

[54] **TURBINE ALTERNATOR UTILIZING FLUID BEARINGS**

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[51] Int. Cl. .. **F42c 15/32, H02k 21/12, F42c 15/40**

[58] Field of Search **102/70.2, 86; 310/156**

[56] **References Cited**
UNITED STATES PATENTS

| | | | |
|-----------|--------|--------------|------------|
| 2,804,824 | 9/1957 | Cruzan..... | 102/70.2 G |
| 2,701,526 | 2/1955 | Rotkin | 102/70.2 G |

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|-----------|--------|---------------|------------|
| 3,093,076 | 6/1963 | Blomgren..... | 102/70.2 G |
| 3,436,570 | 4/1969 | Engels..... | 310/156 |
| 3,125,027 | 3/1964 | Stoller..... | 102/70.2 G |

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[57] **ABSTRACT**

A turbine alternator for use in ordnance projectiles that obviates the need for mechanical bearings as journal means therefor. The moving part of the alternator is maintained in the proper position by a pressure differential created by the ram pressure developed by the projectile as it moves through the fluid medium in accordance with a well-known law of physics known as Bernoulli's Principle. The electrical output from the alternator can be used as a power source in a conventional bomb, rocket or similar projectile. The elimination of the expensive and fragile mechanical bearings provides an unlimited operational life for the alternator.

6 Claims, 9 Drawing Figures

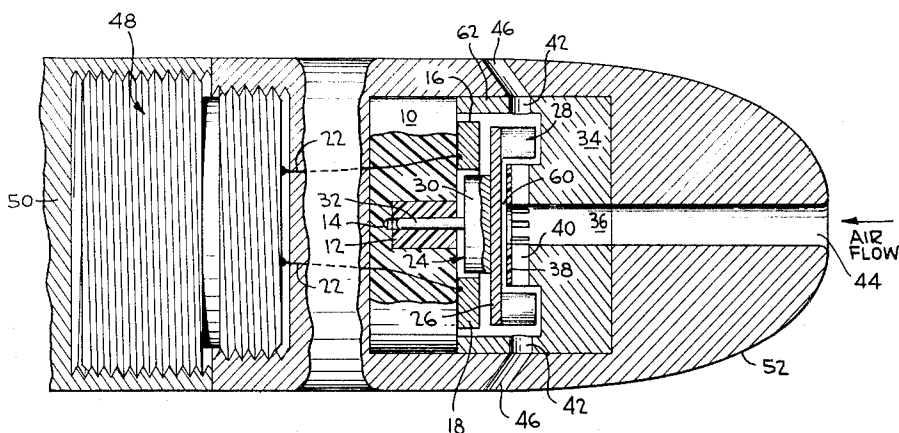


FIG. 1a

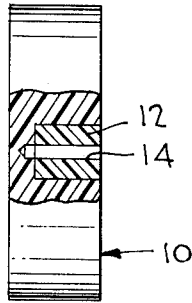


FIG. 1c

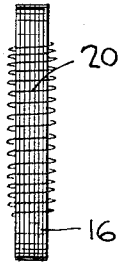


FIG. 1e

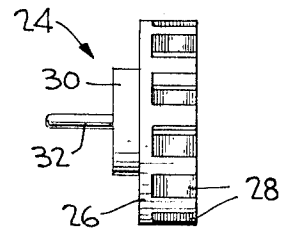


FIG. 1b

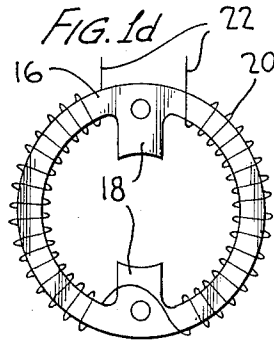
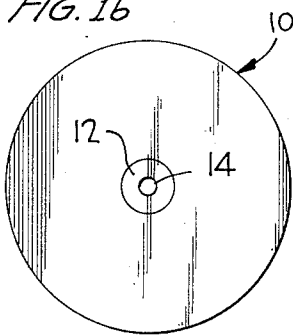


FIG. 1f

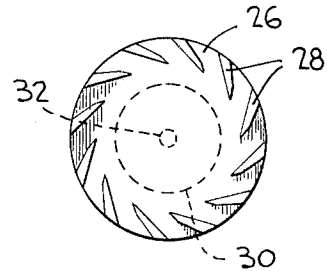


FIG. 1g

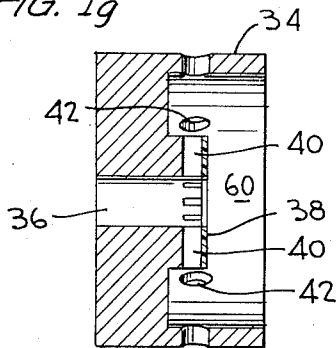
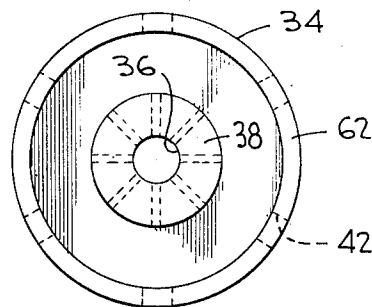


FIG. 1h

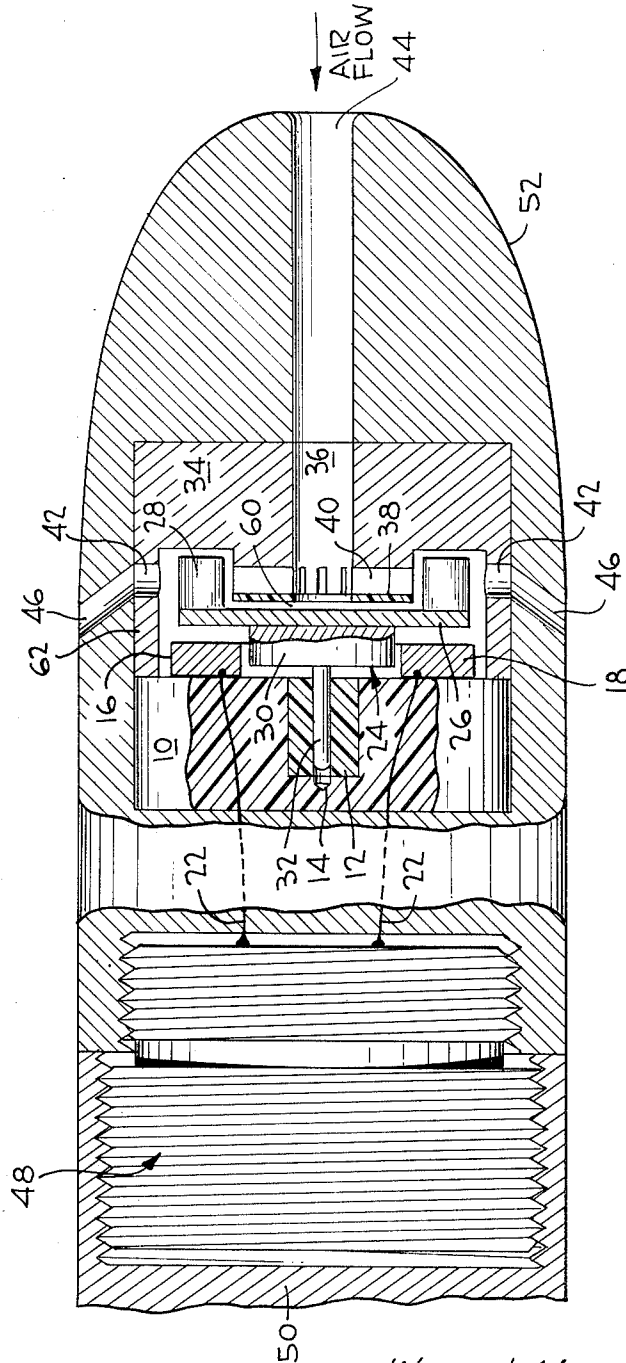


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FIG. 2



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TURBINE ALTERNATOR UTILIZING FLUID BEARINGS

RIGHTS OF GOVERNMENT

The invention described herein may be manufactured, used, and licensed by or for the United States Government for governmental purposes without the payment to us of any royalty thereon.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to turbine alternators, and more particularly, to turbine alternators for use in ordnance projectiles that generate electrical energy that can be utilized in a fuze or similar component of the projectile.

2. Description of the Prior Art

Fluid driven electrical generators for use in ordnance projectiles are per se well-known and documented in the prior art as evidenced by U. S. Pat. Nos. 2,484,206 to Clark, 2,687,095 to Naumann, 2,990,776 to Clarke, and 3,093,076 to Blomgren. In all of the foregoing patents an environmental fluid medium such as air or water is utilized to drive a turbine or propeller that is coupled to an electric generator for providing electrical energy to other components of the ordnance device. Such projectiles typically comprise bombs, rockets, torpedoes, etc., and thus are characteristically subjected to extremely large setback, acceleration, and spin forces during launch and subsequent flight. All the components of the projectile obviously must be able to withstand such forces in order to remain operable during the latter crucial portions of the flight or trajectory. The prime manner employed in the prior art for securing and supporting the moving parts of such generators is by the use of journal means such as mechanical bearings for securing the rotatable shaft to a rigid plate, as particularly evidenced in the aforementioned Clarke and Naumann patents. In order to withstand the attendant forces, such bearings being crucial components of the generators have to be precisely machined from highly durable materials and are thus relatively expensive. Nevertheless the mechanical bearings exhibit a high rate of failure in succumbing to such forces therefore severely limiting the operational life of the generators. It would be a great step forward in the art if reliance upon generators. It would be a great step forward in the art if reliance upon the satisfactory mechanical operation and high cost of such mechanical bearings could be eliminated.

It is therefore a primary object of the present invention to provide a turbine alternator for use in ordnance projectiles that eliminates the need for expensive precision machined bearings as supporting means for the movable apparatus therein.

Another object of the present invention is to provide a turbine alternator whose journal means are not subject to mechanical deterioration or wear to provide a virtually unlimited operational life for the alternator.

A further object is to provide a turbine alternator for use in ordnance projectiles which eliminates mechanical restraints on the moving parts by having the rotatable turbine spin on a steady flow of a layer of pressurized air.

An additional object is to provide a turbine alternator for ordnance projectiles of low cost and rugged design,

having the ability to withstand high setback forces and function during off-center spin of the projectile.

SUMMARY OF THE INVENTION

Briefly, in accordance with the invention, a turbine alternator is provided for use in ordnance projectiles and consists of one moving part called the turbine rotor positioned within a substantially enclosed volume that has input and output ports formed therein for receiving and exhausting fluid jets developed as the projectile moves through the actuating fluid medium. Under setback forces the turbine rotor is forced against a solid support surface and held from spinning due to G forces impressed upon it. As the projectile begins to de-accelerate, the ram pressure developed at the input port positions the turbine over a forced air bearing in accordance with Bernoulli's Principle. As the air barrier is formed the fluid jets begin to spin the turbine and generate electricity. A guide shaft holds the turbine in position over the ram jet input port and also allows the turbine to be positioned to the proper air bearing distance depending on the ram pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

The specific nature of the invention as well as other objects, aspects, uses, and advantages thereof will clearly appear from the following description and from the accompanying drawings, in which:

FIG. 1 illustrates in overhead and side views the basic component parts of a preferred embodiment of the alternator of the present invention; and

FIG. 2 illustrates in a partial side-sectional view a preferred embodiment of the present invention positioned within a typical ordnance projectile in accordance with the teachings hereinafter.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 (a) through (h) illustrates in top and side views the four major components that comprise the turbine alternator of the present invention. FIG. 1 (a) and FIG. 1 (b) represent the side and top views respectively of a rear housing 10 that has a stabilizing guide hole 14 formed therein. The inner walls of guide hole 14 should preferably be of low friction which may be provided by using a nylon guide 12 having guide hole 14 preformed therein. FIG. 1 (c) and FIG. 1 (d) represent the side and top views respectively of a laminated iron coil form 16 that has formed on its inner circumference a pair of pole pieces 18 and also has a coil 20 wound thereon. Current generated in coil 20 is fed to external apparatus via leads 22. FIG. 1 (e) and FIG. 1 (f) show the side and top views respectively of the turbine rotator 24 of the present invention. Turbine rotator 24 comprises a base plate 26 to which are attached on one side and around the periphery thereof a plurality of fins 28. On the reverse side of base plate 26 is attached a disk magnet 30 having a north and south pole perpendicular to the rotational axis of rotator 24. Attached also to base plate 26 and extending outwardly from magnet 30 is a stabilizing shaft 32. FIG. 1 (g) and FIG. 1 (h) show in a side and top view respectively a front housing 34 having an input port 36 centrally formed therein and in open communication with a plurality of vents 40 and an air bearing region 60. Exhaust ports 42 are circumferentially located around the periphery of front housing 34. A low friction cap 38 such as Teflon covers vents

40 in such a manner so as to direct the air issuing therefrom radially towards output ports 42. Cap 38 has a hole centrally formed therein to allow open communication between input port 36 and air bearing region 60.

FIG. 2 illustrates the preferred embodiment of the device of the present invention shown positioned in the nose portion 52 of an ordnance projectile. While the description hereinafter shall be directed to the use of the device with air as the active fluid medium, it is understood that any suitable fluid medium may be utilized with similar results. The projectile nose cone 52 has an opening 44 formed in its ogive in direct communication with input port 36 of front housing 34. Front housing 34 is molded at its end 62 to interconnect with rear housing 10 and is held in place by any conventional suitable means such as bonding adhesive, external clamps or the like. Nose cone 52 has output ports 46 formed therein that are in communication with exhaust ports 42 of front housing 34. It is seen that turbine rotator 24 which comprises base plate 26, fins 28, disk magnet 30, and stabilizing shaft 32 is located in the substantially enclosed volume formed by the meshing of front housing 34 with rear housing 10. It is seen in FIG. 2 that stabilizing shaft 32 is placed in guide hole 14 of nylon guide 12 so as to define the center axis of rotation about stabilizing shaft 32. The depth of guide hold 14 in nylon guide 12 allows for axial movement of turbine rotator 24 but places no mechanical stresses thereon. The limits of axial movement of turbine rotator 24 is defined by the abutment of disk magnet 30 against rear housing 10 at one extreme and by the abutment of base plate 26 against Teflon cap 38 at the other. At rest, turbine rotator 24 is free to rotate about shaft 32 and is free to move axially between the aforescribed physical constraints. Output leads 22 from coil 20 that is wound around iron coil form 16 can be fed through rear housing 10 and connected for example to a fuzing device 48 to provide electrical energy for controlling the operation and/or disposition of payload 50.

As hereinbefore explained, one advantage of the device of the present invention is that its utilization is based on a well-known physics phenomenon known as Bernoulli's Principle which states that when a fluid is in steady flow, its pressure will be high when its velocity is low; and, conversely, its pressure will be low when its velocity is high. This principle is utilized to effectively eliminate the need for mechanical bearings in the device of the present invention, as can already be evidenced by the apparatus as shown in FIG. 2. In operation, the device will work essentially as follows: When the projectile is launched, turbine rotator 24 is forced back against a solid support surface such as rear housing 10 and is prevented from spinning due to the high G setback forces impressed upon it. As the projectile leaves the barrel of the gun, it begins to de-accelerate and admits an air-jet flow through opening 44 into input port 36. This high velocity air-flow impinging upon the underside of base plate 26 creates a low pressure region therein in accordance with Bernoulli's Principle before it de-velocityzes and exits through output ports 42 and 46. The de-velocityzed air jets exiting through ports 42 and 46 create a high pressure region on the reverse side of base plate 26 that will maintain turbine rotator 24 in an equilibrium position. In addition, as the air barrier is formed in region 60, the air jets exiting via ports 42 and 46 act on fins 28 to begin to spin turbine rotator 24. The magnetic poles of disk

magnet 30, being perpendicular to the rotational axis of turbine rotator 24, follow the rotational spin of turbine 24 causing lines of flux to induce alternating current in the windings of coil 20 that are wound around iron coil form 16. Guide shaft 32 holds turbine rotator 24 in position over input port 36 and also gives an axial degree of freedom to allow turbine rotator 24 to be positioned at the proper air-bearing distance depending on the ram pressure. In an embodiment constructed to verify the foregoing principles of operation, the rate of turbine spin with a 1 ohm load was found to be 402 Hz. at a ram pressure of 5 lbs./in.², which yielded an air-bearing distance of 0.018 inches. The power output at that pressure was measured to be 210 mw at 1.5 volts peak-to-peak. The iron coil form 16 was wound with 100 turns of awg 30 wire. In addition, the model was successfully tested to 11,000 rpm with the alternator one-eighth inch off-center of the spin axis.

It is seen that we have provided a turbine alternator for use as a power source in a bomb, rocket or similar projectile. The device could also be utilized as a sensor of a re-entry vehicle from outer space to detect the earth's atmosphere. The advantage of the device of the present invention are low cost, rugged design, mechanical-free bearings, variable power output and the ability to survive high set-back forces and function during off-centered spin of military projectiles. The turbine alternator has an unlimited operational life due to the elimination of mechanical stresses by utilizing a turbine rotator that spins on a steady flow of a layer of pressured air.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

We claim as our invention:

1. An electrical power source for use in ordnance projectiles which comprises:

- a. a front housing having an input port formed therein for receiving fluid flow;
- b. a rear housing fitted with said front housing to form a substantially enclosed volume therebetween;
- c. a turbine rotator located within said enclosed volume and driven by said fluid flow, the axial support of said rotator within said inclosed volume being adapted for positional control by an air cushion formed within said enclosed volume due to said fluid flow, and
- d. means located within said enclosed volume for transducing the rotation of said turbine rotator into electrical energy.

2. The device according to claim 1 wherein said rear housing further comprises a stabilizing guide hole formed therein.

3. The device according to claim 2 wherein said turbine rotator comprises a base plate to which are affixed:

- a. a plurality of turbine fins located around the periphery of said base plate;
- b. a stabilizing shaft adapted to fit within said stabilizing guide hole and free to move axially therein; and
- c. a permanent magnet from which said shaft extends.

4. The device according to claim 3 wherein said turbine rotator is circularly symmetrical about said stabilizing shaft.

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5. The device according to claim 4 wherein said transducing means comprises an iron stator ring wound with a coil and having a pair of pole pieces formed thereon, said pole pieces located in close proximity to said magnet whereby upon rotation of said rotator an alternating current is induced in the windings of said coil.

6. An electrical power source for use in ordnance projectiles which comprises:

- a. an input duct adapted to receive fluid flow and transmit it to a substantially enclosed volume upon

- the launching of said projectile;
- b. a turbine rotator located within said enclosed volume and driven by said fluid flow, the axial support of said rotator within said enclosed volume being adapted for positional control by an air cushion formed within said enclosed volume due to said fluid flow; and
- c. means for transducing the rotation of said turbine rotator into electrical energy.

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