

Feb. 21, 1939.

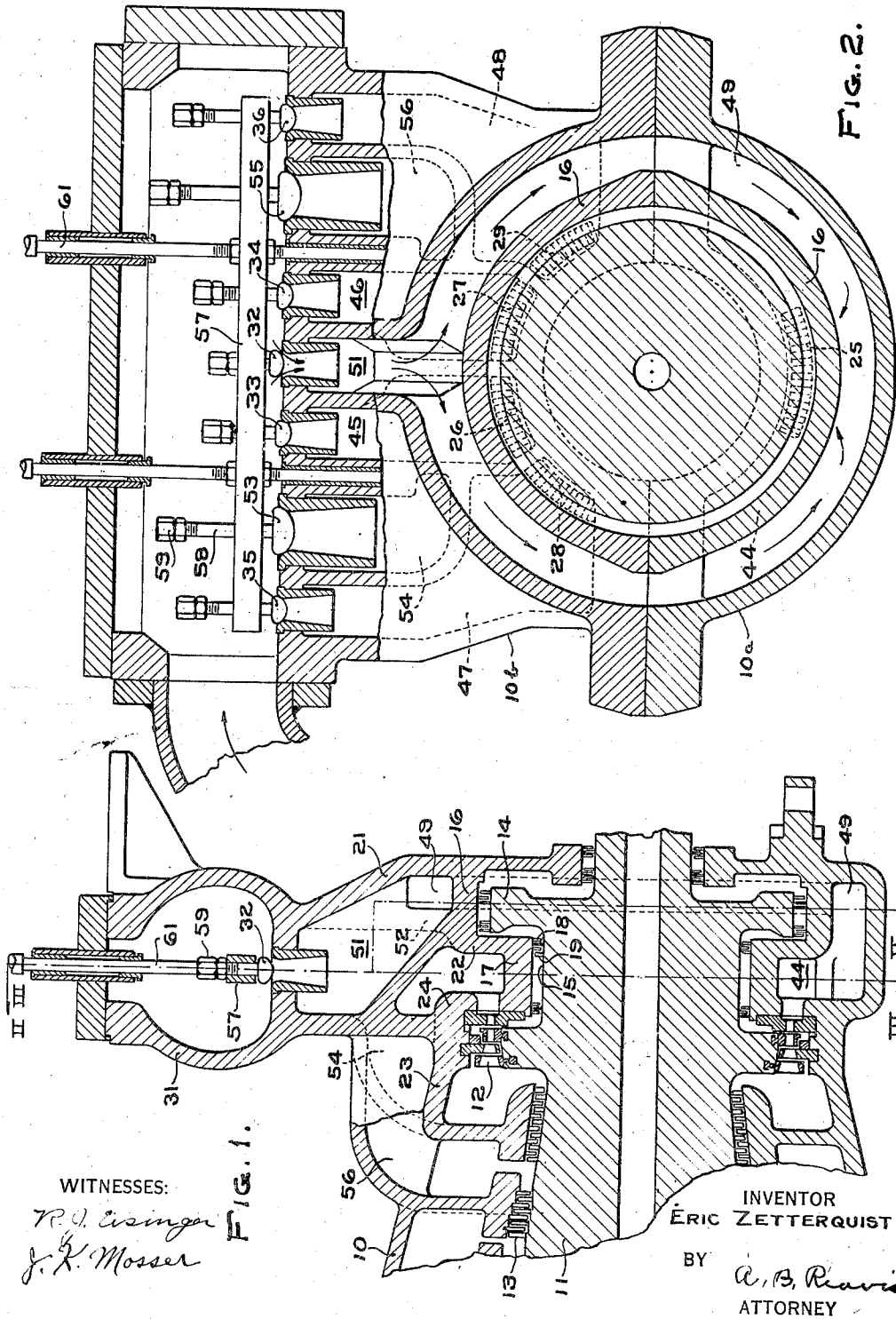
E. ZETTERQUIST

2,147,874

ELASTIC FLUID TURBINE

Filed Oct. 19, 1937

2 Sheets-Sheet 1



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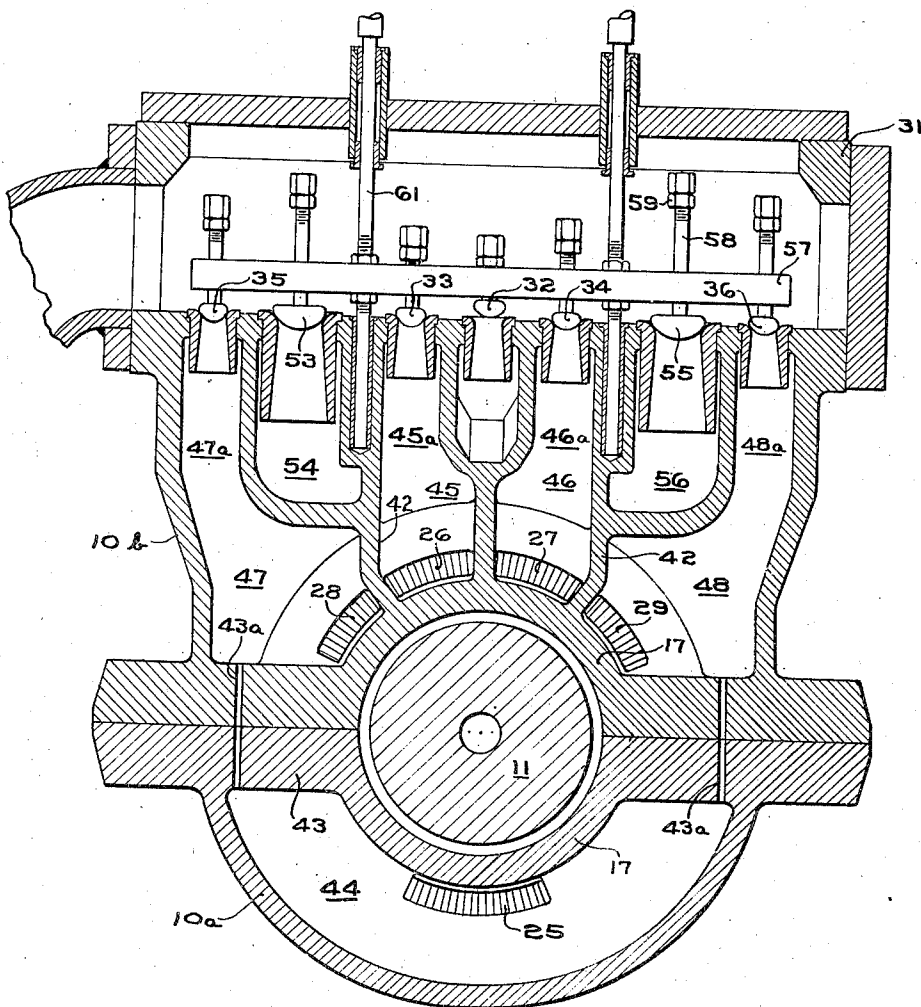
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FIG. 3.



WITNESSES:

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ELASTIC FLUID TURBINE

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13 Claims. (Cl. 253—39)

My invention relates to an elastic fluid turbine, more particularly to a turbine having a dummy piston and having a plurality of nozzle segments in its first stage, and it has for an object to provide an improved structure.

A particular object of the invention is to provide annularly uniform heating of the admission or high pressure end of the casing, particularly the portion that is in sealing relation with the dummy piston of the rotor, so as to avoid or minimize distortions due to unequal heating and the difficulties arising therefrom.

A further object is to provide uniform heating of the abutting portions of the casing which constitute partitions between different nozzle chambers.

In accordance with my invention, the turbine casing is formed to provide an annular steam belt or passage in communication with the primary nozzle segment, so as to provide annularly uniform heating as long as motive fluid is admitted to turbine. The portion of the casing in sealing relation with the dummy piston and on which dummy packing elements are usually mounted preferably constitutes one wall of such annular passage, so that said portion is uniformly heated and expanded, thereby preserving the proper clearance between the dummy packing elements carried thereby and the dummy piston of the rotor.

The above recited and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawings forming a part of this application, in which:

Fig. 1 is a longitudinal section of the high pressure or admission end of a turbine embodying my invention; and

Figs. 2 and 3 are transverse sections on the lines II—II and III—III of Fig. 1, respectively.

Referring now to the drawings in detail, I show a turbine having a casing 10 and a rotor 11. The casing is divided on the horizontal plane of the turbine axis, forming a base 10a and a cover 10b. The turbine is of the combination impulse-reaction type, being provided with an initial impulse stage 12 and a number of reaction stages 13. The rotor is formed with dummy pistons 14 and 15 for the purpose of balancing the end thrust imposed by the reaction stages 13. The casing is formed with cylindrical wall portions 16 and 17 encompassing the dummy pistons 14 and 15, respectively, and arranged in sealing relation therewith, which sealing relation may be provided in any suitable manner, as by

packing or sealing elements 18 and 19 carried by the cylindrical wall portions and the dummy pistons, respectively, and providing sealing of either the radial clearance or axial clearance type. The use of dummy pistons for balancing end thrust is well known in the art and need not be further described herein, the present invention dealing with the problem of providing uniform heating and expansion of the cylindrical wall portions to maintain the proper sealing relation.

In the present embodiment, the cylindrical wall portions 16 and 17 are formed integrally with the casing 10. The wall portion 16 is connected directly to the end wall or diaphragm 21, adjacent ends of the wall portions 16 and 17 are connected by a wall portion or diaphragm 22 lying in a plane normal to the axis of the turbine, and the other end of the cylindrical wall portion 17 is connected to the outer or tubular wall 23 of the casing by a wall or diaphragm 24 lying in a plane normal to the axis of the turbine.

The impulse stage 12 includes a plurality of nozzle segments which are mounted on the wall or diaphragm 24, the primary, secondary, tertiary, quaternary, quintary nozzle segments being designated at 25 to 29, respectively. The impulse stage also includes two rows of moving blades and one row of stationary blades as is well understood in the art.

A steam chest 31 is preferably formed integrally with the casing 10 and contains governing or regulating valves extending in a row transversely of the turbine axis, the valves 32 to 36 thereof controlling the admission of motive fluid to the nozzle segments 25 to 29, respectively.

The space between the wall portions or diaphragms 22 and 24 is divided by wall or partition portions 42 and 43, into nozzle chambers 44 to 48 communicating with the nozzle segments 25 to 29, respectively. The wall partition portions 43 of the base and the cover are disposed in abutting relation along the plane of division, as shown in Fig. 3, and are formed with registering orifices 43a providing restricted flow of high temperature motive fluid from the primary nozzle chamber 44 to the quaternary and quintary nozzle segments 47 and 48.

The nozzle chambers 45 to 48 have upwardly extending portions 45a to 48a with which the valves 33 to 36, respectively, communicate, the upwardly extending portions and the valves being in the normal transverse zone of such nozzle chambers.

The primary nozzle chamber 44, which extends throughout the base between the wall or parti-

tion portions 43 thereof and is located in said transverse zone, as shown in Fig. 3, is connected to the primary valve 32 by an annular steam belt or passage 49 and a passage 51 connecting the top thereof with the valve 32. The annular passage 49 is disposed in a normal transverse zone at the side of said first zone remote from the nozzle segments or at the outer end of the turbine and it is formed by integral wall portions of the casing, including end wall diaphragm 21, the cylindrical wall portion 16 and a wall portion or diaphragm 52 separating the same from the nozzle chambers 45 to 48 in the cover. The passage 49 opens into the primary nozzle chamber 44, as shown in Fig. 1, throughout the length of said chamber. Since the passage 49 is in a zone disposed laterally of that of the nozzle chambers and of the valves, the passage 51 is inclined to bring its upper end into the nozzle chamber zone with the result that its valve 32 may be arranged in the latter zone and therefore in line with the other valves.

The valve 53 controls flow of steam through a passage 54 for by-passing the impulse stage, and a valve 55 controls flow of steam through a passage 56 for by-passing both the impulse stage and a number of reaction stages at the high pressure end, the by-pass passages being suitably arranged for this purpose and having their inlet ends in the nozzle chamber zone so that their valves may be located in that zone.

The governing or regulating valves, including the by-pass valves, are of the plug or poppet type, and are actuated by a vertically movable horizontal bar 57. Each valve includes a stem 58 extending loosely through the bar 57 and having nuts 59 screw threaded on the upper end thereof. The nuts 59 of the valves 32 to 36, 53 and 55 are adjusted at successively higher positions, so that, as the bar 57 is raised they are successively engaged, thereby providing successive opening of the valves upon upward movement of the bar. Upon downward movement of the bar the valves are closed in the reverse order. The bar 57 is adapted to be raised or lowered through rods 61 by any suitable governor controlled valve operating mechanism (not shown) as is well-known in the art.

Operation

The turbine operates in the conventional way. Motive fluid, preferably steam, is supplied to the steam chest and the flow thereof is controlled by the valves to the respective nozzle segments.

In bringing the turbine up to speed from shutdown, it is desirable to adjust the valve operating mechanism, in a suitable manner which forms no part of the present invention, to a position in which only the primary valve 32 is open, as shown in Figures 2 and 3. In this position, steam flows from the valve 32 through the passage 51, the annular passage 49 and the primary nozzle chamber 44 to the primary nozzle segment 25 and then through the several stages of the turbine.

The steam flowing through the annular passage 49 flows in direct contact with the periphery of the cylindrical wall portion 16, thereby assuring uniform heating and expansion thereof, and avoiding distortions, either radial or axial that might be caused by uneven heating.

The cylindrical wall portion 17 is also heated to a sufficiently uniform extent in the present embodiment, to avoid objectionable distortion thereof. The part of the cylindrical wall por-

tion 17 contained in the base 10a is heated by contact with the steam in the primary nozzle chamber 44. Steam from the primary nozzle chamber 44 also flows through the orifices 43a to the quaternary and quintary nozzle chambers 47 and 48, so that the parts of the wall portion 17 extending along the latter chambers are similarly heated. The part of the cylindrical wall portion 17 extending along the secondary and tertiary nozzle chambers 45 and 46 is sufficiently heated by conduction of heat from other parts of said wall portion and also by conduction of heat from other heated wall portions through the walls or diaphragms 22 and 24.

The orifices 43a serve another important purpose, namely, to heat the wall or partition portions 43 carried by the cover 10b to substantially the same temperature as the wall or partition portions 43 carried by the base 10a, so that the proper alignment of the wall portions 43 is maintained.

After the turbine has been brought up to speed and placed under load, the flow of steam is controlled by the several governing or regulating valves. At low load, only the primary valve 32 is opened. As the load increases valves 33 to 36 are successively opened until steam is supplied to all of the nozzle segments. Upon further increase in load, the valves 53 and 55 are successively opened in which case the impulse stage is by-passed. The flow of steam through the nozzle segments is greatly diminished but the temperature thereof is not reduced since the pressure of the motive fluid is as high or higher than with the valves 53 and 55 closed. Thus, the high pressure end structure of the casing is maintained at substantially uniform temperature under such conditions.

From the above description, it will be seen that I have provided a high pressure end structure for a turbine casing wherein the several parts are not only uniformly heated as soon as motive fluid is admitted to the turbine, thereby maintaining proper alignment and sealing clearances and avoiding distortions and the difficulties arising therefrom, but wherein such parts contribute to produce a structure having a greater degree of symmetry and uniformity of wall thickness with the result that irregularities in expansion and contraction are avoided. These advantages make the structure particularly desirable in dealing with high temperatures.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. An elastic fluid turbine, a casing having a plurality of nozzle segments, a rotor having a dummy piston and disposed in the casing, means providing an annular passage for conveying motive fluid to one of said nozzle segments, one wall of said passage means being arranged in sealing relation with said dummy piston, whereby said one wall is heated by the motive fluid in said passage and expands uniformly to maintain proper sealing relation with said dummy piston.

2. In an elastic fluid turbine, a casing having a plurality of nozzle segments, a plurality of valves for controlling the admission of motive fluid to the nozzle segments, respectively, means

for operating said valves and arranged to open one of said valves before the others upon valves opening movement, a rotor having a dummy piston and disposed in said casing, means providing an annular passage for conveying motive fluid from said one valve to one of said nozzle segments and including an annular part arranged in sealing relation to said dummy piston, whereby said annular part is heated by the motive fluid flowing in said passage and expands uniformly, annularly, as long as motive fluid is admitted to the turbine.

3. In an elastic fluid turbine, a casing, a rotor having a dummy piston and disposed in the casing, an annular part in the casing arranged in sealing relation with the dummy piston, a plurality of nozzle segments mounted in the casing, valves for controlling the flow of motive fluid to said nozzle segments, respectively, means providing an annular passage for conveying motive fluid from one of said valves to its associated nozzle segment in contact with said annular part, whereby the latter is uniformly heated by the motive fluid flowing in the annular passage to preserve proper sealing relation with the dummy piston.

4. In an elastic fluid turbine, a rotor having a dummy piston, a casing for the rotor having a part in sealing relation with the dummy piston, said casing having a plurality of nozzle segments including a primary nozzle segment, a plurality of valves for controlling the admission of motive fluid to the respective nozzle segments, respectively, said casing being formed to provide a passage connecting the primary nozzle segment with its valves, said passage extending annularly about the axis of the turbine, said dummy sealing part constituting a wall of said passage, whereby the same is heated and expands annularly uniformly to provide proper sealing relation as long as motive fluid is admitted to the turbine.

5. In an elastic fluid turbine, the combination of a casing, a rotor mounted therein and having a dummy piston, said casing having an annular part arranged in sealing relation to said dummy piston, primary and secondary nozzle segments in the casing, primary and secondary valves for controlling the supply of motive fluid to said primary and secondary nozzle segments, respectively, means for opening said primary and secondary valves successively in the order named, said casing having first and second passages connecting said primary and secondary valves with said primary and secondary nozzle segments, respectively, said first passage being arranged to provide motive fluid in contact with said annular part throughout the circumference thereof.

6. In an elastic fluid turbine, the combination of a rotor having a dummy piston, a casing, a nozzle chamber structure carried by the casing, a plurality of nozzle segments including a primary nozzle segment mounted on said nozzle chamber structure, said nozzle chamber structure being formed to provide nozzle chambers or motive fluid supply passages for the nozzle segments, the passage for the primary nozzle segment extending annularly about the turbine axis and including one wall that is arranged in sealing relation to said dummy piston, whereby said one wall is uniformly heated to maintain proper sealing relation as long as motive fluid is supplied to the turbine.

7. In an elastic fluid turbine, the combination of a rotor having a dummy piston, a casing hav-

ing a plurality of nozzle segments, said casing having integral wall portions forming motive fluid supply passages for said nozzle segments, respectively, said nozzle segments being mounted on one of said wall portions, another of said wall portions being of cylindrical form and disposed about said dummy piston in sealing relation therewith, and one of said fluid supply passages extending about the periphery of said cylindrical wall and conveying motive fluid in contact therewith to provide uniform heating and expansion of said cylindrical wall.

8. In an elastic fluid turbine, the combination of a rotor having a dummy piston, a casing having a plurality of nozzle segments, said casing having integral wall portions forming motive fluid supply passages for said nozzle segments, respectively, said nozzle segments being mounted on one of said wall portions, another of said wall portions being of cylindrical form and disposed about said dummy piston in sealing relation therewith, and one of said fluid supply passages extending about the periphery of said cylindrical wall portion and conveying motive fluid in contact therewith to provide uniform heating and expansion of said cylindrical wall portion.

9. In an elastic fluid turbine, a plurality of nozzle groups including a primary nozzle group, a casing having a high-pressure end carrying the nozzle groups and providing chambers for the latter, said high-pressure end of the casing having passages for supplying steam to the chambers, the passage for the primary nozzle group including a portion extending entirely around the circumference of said end and offset laterally of said chambers, and valves for said passages including a primary valve for the primary nozzle group passage.

10. In an elastic fluid turbine, a plurality of nozzle groups including a primary nozzle group, a casing having a high-pressure end carrying the nozzle groups and providing chambers for the latter, said high-pressure end of the casing having passages for supplying steam to the chambers, the passage for the primary nozzle group including a portion extending entirely around the circumference of said end and offset laterally of said chambers, a steam chest and valves therein for said passages including a primary valve for the primary nozzle group passage.

11. In an axial-flow elastic fluid turbine, a casing; a rotor; blading including an initial row of impulse blades; said casing having an end structure extending radially inward with respect to the impulse blades; said end structure having a wall disposed substantially parallel to the plane of the inlet edges of the initial row of blades, having a plurality of nozzle chambers distributed circumferentially and in substantially the same axial zone, and having steam supply passages for the nozzle chambers, said supply passages including a belt passage arranged in the axial zone of the structure at the side of the first zone remote from the blading and said wall forming a part of the enclosure for each nozzle chamber and having arcuate steam discharge openings for the chambers; nozzle segments for said openings; means including valves for supplying steam to the respective passages; and means for operating said valves so that the valve for the belt passage is open whenever the turbine is in operation.

12. In an elastic fluid turbine, a rotor including a circumferentially-extending sealing surface, a casing for the rotor and including an an-

nular structure provided with a plurality of circumferentially-distributed nozzle segments, said structure having passages for supplying steam to the nozzle segments and one of the passages being formed as a belt passage in order that steam supplied thereto may heat the structure substantially uniformly circumferentially and said structure having a circumferentially-extending sealing surface disposed in opposed relation with respect to the rotor sealing surface and defining, with the latter, a space to be sealed, said belt passage having a wall provided with at least a circumferentially-extending part of said sealing surface of the structure, means in said space for effecting a seal between said sealing surfaces, means including valves for supplying steam to the respective passages, and means for operating the valves so that steam is supplied to the belt passage whenever the turbine is in operation.

13. In an axial-flow elastic fluid turbine, a casing: a rotor including a circumferentially-extending sealing surface: blading including an initial row of impulse blades: said casing having an end structure extending radially inward with respect to the first row of impulse blades:

said end structure having a wall disposed substantially parallel to the plane of the inlet edges of the initial row of blades, having a circumferentially-extending sealing surface disposed in opposed relation with respect to the rotor sealing surface, having a plurality of nozzle chambers distributed circumferentially in substantially the same axial zone, and having steam supply passages for the nozzle chambers; said supply passages including a belt passage arranged in the axial zone of said structure at the side of the first zone remote from the blading, said wall forming a part of the enclosure for each of the nozzle chambers and having arcuate steam exit openings for the latter, and said belt passage having a wall provided with at least a circumferentially-extending portion of said sealing surface of the structure: nozzle segments for said openings: means in said space for effecting a seal between said sealing surfaces: means including valves for supplying steam to the respective passages: and means for operating the valves so that the valve for controlling the supply of steam to the belt passage is maintained open as long as the turbine is in operation.

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