

July 11, 1950

P. KOLLSMAN
U-PASSAGE GAS TURBINE WITH TURBULENT
HEAT TRANSFER ZONE

2,514,875

Filed Aug. 29, 1945

3 Sheets-Sheet 1

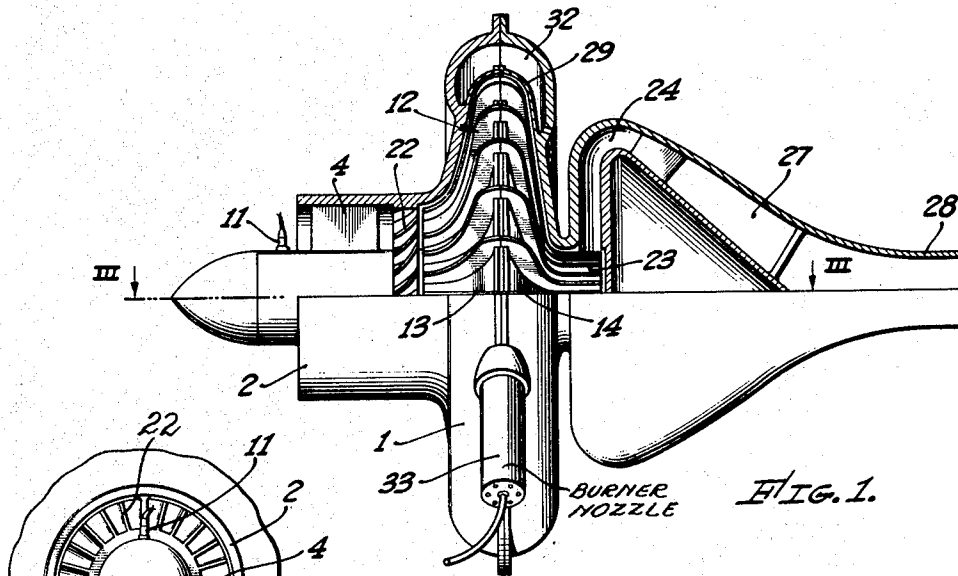
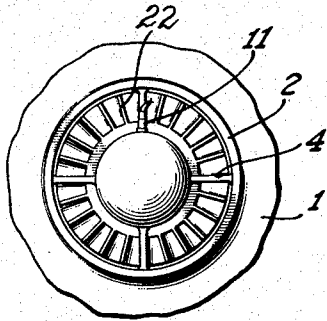


FIG. 2.

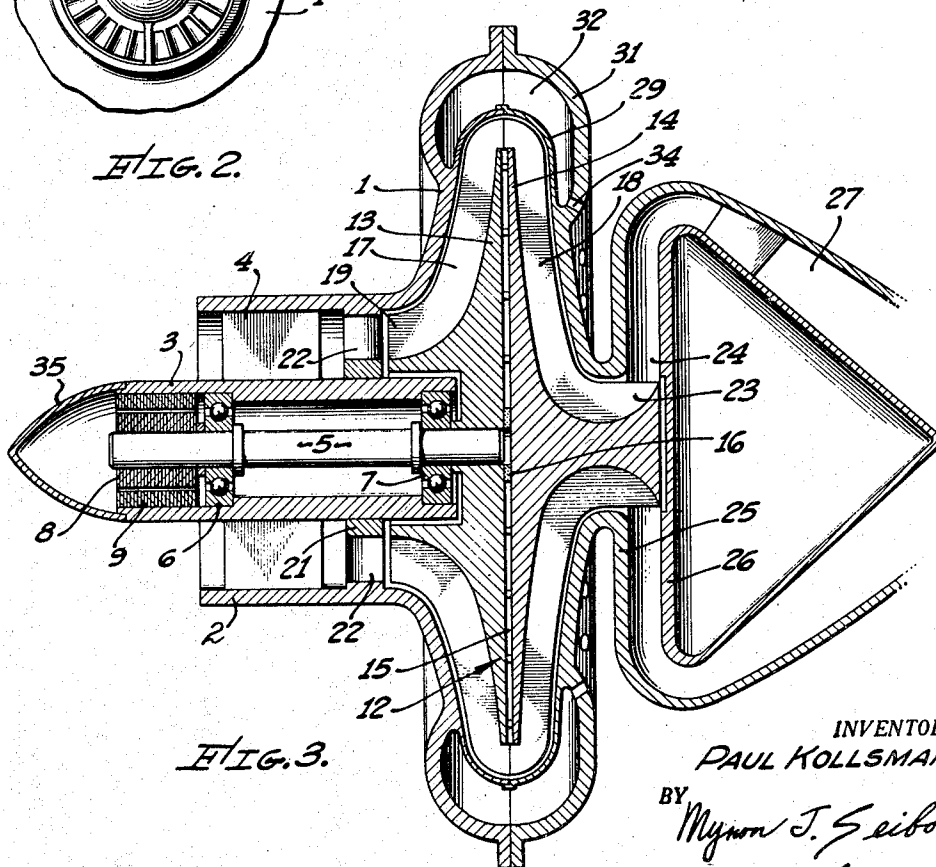


FIG. 3.

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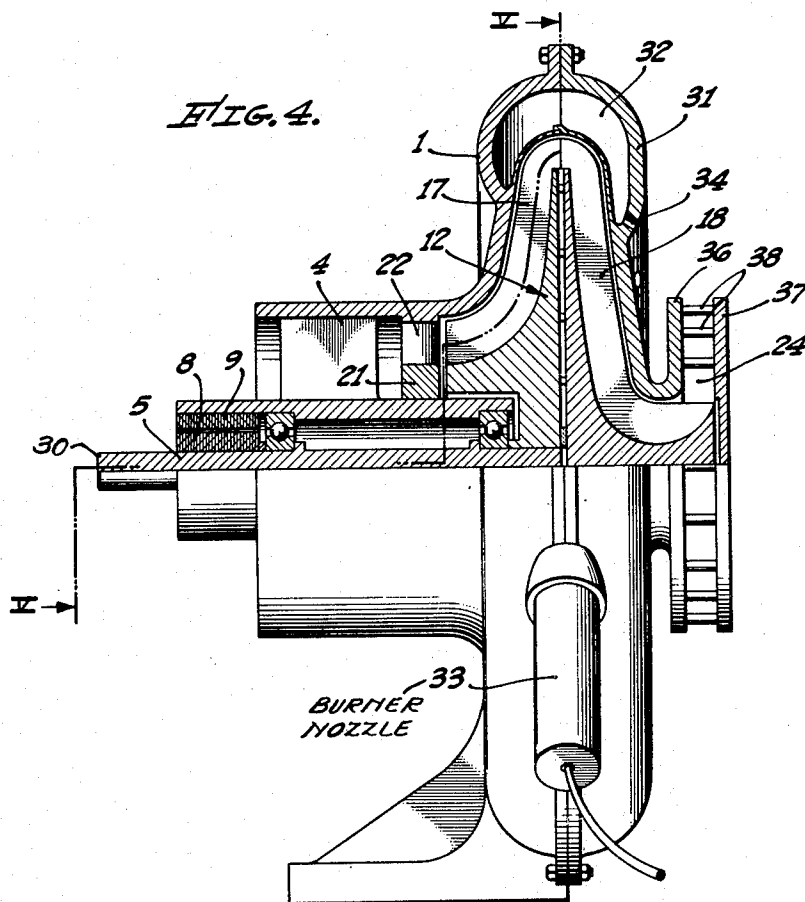
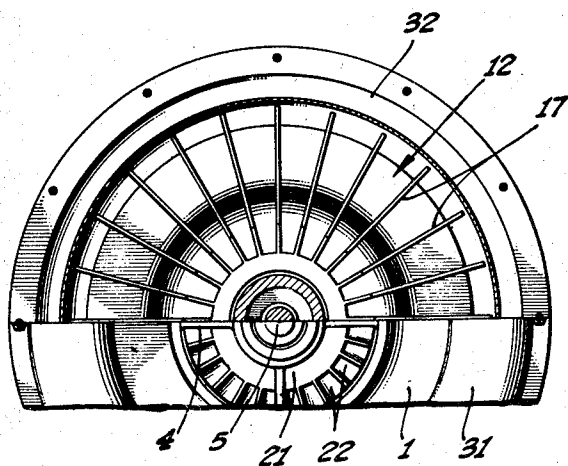
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3 Sheets-Sheet 2



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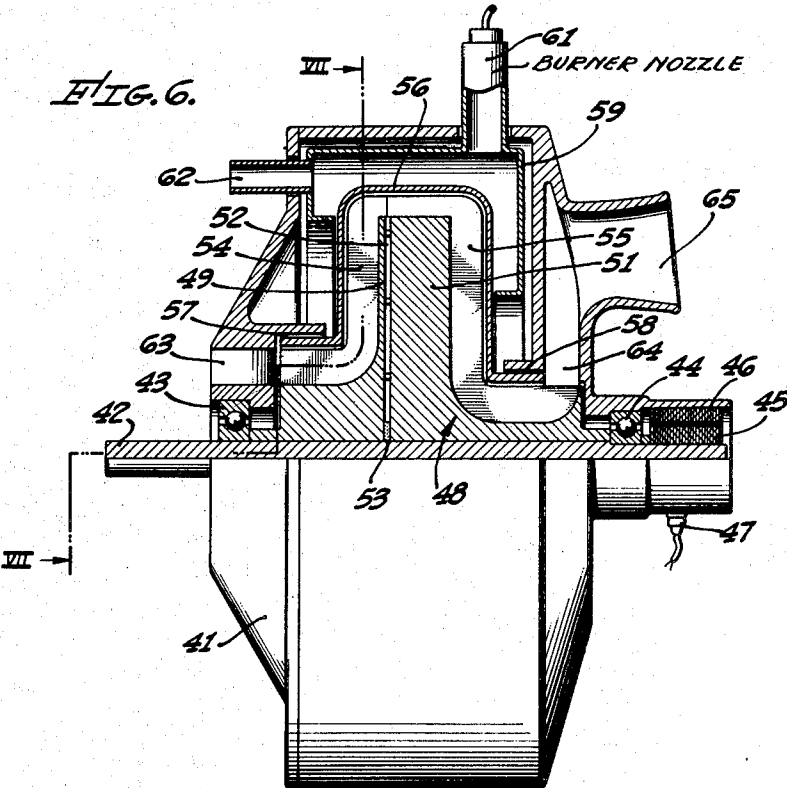
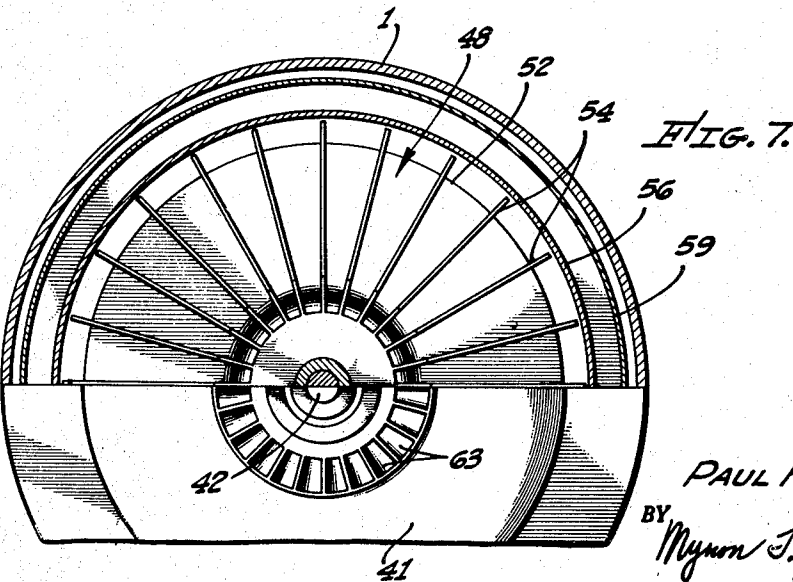
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3 Sheets-Sheet 3



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U-PASSAGE GAS TURBINE WITH TURBULENT HEAT TRANSFER ZONE

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7 Claims. (Cl. 60-41)

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This invention relates to a thermodynamic engine for converting heat energy into mechanical energy.

One object of the invention is the provision of a thermodynamic engine in which air or other gas is rotated to effect a compression-expansion cycle with the introduction of heat energy into the compressed gas, in which the rotational energy of the gas is imparted to the engine to effect its rotation.

Another object of the invention is the provision of a thermodynamic engine in which air or other gas is rotated to effect a compression-expansion cycle, with heat imparted to the compressed gas, with the rotational energy of the gas returned to the engine to effect its rotation and with the gas collected and discharged through a jet nozzle to produce a reactive force.

Another object of the invention is a provision of a thermodynamic engine providing a substantially U-shaped rotatable path in which air or other gas is subjected to a compression-expansion cycle, the flow of gas through the path being effected by the difference in the action of centrifugal force on the different density gas in the legs of the U, with an annular diffuser through which the gas is discharged to convert its rotational energy to assist the flow of gas through the path, and in which mechanical energy may be taken directly from the rotating parts or in which the gas emerging from the path may be discharged through a jet nozzle to secure a reactive thrust.

Other objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawings illustrating certain preferred embodiments in which:

Figure 1 is a view partly in section and partly in elevation of an engine according to the present invention.

Figure 2 is a partial elevational view of the engine.

Figure 3 is a vertical sectional view through the engine on plane III-III of Figure 1.

Figure 4 is a view partly in vertical section and partly in elevation of a modified form of the invention.

Figure 5 is a partial sectional view on the line V-V of Figure 4.

Figure 6 is a view partly in vertical section and partly in elevation of a further modification of the invention.

Figure 7 is a partial view on the line VII-VII of Figure 6.

In the form of the invention shown in Figures

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1, 2, and 3 there is provided a stationary exterior casing 1 having a forwardly extending cylindrical portion 2 in which is supported an interior, stationary, cylindrical portion 3 by means of spider legs 4. Within the cylindrical portion 3 is mounted a rotatable shaft 5 as by means of bearings 6 and 7. Upon the forward end of shaft 5 is mounted a rotor 8 of an electrical starting motor whose stator is indicated at 9 and the wiring connection at 11. Upon the inner end of the shaft 5 is mounted a rotor indicated generally at 12 and comprised of sections 13 and 14 joined together in spaced relations to provide an insulating space 15 therebetween. Adjacent to the axis of the rotor the space 15 is filled by an insulating seal 16.

Upon the sections 13 and 14 of the rotor 12 are mounted a plurality of circumferentially spaced, radially disposed fins 17 and 18 arranged in aligned relation so as to divide the space between the rotor 12 and the interior walls of the casing 1 into a plurality of individual substantially U-shaped passages or chambers. The fins 17 have axially extending portions 19 directed toward the air inlet provided between the cylindrical portions 2 and 3 and about the cylindrical portion 3 is disposed a ring 21 carrying a plurality of directional vanes 22 which curve in the direction of rotation of the rotor 12 and serve to direct the incoming gas to the passages between the fins 17 with a substantial tangential velocity. The inward ends of the fins 18 have axially extending portions 23 with the gas therebetween passing into a diffuser passage 24 formed between parallel annular walls 25 and 26; the gas passing from the outlet of diffuser 24 into a collector 27 and being thence discharged through a jet nozzle 28 to produce a reactive working thrust.

Adjacent the bights of the U-shaped passages or chambers the casing 1 is provided with double walls 29 and 31 having a space 32 therebetween for the reception of a heating medium, here illustrated as gases of combustion from a burner nozzle 33 which are directed into the chamber 32. The inner wall 29 is shown as a relatively thin section to facilitate heat exchange and this wall is preferably formed of a material effecting the transfer of heat with high efficiency. The heat exchange wall 29 extends not only around the bights of the U-shaped chambers but preferably for a distance along the legs of the passages between fins 18. The heating gases within chamber 32 are discharged through outlet orifices 34. The legs of the passages or chambers between fins 17 and 18 are of unequal length with the out-

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let leg between fins 18 extending the greater distance toward the axis of the rotor. A streamlined cap 35 is provided to reduce the air resistance which the elements in the cylindrical portion 3 would otherwise offer to movement.

In the operation of the machine the rotor is initially brought up to a considerable speed by energizing the electric motor formed by stator 9 and rotor 8. Heat is supplied to the chamber 32 from the burner nozzle 33 to heat the gases compressed adjacent to the periphery of the engine. The air or gas in the passages between fins 18 will be at a considerably higher temperature than that between fins 17 and the difference in density of the air in the columns and the action of centrifugal force thereon will effect a flow of air through the passages from the intake portion 19 to the outlet portion 23. The incoming air will be directed with a substantial tangential velocity by the vanes 22 to facilitate its entrance into the passages between the fins 17. The rotational energy imparted to the gas in its travel through the rotor passages between fins 17 will not only be returned to the machine in its movement inwardly toward the axis in the passage between the fins 18, but an additional rotational energy will be imparted to the rotor by the greater length of the passage between fins 18 and by the heat energy imparted to the gas. The annular diffuser 24 converts the rotational energy of the gases passing thereinto from the passage outlets between fin portions 23 into pressure energy and increases the normal flow of air through the U-shaped passages. The air emerging from the outlet of diffuser 24 passes into the collector 27 and is finally discharged through the jet nozzle 28 to provide a reactive forward thrust.

In the form of the invention illustrated in Figures 4 and 5 the engine is quite similar to that illustrated in Figures 1, 2, and 3 but the mechanical energy is now taken from the machine from the rotor shaft. Like parts in the machine have been given like reference numerals. The principal changes in the machine of Figures 4 and 5 lie in the omission of the collector 27 and nozzle 38, the working extension of shaft 5, and the change in the relative lengths of the legs of the U-shaped gas passages. The rotatable shaft 5 is provided with an extension 30 to which a power connection can be made and the diffuser opening 24 is provided between parallel annular walls 36 and 37 joined together by spaced pins 38 with the air from the diffuser outlet discharged into the atmosphere.

In the form of the invention of Figures 4 and 5 the legs of the passages between fins 17 have been made considerably shorter than legs of the passages of the machine of Figures 1, 2 and 3 to secure a greater difference in length between the incoming and outgoing legs. In the machine of the Figures 1 through 3 it is desirable to have a considerable pressure energy in the gas passing into the collector 27 with only sufficient rotational energy imparted to the rotor 12 to effect its self-rotation at the high speeds of operation of the machine.

In the form of the invention of Figures 4 and 5 it is desired that the gas emerging from the diffuser 24 have little pressure energy and that the energy of the gas passing through the engine be delivered to the rotor 12 in the form of rotational energy; therefore, the difference in length of the two legs of the U-shaped passages is made considerably greater in the form of the invention of Figures 4 and 5 to secure the transfer of the

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major portion of gas energy to the rotor in the form of rotational energy.

While the connecting bights for U-shaped passages in the modifications of the invention shown in Figures 1 through 5 have been shown as relatively short, it will be understood that they may have a considerable axial extension where desired for the heat energy to be imparted to the gas passing through the engine.

The modification of the invention shown in Figures 6 and 7 is similar in its operation to that shown in Figures 4 and 5 and its general construction may also be utilized with the collector and jet nozzle of Figures 1 through 3. The engine shown in Figures 6 and 7 comprises an outer casing 41 within which is mounted a rotatable shaft 42 on bearings 43 and 44. On shaft 42 is mounted a rotor 45 of an electric motor whose stator is indicated at 46 and the wiring connection there- to at 47. Upon shaft 42 is mounted a rotor, indicated generally at 48, and comprising a pair of sections 49 and 51 mounted together in spaced relation to form an insulating space 52 therebetween. Adjacent the axis of the engine the space 52 is closed by a solid insulating seal 53. Upon sections 49 and 51 of the rotor 48 are mounted circumferentially spaced, radially disposed fins 54 and 55 which are aligned to form a plurality of individual substantially U-shaped passages or chambers. About the rotor fins there is disposed a casing 56 formed of a material effecting transfer of heat with high efficiency, which casing is freely rotatable on the bearings 57 and 58 as a follower by air drag from the rotation of the air in the rotor chambers. Within casing 1 and about the periphery and one side of the casing 56 is disposed a stationary casing 59 into which are directed combustion gases from a burner nozzle 61 with the combustion gases exhausted through an outlet 62.

For directing the incoming air or gas there are provided a plurality of vanes 63 similar to vanes 22 of the forms of the invention shown in Figures 1 through 5, the vanes 63 also serving to mechanically support the stationary portion containing bearing 43. Gas discharging from the engine from the passages between fins 55 passes through a diffuser passage 64, formed by parallel annular walls in the casing, to an outlet 65, from which they are exhausted to atmosphere in the case of an engine where mechanical energy is taken from the rotor shaft or from which they are collected and discharged from a jet nozzle as shown in the modification of Figures 1 through 3.

The operation of the engine of Figures 6 and 7 is similar to that previously described, the rotor 48 being initially brought up to a considerable speed by the electric motor and heat supplied from the chamber 59 through the walls of casing 56 to the compressed gas within the gas passages. Again the air flows through the gas passages by the difference of density in the columns of the incoming and outgoing legs and the gas passing inwardly toward the axis between fins 55 returns its rotational energy to the rotor 58. The outgoing legs of the gas passages are again made longer than the incoming legs with resultant rotational mechanical energy supplied to the rotor of the engine. The diffuser 64 again serves to convert the rotational energy of the gas passing therethrough to assist the normal flow of air through the rotor passages.

While the air or gas in the rotor passages in the forms of the invention illustrated in Figures

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1 through 5 is rotated in contact with a stationary casing, in the form of the invention shown in Figures 6 and 7 the casing 50, forming the outer boundary wall for the U-shaped passages, is free to rotate as a follower to the rotor 48 which it will do at substantially one-half speed with a theoretical reduction in air frictional losses to one-fourth.

While the legs of the gas passages have been referred to herein and in the appended claims as being radial it will be understood that they may have any direction from the axis toward the periphery which has a radial component.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. A gas turbine comprising a stationary casing, a rotor within said casing, said rotor including a body and a plurality of circumferentially spaced substantially radially extending blades on said body, said blades together with said body defining a plurality of substantially U-shaped rotor channels which together with the interior wall of the casing constitute individual and separate U-shaped passages, the legs of the U extending substantially radially and the bight of the U lying remote from the rotor axis, the two legs of the passages being of unequal length, the end of the shorter leg constituting an intake port and the end of the longer leg constituting an outlet port located closer to the axis than the inlet port, said blades constituting continuous channel walls within the leg portions and the bight portion of said passages separating said passages from one another at the bight portion, and means associated with the casing for supplying heat to the portion of the casing wall at the bight of said U-shaped passages, whereby gas passing through said passages and compressed by centrifugal force is heated by transfer of heat from said casing within the area of greatest compression in a state of turbulence promoted by the movement of said passages relative to said interior wall, the heated gas expanding in its flow towards the discharge port transmitting energy to the rotor.

2. A gas turbine as set forth in claim 1 in which the heat transferring wall portion of the casing extends with a greater area over said longer leg than it extends over the shorter leg of said passages.

3. A gas turbine comprising a casing, a rotor within said casing, said rotor including a body and a plurality of circumferentially spaced substantially radially extending blades on said body, said blades together with said body defining a plurality of substantially U-shaped rotor channels which together with the interior wall of the casing constitute U-shaped passages, the legs of the U extending substantially radially and the bight of the U lying remote from the rotor axis, the two legs of the passages being of unequal length, the end of the shorter leg constituting an intake port and the end of the longer leg constituting an outlet port located closer to the axis than the inlet port, the said passages at the outlet port being of concave curvature with respect to the axis to discharge gas therefrom in a substantially radial outward direction, means associated with the casing for supplying heat to the portion of the casing wall at the bight of said

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U-shaped passages, whereby gas passing through said passages and compressed by centrifugal force is heated by transfer of heat from said casing within the area of greatest compression, the heated gas expanding in its flow towards the discharge port transmitting energy to the rotor, and a diffuser adjacent said discharge passages, the diffuser including lateral walls defining between them a space progressively enlarging with the distance from the axis, the lateral walls being substantially symmetrically arranged with respect to the outward direction of the discharged gas.

4. A gas turbine as set forth in claim 3 in which the lateral walls of the diffuser are substantially symmetrically arranged with respect to a central plane lying parallel with the plane of largest diameter of the rotor.

5. A gas turbine comprising an outer enclosing member; a core member within said outer member, one of said members being rotatable relatively to the other about an axis, the other member being stationary, the interior surface of the outer member and the exterior surface of the inner member providing an interior space between them, the rotatable member being provided with a plurality of circumferentially spaced substantially radially extending blades subdividing the interior space into a plurality of substantially U-shaped channels which together with the wall of the stationary member constitute individual and separate U-shaped passages, the legs of the U extending substantially radially and the bight of the U lying remote from the axis, the two legs of the passages being of unequal length, the end of the shorter leg constituting an intake port and the end of the longer leg constituting an outlet port located closer to the axis than the inlet port, said blades constituting continuous channel walls within the leg portions and the bight portion of said passages separating said passages from one another at the bight portion; and means associated with the stationary member for supplying heat to the wall portion of the stationary member at the bight of the said U-shaped passages, whereby gas passing through said passages and compressed by centrifugal force at the bight is heated by transfer of heat from said wall portion within the area of greatest compression, transfer of heat being promoted by the flow of gas within said passages and also by the relative movement of said passages with respect to said wall portion, the heated gas expanding in its flow towards the discharge port and transferring energy to the blades of the rotating members.

6. A gas turbine comprising an outer enclosing member, a core member within said outer member, one of said members being rotatable relatively to the other about an axis, the other member being stationary, the interior surface of the outer member and the exterior surface of the inner member providing an interior space between them, the rotatable member being provided with a plurality of circumferentially spaced substantially radially extending blades, an intermediate casing within said space mounted with freedom to spin about said axis, said blades subdividing the space between the rotatable member and said intermediate casing into a plurality of substantially U-shaped channels which together with the wall of said intermediate casing constitute U-shaped passages, the legs of the U extending substantially radially and the bight of the U lying remote from the axis, the two legs of the passages being of unequal length, the end of the shorter leg constituting an intake port and the end of the longer

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leg constituting an outlet port located closer to the axis than the inlet port; and means for supplying heat to the bight of said U-shaped passages exterior of said passages, whereby gas passing through said passages is heated within the passage portion within which the gas is under greatest compression, the heated gas expanding in its flow towards the discharge port and transmitting energy to the rotor.

7. A gas turbine comprising a casing, a rotor within said casing, said rotor including a body and a plurality of circumferentially spaced substantially radially extending blades on said body, said blades together with said body defining a plurality of substantially U-shaped rotor channels which together with the interior wall of the casing constitute U-shaped passages, the legs of the U extending substantially radially and the bight of the U lying remote from the rotor axis, the two legs of the passages being of unequal length, the end of the shorter leg constituting an intake port and the end of the longer leg constituting an outlet port located closer to the axis than the inlet port, the body of the rotor comprising two portions, one portion being adjacent said shorter leg and the other portion being adjacent the longer leg, said two portions being separated by an area having poorer heat conductivity than the said

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portions, and means associated with the casing for supplying heat to the portion of the casing wall at the bight of said U-shaped passages, whereby gas passing through said passages and compressed by centrifugal force is heated by transfer of heat from said casing within the area of greatest compression, the heated gas expanding in its flow towards the discharge port transmitting energy to the rotor.

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