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GAS TURBINE HOUSING

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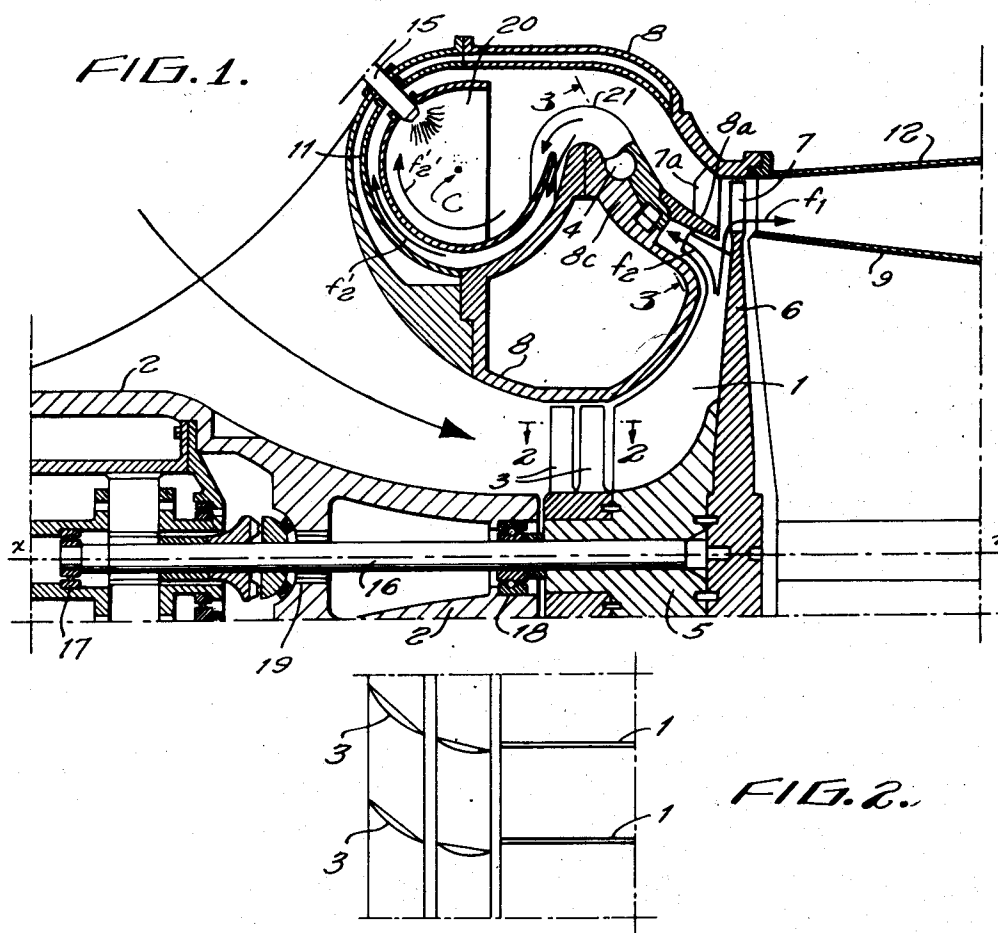
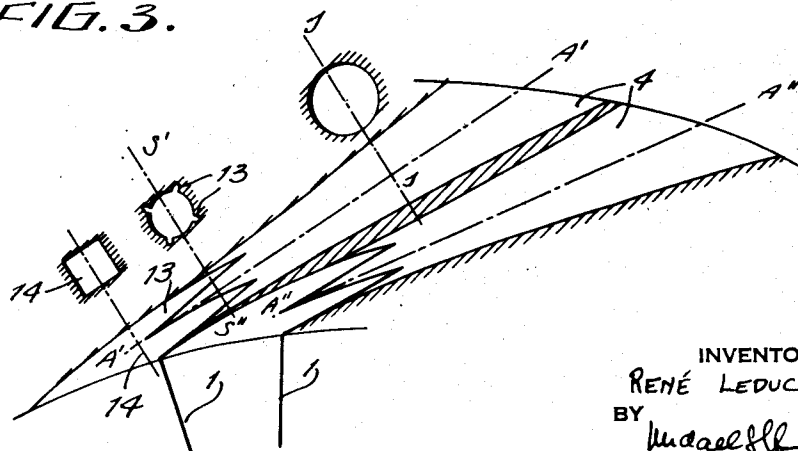


FIG. 3.



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GAS TURBINE HOUSING

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2 Claims. (Cl. 60—39.36)

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This invention relates to gas-turbine engines of the kind in which a centrifugal compressor is directly coupled to a turbine and a fixed combustion chamber is located intermediate in the flow path between the compressor outlet and the turbine inlet, and especially to gas-turbine engines of this kind designed to run at very high speeds of the order of 30,000 R. P. M.

An object of the invention is an arrangement of the compressor-turbine assembly by which air for cooling the turbine blades, the rim of the turbine-wheel and the inner wall of the turbine-exhaust annulus is delivered directly from the impeller of the compressor into the turbine annulus, the impeller being closely adjacent, and optionally integral with, the turbine wheel.

Another object of the invention is the provision of a special form of combustion chamber which ensures adequate turbulence and the formation of a layer of cool air between the outer wall of the combustion chamber and the flame region.

The preferred combustion-chamber arrangement comprises a single annular combustion chamber in the form of a solid of revolution struck about the compressor-turbine axis, of generally toroidal shape. Within this is preferably mounted an internal partition of similar general shape to the outer wall of the combustion chamber and spaced at a substantially constant distance from the outer wall; this partition extends to the entry of the combustion chamber and serves to divide the entering air into two streams of which the outer stream flows between the partition and the outer wall which it follows without separation and serves to cool the wall and partition, while the inner stream supplies the primary combustion air.

The said partition is preferably supported on stays which converge inwardly towards the compressor-turbine axis, on which the partition has at least limited freedom to move axially of the stays, thus permitting the partition to expand freely. The convergent stays may advantageously be constituted by the fuel-burners themselves.

Another object of the invention is the provision of improved diffuser means between the compressor outlets and the combustion chamber inlets.

Preferably, the compressor outlets deliver into a number of generally trumpet-shaped diffuser passages, which may be pierced in the solid metal of a diffuser housing, the expansion-cone portion of each diffuser-passage having a straight-line axis; and the section of the expansion-cone por-

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tion, which is preferably of circular section; increases in the down-stream direction in accordance with the law,

$$\frac{d\omega}{ds} = \frac{k}{2\sqrt{\pi}} U(1-M^2)$$

where ω is the area of an orthogonal cross-section of the expansion-cone, s is the axial coordinate of the section, U the peripheral length of the section, M the local Mach number of the fluid stream, and k a coefficient depending mainly on the physical characteristics of the fluid.

The invention will be more fully understood from the following description with reference to the accompanying drawing of a gas-turbine engine in accordance therewith, which is given by way of example only and not of limitation, the scope of the invention being defined in the hereto annexed claims. In the drawing,

Figure 1 is an axial half-section of the gas-turbine engine.

Figure 2 is a detail section along the line 2—2 of Figure 1.

Figure 3 is an axial section of two adjacent diffuser ducts corresponding approximately to the line 3—3 of Figure 1.

The gas-turbine engine shown in Figure 1 comprises a centrifugal impeller 1 mounted on an impeller boss 5, which is keyed to a turbine rotor 6 carrying blades 7. The rotor assembly 1, 5, 6, 7, is mounted on a shaft 16 supported by the stationary structure 2 of the engine in bearings 17, 18, the rotor assembly being overhung on the end of shaft 16 which projects beyond the bearing 18.

A second built-up fixed structure 8 forms the impeller casing and the turbine casing, and encloses an annular combustion chamber 20 of generally toroidal shape, bounded partly by a thin wall 11 supported from the outer wall of the structure 8 and partly by an inner wall 8b of the latter structure, which together define a solid of revolution about the axis X—X of the shaft 16.

The fixed structures 8 and 2 define between them an annular air entry through which the air enters, as shown by the large arrow in Figure 1, to reach the eye of the impeller which is provided with two rows of curved inclined rotary guide vanes 3 mounted in the impeller boss 5.

An internal wall 8a of the structure 8 separates the outlet of the combustion chamber or turbine nozzle ring provided with stationary blading 1a from the peripheral part of the impeller chamber occupied by the tips of the impeller blades 1. Between the wall 8a and the rim of the turbine rotor 6 is a small gap through which a part of

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the air delivered by the impeller escapes directly into the turbine annulus, as shown by the arrow f_1 . This air serves to cool the roots of the turbine blades 7, the rim of the turbine rotor 6 and the internal wall of the turbine exhaust duct indicated at 9.

The greater part of the air delivered by the impeller follows the course indicated by arrow f_2 and enters a series of diffuser ducts 4 formed in the mass of the intermediate wall 8c of the structure 8.

Within the combustion chamber 20 is an internal partition 10 which is of the same general form as and at a substantially constant distance from the outer wall 11. Supported in the outer wall of the combustion chamber casing 8 are a number of fuel burners 51 which project into the combustion chamber 20 converging towards the axis X—X of the engine. The burners 15 also act as stays supporting the combustion chamber wall 11 and partition 10 which are free to slide in the axial direction of the burners 15, thus providing ample freedom of expansion effects.

The partition 10 extends into the mouth of an annular diffuser outlet defined by an annular hood 21 and serves to divide the air-stream f_2 issuing from the diffusers into two streams f'_2 , f''_2 , of which the outer f'_2 passes between the partition 10 and the outer wall 11 of the combustion chamber and serves to cool the outer wall to which it tends to cling, thus forming a layer of cold air next to the outer wall of the combustion chamber, which, on reaching the turbine annulus, helps to cool the tips of the turbine blades 7 and the outer wall of the turbine exhaust duct indicated at 12. The inner stream f''_2 of the air entering the combustion chamber provides the primary combustion air for the burners, and the form of the combustion chamber and its internal partition 10 ensures that the primary air is given sufficient turbulence to ensure efficient combustion. It will be seen that the air-streams through the combustion chamber follow paths of curved form looped about the circular axis of the toroidal combustion chamber. The intersection of this circular axis with the plane of Figure 1 is indicated in that figure by the point C.

The form of the diffuser ducts 4 is shown in Figure 3. The axes of these ducts are straight lines which are skewed with respect to the axis X—X of the engine, and being equally spaced round this axis they constitute the generators of a hyperboloid which is an undevelopable surface of revolution. The line 3—3 of Figure 1 is the projection of one of these duct axes on the plane of the figure, and Figure 3 is the development of a conical surface with axis X—X, whose generator is the line 3—3 of Figure 1. The lines A'—A' and A''—A'' of Figure 3 are the projections of the annular duct axes on this conical surface.

It will be seen that the diffuser ducts are trumpet-shaped and the expansion-cone parts thereof are of circular cross-section, as shown at s—s in Figure 3.

The areas and peripheries of these sections are related by the law previously stated, and the circular sections of the diffuser expansion-cones are merged into the square sections of the diffuser entry indicated at 14 in Figure 3 by means of V-shaped fillets 13.

To safeguard the shaft 16 while passing through critical whirling speeds in running up to its operating speed, which may be as high as 30,000 R. P. M., a clearance bearing 19 is interposed between the bearings 17 and 18. This bearing

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normally has a generous clearance from the shaft which is therefore supported only by the bearings 17, 18. As the shaft approaches a critical speed, however, it will deflect and come into contact with the bearing 19; the support thus provided will immediately approximately double the critical speed. If the speed continues to increase, the original critical speed is therefore passed through harmlessly and the shaft realigns itself at speeds between the (original) critical speed for two-point support and the temporary critical speed for three-point support; but once the shaft is realigned it ceases to make contact with the bearing 19 and consequently the former critical speed for two-point support is restored, the higher speed, which is only critical for three-point support, being no longer critical in the final condition. The engine may, therefore, be safely run up to its full operating speed which is normally well above the critical speed for two-point support of the shaft.

I claim:

1. In a gas turbine, in combination, an impeller having an outer periphery and being mounted for rotation about its axis; a plurality of turbine blades also mounted for rotation about said impeller axis and being located beyond said outer periphery of said impeller and adjacent thereto; and a housing having a central axis coinciding with said impeller axis and encasing said impeller and turbine blades for rotation therein, said housing being formed with an air inlet leading to said impeller, with an annular combustion chamber located about said central axis thereof and with an annular passage leading from said combustion chamber to said turbine blades, and said housing having an annular wall portion located about said central axis thereof and separating said impeller from said combustion chamber, said wall portion having an outer annular surface forming one side of said annular passage leading from said combustion chamber to said turbine blades and said wall portion being formed with a plurality of separated diffuser passages extending therethrough and each having one open end facing said impeller and an opposite open end facing said combustion chamber, said diffuser passages being evenly distributed in said wall portion and each extending along an axis which is skewed with respect to said central axis, and each of said diffuser passages increasing in cross-section from said one open end thereof to said opposite open end thereof, whereby air passing through said air inlet to said impeller must pass through said diffuser passages before entering said combustion chamber and whereby said air after entering said combustion chamber flows through said annular passage to said turbine blades, said diffuser passages decreasing the speed of the air flowing therethrough and increasing the pressure thereof.

2. In a gas turbine, in combination, an impeller having an outer periphery and being mounted for rotation about its axis; a plurality of turbine blades also mounted for rotation about said impeller axis and being located beyond said outer periphery of said impeller and adjacent thereto; a housing having a central axis coinciding with said impeller axis and encasing said impeller and turbine blades for rotation therein, said housing being formed with an air inlet leading to said impeller, with an annular combustion chamber located about said central axis thereof and with an annular passage leading from said combustion chamber to said turbine blades, and said housing having an annular wall

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portion located about said central axis thereof and separating said impeller from said combustion chamber, said wall portion having an outer annular surface forming one side of said annular passage leading from said combustion chamber to said turbine blades and said wall portion being formed with a plurality of separated diffuser passages extending therethrough and each having one open end facing said impeller and an opposite open end facing said combustion chamber, said diffuser passages being evenly distributed in said wall portion and each extending along an axis which is skewed with respect to said central axis, and each of said diffuser passages increasing in cross-section from said one open end thereof to said opposite open end thereof, whereby air passing through said air inlet to said impeller must pass through said diffuser passages before entering said combustion chamber and whereby said air after entering said combustion chamber flows through said annular passage to said turbine blades, said diffuser passages decreasing the speed of the air flowing therethrough and increasing the pressure thereof; and a plurality of stationary blades mounted in said annular passage leading from

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said combustion chamber to said turbine blades, extending across the same and being located adjacent to said turbine blades.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,926,225	Birmann	Sept. 12, 1933
1,959,703	Birmann	May 22, 1934
2,080,425	Lysholm	May 18, 1937
2,114,285	Berger	Apr. 19, 1938
2,157,002	Moss	May 2, 1939
2,256,198	Hahn	Sept. 16, 1941
2,272,676	Leduc	Feb. 10, 1942
2,408,743	Elliott	Oct. 8, 1946
2,489,692	Whittle	Nov. 29, 1949
2,556,161	Bailey et al.	June 12, 1951
2,595,505	Bachle	May 6, 1952
2,609,141	Aue	Sept. 2, 1952

FOREIGN PATENTS

Number	Country	Date
441,683	Germany	Mar. 8, 1927