

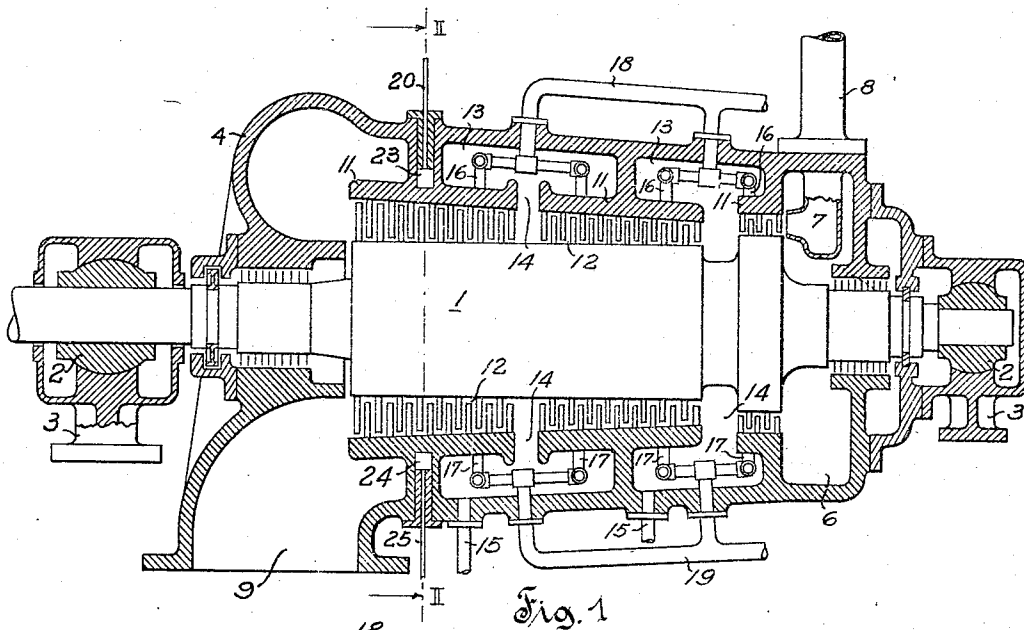
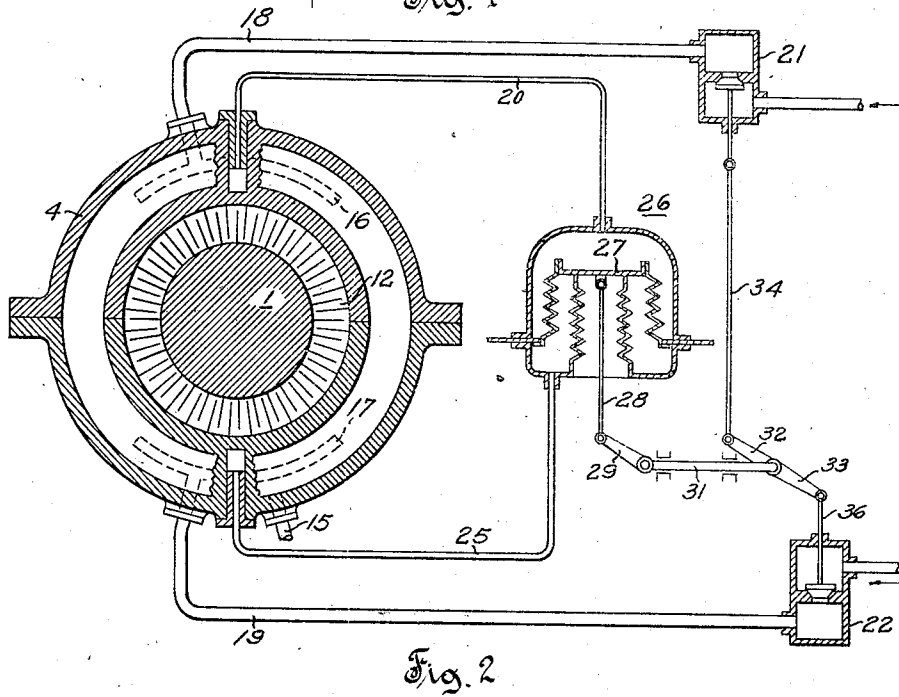
June 25, 1946.

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2,402,841

ELASTIC FLUID TURBINE APPARATUS

Filed June 26, 1944



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UNITED STATES PATENT OFFICE

2,402,841

ELASTIC FLUID TURBINE APPARATUS

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Application June 26, 1944, Serial No. 542,074

10 Claims. (Cl. 60—43)

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This invention relates to elastic fluid turbines and has for its object the provision of means operative to eliminate the vibration and damage attributable to distortion caused by the unequal expansion and contraction of correlated parts.

In this connection, the top portion of the cylinder, particular reference being had to the blade carrying parts thereof, in some instances becomes heated more rapidly than does the bottom portion whenever operation of the turbine is initiated and whenever the quantity and the temperature of the motive fluid flowing through the turbine is suddenly increased a considerable amount. Moreover, in some instances the top portion cools more slowly than does the bottom portion whenever the quantity and the temperature of the motive fluid flowing through the turbine is suddenly decreased a considerable amount. Consequently, whether attributable to the above stated or other reasons, the fact remains that the temperature of the top and bottom and/or other circumferentially spaced portions of the cylinder is frequently, nonuniformly varied over a relatively wide range thereby effecting unequal expansion and contraction, over stressing, and in some instances, rubbing contact and damage to correlated parts. In any event, the continued over stressing of correlated parts ultimately results in serious and sometimes irreparable damage to moving elements of the turbine thereby materially reducing its trouble-free life expectancy particularly when employed under conditions subjecting the turbine to frequent and sudden large changes in load and speed.

In accordance with this invention, the over stressing and damage caused by the unequal expansion and contraction of correlated parts is substantially eliminated by maintaining the temperature of the stationary blade carrying means mounted within the turbine cylinder substantially uniform for all conditions of operation irrespective of the rapidity and extent of load change. And this result is preferably attained by the provision of means for cooling the hotter portion and for simultaneously heating the cooler portion of the stationary blade carrying structure; the cooling and heating being preferably effected by a gaseous fluid or fluids in order to render the invention readily applicable to constructions in which the space between the stationary blade carrying structure and cylinder is in communication with the bladed motive fluid confining passage defined by the blade carrying rotor and the surrounding stationary blade supporting structure.

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Accordingly, the invention may be considered as consisting of the various details of construction, correlations of elements and arrangements of parts as is more fully set forth in the appended claims and in the detailed description, in which:

Fig. 1 is a longitudinal section through an elastic fluid turbine embodying the invention; and

Fig. 2 is a section taken on line II—II of Fig. 1 schematically showing control apparatus for automatically practicing the invention.

Referring to the drawing, it is seen that the invention may be applied to an elastic fluid turbine embodying a spindle or rotor 1 supported by a pair of axially spaced bearings 2 which are in turn mounted on suitable pedestals or other structures 3, and a casing or cylinder structure 4 enclosing and forming with the rotor 1 an annular inlet space 6 in which is disposed a nozzle structure or box 7 receiving motive fluid from a suitable source (not shown) through a pipe 8 and an annular exhaust space 9; the casing 4 including one or more inwardly projecting stationary blade carrying cylindrical parts or segments 11 which form with the blade carrying portion of the rotor and with the inner peripheral portion of the casing proper an inner bladed motive fluid confining passage 12 and a surrounding space or spaces 13 having restricted communication with the motive fluid confining passage 12 by means of openings or passages 14. If desired, the casing may be provided with one or more suitable condensate drains designated 15.

In applying apparatus for practicing the invention to a turbine of the type briefly described herein, the top and bottom portions of one or more of the surrounding spaces 13 are provided with fluid distributing conductors 16 and 17, respectively, and the conductors 16 and 17 are severally and controllably connected with suitable sources of cooling and heating fluids, preferably gaseous fluids, (not shown) by means of valve controlled fluid conducting pipes or the like 18 and 19, respectively; the valves being designated 21 and 22 as is clearly indicated in Fig. 2. The fluid for cooling and the fluid for heating may be of the same or different types and the only requisites in this connection are that the fluids be maintained at materially different temperatures effective to accomplish the desired result and that the nature of the fluids should not be such as to injure parts of the machine with which they come in contact.

All that remains to be done in order to maintain the temperature of the top and bottom portions of the casing substantially uniform as the load on the machine varies is to determine the temperature of such top and bottom portions (preferably by taking temperature readings of the portions 11) and, if the temperature readings of such portions are appreciably different, to appropriately vary the flow of cooling and heating fluids to the distributing conduits 16 and 17. However, this procedure would not be commercially practical in many instances as it would require considerable time and a high degree of alertness on the part of the operator in order to attain satisfactory results particularly with respect to machines subjected to rapid and material fluctuations in load.

In order to render apparatus of the type herein disclosed satisfactorily operable irrespective of the rapidity and the extent to which the load on the machine changes, the top and bottom portions of parts 11 are provided with suitable temperature indicating or responsive elements 23 and 24, respectively, and these elements or means, which as indicated in Fig. 2 may be of the expanding fluid type, are operatively connected by means of pipes 20 and 25 with a bellows or other type of actuating device 26 having at least one movable element, such as the diaphragm 27, which is in turn operatively connected with the stem portions of valves 21 and 22 by means of a link 28, an arm 29 integral with a rocker shaft 31, arms 32 and 33 on shaft 31, and links 34 and 36; the arrangement of these parts being such that an appreciable difference in the temperature of the top and bottom portions of parts 11 results in a movement of element 27 and a simultaneous resulting movement of valves 21 and 22.

For example, if the temperature of the top portion increases relative to the temperature of the bottom portion, the pressure of the fluid acting on the top side of diaphragm element 27 increases and moves the diaphragm downward as viewed in Fig. 2 thereby effecting a counterclockwise movement of rocker shaft 31 which in turn effects an opening movement of both valves 21 and 22 thereby increasing the cooling fluid delivered to distributing conduit 16 and the heating fluid delivered to distributing conduit 17; such increased deliveries of the cooling and heating fluids continuing until the temperature of the top and bottom portion of the parts 11 is again equalized. If however, the temperature of the top portion decreases relative to the temperature of the bottom portion, it should now be obvious that the diaphragm element 27 will move upward as viewed in Fig. 2 and effect a simultaneous closing movement of both valves 21 and 22 thereby decreasing the delivery of cooling and heating fluids to the distributing conduits 16 and 17.

The apparatus schematically illustrated in Fig. 2 inherently operates to maintain the temperature of circumferentially spaced portions (the top and bottom portions) of the parts 11 substantially uniform irrespective of the rapidity and extent of load change on the turbine or other machine to which the invention is applied. And in accordance with this invention, the trouble-free life expectancy of a machine is materially increased by maintaining the temperature of parts, such for example as those herein designated 11, substantially uniform irrespective of the rapidity and extent of load change by subjecting two or more circumferentially spaced portions of such

parts to the temperature equalizing action of fluids conditioned to effect the desired result.

Consequently, it should be obvious that the invention is generally applicable to all types of elastic fluid turbine constructions in which circumferentially spaced portions of the stationary blade carrying means or other parts attain materially different temperatures irrespective of the operating conditions producing the difference, and it should, therefore be understood that it is not intended to limit the invention to the exact details of construction and operation herein shown and described for purposes of illustration, as various modifications within the scope of the appended claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In an elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means surrounding a rotor-receiving space and having at least two circumferentially spaced portions subject to attaining materially different temperatures during normal operation, means for simultaneously flowing separate cooling and heating fluids in heat exchanging relation to the higher and lesser heated ones of said spaced portions, respectively.

2. In an elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means surrounding a rotor-receiving space and having at least two circumferentially spaced portions subject to attaining materially different temperatures during normal operation, means for severally subjecting the higher and lesser heated ones of said spaced portions to the temperature equalizing action of separate cooling and heating fluids respectively.

3. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means forming a rotor-receiving space, means for indicating a material difference in the temperature of at least two circumferentially spaced portions of said stationary means, and means for simultaneously effecting equalizing changes in the temperature of said portions.

4. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means forming a rotor-receiving space, means for indicating a material difference in the temperature of at least two circumferentially spaced portion of said stationary means, and means for simultaneously subjecting said portions to the temperature equalizing action of fluids conditioned to maintain the temperature of the spaced portions substantially uniform.

5. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means forming a rotor-receiving space, means for changing the temperature of at least two circumferentially spaced portions of said stationary means, and control means responsive to a temperature difference between said portions for automatically and simultaneously effecting equalizing changes in the temperature of said portions.

6. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying inward-extending, stationary blade carrying means forming a rotor-receiving space, means for subjecting circumferentially spaced portions of said station-

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ary means to the temperature equalizing action of fluids conditioned to compensate for a difference in the temperature of said portions, and control means responsive to a temperature difference between said portions for automatically and simultaneously subjecting said portions to the temperature equalizing action of said fluids.

7. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying therein stationary means forming a coaxial rotor-receiving space and a surrounding annular space having restricted communication with said rotor space, means for severally introducing gaseous fluids to circumferentially spaced portions of said fluids being conditioned to change the temperature of the walls bounding said portions, and control means for simultaneously effecting a temperature equalizing variation in the flow of said fluids in response to a difference in the temperature of the walls bounding said portions.

8. An elastic fluid turbine apparatus comprising a rotor-enclosing casing embodying therein stationary means forming a coaxial rotor-receiving space and a surrounding annular space having restricted communication with said rotor space, means for severally introducing gaseous cooling and heating fluids to circumferentially spaced portions of said annular space, and control means responsive to a difference in the temperature of the walls bounding said portions for automatically and simultaneously varying the flow of both fluids to compensate for such difference.

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9. In combination with an elastic fluid turbine embodying a blade carrying rotor and a casing enclosing said rotor and having therein a stationary blade carrying means forming with said rotor a bladed motive fluid confining passage and a surrounding space having restricted communication with said passage, means for simultaneously delivering gaseous cooling and heating fluids into the top and bottom portions, respectively, of said space, and control means for varying the flow of both fluids to compensate for a difference in the temperature of the top and bottom portions of said stationary means.

10. In combination with an elastic fluid turbine embodying a blade carrying rotor and a casing enclosing said rotor and having therein a stationary blade carrying means forming with said rotor a bladed motive fluid confining passage and a surrounding space having restricted communication with said passage, means for simultaneously delivering gaseous cooling and heating fluids into the top and bottom portions, respectively, of said space, temperature responsive elements operatively associated with the top and bottom portions of said stationary means, and means rendering said elements operative to simultaneously vary the flow of both fluids in response to a difference in the temperature of the top and bottom portions of the stationary means.

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