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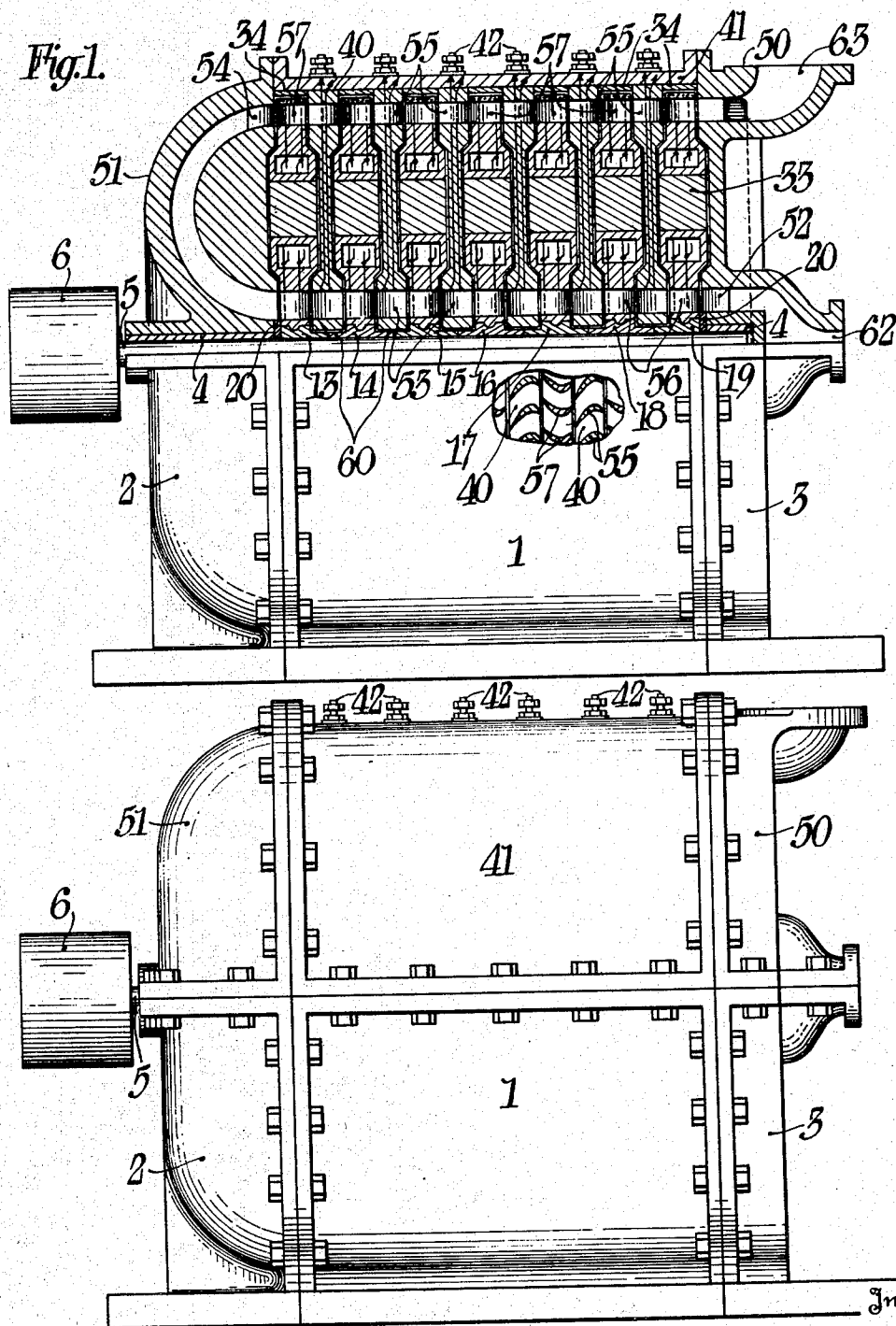
R. J. MATHIAS

2,031,968

THERMOELECTRIC TURBINE

Filed Nov. 26, 1934

2 Sheets-Sheet 1



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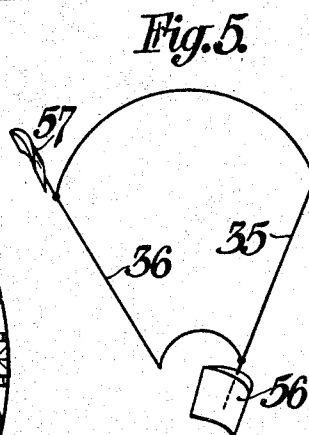
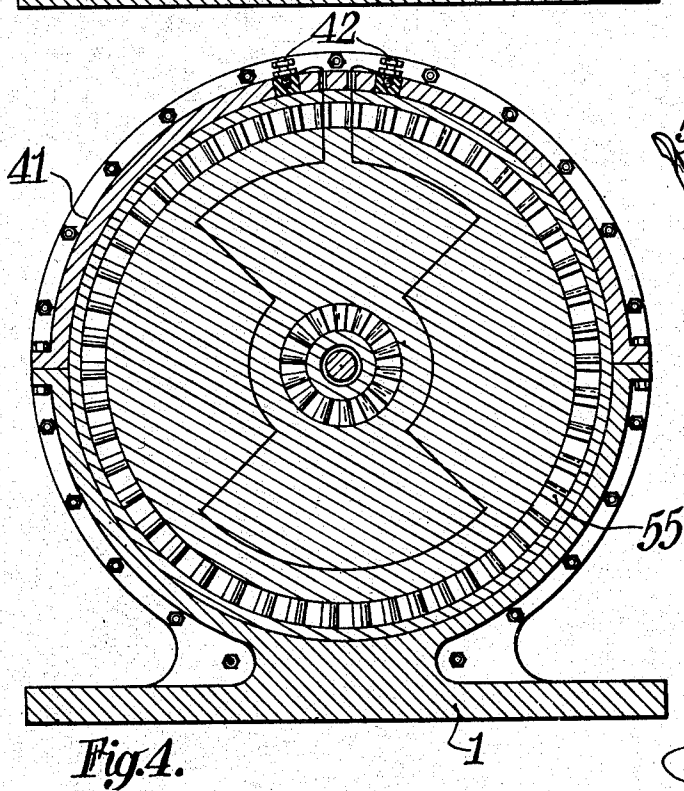
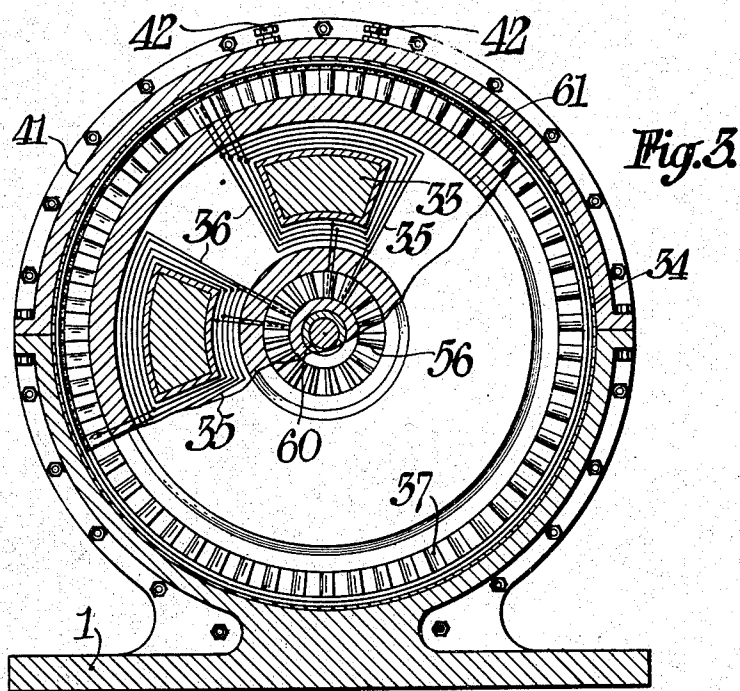
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2 Sheets-Sheet 2



Inventor:

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UNITED STATES PATENT OFFICE

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THERMOELECTRIC TURBINE

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Application November 26, 1934, Serial No. 754,927

4 Claims. (Cl. 290—52)

This invention relates to turbines, but more specifically to a turbine wherein thermo-electric action is created by utilizing desirable temperature conditions in the fluid actuating, or actuated by, the turbine.

The design of steam turbines, mercury vapor turbines, turbo-compressors, hydraulic turbines and other turbine structures is widely understood by those skilled in the art; and installations of these machines are commonplace throughout the country.

Moreover, countless adaptations of thermo-electric structures also have been designed and built; so that the fundamental and inherent actions and characteristics in thermo-couples with opposite junctions at different temperatures are not considered novel. Some discussion on the subject of thermo-couples has been included in my applications, Serial Number 754,925 for Centrifugal thermo-electric machine and Serial Number 754,926 for thermo-electric motor-generator, of even date, to which reference is made. The machines of these two applications illustrate practical adaptations of thermo-electric action.

The invention of this application is unique in that it employs thermo-couples, encased in the rotor or stator units of a turbine, to utilize through their novel arrangement and placement, temperature conditions existing in a fluid passing through the machine. The creation and utilization of these useful thermo-electric effects is an invention of the instant application.

It is, therefore, an object of this invention to provide a novel thermo-electric turbine. It is a further object to provide a machine including thermo-couples which utilize temperature differences created in the turbine by the fluid which passes therethrough. Further objects will appear hereinafter.

In the accompanying drawings, in which like reference numerals refer to like parts:

Figure 1 is a side elevation of the machine, with one quadrant cut away to illustrate parts in section; a broken away portion of the lower casing is also shown to indicate positioning of turbine blades in the outer periphery of the machine;

Figure 2 is a full side elevation of the machine;

Figure 3 is an end view illustrating a rotor unit in position in the machine; a portion of the unit is shown cut away to illustrate part of the rotor in section;

Figure 4 likewise is an end view showing a stator unit in position in the machine; an en-

closed winding is indicated diagrammatically; and

Figure 5 is a view perspective, showing junctions of a thermo-couple connected to vanes of the turbine.

An adaptation of the form of machine of my application, Serial Number 754,926 (to which reference is hereby made) has been incorporated in the machine of the instant application. Details of the construction of this part of the machine, therefore, have not been elaborated upon herein.

The casing for the machine, preferably made of cast steel, is composed of six parts: the lower central case 1, the lower return case 2, the lower inlet case 3, upper inlet case 50, upper central case 41 and upper return case 51. Casings 3 and 50 form intake port 62. Casing 50 includes the exhaust port 63.

In bearings 4 (termed front and rear) is journaled shaft 5, with a pulley 6 keyed to the rear end thereof for transmission of rotary power.

Keyed to the shaft 5 are rotor units 13, 14, 15, 16, 17, 18 and 19. Spaced between the rotor units, and in closely spaced relation with the rings 34, are stator units 40. The entire stator assembly is held in position by the clamping action of the casing parts 1, 2, 3, 50, 41 and 51. To minimize end play of the rotor, thrust washers 20 are provided.

In the inner inlet annulus of casings 3 and 50, are provided stator vanes 52. In the inner annulus of stator units 40, are provided stator vanes 53. In the outer annulus of casings 2 and 51, are provided stator vanes 54 and in the outer annulus of stator units 40 are provided stator vanes 55. The rotor units 13 to 19 have an inner annulus provided with rotor vanes 56, and an outer annulus provided with rotor vanes 57. Inner vanes and outer vanes of either rotor or stator units are, of course, equally spaced and centered, with respect to shaft 5, and are of approved turbine vane design for operating efficiently, with steam, mercury vapor, or any of the fluids customarily employed.

The rotor units 13—19 are adapted to a molded construction. The molding or casting of quite intricate designs from such materials as bakelite, glass, cellulose acetate and other such materials from which the rotors 13 to 19 may be made, and with various types of inserts, is well known to those skilled in the molding art, and any special elaboration on these operations is not necessary here. The positions and forms of the inserts cast in these rotor units will, however, be

fully described. The construction follows the order described herewith—

Thermo-couple units are first made from thousands of thermo-couples of two different metal elements 35 and 36 and in somewhat of a coil-form, and of such size and shape that each coil unit may constitute a quadrant of a rotor. A diagram of the construction of thermo-couple units of this type is shown in the sectional portion of the rotor unit in Figure 3, whereas the actual manufacture of such units has been amply described in my application Serial Number 754,926, of even date. These thermo-couples may be made of suitable well known pairs of metal wires, such as copper and iron, welded, twisted or otherwise joined together to form a closed circuit with two junctions for each pair of metals. Or, the metal wires may be connected alternately copper to iron to copper etc., to form a long series of thermo-couples in series for each quadrant. The quadrants are, of course, positioned 90° apart and centered with respect to the axis. One divergence in design of the thermo-couple units of this application, however, is in the comparatively long junctions which extend or protrude beyond what constitutes the outer boundary of the thermo-couple windings. These projections are illustrated in the junction of thermo-couple elements 35 and 36 of Figures 3 and 5, and will be explained more fully hereinafter.

These thermo-couple units are positioned in quadrant form for molding, after the arrangement indicated in Figure 3 of this application, and more completely in my application, Serial Number 754,926, of even date. About the thermo-couple units is molded or cast, the inner and outer annuli of turbine vanes, and included in or attached to these vanes, and insulated from each other, are the thermo-couple junctions previously mentioned, with opposite junctions being cast in inner and outer annuli of vanes, respectively. Figure 5 is indicative of the placement of these junctions.

In the specific form of machine of this application, these annular vane castings are of rugged glass or porcelain, which electrically insulates the thermo-couple junctions, as well as withstands heat and erosion of an actuating fluid in the turbine.

Cast also in each rotor is an inner metal hub 60, for mounting the rotor on the shaft, and a reinforcing metal screen 61 in the outside rim of the outer annulus.

The remaining operation in the formation of the rotor unit is to cast the existing structure, composed of the vane annuli, and thermo-couple units, in a suitable mold of a construction as illustrated in the drawings. An iron core 33, is positioned within each quadrant of thermo-couples before casting the rotor. This structure then constitutes a complete rotor unit.

A stator unit may more simply be made and formed of metal, such as iron. Coil windings are insulated and wedged in slots cut into the iron stator unit in the form of the stator winding shown in the diagram. These operations are well understood by those versed in the art, and reference to the stator unit construction has been made in my application, Serial Number 754,926, of even date. Electric connection with the stator coil windings of the machine is indicated in terminals 42. These terminals are electrically insulated from the casing 41, by mounting in fibre inserts, screwed in proper position in the casing of the machine. Two terminals 42

connecting with the stators have been shown, whereas the positions of others are indicated by center lines, above the stator units.

These rotor units and stator units are installed alternately in the machine and with their incorporated windings, constitute field and armature units of a dynamo. Because of the vanes or blades also incorporated, they constitute stages of a turbine. How the machine functions as a thermo-electric turbine will now be explained.

A gaseous fluid, under pressure, such as steam, is supplied through the intake port 62; and takes for its passage through the machine, the paths formed by the vanes 52, 56, 53, 54, 57 and 55 of the stators and rotors; and openings cast in the casings 3, 2, 51 and 50. As the steam travels through the machine, its kinetic energy creates rotary motion of the rotor. The outside annuli of blades of rotor and stator units are directed so that the steam passing through these outer paths, tends to produce the same direction of rotation of rotor as that produced in the inner paths. The turbine vanes tend to acquire the temperatures of the steam, passing around them and so consequently do the thermo-couple junctions attached to the vanes.

Now if the steam in heat exchange relation with the opposite junctions of the thermo-couples become of proper different temperatures, electric currents will be produced in the thermo-couple units. This is accomplished in this machine by virtue of the steam practically adiabatically expanding and giving up its energy in successive stages with a resultant decrease in temperature in successive stages. And, by positioning the opposite thermo-couple junctions in stages of the turbine wherein temperature differences exist—the desired conditions are met. In this machine the requirements are fulfilled by placing opposite thermo-couple junctions at inner and outer vane annuli respectively.

These electric currents created in the thermo-electric structures are then utilized in the manner of a dynamo, as described in my application, Serial Number 754,926, of even date. This operation of producing electric energy imposes further load on the turbine, which tends to create more advantageously the temperature differential of steam in inner and outer stages.

Reference is made here also to somewhat of a reclamation process occurring within the machine of this invention. The inner annuli of turbine vanes of the turbine normally acquire temperatures higher than those of the outer annuli. A conduction of heat therefore follows, in which heat acquired in inner annuli tends to move outwardly through rotor and stator structures to the cooler outer annuli, wherein it may be again reclaimed in part through heat transfer, by the steam as it passes through the outer annuli. The steam exhausting, therefore, possesses somewhat additional heat energy which may be utilized externally in some other useful device.

In any of the foregoing constructions, the rotor assembly rotates as the impelling fluid impinges upon the rotor vanes. The temperature differentials set-up between the thermocouple junctions cause a current to flow in the thermo-couple circuits and create lines of force which alternately cut the stator coils and thereby alternately induce a current to flow in the stator coils which is delivered to the terminals 42. The alternation of the current depends, of course, upon the speed of rotation of the rotor assembly.

What I claim as my invention and desire to

be secured by Letters Patent of the United States is:

1. A thermo-electric turbo-generator comprising a rotatable thermo-couple system having "hot" and "cold" junctions, means for first-stage conversion of fluid kinetic energy into rotary power associated with the "hot" junctions of the thermo-couple system and means for second-stage conversion of that fluid kinetic energy into rotary power associated with the "cold" junctions of the thermo-couple system.

2. A thermo-electric turbo-generator comprising a rotatable thermo-couple system having "hot" and "cold" junctions, means for first-stage conversion of fluid kinetic energy into rotary power associated with the "hot" junctions of the thermo-couple system, means for second-stage conversion of that fluid kinetic energy into rotary power associated with the "cold" junctions of the thermo-couple system, and an armature unit in close spaced relation with the thermo-couple system.

3. A thermo-electric turbo-generator comprising a casing having a central annular inlet and a peripheral annular outlet, a shaft journaled and centered in the casing, a stator unit located in the casing centered about the shaft and having an inner vane annulus and an outer vane annulus with directional vanes located in said annuli, said stator having an armature winding positioned therein and having its inner vane annulus in proximity to the central inlet and its outer vane annulus in proximity to the peripheral outlet, a rotor unit centered and mounted on said shaft having an inner annulus and vanes contained therein and an outer annulus and vanes contained therein in opposition to

but located similarly to the stator annuli and vanes, a thermo-couple system located in said rotor unit and having inner junctions and outer junctions in heat exchange relation with the inner and outer rotor vanes respectively, and a return conduit from the inner rotor vane annulus to the outer rotor vane annulus.

4. A thermo-electric turbo-generator comprising a casing having a central annular inlet and a peripheral annular outlet, a shaft journaled and centered in the casing, alternate stator and rotor units located in the casing and centered with respect to the shaft, the stator units each having an inner vane annulus and an outer vane annulus with directional vanes located in said annuli and having an armature winding positioned therein connected with terminals and comprising at least two opposite quadrants, the rotor units each being mounted on the shaft and having an inner annulus and vanes contained therein and an outer annulus and vanes contained therein in opposition to but located similarly to the stator annuli and vanes, four thermo-couple quadrants located 90° apart in each rotor unit, centered similarly to the stator quadrants and having inner junctions and outer junctions in heat exchange relation with the inner and outer rotor vanes respectively, the inner annuli being substantially in line and communication with the central inlet and the outer annuli being substantially in line and communication with the peripheral outlet and a return conduit from the inner annulus most remote from the inlet to the outer annulus most remote from the outlet to the casing.

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