L. CUBELIC.

MIXED PRESSURE TURBINE.

APPLICATION FILED JAN. 20, 1911.

1,000,783.

Patented Aug. 15, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

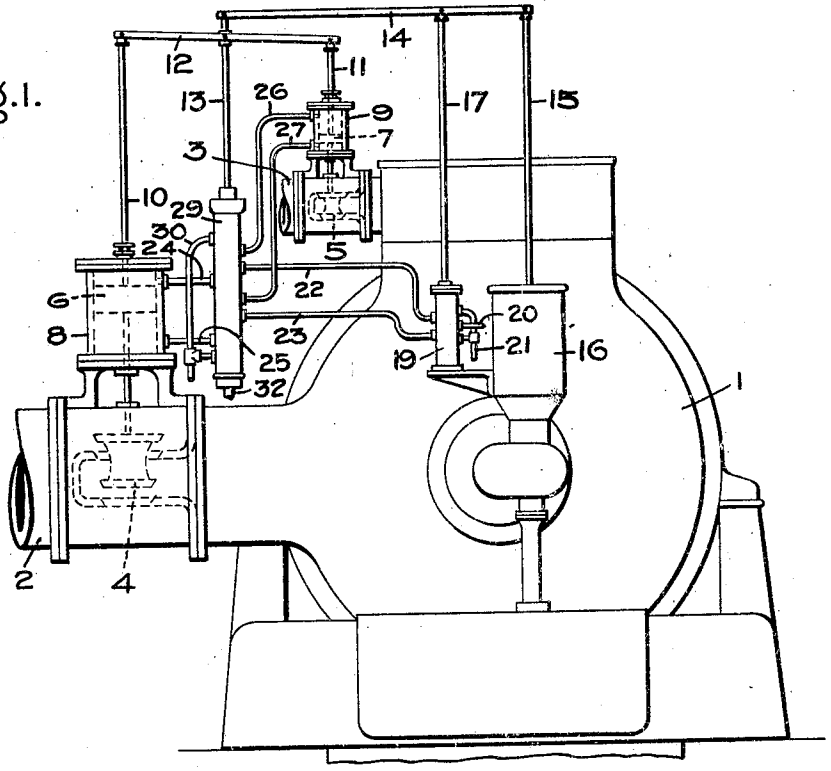
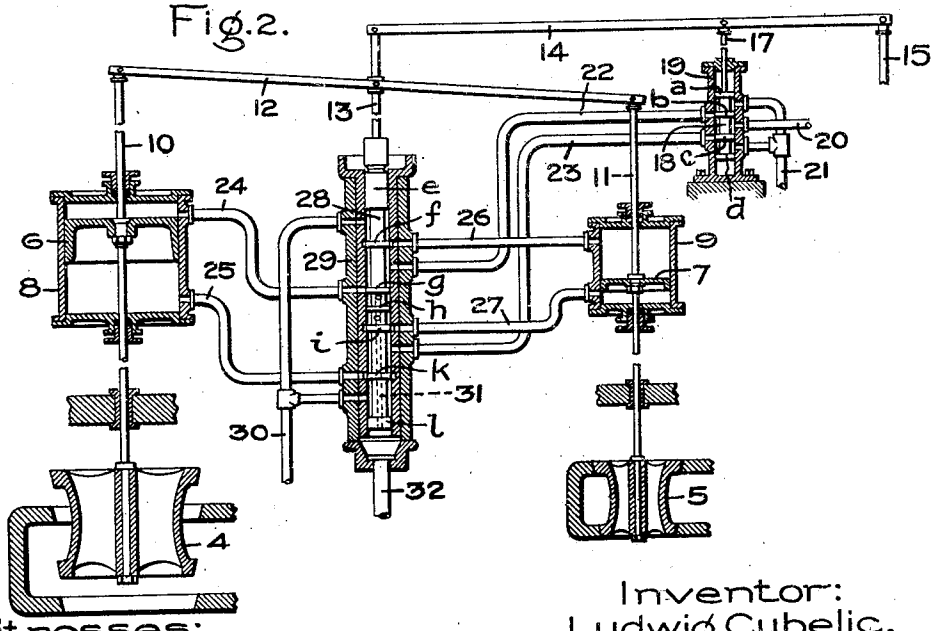


Fig. 2.



Witnesses:

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2 SHEETS—SHEET 2.

Fig. 3.

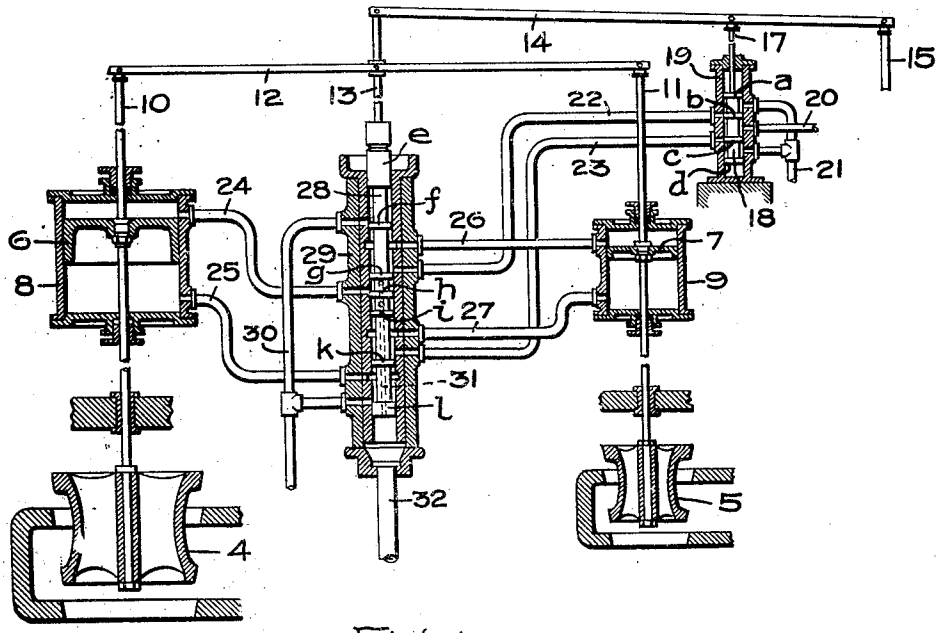
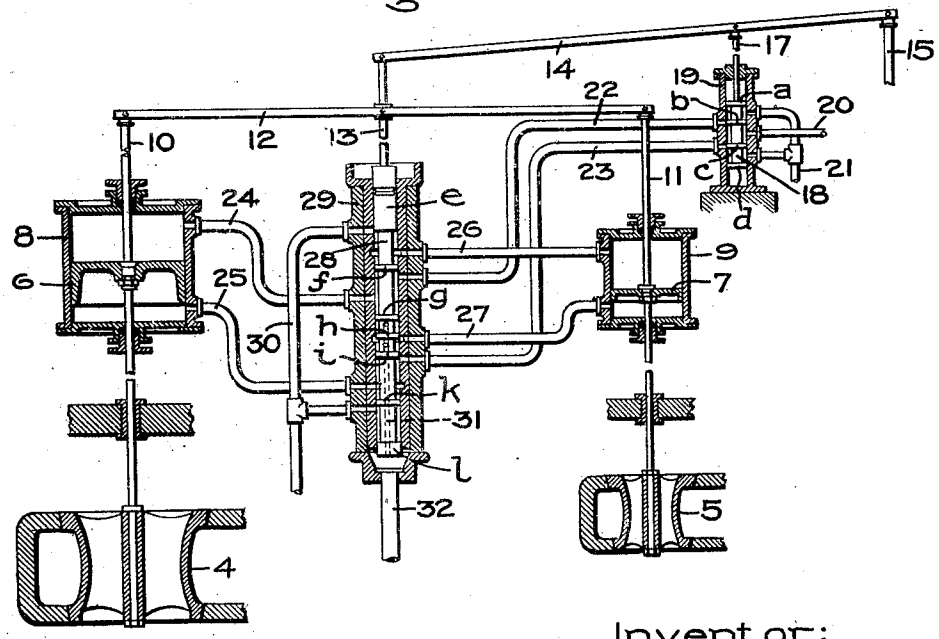


Fig. 4.



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UNITED STATES PATENT OFFICE.

LUDWIG CUBELIC, OF CHARLOTTENBURG, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MIXED-PRESSURE TURBINE.

1,000,783. Specification of Letters Patent. Patented Aug. 15, 1911.

Application filed January 20, 1911. Serial No. 603,681.

To all whom it may concern:

Be it known that I, LUDWIG CUBELIC, a subject of the King of Prussia, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Mixed-Pressure Turbines, of which the following is a specification.

This invention relates to elastic-fluid turbines which are arranged to be driven by exhaust steam as well as by live steam, and the object of the invention is to provide improved means for regulating the several supplies of said fluid to said turbines.

It is customary in some steam turbines to provide the throttle valve with a motor for moving it, said motor being usually actuated by hydraulic pressure, and being in turn controlled by a pilot valve connected with the speed governor of the turbine. A follow-up device is generally employed, which returns the pilot valve to its mid position after the throttle valve has been moved by the motor.

In the case of a mixed pressure turbine, the normal supply of motive fluid is exhaust steam from another prime mover or from some apparatus using live steam, and the regulating mechanism must be arranged so that with an increasing load the exhaust steam supply must be wide open before the live steam is turned on, and conversely, the live steam must be shut off before the exhaust steam is partially or wholly shut off. In order to attain these ends I provide the two steam supply pipes with throttle valves, each having its own actuating motor. The pilot valve, or main reversing valve, to which the speed governor is directly connected, is supplemented by an auxiliary reversing valve, by means of which the motive fluid passing through the main valve is properly distributed to the two motors actuating the throttle valves. The auxiliary reversing valve derives its motion from a bar pivotally connected to the piston rods of the two motors. The floating lever which actuates the pilot valve is also pivoted at one end to the stem of the auxiliary valve. In order to hold the pistons of the motors when once they have been moved, I provide a special or secondary supply of motive fluid, which is controlled by the auxiliary reversing valve.

In the accompanying drawings, Figure 1 is an end elevation of a mixed pressure turbine equipped with my invention; Fig. 2 is a diagrammatic view showing the position of the parts when the exhaust steam throttle is wide open and the live steam throttle is closed; Fig. 3 is a diagrammatic view showing the same parts when the live steam throttle has been opened in addition to the exhaust throttle; and Fig. 4 shows both throttles closed.

The operating parts of the turbine are inclosed in a casing 1, with which connect the exhaust steam supply main 2 and the live steam main 3. The former is controlled by the throttle valve 4 and the latter by the throttle valve 5. Attached to the stems of these throttles, respectively, are the pistons 6 and 7 moving respectively in the cylinders 8 and 9. The two piston rods 10 and 11 are pivotally connected with the ends of a bar 12, which at some intermediate point is pivoted to the stem 13 of the auxiliary reversing valve, to be hereinafter described. Said stem 13 is also pivoted to one end of the floating lever 14, whose other end is pivoted to the rod 15 receiving motion from a speed governor of any approved design driven from the turbine shaft and inclosed in a casing 16. To the floating lever is also pivoted the stem 17 of the pilot valve 18, which is inclosed in the casing 19 and is provided with four collars or pistons, *a*, *b*, *c*, *d*. A pipe 20 conveys fluid under pressure to the casing at a point between the collars *b* and *c*, while the spaces between the collars *a* and *b* and between *c* and *d* respectively are in communication with the escape pipe 21. The collars *b* and *c*, when the valve is in its mid position, cover two ports leading respectively to the pipes 22 and 23, which connect with the casing of the auxiliary reversing valve. In said casing, below the pipes 22 and 23, are ports which communicate by pipes 24 and 25 respectively with the upper and lower ends of the motor cylinder 8; while similar ports above the pipes 22 and 23 communicate by the pipes 26 and 27 respectively with the upper and lower ends of the motor cylinder 9.

The auxiliary valve 28 has seven collars or pistons, *e*, *f*, *g*, *h*, *i*, *k*, *l*, of which the collars *f*, *g*, *i* and *k* normally cover the ports leading to the pipes 24, 25, 26 and 27, but are given a slight lead so that motive fluid can slowly enter said pipes when it is admitted to the casing 29 of the auxiliary valve. The collars *e* and *l* close the ends of the cas-

ing, while the collar *h* is located midway of the length of the valve and divides the casing into two chambers with which the two sets of pipes connect. A secondary supply of motive fluid is conveyed to the casing 29 through a pipe 30, which communicates with the aforesaid chambers above and below the collars *f* and *k* respectively. A duct 31 is drilled lengthwise of the auxiliary valve from its lower end and is provided with lateral openings communicating with the interior of the casing between the collar *h* and the two collars *g* and *i* on each side thereof. A pipe 32 conveys liquid away from the bottom of the valve casing.

The operation is as follows: In Figs. 1 and 2, the parts are shown in the position they occupy when the exhaust throttle is wide open and the live steam throttle is closed. If the load now increases, live steam must be supplied. This is automatically effected as follows: The slowing down of the speed governor under the increased load pulls down the rod 15, causing the floating lever 14 to fulcrum on its point of attachment to the stem 13. The pilot valve 18 is moved down by the lever, uncovering the pipe 23 to the motive fluid entering through the pipe 20. Said fluid enters the casing 29 between the collars *i* and *k* and by reason of the slight lead of these collars it passes to the pipes 25 and 27 and thus to the cylinders 8 and 9. In the cylinder 8 it simply serves to hold the piston 6 fast in its elevated position. In the cylinder 9 it causes the piston 7 to move upward, thereby opening the live steam throttle 5. The upward movement of the piston 7 raises the bar 12, which turns on its point of attachment to the piston rod 10. This movement lifts the auxiliary valve 28, fully opening the pipe 27 to the motive fluid and putting the pipe 25 into full communication with the secondary supply of motive fluid in the pipe 30. Meanwhile, the pipe 26 is placed in free communication with the pipe 22, which by the downward movement of the pilot valve has been placed in communication with the escape pipe 21, so that the fluid in the upper part of the cylinder 9 can escape and offer no resistance to the upward movement of the piston 7. The lifting of the bar 12 by the piston 7 also carries up one end of the floating lever 14, which raises the pilot valve and returns it to its mid position. The parts have now assumed the positions shown in Fig. 3, with both throttle valves wide open.

As stated above, the pipe 25 has been opened to the secondary supply of fluid pressure in the pipe 30, which serves to hold the piston 6 firmly in place, in spite of any leakage of pressure past the collars on the auxiliary valve. Any pressure which might tend to accumulate in the space above the piston 6 can escape freely through the pipe 24 and the openings into the longitudinal duct 31. Now, when the speed of the turbine begins to increase to an abnormal degree, it is desirable to shut off the live steam before beginning to close the exhaust. This will be automatically effected in the following manner: The parts still being in the position shown in Fig. 3, the increasing speed of the speed governor will lift the rod 15, causing the floating lever 14 to fulcrum on the point of attachment to the stem 13, and lift the pilot valve 18. This admits fluid pressure from the pipe 20 to the pipe 22, and thence to the pipe 26 and the space above the piston 7, which at once descends, shutting the throttle 5, and at the same time carrying down the auxiliary valve 28 and pulling down the floating lever, which returns the pilot valve 18 to its mid position. All this occurs without in any way disturbing the exhaust steam throttle 4; the fluid below the piston 7 escaping through the pipes 27, 23 and 21. If, however, the full supply of exhaust steam is more than is necessary for the lighter load, then the exhaust throttle will be automatically and gradually closed until the supply has been cut down to the required amount. The parts are assumed to have returned to the positions shown in Fig. 2. As shown in Fig. 4, the speed governor will raise the rod 15, lifting the pilot valve and again admitting fluid pressure into the pipe 22. The leakage of fluid past the collar *f* into the pipe 26 is enough to hold the piston 7 in its lowered position, while the leakage past the collar *g* into the pipe 24 will begin to move the piston 6 downward. The bar 12 fulcrums on its point of attachment to the piston rod 11, carrying down the auxiliary valve 28 and fully opening the pipe 24 to the pressure coming through the pipe 22. At the same time the pipe 25 is put in communication with the pipe 23 so that the fluid under the piston 6 can escape through these pipes to the pipe 21. The secondary fluid supply is fully connected with the pipe 26, to assist in holding the piston 7 stationary. Any leakage of fluid past the piston 7 will escape through the pipe 27 and the openings into the duct 31. Presently the downward movement of the rod 13, which is pivoted to the lever 14, will cause said lever to fulcrum about its connection to the rod 15 and return the pilot valve to its mid position.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In a mixed pressure turbine, the combination with an exhaust steam throttle and a live steam throttle, of a motor for each throttle, a speed governor, a pilot valve actuated by said governor and controlling a supply of fluid pressure, an auxiliary reversing valve controlling the distribution of said pressure to said motors, and pivoted connections between said motors and said auxiliary valve and between said auxiliary valve and said pilot valve.

2. In a mixed pressure turbine, the combination with motor-actuated throttle valves for the exhaust steam and the live steam, of an auxiliary valve for distributing fluid pressure to said motors in succession, and a pilot valve for admitting fluid pressure to said auxiliary valve.

3. In a mixed pressure turbine, the combination with motor-actuated throttle valves for the exhaust and the live steam, of a casing connected with both of said motors, an auxiliary valve in said casing controlling said connections, a governor-controlled pilot valve controlling a supply of fluid pressure to said casing, and a system of pivoted members whereby the movements of the motors actuate the auxiliary valve.

4. In a mixed pressure turbine, the combination with motor-actuated throttle valves for the exhaust and the live steam, of a casing connected with both of said motors, an auxiliary valve in said casing controlling said connections, a governor-actuated pilot valve controlling a supply of fluid pressure to said casing, and a system of pivoted members whereby the live steam throttle can open and close only while the exhaust steam throttle is wide open.

5. In a mixed pressure turbine, the combination with motor-actuated throttles for the exhaust and the live steam, of an auxiliary valve adapted to admit fluid pressure first to the exhaust steam throttle motor and then to the live steam throttle motor, and to exhaust them in reverse order, a governor-actuated pilot valve controlling a supply of fluid pressure to said auxiliary valve, a floating lever connected to said governor, pilot valve and auxiliary valve, and a bar pivoted to both motors and to said auxiliary valve.

6. In a mixed pressure turbine, the combination with motor-actuated throttle valves for the exhaust and the live steam, of a casing, an auxiliary valve in said casing provided with collars dividing said casing into two chambers, pipes leading from each chamber to corresponding ends of the motor cylinders, a pilot valve controlling a supply of fluid pressure, pipes for conveying said pressure to said chambers, additional collars on said auxiliary valve controlling the ports leading to the several pipes, and pivoted members for causing the movement of either motor to actuate the auxiliary valve and assist in returning the pilot valve to its mid position.

7. In a mixed pressure turbine, the combination with motor-actuated throttle valves for the exhaust and the live steam, of a supply of fluid pressure for actuating said motors, a pilot valve and an auxiliary valve for distributing said pressure to said motors, and a secondary supply of fluid pressure for holding either of said motor pistons fast during the time that the other motor is operating.

In witness whereof, I have hereunto set my hand this December day of 27th, 1910.

LUDWIG CUBELIC.

Witnesses:
ERICH ÜBERLÉE,
GUSTAV HÜLBROCK.