March 6, 1945. C. W. SMITH 2,370,694

GAS TURBINE ARRANGEMENT

Filed Sept. 17, 1941

Fig. 1.

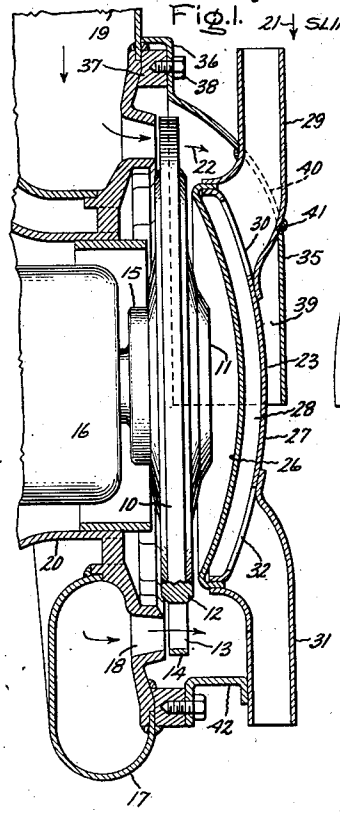


Fig. 2.

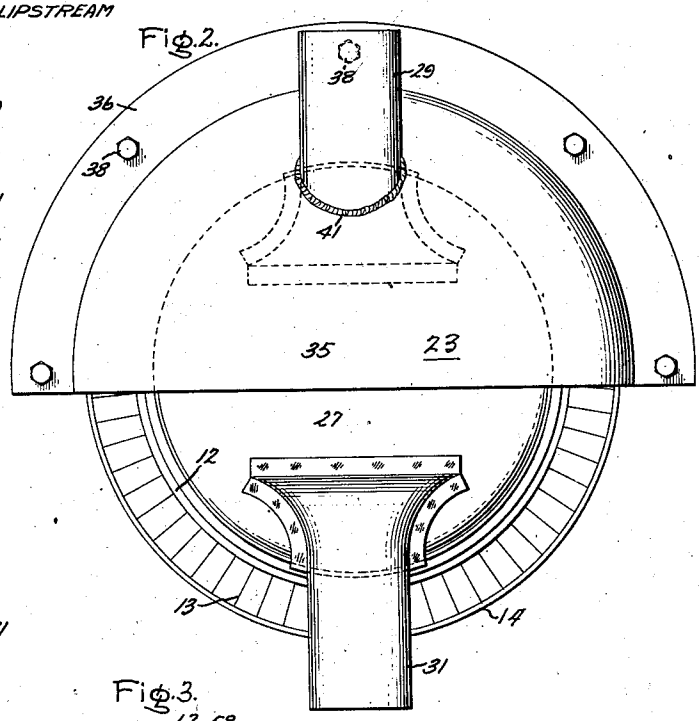


Fig. 3.

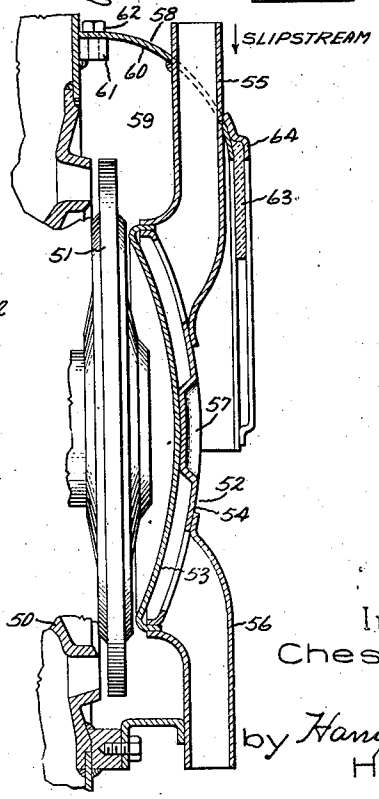
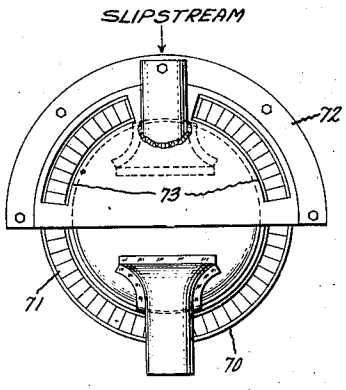


Fig. 4.



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GAS TURBINE ARRANGEMENT

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Application September 17, 1941, Serial No. 411,215

6 Claims. (Cl. 60—41)

The present application is a continuation in part of my application Serial No. 281,562, filed June 28, 1939.

The invention relates to gas turbine arrangements wherein a turbine has a bucket wheel so located that the exhaust gases issuing from the turbine buckets may sweep across the face of the wheel, or where one or more wheels are exposed to a current of air from the atmosphere or other source which furnishes oxygen for combustion of unburned fuel contained in the gases issuing from the wheel. The invention is of particular significance in connection with aircraft arrangements in which an axial flow gas turbine wheel is secured to an overhung shaft portion with its outlet side substantially exposed to the atmosphere and having a surface substantially parallel to the slipstream of the aircraft. In such an arrangement the gases discharge from the wheel at an angle substantially perpendicular to the direction of the slipstream. Such gas turbines when operated with gases discharged from a combustion engine at temperatures of the order of 1400° F. and above are subject to high temperatures during operation. The high temperatures may considerably weaken the material of the bucket wheel and thereby endanger the safety of the plant.

The high temperatures of the wheels in arrangements of the kind described above are due essentially to two causes. One cause is the afterburning of gases issued from the bucket wheel in proximity thereto and the other cause is due to the slipstream which forces gases issued from the nozzles and buckets on the upstream side of the bucket wheel towards the central portion thereof.

The object of my invention is to provide improved constructions and arrangements whereby excessive heating of a gas turbine of the type above described is prevented. This is accomplished in accordance with my invention by an arrangement in which the aforementioned causes are substantially eliminated.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing Fig. 1 illustrates a sectional view of a gas turbine arrangement embodying my invention; Fig. 2 is a front view of Fig. 1; and Figs. 3 and 4 are modifications in accordance with my invention.

A gas turbine arrangement according to my invention, as shown in Figs. 1 and 2, comprises a bucket wheel 10 which has a central solid disk 11 forming a rim 12 and a row of buckets 13 secured to the rim 12. The outer ends of the buckets 13 are connected by a band or shroud 14. The bucket wheel is secured to an overhung shaft 15 supported on a bearing 16. An annular nozzle box 17 having a row of blades 18 forming nozzles between them is arranged to supply operating gas to the bucket wheel. The nozzle box has an inlet conduit 19 for connection to a suitable source of supply, such as the manifold of a combustion engine, not shown. A partition or heat-insulating wall 20 is provided between the nozzle box 17 and the bearing 16 to reduce heat transfer from the nozzle box to the bearing. In aircraft such gas turbine may serve to drive a supercharger or a generator.

In many installations the turbine is mounted so that the front surface of the bucket wheel is substantially parallel to the direction of the slipstream as indicated by an arrow 21 in the drawing. The direction of the gases issuing from the bucket wheel, as indicated by another arrow 22, is substantially perpendicular to the direction of the slipstream. With regard to the slipstream, the upper portion of the bucket wheel in the drawing constitutes a leading portion or edge and the lower portion of the bucket wheel constitutes a trailing portion or edge.

The heating of the bucket wheel disk by gases discharged from the bucket wheel is considerably reduced in accordance with my invention by the provision of a cap or cooling device 23 arranged adjacent the bucket wheel. In the present instance the cap is concave-shaped with a rim bent inward and closely spaced with the adjacent surface of the bucket wheel disk, the spacing from the disk increasing towards the center of the cap. With the provision of such protecting cap, only a small amount, if any, of the gas issued from the bucket wheel will be forced through the clearance between the cap and the bucket wheel while the major portion of the gas issued from the leading portion of the bucket wheel is conducted along the outer surface of the cap to the atmosphere. Gases forced towards the cap 23 may cause heating of the latter but do not directly heat the bucket wheel as would be the case were no cap provided. Thus, the cap constitutes a device for protecting the bucket wheel disk from the heat of the gases issued from the bucket wheel.

In the present example, the cooling cap is formed by inner and outer substantially uniform-

ly spaced walls 26 and 27 sealed together along their outer edges and forming a space 28 between them. Cooling air is conducted to the space 28 by means of an inlet conduit 29 connected to an opening 30 in the outer wall 27 and arranged to receive cooling air from any suitable source, preferably from the slipstream. The cooling air is discharged from the space 28 through an outlet conduit 31 connected to an opening 32 in the outer wall 27 diametrically across the opening 30. The cooling cap protects the bucket wheel by preventing gases issued therefrom from being forced towards the central portion of the wheel by the action of the slipstream. Cooling of the cap increases the radiation from the bucket wheel and the cooling air passed through the cap carries away a substantial amount of heat radiated towards the cap.

The leading half of the bucket wheel and the leading or upper portion of the cooling cap or device are enclosed or shielded by a semi-annular shield 35 to form a smooth discharge passage for the gases discharged from the leading portion of the wheel and to prevent these gases from mixing with air in proximity to the leading portion of the wheel. The shield 35 has an outer flanged portion 36 fastened and sealed to the nozzle box by means including studs 37 and bolts 38. The shield, as stated above, covers about one-half of the bucket wheel and is spaced therefrom to form a channel 39 for smoothly discharging the gases in downward direction or, with reference to an aircraft, in rearward direction. During operation no air enters the channel 39 so that after-burning within the channel is reduced to a minimum. In addition, the shield 35 acts as a deflector for the slipstream, thus preventing the gases issuing from the bucket wheel from being forced with great intensity towards the leading portion of the cooling cap.

The inlet conduit 29 of the cap projects through an opening 40 of the shield 35 and is supported thereon and sealed thereto by a weld 41. Thus the semi-annular shield covering the leading portion of the bucket wheel and the cooling cap also acts as a support for the latter. The cap is additionally supported by a bracket 42 securing the outlet conduit 31 to the nozzle box 17.

The gas turbine arrangement shown in Fig. 3 comprises a nozzle box 50 corresponding to the box 17 of Fig. 1 for conducting gases to a bucket wheel 51 having an axis of rotation substantially perpendicular to the direction of the slipstream. The central portion or disk of the bucket wheel is protected by a cooling cap 52 including an inner disk 53 and an outer disk 54 with bent rim portions suitably secured and sealed together. The cooling air from the slipstream is conducted to the leading portion of the cap by an inlet conduit 55 and discharged from the cap by a discharge conduit 56 having an opening facing in the direction of the slipstream. A central portion 57 of the outer disk 54 is dished-in or indented and closely spaced with or engaging the inner disk 53. This dished-in portion 57 of the outer disk 54 broadly constitutes a baffle to prevent cooling air received from the inlet conduit 55 from flowing directly along a diameter to the outlet conduit 56. Thus, the dished-in portion causes the cooling air conducted to the cap to flow along the outer portions thereof and thereby effect thorough cooling of the cap to increase the radiation from the wheel. The leading portions of the bucket wheel 51 and the cap 52 are enclosed by a shield 58 to form a smooth discharge channel 59 for the gases discharged from the leading portion of the bucket wheel and to prevent the slipstream from forcing these gases towards the leading portion of the cooling cap. The shield 58 comprises a semi-annular metallic ring 60 curved in cross-section and having an edge portion in sealing contact with the casing of the nozzle box 50 and secured to ears 61 on the nozzle box by bolts 62. The semi-annular ring 60 is concentrically spaced with the bucket wheel. The shield includes another semi-annular ring 63 of transparent heat resistant material supported on the inner edge of the ring 60 by means of a supporting member 64. The ring 63, that is, the part of the shield towards which the main radiation from the bucket wheel takes place, is made from quartz, flint glass or like heat resistant material which is transparent to infra-red radiation. The transparent ring 63 during operation of the turbine promotes radiation of heat from the bucket wheel, in particular the buckets thereof, and thereby reduces the temperature and accordingly weakening of the buckets.

The gas turbine arrangement shown in Fig. 4 comprises a bucket wheel 70 having an annular row of buckets 71 corresponding to the buckets 13 in Figs. 1 and 2. The leading portion of the wheel 70 is substantially enclosed by a shield 72 similar to the shield 35 in Figs. 1 and 2 except that the shield 72 is provided with openings or perforations 73 opposite the discharge passages formed by and in axial alignment with the buckets 71. These openings permit heat radiation from the buckets 71 into the atmosphere during operation. Little, if any, gases discharged from the bucket passages pass through the perforations 73 because the gases discharge from the bucket passages at an angle toward the axial direction and are readily carried downward in the direction of the slip stream underneath the shield 72.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Gas turbine arrangement for aircraft comprising a turbine wheel, a nozzle box for conducting gases to the wheel, a device for preventing heating of the turbine wheel by the gases issuing therefrom comprising a hollow cap concave-shaped towards the outlet side of the wheel and having a rim closely spaced with the wheel and inlet and outlet conduits for cooling medium connected to diametrically opposite portions of the cap, and a semi-annular shield having an outer portion uniformly radially spaced from the bucket wheel with one edge sealed to the nozzle box and a semi-annular member supported on the other edge and made of material transparent to heat radiation from the bucket wheel.

2. Gas turbine arrangement for aircraft comprising a turbine wheel with a row of buckets, a nozzle box disposed on one side of the wheel, and means to protect the central portion of the wheel and to form a discharge channel for gases issuing from the wheel, said means comprising a hollow cap having inner and outer substantially parallel walls sealed along their rims and concave-shaped towards the central portion of the bucket wheel, substantially aligned inlet and outlet conduits connected to diametrically opposite portions of the cap, and a semi-annular shield sealed to the nozzle box and enclosing a portion only of the bucket wheel and the cap, said shield

having a portion facing the buckets made from transparent material.

3. A cooling cap for gas turbine bucket wheels having an inner concave-shaped wall, an outer concave-shaped wall sealed to the inner wall and having a central indented portion engaging the inner wall, and inlet and outlet conduits connected to diametrically opposite portions of the outer wall.

4. In a gas turbine arrangement for aircraft comprising a bucket wheel for rotation about an axis perpendicular to the direction of the slipstream, a nozzle box located on one side of the wheel and a shield located on the other side of the wheel to prevent the slipstream from forcing gases issuing from the leading portion of the wheel towards the central portion thereof, said shield being sealed to the nozzle box and enclosing the leading portion only of the wheel, a portion of the shield being made of material transparent to heat radiation from the bucket wheel.

5. Gas turbine arrangement for aircraft comprising a bucket wheel with a row of buckets mounted for rotation about an axis substantially perpendicular to the slipstream, and means forming a discharge channel for gases issuing from the leading portion of the wheel comprising a shield enclosing the leading portion to prevent the slipstream from forcing gases issuing from the leading portion towards the central portion of the wheel, said shield having perforations in axial alignment with the buckets to permit free heat radiation therefrom into the atmosphere.

6. A shield for gas turbine bucket wheels discharging directly into the atmosphere, said shield comprising a semi-annular ring curved in cross-section, and another semi-annular ring made of heat resistant material transparent to infra-red radiation, and means securing the other ring on the inner edge of the first mentioned ring.

CHESTER W. SMITH.