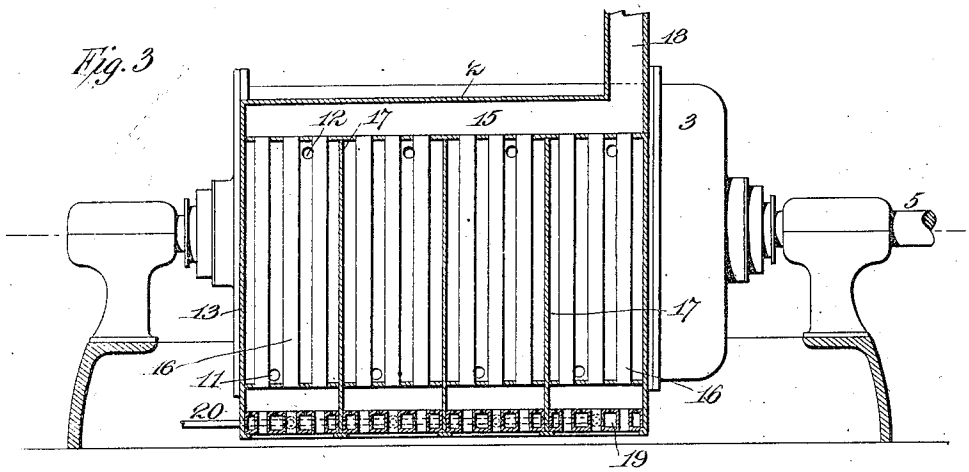


Fig. 4

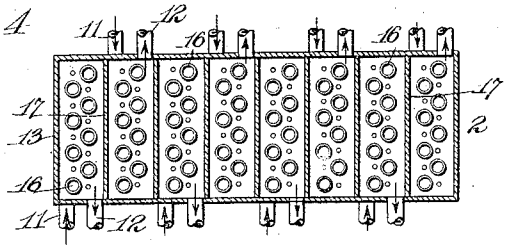


Fig. 5

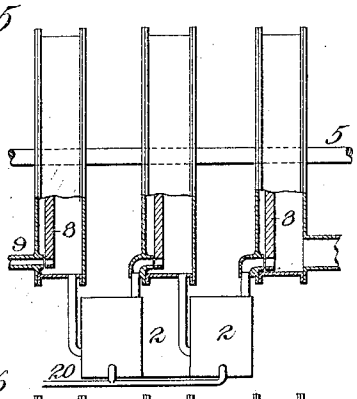
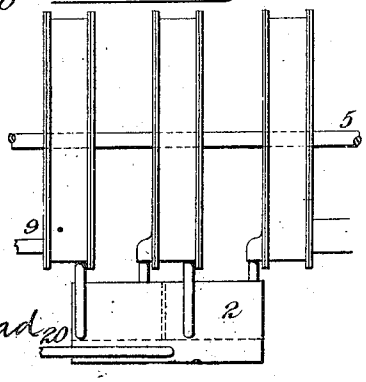


Fig. 6



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3 SHEETS—SHEET 3.

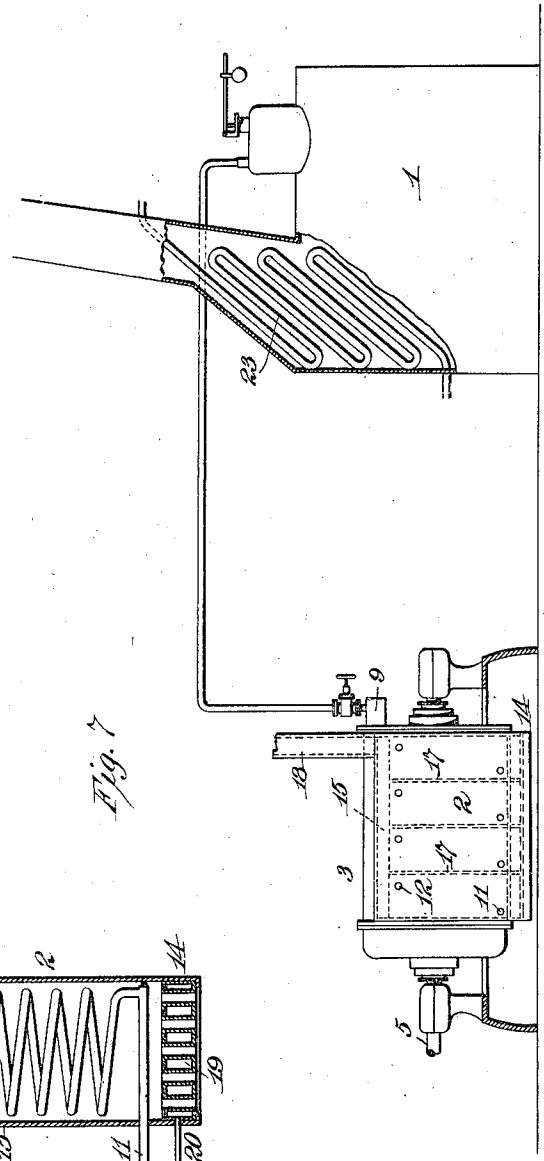

Fig. 7

Fig. 8

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UNITED STATES PATENT OFFICE.

LOUIS C. LOEWENSTEIN, OF LYNN, MASSACHUSETTS, AND LEONARD H. DYER, OF GREENWICH, CONNECTICUT, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELASTIC-FLUID TURBINE.

960,357. Specification of Letters Patent. **Patented June 7, 1910.**

Application filed September 28, 1909. Serial No. 520,003.

To all whom it may concern:

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

The object we have in view is to increase the efficiency of turbine plants employing multi-stage turbines, driving a plurality of shafts, by reheating the steam between stages of the two or more turbines, by means independently of the main steam generator, and by simple and efficient apparatus.

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

In the drawings Figure 1 is a plan view, partly in section, of a twin screw lay-out for marine use, showing the two turbines partly in section. Fig. 2 is an end view of the same, partly in section. Fig. 3 is a sectional view through the line 3—3 of Fig. 1. Fig. 4 is a detailed view of a modification of the reheater. Fig. 5 is a diagrammatical view of the invention applied to single stage turbines. Fig. 6 is a different embodiment of the same idea. Fig. 7 is a diagrammatical view of a marine lay-out showing the relation of the turbines to the generator. Fig. 8 is a detail, also showing a modification.

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

In carrying out our invention we provide a plurality of elastic fluid turbines which may be steam turbines, although the invention is not limited to the use of steam as the fluid.

The invention is disclosed in the following specification and illustrated in the drawings as used in connection with a turbine of the horizontal type, but the invention is not so limited.

According to our invention a plurality of turbines are mounted on separate shafts. On each shaft may be a single turbine of a number of stages, or a number of turbines of one or more stages each, located in cooperative arrangement with the turbines, and preferably between the two shafts, if two shafts only are used, is a single stage reheater, or a plurality of reheaters in series arrangement. This reheater is divided into sections, each of which is piped for connection with the stages of different pressures in the turbine, and is so arranged that the elastic fluid from one stage will circulate through the proper section of the reheater before entering the next turbine stage of lower pressure. The said reheater is provided with a furnace which is separate from the furnace of the main generator. Preferably a liquid fuel furnace is provided, such furnace being susceptible of nice heat regulation, and also is capable of being divided into sections located under the separate sections of the reheater for governing the temperature of each section of the said reheater and its contents.

In the drawings, Fig. 7, 1 is a main generator, 2 the reheater.

In Fig. 1 the turbines are shown as indicated by 3—4. Each turbine is provided with the usual shaft 5, shell 6, divided by diaphragms 7, into stages of different pressures. On the shafts are wheels 8, containing rows of buckets of the usual form.

We have shown the invention as applied to a turbine of the single wheel per stage type, but it is to be understood that any form of turbine may be employed. The elastic fluid enters the stage of highest pressure through a nozzle 9, and acts upon the buckets of the first stage. In the stage is a diaphragm 10, dividing the stage into two parts without pressure difference. A pipe 11 leads from the anterior side of the diaphragm 10 into the first section of the reheater 2. A second pipe 12 leads from the same section of the reheater to the posterior side of the diaphragm 10. The reheater illustrated in Fig. 1 is shown as divided into sections, four in number, corresponding to the number of diaphragms 10. The reheater is shown as formed by the casing 13, the fire box 14 at the bottom and smoke box 15 at the top. The tubes 16 connect the two boxes. The casing 13 is divided into sections by partitions 17. The elastic fluid circulates outside the tubes 16 and the gases from the furnace of the reheater pass upward from the fire box through the tubes

16 into the smoke box and are discharged upward through the stack 18. It is apparent that it is not necessary to have the elastic fluid circulate outside of the tubes and the hot gases circulate within the tubes, as a different arrangement can be made, as is well understood in connection with steam boilers.

Fig. 8 illustrates an arrangement in which the fluid circulates through the tubes, while the gases pass outside thereof.

The furnace 19 can be of any type, that shown being for the purpose of burning liquid fuel, such fuel being admitted through the pipe 20. We prefer to so arrange the furnace that it is in sections which correspond in number and location to the several sections of the reheater. To that end each section of furnace is provided with a pipe 20 and a controlling valve 21, as shown in Figs. 1 and 2. It is possible by this arrangement to regulate the flame within each furnace, and consequently regulate the temperature of each section of the reheater. In Fig. 8 is illustrated a thermodynamic device 24, located in coöperative relation with the fluid contents of the section of the reheater, and connected with the valve 21, so as to automatically control the admission of fuel to the furnace depending upon the temperature of the fluid within the sections. It is our purpose to use one such device in each section of the reheater.

The two turbines are arranged in opposite sides of the reheater, and each discharges into a section thereof, as shown in Figs. 1 and 2. For ordinary purposes each turbine is of the same size, and divided into the same number of stages. The pressure in the given stage of each turbine in the pair is substantially the same, consequently the stages of the reheaters may be used in common with the same stages of the turbine. If desired to have separate stages in the reheater for corresponding stages in the turbine, it may be arranged as shown in Fig. 4.

In the event that one turbine is being run while the other is at rest, it may be desirable to cut off the connection between the turbine and the reheater, and for this reason we employ valves 22 arranged in the pipes 11 and 12.

In Fig. 5 we show a view of an arrangement in which one of the two shafts is shown as driven by three separate turbines arranged in series. In connection with these turbines are shown two reheaters also arranged in series. In Fig. 6 we show the same arrangement of turbines with a single reheater. Both of these views show the applicability of the invention to turbines which are not in stages.

In Fig. 7 we show the applicability of the invention to a marine plant in which a feed water heater 23 is employed in the main generator 1. The advantage of using the reheater separate from the main generator is apparent, particularly in connection with a feed water heater. The temperature of the fluid between stages may be accurately controlled, by means of the separate furnaces, and this may be entirely independent of the action of the feed water heater 23.

Certain broad features herein disclosed are not claimed herein, but are claimed in our co-pending applications for patents filed September 28th, 1909, and numbered 520,001 and 520,002.

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 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. The combination with a plurality of elastic fluid turbines, on separate shafts, of a reheater arranged between the turbines.

2. The combination with a main fluid generator and a plurality of elastic fluid turbines, on separate shafts, of a reheater between the turbines and having a furnace independent of the main generator.

3. The combination with a plurality of elastic fluid motors, arranged in stages of different pressures, of a common reheater, divided into sections, and connected to corresponding stages, and a means for independent firing.

4. The combination with a plurality of stages of equal pressures in separate motors, of a common reheater section, and a means for independent firing.

5. The combination with a plurality of elastic fluid motors, of a common reheater, fuel controlling means for the reheater, and automatic means for controlling admission of fuel corresponding with temperature of the steam.

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

LOUIS C. LOEWENSTEIN.
LEONARD H. DYER.

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