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(54) TESLA TURBINE

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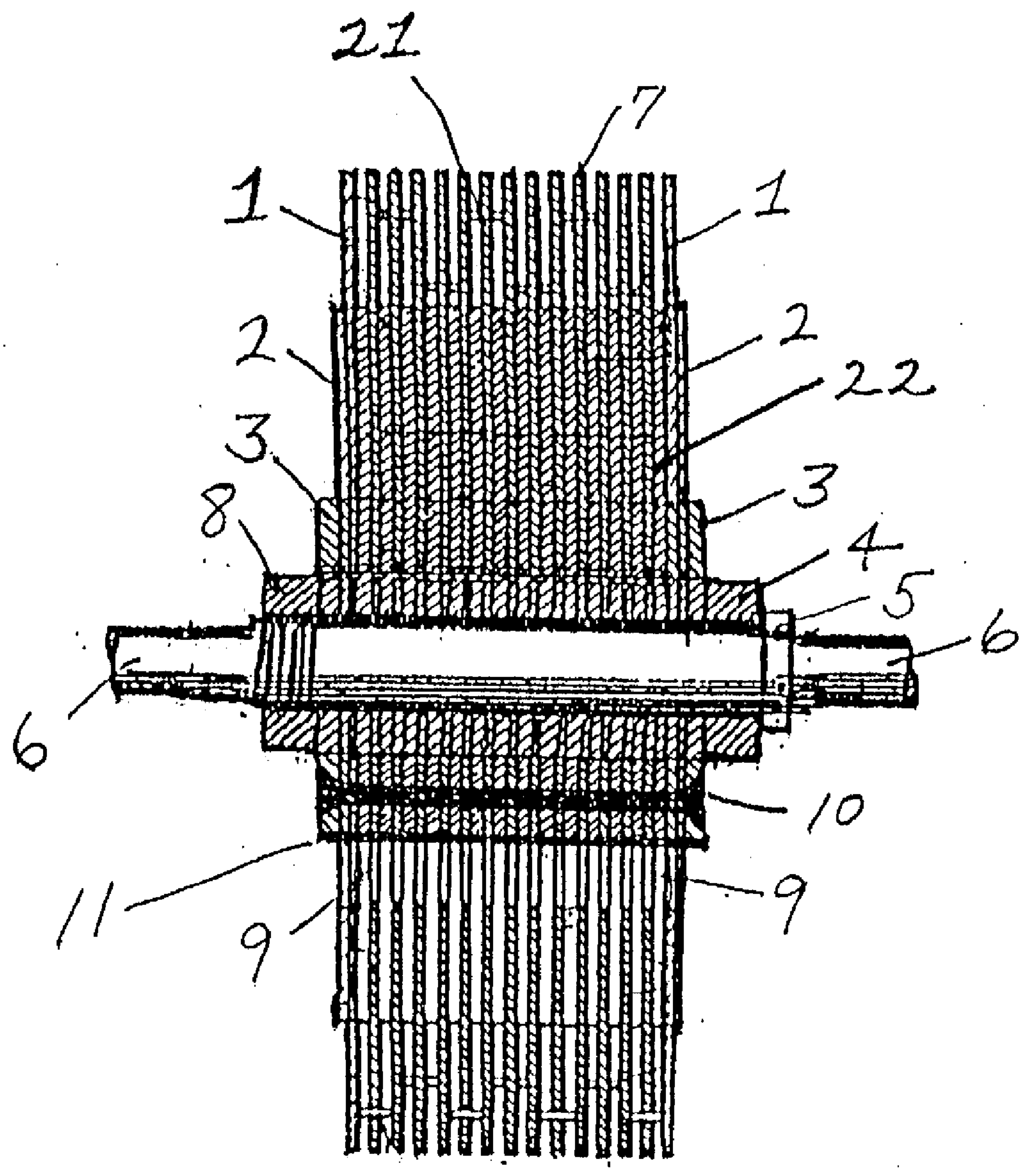
(52) U.S. Cl. 415/90

(57) **ABSTRACT**

Abstract of the Invention An improved turbine using the edge of the blades of the working surface instead of the blade's face, and further utilizing both expansion blades and adhesion discs.



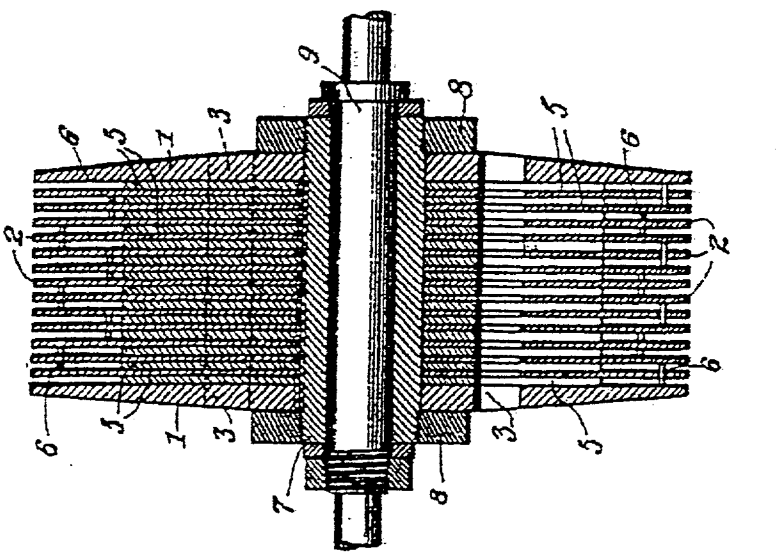


FIG. 1 (PRIOR ART)

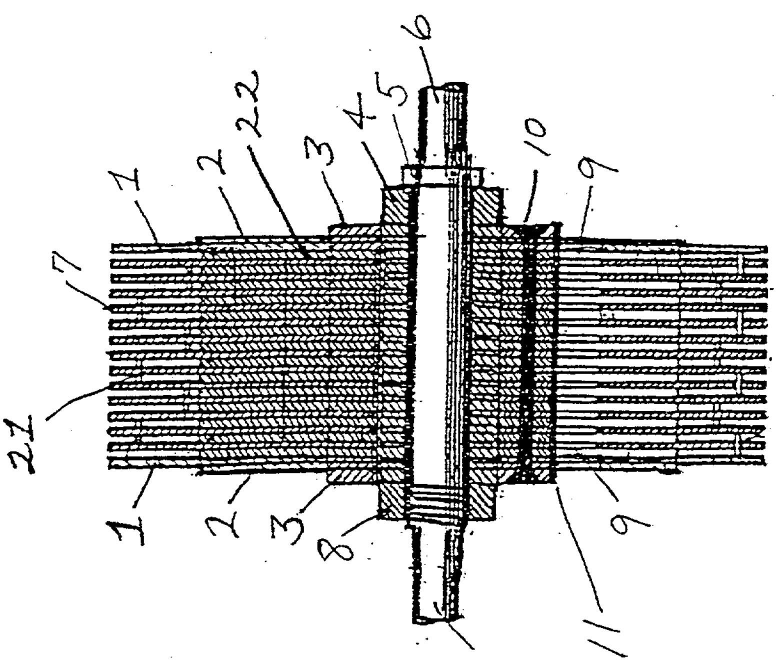


FIG. 2

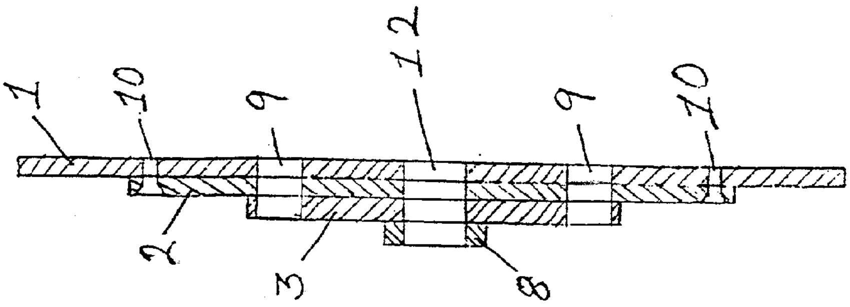


FIG. 4

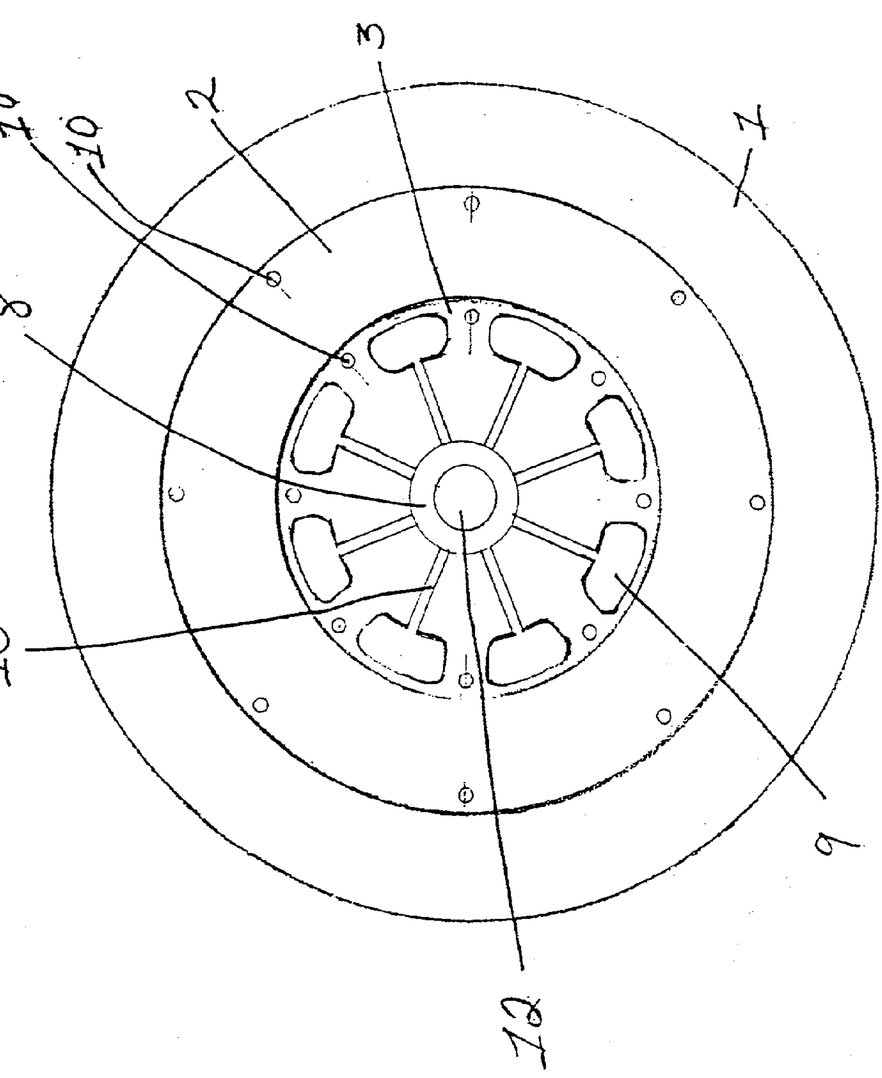


FIG. 3

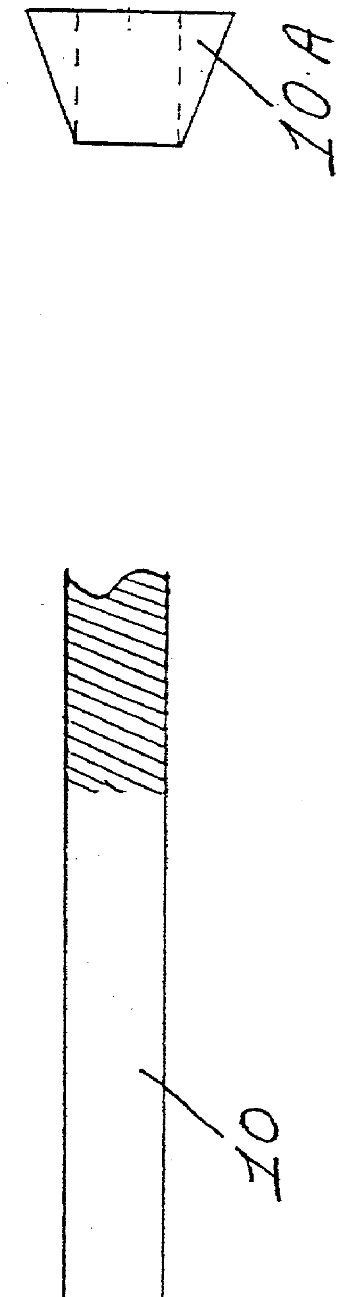


FIG. 5

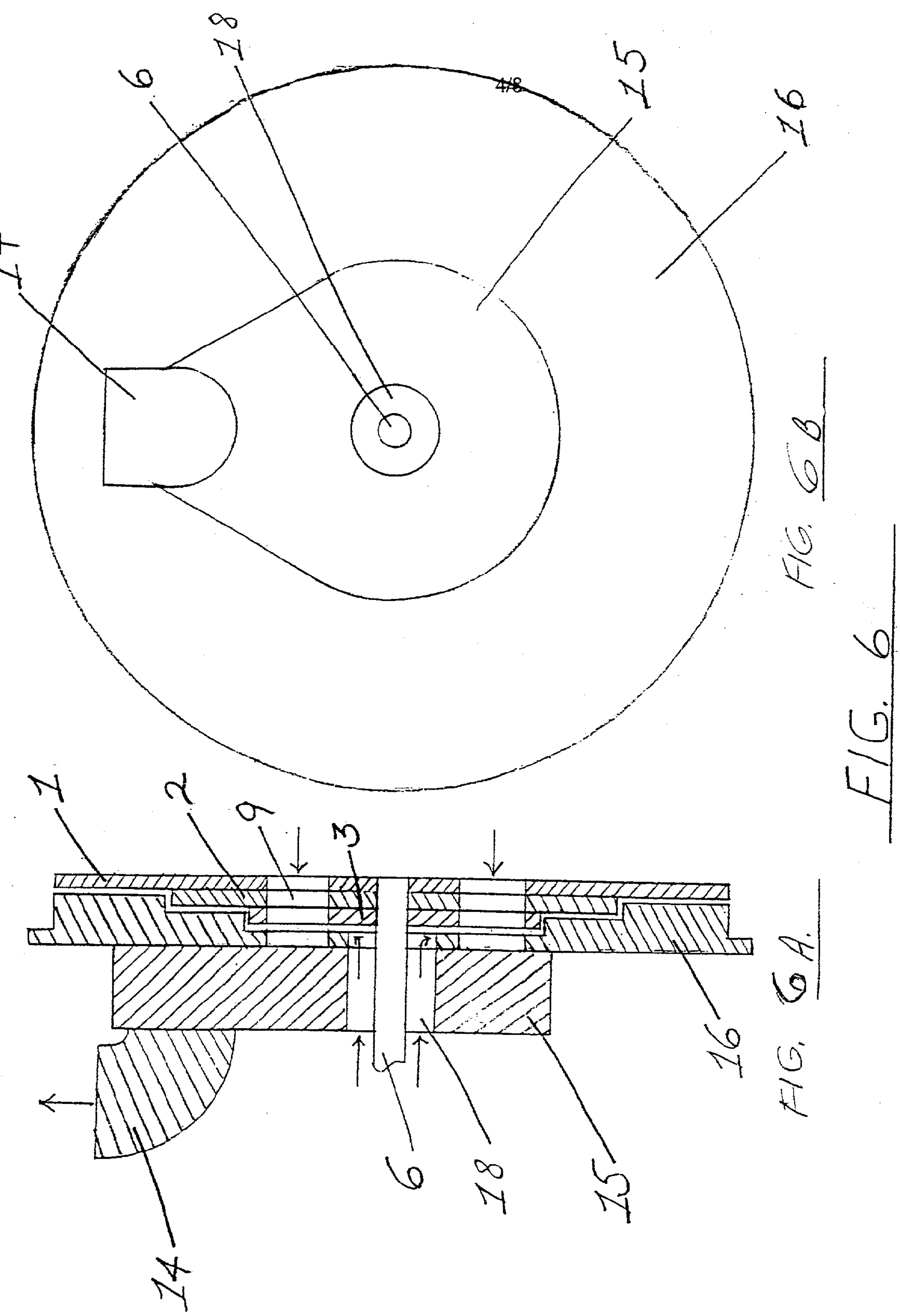


FIG. 6B

FIG. 6A.

FIG. 6

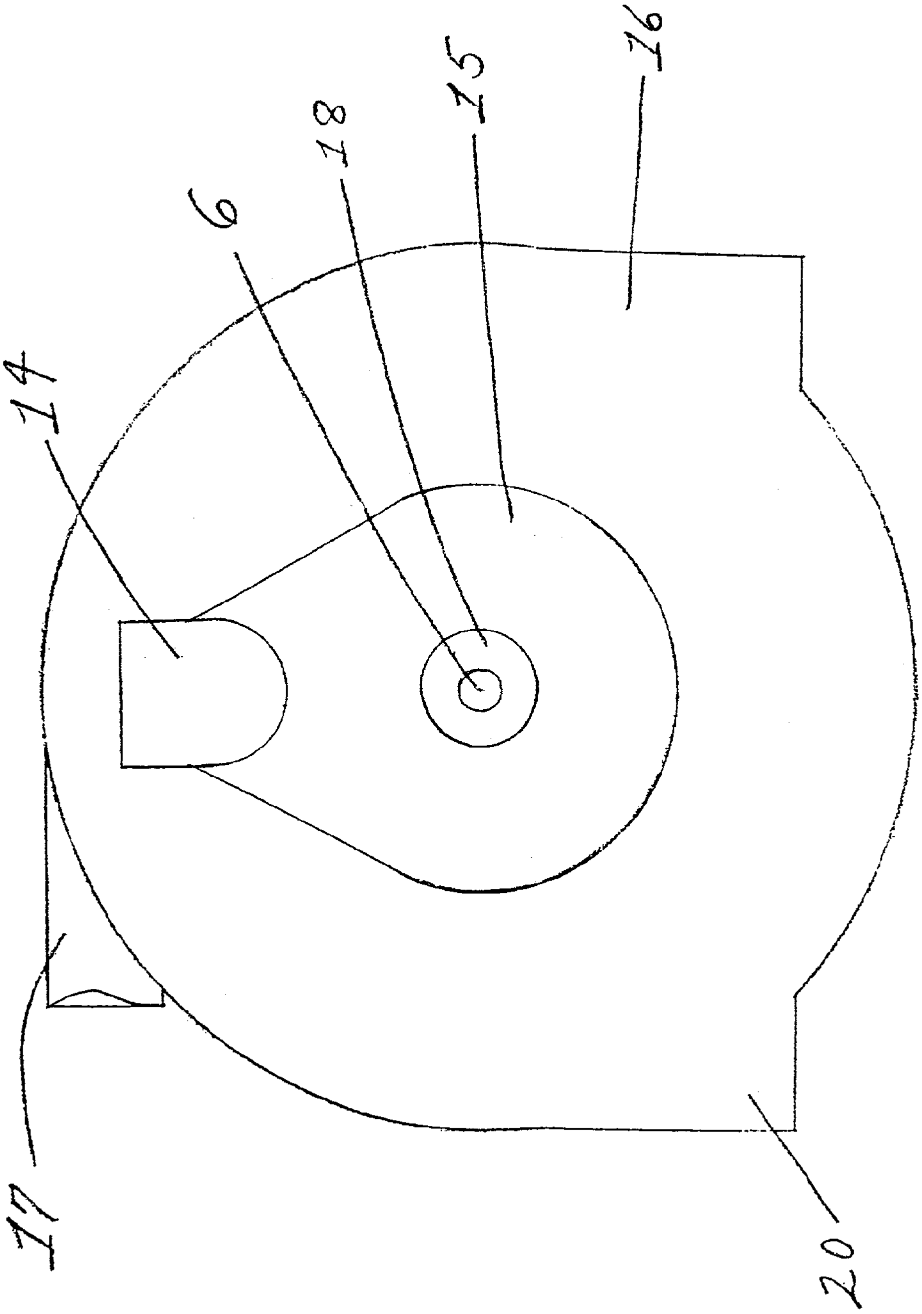


FIG. 7

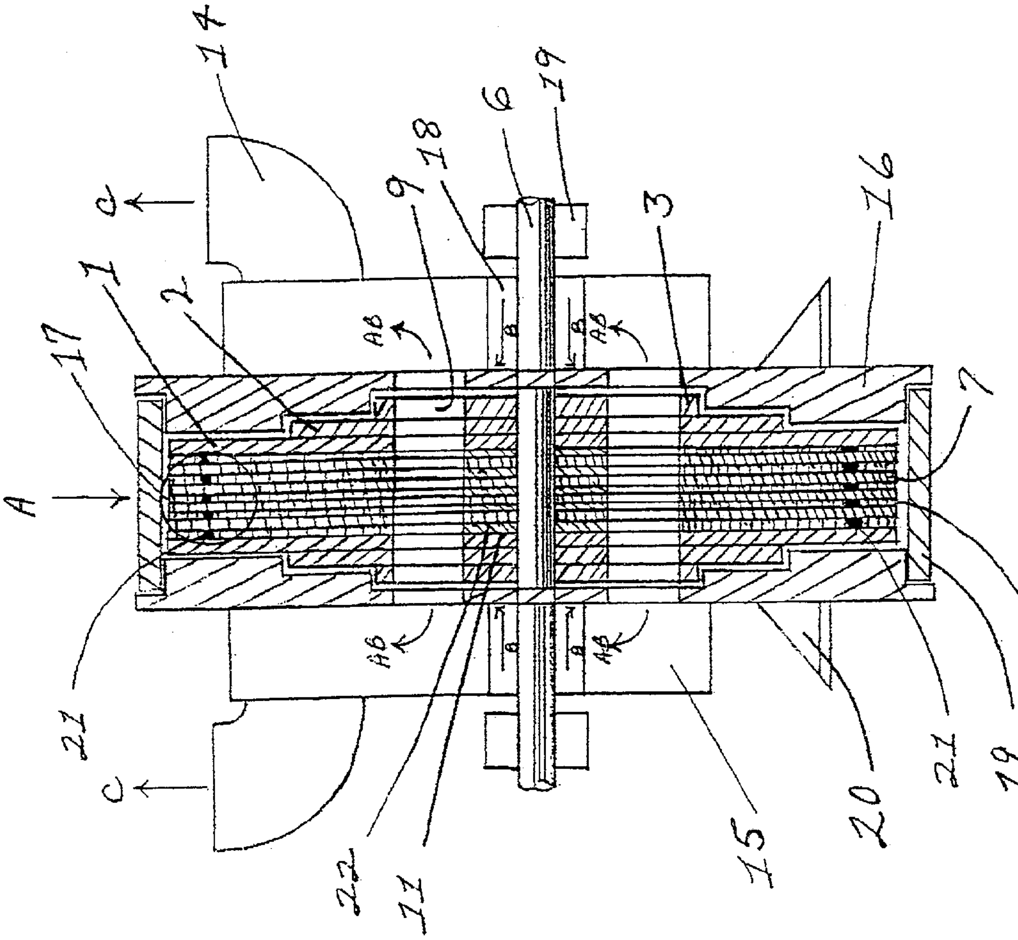


FIG. 8

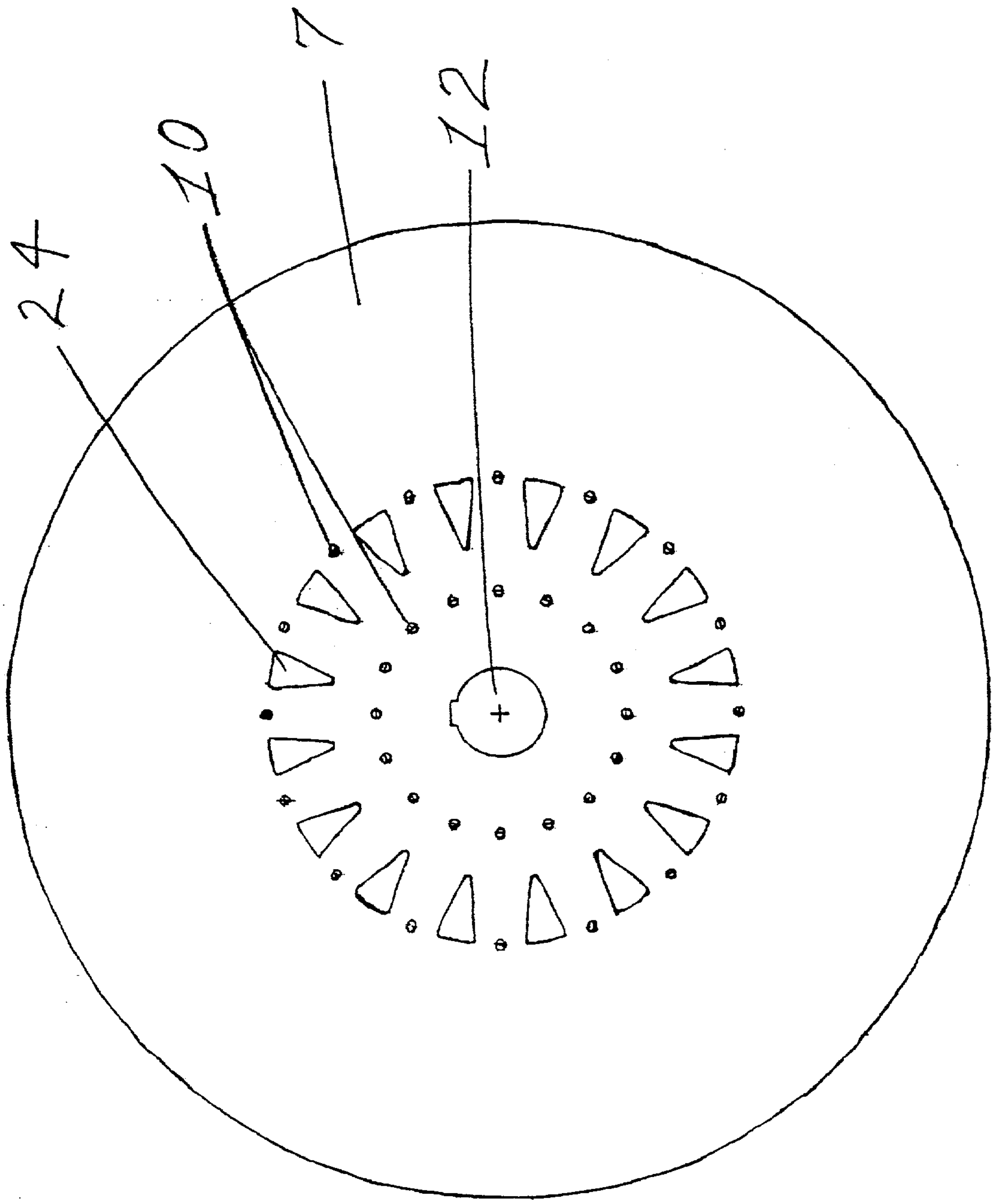


FIG. 9

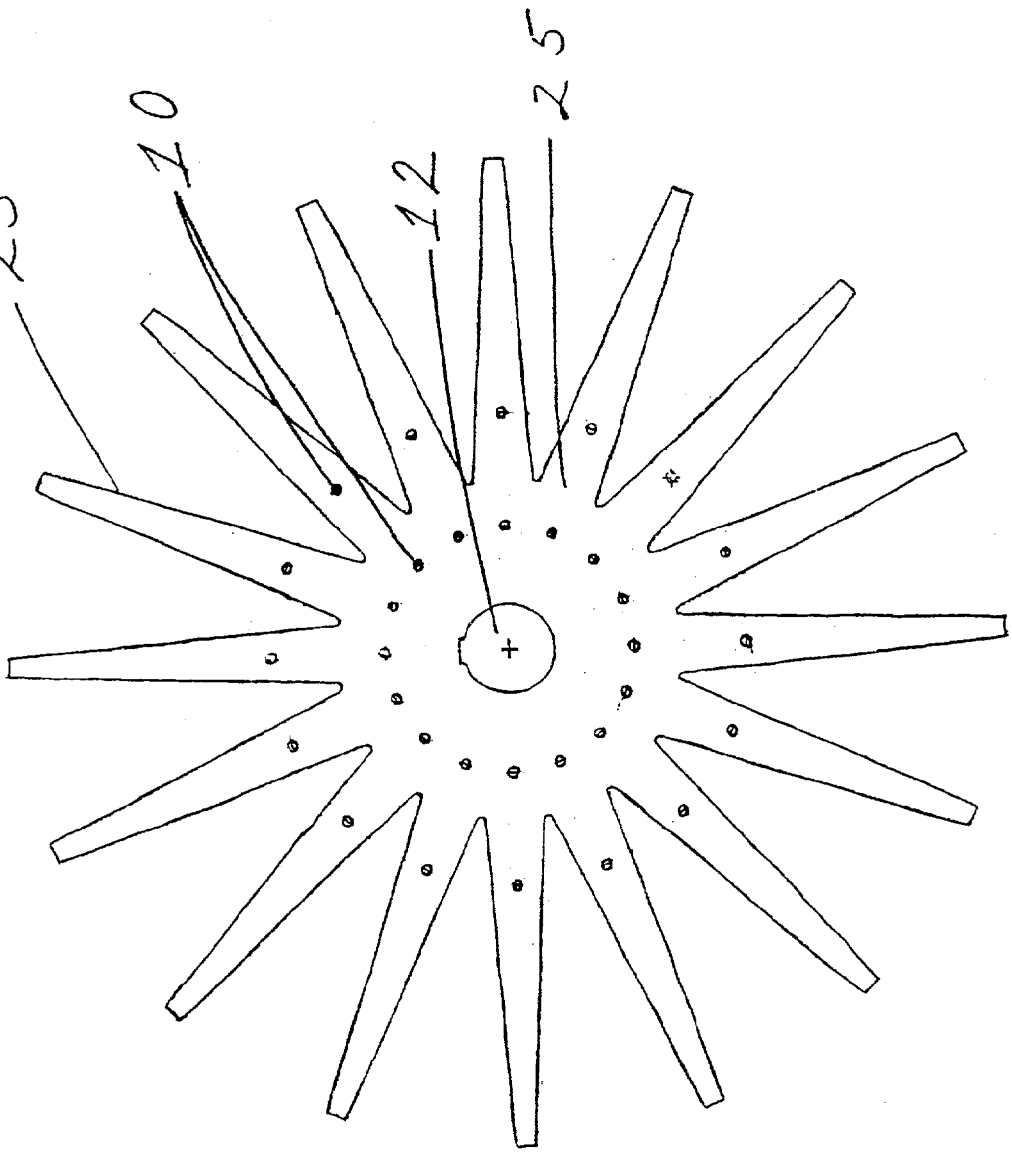


FIG. 10

TESLA TURBINE

RELATED APPLICATION

[0001] This Application is related to co-pending Provisional Application to Serial No. 60/255,588, filed Dec. 14, 2000, entitled "Improved Tesla Turbine," the teachings of which are incorporated herein to the extent they do not conflict herewith.

FIELD OF THE INVENTION

[0002] The present invention relates generally to gas, steam or fluid driven turbines, and more particularly to Tesla Turbines.

BACKGROUND OF THE INVENTION

[0003] All gas and steam turbines built to date have one thing in common. The working fluid is propelled to and is expanded against the face of the turbine blades. This is true in both the radial inflow and axial flow turbines. The problems with both designs is the inability to handle particulates, contaminates and heavy moisture. Also, due to the frontal impact of the working fluid, stresses are more pronounced and a much heavier and higher alloy material is needed. This relates to higher initial cost and a necessity to utilize very clean and dry working fluid. High cost of manufacturing is also always inherent to conventional turbines due to the necessity of forgings, castings, and multi axis machining operations.

[0004] Nikola Tesla 1856-1943, was well known for his contribution to the AC power system, radio, wireless electricity, magnetics, x-ray and electron microscope among hundreds of others inventions. One invention in 1910, U.S. Pat. No. 1,061,206 and British Patent No. 24,001, outlined a turbine design with a rotor consisting of discs with openings in the central areas and separating star washers. When assembled, these parts are riveted together into a single, solid structure and keyed to the shaft. Tesla's improvements to this design came in 1922, British patent number 186,082, and utilized heavier end plates on each side of the rotor that were machined tapering toward the periphery for the purpose of reducing the maximum centrifugal stress as much as possible. The star washers were of a radial design and meant to be of a diameter approximately two thirds of the diameter of the rotor. All of the discs, end plates and star washers were fitted on and keyed to a sleeve threaded at both ends and equipped with nuts and collars for drawing the laminations tightly together. This sleeve design allowed the rotor to be removed from the shaft during assembly or disassembly and remain in one unit.

SUMMARY OF THE INVENTION

[0005] This invention relates to improvements in the construction of the Tesla turbine, (British Patent No. 186,082), and more particularly to the simplification, increased speed of assembly, lower cost of labor and materials for the rotor as well as elimination in the need for shaft sealing. This will allow for bearing and shaft cooling and also the internal cooling of the rotor for the purpose of lengthening the life of the discs while retarding the warpage.

[0006] It is an objective of the invention to eliminate the need for machine tapering the end plates and instead utilize heavy discs or plates in a stepping fashion to achieve the same purpose and thus greatly reduce assembly time, cost of labor and machining.

[0007] It is another objective of the invention to bolt the stepping discs or plates together to form a stepped end plate unit. This stepping end plate unit can then be mounted in a lathe and lightly machined to preferred tolerances if desired.

[0008] It is a further objective of the invention to eliminate the sleeve construction and manufacture the stepped end plates, discs and star washers to fit directly to the shaft held on with standard shaft nut design and shaft bosses. The rotor will hold together as one unit using special tapered head bolts (flat socket head cap bolts) with matching tapered nuts to create a flush finish as described in the next paragraph.

[0009] It is a further objective of the invention to utilize specially designed tapered head bolts (flat socket head cap bolts) with matching tapered nuts to hold the stepped end plates and the entire rotor assembly together as one unit. The bolts consist of a standard flat socket head cap jbolt utilizing a heavy hex nut of the same size that is machined to the same taper as the bolt head.

[0010] When inserted and torqued the finish is flush on both sides and can be removed for disassembly unlike the use of rivets. This new bolt design greatly speeds up the turbine rotor construction, eliminates the need for the use of a sleeve and lowers the costs of the rotor by reducing labor and machining.

[0011] It is a further objective of this invention to eliminate any shaft seals or sealing in the housing and instead utilize large openings in the area where the shaft enters the turbine housing. The smaller disc or plate on each of the stepped end plate assemblies have milled slots starting at the periphery of the shaft nuts and terminating at the gas discharge openings or the rotor. The spinning centrifugal effect of the slotted disc draws ~esh air into the central area of the rotormovlng outwards towards the discharge openings that is exited into the turbine housing. This action of the incoming fresh air helps cool the central solid laminated mass of the rotor and allows a heat transfer to take place from the periphery of the rotor discs moving inward towards the central mass of the rotor. This cooling stabilizes the thermal growth of the discs, lengthens the life of the disc, retards disc warpage and discharges the heated fresh air out of the discharge manifold along with the gas exhaust.

[0012] It is an objective of the invention for the present turbine to have blades with expansion properties such as a conventional turbine (radial inflow or axial) and discs with adhesive properties such as Tesla disc turbine.

[0013] It is another objective of the invention to be free of forgings, castings, and multi axis machining operations.

[0014] It is a further objective of the invention to have the lowest cost possible and still maintain high durability, dependability with acceptable efficiency.

[0015] It is a further objective of the invention: to utilize blades made from standard sheet metal stock of the desired thickness and alloy that would incorporate I full row of blades, bolt holes and a central hole for shaft mounting.

[0016] It is a further objective of the invention to utilize discs with the same diameter as the blades and have discharge parts for the exiting gasses and be made from standard sheet metal stock of the desired thickness and alloy.

[**0017**] It is a further objective of the invention to utilize the blades and the discs in alternating rows or layers to form a complete radial inflow turbine rotor of the desired size and thickness.

[**0018**] It is a further objective of the invention to utilize the edge of the blades to perform work instead of the blade faces, thus decreasing stresses and wear.

[**0019**] It is a further objective of the invention to utilize discs mounted on each side of the blade rows to capture the working fluid and channel it to the blades, to add power to the rotor by adhesion, to help remove heat away from the blades, and to keep the blades straight in order to eliminate twisting and vibrating.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0020**] **FIG. 1** shows the prior Tesla improvement in the construction of steam and gas turbines, continue as described in British patent No. 186,082, representing an improvement in his turbine design showing in his earlier U.S. Pat. No. 1,061,206 and British patent No. 24,001. The turbine of **FIG. 1**, shows tapering end plates **1**, rotor discs **2**, exhaust ports **3**, star washers **5**, rivets **6**, shaft sleeve **7**, retaining nuts **8** and the shaft **9**.

[**0021**] **FIG. 2** shows a cross sectional view of the improvements of the stepping end plates **1,2,3**, and the absence of the shaft sleeve design **7** of **FIG. 1**, for an embodiment of the invention. **FIG. 2** also details shaft collar **4**, shaft step boss **5**, shaft **6**, discs **7**, shaft nut **8**, exhaust openings **9**, special tapered bolts and nuts **10**, turbine rotor assembly **11**, rivets **21** and star washers **22**, for embodiments of the invention.

[**0022**] **FIG. 3** is a side elevational view of the stepped end plate assembly **1,2,3**, shaft nut **8**, exhaust ports **9**, bolting holes **10**, shaft bore **12** and milled grooves **13**, of the invention.

[**0023**] **FIG. 4** is a cross sectional view of the stepped end plate assembly, plates **1,2,3**, exhaust ports **9**, shaft nut **8**, tapered bolts **10**, and the shaft bore **12**, of the invention.

[**0024**] **FIG. 5** is a cross section of the flat socket head cap bolt **10**, with matching tapered nut **10**A, for an embodiment of the invention.

[**0025**] **FIG. 6 A** is a cross sectional view of the stepped turbine housing **16**, matching the stepped end plates **1,2,3**, and the working fluid and cooling air flows. Also included are shaft **6**, exhaust ports **9**, exhaust piping **14** and the exhaust manifold **15**, stepped housing **16** and cooling air duct **18**, for various embodiments of the invention.

[**0026**] **FIG. 6B** is the side elevational view of the housing of **FIG. 6**A, showing stepped housing **16**, exhaust manifold **15**, shaft **6** and the exhaust piping **14**, of the invention.

[**0027**] **FIG. 7** shows a side elevational view of the turbine housing (same as **FIG. 6B**) with the addition of mounting feet **20** and inlet nozzle **17**, for an embodiment of the invention.

[**0028**] **FIG. 8** is a cross sectional view of the present turbine with arrows depicting the working fluid inlet flow A, the fresh cooling air inlet flow B, the mixed flows of AB exiting the rotor and entering the exhaust manifold and the total exhaust C. Also included is the complete rotor **11**, with stepped end plates **1**, **2**, **3**, discs **7**, shaft **6**, exhaust ports **9**, rotor **11**, exhaust piping **14**, exhaust manifold **15**, stepped housing **16**, nozzle port **17**, cooling air duct **18**, bearings **191**, mounting feet **20**, rivets **21**, star washers **22**, for embodiments of the invention.

[**0029**] **FIG. 9** shows the disc **7** with the bolt holes **10**, exhaust ports **24** and the shaft bore opening **12** of the invention.

[**0030**] **FIG. 10** shows the rotor blades **25** with the bolt holes **10**, blades **23** and the shaft bore **12** of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[**0031**] Note that with reference to the first embodiment of the invention of **FIG. 2** through **7**, and portions of **FIG. 8**, only discs **7** are provided for converting fluid flow through the housing **16**, **19** into a mechanical rotation. In a preferred embodiment of the invention, the rotor blades **25** of **FIG. 10** are included between each successive pair of discs **7**, as shown in **FIG. 8**. Also, as shown in **FIG. 8**, inlet air "A" is directed into the housing through an air inlet port **17** located on the case ring **19** (also see **FIG. 8**).

[**0032**] In this improved design (**FIG. 2**), I utilize three heavy discs or plates (**1,2,3**), with varying diameters, creating a stepping end plate effect. The original Tesla design (**FIG. 1**) utilizes tapering end plates (**1**), which are difficult and expensive to machine. To simplify the original design further, I employ discs **7** (see **FIG. 2**) which are bored and fitted directly to the shaft (**6**) and the entire rotor shaft assembly (**11**) is bolted together utilizing special bolts and tapered nuts (**10**). This arrangement allows for the rotor (**11**), to be assembled quickly and less expensively and allows for the rotor (**11**), to be installed or removed from the shaft (**6**) while remaining in one unit thus totally eliminating a sleeve arrangement **7** (see **FIG. 1**). **FIG. 4** shows this new design more clearly with plates **1**,**2** and **3** bolted together (**10FIG. 3**), to form a stepped end plate assembly. When used as a gas turbine, the large plate **1** (**FIG. 4**), can be constructed of a higher alloy material such as 310SS, Enco 600 or ect, due to higher temperatures, while plates **2** and **3** can be constructed from a lower alloy such as 304SS, 316SS or ect because the heat is lower in this area thus reducing cost. The bolts utilized in holding the stepped end plates together (**10FIG. 3**) and also used in holding the rotor assembly together (**10FIG. 2**), are configured into a unique arrangement (**FIG. 5**) utilizing a flat socket head cap bolt **10** and a matching tapered nut **10**A. This allows easy assembly and disassembly of the turbine rotor (**11FIG. 2**) and eliminates the need for a shaft sleeve (**7FIG. 1**) for the purpose of holding the rotor together as one unit and is utilized in holding together the stepped end plates **1,2,3**, (see **FIG. 3** and **4**) for easy rotor construction.

[**0033**] The improvements to N. Tesla's British Patent number 186,082 are further accomplished by eliminating all shaft sealing methods creating a cavity or duct (**18**, FIG. g) surrounding the shaft (**6**) allowing for a flesh air passage directly to the stepped end plate (**3**). As the turbine rotor rotates (II), the milled slots in the small plate (**13FIG. 3**), draws fresh air into the turbine (**11FIG. 8**) (due to centrifugal action) through the cool air duct (**18FIG. 8**) across the slotted grooves (**13FIG. 3**) and discharging into the exhaust manifold (**15FIG. 8**) and out of the exhaust pipe (**14**). This allows heat to be removed from the shaft in the area between the bearing (**6**) and the turbine rotor, thus regulating the temperature of the bearings. This cooled air after entering the turbine between the housing **16** (**FIG. 8**) and the rotor(**11**) draws heat off of the central mass of the stepped end plate (**3**). This cooling process or heat regulation creates a heat sink drawing heat away from the rotor discs (**7FIG. 8**) which prolongs life and retards warpage.

[**0034**] In this improved turbine rotor design I employ discs or plates **FIG. 91** at the full diameter of the rotor, constructed of sheet metal of uniform thickness and alloy, exhaust ports **24**, arranged in a suitable manner, bolt holes **10**, located in the desired locations, and a central opening **12**, for shaft mounting. In between each disc, I utilize one row of blades **25**, **FIG. 10**, constructed of sheet metal of uniform thickness, cut on a taper for strength, made at the full diameter of the rotor, and constructed in such a manner to accommodate the exhaust ports **24**, bolts holes **10** and shaft opening **12**. When assembled to the desired width, the discs **7** and blades **25** form a layered or laminated assembly.

[**0035**] Referring to **FIG. 8**, in one embodiment, operation of the apparatus is begun by delivering hot exhaust gas, (spent methane, waste gasses, other combustible fuels), steam or other high pressure gasses into the periphery of the housing structure **16**, via the nozzle **17**, located on the case ring **19**. As the gas (working fluid) passes through the nozzle **17**, the pressure of the gas is converted into a high velocity stream by virtue of the nozzle restriction or throat and then enters between the rotor discs **7**. Due to the nature of viscosity and adhesion, the rotor discs **7** absorb the energy of the high velocity gas as it spirals towards the exhaust ports **9**. The gas then enters the exhaust manifold **15** and exits from the apparatus via the exhaust piping **14** as the turbine rotor **11** rotates, fresh air is drawn into the cooling air ports **18**, due to the spinning centrifugal effect of the milled slots **13**, **FIG. 3**, cut into the face of the stepped plate **3**. This incoming air cools the bearings **191**, **FIG. 8**, the shaft **6** and the central core of the rotor **11**. This cooling air is then discharged along with the working fluid gas out of exhaust ports **9**, the exhaust manifold **15** and then discharged from the apparatus via the exhaust piping **14**. The net result is a spinning action of the turbine rotor **11**, absorbing the energy entering through the nozzle **17**, producing output power for electrical generation, driving compressors, pumps, etc. and other miscellaneous prime moving.

[**0036**] Operation of the apparatus begins in another embodiment of the invention by delivering hot exhaust gas, (spent methane, waste gas, other combustible fuels), steam or other high pressure gasses into the periphery of the housing structure **16**, **FIG. 8**) via the nozzle **17**, located on the case ring. **19**. (This can be clockwise or counter clockwise rotation) as the gas (working fluid) passes through the nozzle **17**, the pressure of the gas is converted into a high velocity stream by virtue of the nozzle restriction or throat and then enters between the rotor discs **7**, (**FIG. 8** and **9**). Upon entering between the disc **7**, the gasses give energy to the discs **7** by virtue of adhesion. Concurrently, the gasses impinge and expand against the blades **23**, (**FIG. 10**), where the majority of—the energy is the absorbed. The gasses then travel along the radial blades **23**, and discharge into the exhaust Ports **24** (see **FIG. 9**).

[**0037**] Although various embodiments of the invention have been shown and described, they are not meant to be limiting. Those of skill in the art may recognized certain modifications to these embodiments, which modifications are meant to be covered by the spirit and scope of the appended claims.

What is claimed is:

1. A Tesla turbine, wherein the improvement comprises:

a rotor shaft; a plurality of rotor discs each having a given outside diameter, and each including a plurality of spaced apart exhaust ports arranged in a circle of smaller diameter than said outside diameter, a plurality of spaced apart bolt holes arranged in first and second concentric circles, all of which are centered about a centrally located shaft opening for receiving a portion of said rotor shaft; a plurality of rotor blades, each including a plurality of radially directed, equally spaced, successive blades arranged in a circle about a centrally located hub portion, a plurality of spaced apart bolt holes arranged in first and second concentric circles, all of which are centered about a centrally located shaft opening for receiving a portion of said rotor shaft, said plurality of blades and hub being formed ~om a single piece of material; alternating ones of said plurality of rotor discs and plurality of rotor blades being assembled on said rotor shaft, with said exhaust ports of the former opening into the spaces between associated said blades, thereby forming a rotor assembly; a housing including:

two opposing end plates; a case ring between said end plates, said case ring providing a circumferential portion of said housing; a fluid inlet port located on said case ring of said housing; said assembly of said plurality of rotor discs and plurality of rotor blades on said rotor shaft being rotationally mounted within said housing; and an exhaust manifold being mounted on said housing for receiving exhaust fluid expelled from said rotor assembly and housing.

2. A turbine utilizing the edge of turbine blades as the working surface instead of the blade's face.

3. A turbine comprising both expansion blades and adhesion discs.

* * * * *