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MEANS FOR COOLING TURBINE-BLADES BY LIQUID JETS

Filed April 5, 1951

2 Sheets-Sheet 1

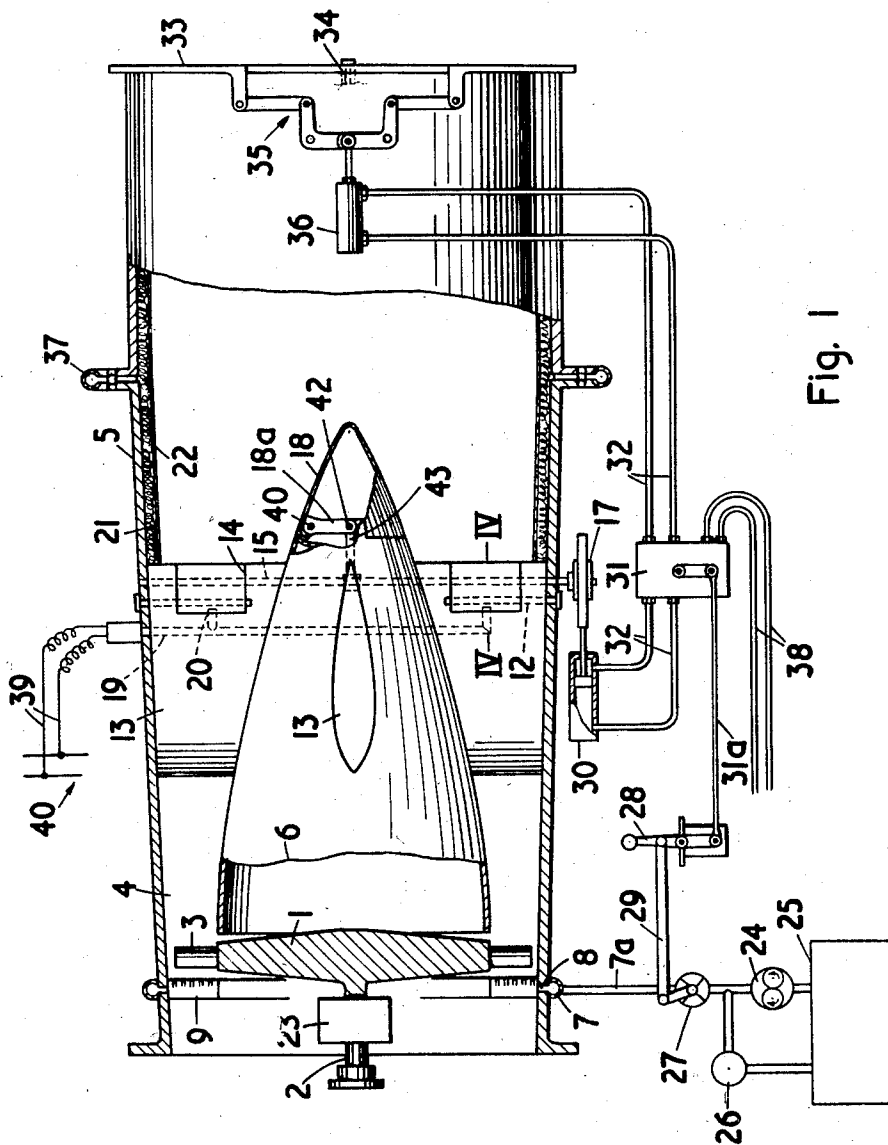


Fig. 1

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2 Sheets-Sheet 2

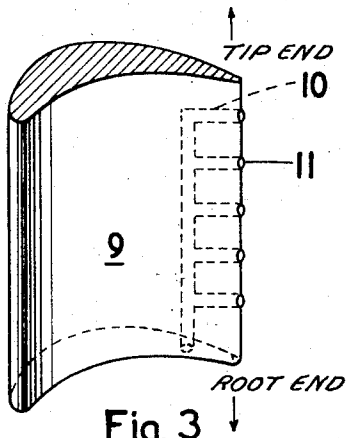


Fig. 3

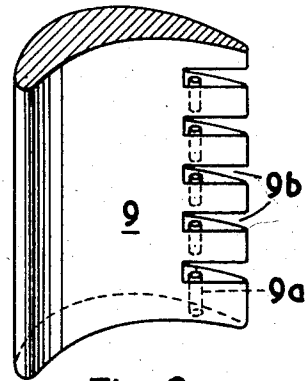


Fig. 2

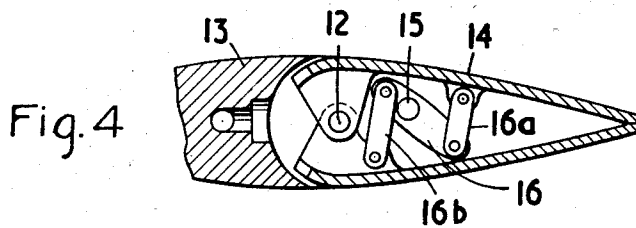


Fig. 4

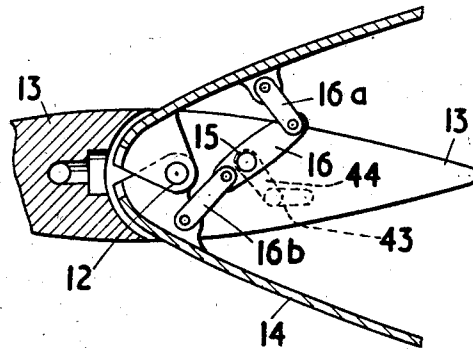


Fig. 5

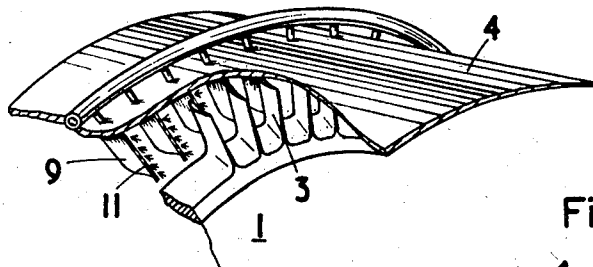


Fig. 6

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MEANS FOR COOLING TURBINE-BLADES BY LIQUID JETS

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Claims priority, application Great Britain April 14, 1950

8 Claims. (Cl. 60—35.6)

The primary object of this invention is to provide for the more effective cooling of turbine blades.

According to the invention, liquid-emitting nozzles provided adjacent to the turbine blades on the upstream side, are located to direct jets of coolant liquid directly on to the leading edges of the turbine blades. More particularly, the nozzles are incorporated in stator guide vanes with their orifices in the trailing edges of the vanes.

Water may be used as a liquid coolant. If, however, a liquid fuel be used as the coolant, a further feature of the invention consists in providing means downstream of the turbine for burning the resultant combustible mixture.

One form of the invention as applied to a turbine for a jet propulsion plant as shown in the accompanying drawings, in which:

Figure 1 is an axial section through the turbine and jet propulsion duct;

Figure 2 is a view of a stator guide vane as it appears at a stage in the course of manufacture;

Figure 3 shows a finished stator guide vane;

Figures 4 and 5 are two views in section on IV—IV of Figure 1, and

Figure 6 is a part perspective view showing the coolant jets issuing from the nozzles on to the blades.

In Figure 1 a turbine rotor 1 of a gas turbine jet propulsion unit is mounted on a shaft 2 supported by bearing 23 and carries turbine blades 3. The gases of combustion after driving the turbine rotor 1 pass through a jet pipe 4 having an enlarged portion 5 and the usual exhaust cone 6 is provided downstream of the turbine 1.

Adjacent to the ring of turbine blades 3 on the upstream side is the usual ring of stator guide vanes 9. Coolant liquid is fed through pipe 7 and branch pipes 8 to each of a number of these vanes 9 which are constructed to serve as coolant-emitting nozzles. As shown in Figure 2, each of these vanes is formed with an internal passage 9a and with communicating slots 9b along its trailing edge. If there is not room for slots which communicate with passage 9a by drilled holes in which tubes can be inserted, there are provided slots as shown into which are fastened internally bored inserts 10 to form passages leading to the discharge apertures or orifices 11. Weld metal which secures these inserts serves to fill up any gaps in the slots to form a finished smooth-edge multi-apertured vane as shown in Figure 3. The orifices 11 point towards the leading edges of the turbine blades 3, i. e. they are in a position to direct jets of coolant liquid directly on to the leading edges of the blades, as can be seen in Figure 1 and Figure 6. Furthermore, the orifices are of such size and distribution as to give efficient cooling, in relation to the distribution of temperature and of stress in the moving blades, e. g. the orifices decrease in size and increase in spacing towards the tip of the vane so that the coolant liquid discharge decreases from a maximum at positions opposite the root portions of the blades to a minimum in the regions of the blade tips.

The coolant is supplied by the pump 24 from the reser-

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voir 25 through the control valve 27 and the pipes 7a, the pump having the usual pressure relief valve 26.

Although water may be used, the arrangement shown and hereinafter described is intended for use when the coolant liquid is a fuel.

The cone fairing 6 is carried by four hollow streamlined struts 13 and parts of the wall of these struts are formed as retractable flaps 14 pivoted on pivots 12 adjacent to a shaft 15, which by means of an operating member 16 and links 16a and 16b can, when rotated, open the flaps 14 from the position shown in Figure 4 to that shown in Figure 5. When these are in the open position as shown in Figure 5 they form stabilising baffles for the flame produced by combustion of the fuel.

The fuel is ignited by means of an igniter 19 having electrodes 20 extending within the space enclosed by the flaps 14. The arrangement is shown in Figures 4 and 5 with the igniter removed for clearness, as this is the normal and conventional igniter; the hole for accommodating the igniter can, however, be seen in the strut 13 at the back of the flaps. Further retractable flaps 18 pivoting on pins 40 may be included in the wall of the downstream end of the cone 6 itself, as shown in Figure 1. These may be operated by the radial engagement with forked tails 18a on these flaps of radial pegs 42 projecting from the end of link 43 which is actuated by lever 44 secured to shaft 15; the lever 44 can be seen also in Figure 5.

A hydraulic jack 30 acting on the operating means 17 for rotating shaft 15 cause the flaps to open out with injection of the additional fuel through the orifices 11. This is effected by the connection of the handle 28 to the valve 27 by the link 29 and to the control valve 31 by the link 31a.

Preferably a variable outlet nozzle is provided; this is shown as the device set forth in U. S. Patent 2,565,854 and is in the form of calliper arms 33 on the pivot 34 actuated through the linkage 35 by the hydraulic jack 36 which is also controlled by the control valve 31 so that the calliper device is actuated simultaneously with the injection of the additional fuel and the actuation of the flaps 14 and 18.

The jacks 30 and 36 are both supplied from the control valve 31 through the pipes 32, the hydraulic actuating fluid being supplied through valve 31 from the mains 38. The igniter 19 is supplied from the electric mains 39.

The widened part of the jet pipe is provided with a liner 21 supported by a retainer 22, and the liner may be formed of ceramic material, or alternatively, of porous or gauze material through which air may be admitted in non-turbulent manner to form a cool lining over the inner surface of the liner. The porous liner may also be supplied with a small quantity of water for cooling purposes from the water supply main 37, this entering into the jet pipe and the steam produced being ejected into the atmosphere together with the gases of combustion.

Since the flaps 14 forming stabilising baffles are integral with the struts 13 and the flaps 18 are integral with the cone 6, thrust losses when these flaps are retracted are reduced to a minimum since the cone and struts must be present in any case.

What I claim is:

1. A gas turbine having a ring of blades and a plurality of multi-apertured liquid-emitting nozzles adjacent said blades on the upstream side pointing downstream towards said blades and separated therefrom only by the axial clearance necessary between relatively rotating components whereby said nozzles are adapted to direct jets of coolant liquid directly onto the leading edges of said blades along the length of the blades, the arrangement and disposition of the apertures along the direction of the blade length being such that the coolant liquid discharge decreases from a maximum at positions oppo-

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site the root portions of the blades to a minimum in the regions of the blade tips.

2. A gas turbine plant including a turbine having a ring of blades, liquid-fuel-emitting nozzles adjacent said blades on the upstream side pointing downstream toward said blades and separated therefrom only by the axial clearance necessary between relatively rotating components whereby said nozzles are adapted to direct jets of coolant liquid fuel directly onto the leading edges of said blades, an exhaust duct on the downstream side of said turbine blades, a baffle located in said duct for producing a combustion-stabilizing zone, and means for igniting in said zone the combustible mixture resulting from the introduction of said coolant liquid fuel into the working gases of said turbine on the upstream side of said blades.

3. A gas turbine plant as claimed in claim 2 including a conical fairing in said exhaust duct downstream of said turbine blades and a strut for supporting said conical fairing in said duct, part of said strut comprising a pivoted retractable member constituting said stabilizing baffle.

4. A gas turbine plant as claimed in claim 2 including a conical fairing in said exhaust duct downstream of said turbine blades and a pivoted retractable part of the structure of said fairing which constitutes said stabilizing baffle.

5. A gas turbine plant as claimed in claim 2 wherein said stabilizing baffle is retractable from a position in which it extends into the duct, and including means for moving said baffle and for controlling the discharge of said coolant fuel on to said turbine blades.

6. A gas turbine plant as claimed in claim 2 wherein said stabilizing baffle is retractable from a position in which it extends into the duct, and including a variable outlet nozzle on said exhaust duct, and inter-connected means for moving said stabilizing baffle, for actuating said nozzle and for controlling the discharge of said coolant fuel on to said turbine blades.

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7. A gas turbine plant as claimed in claim 2 and having in said duct a liner of porous material and means for introducing cooling water through the liner.

8. A gas turbine having a ring of rotor blades and stator guide vanes located on the upstream side of said blades and adjacent thereto and incorporating in their trailing edges liquid emitting nozzles pointing downstream towards said rotor blades, the nozzle aperture arrangement and disposition in the trailing edges of said stator guide vanes being such that the coolant liquid discharge decreases from a maximum at positions opposite the root portions of the blades to a minimum in the regions of the blade tips, the trailing edges of said stator guide vanes and the leading edges of said rotor blades being separated only by the axial clearance necessary between relatively rotating blade rows whereby said nozzles are adapted to direct jet coolant liquid directly on to the leading edges of said rotor blades.

References Cited in the file of this patent

UNITED STATES PATENTS

1,824,893	Holzwarth	Sept. 29, 1931
2,149,510	Darrieus	Mar. 7, 1939
2,320,391	Wakefield	June 1, 1943
2,354,151	Skoglund	July 18, 1944
2,479,777	Price	Aug. 23, 1949
2,482,505	Pierce	Sept. 20, 1949
2,520,967	Schmitt	Sept. 5, 1950
2,549,819	Kane	Apr. 24, 1951
2,565,854	Johnstone et al.	Aug. 28, 1951
2,636,344	Heath	Apr. 28, 1953
2,651,178	Williams	Sept. 8, 1953
2,657,532	Reid et al.	Nov. 3, 1953

FOREIGN PATENTS

346,599	Germany	Jan. 5, 1922
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