

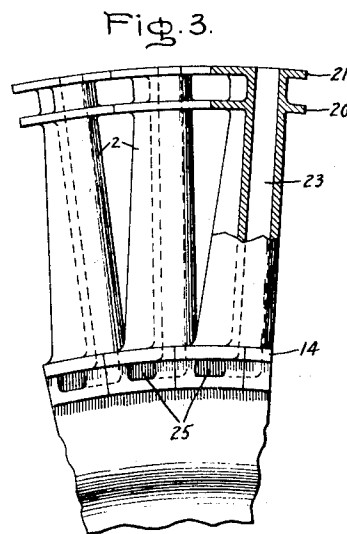
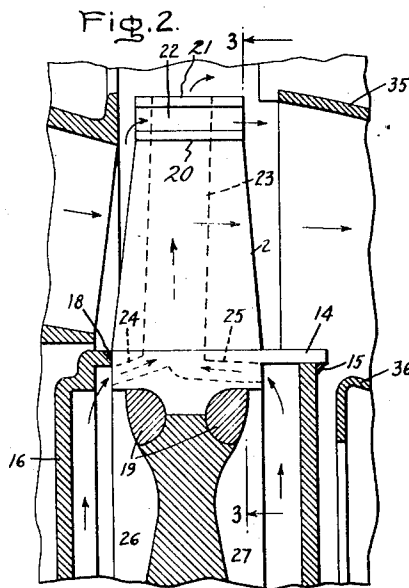
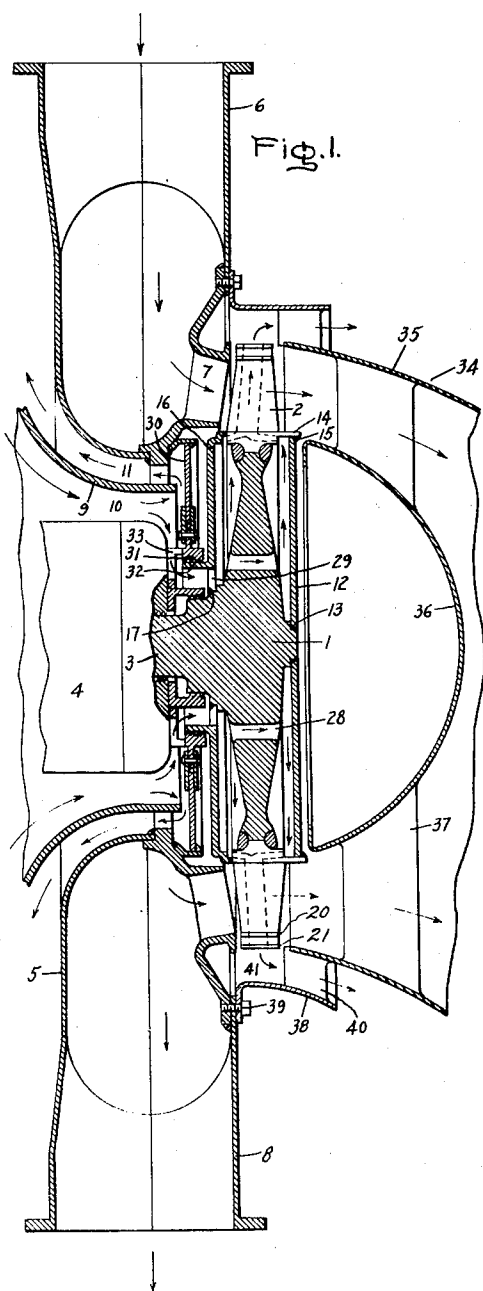
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2,440,069

HIGH TEMPERATURE ELASTIC FLUID TURBINE

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HIGH-TEMPERATURE ELASTIC FLUID
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4 Claims. (Cl. 60—41)

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The present invention relates to high temperature elastic fluid turbines such as gas turbines for aircraft turbosuperchargers. Such turbines may be operated at temperatures of the order of 1500° F. or higher which makes it necessary to provide cooling means, especially for the bearing and the bucket wheel. Also, where a single stage bucket wheel is supported on an overhung shaft and exhausts directly into atmosphere, it is important to reduce leakage of air into the clearance space between the wheel and the nozzles for conducting gases thereto in order to preclude excessive temperatures within the wheel due to after-burning of gases in the bucket passages.

The object of my invention is to provide an improved turbine which is effectively cooled and in which the after-burning of combustible material in the bucket passages due to air leaking into the clearance space between the wheel and the nozzles is substantially reduced.

For a consideration 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 an exhaust gas operated turbine for aircraft turbosuperchargers; Fig. 2 is an enlarged view of part of Fig. 1; and Fig. 3 is a view along line 3—3 of Fig. 2.

The turbine comprises a bucket wheel having a disk 1 and a plurality of circumferentially spaced buckets 2 attached to the rim of the disk. The disk 1 is secured, as by flash-welding to a shaft 3 supported on a bearing 4. Operating gases are conducted to the passages formed between adjacent buckets by means of a nozzle box 5 which has an inlet 6 and a ring of circumferentially spaced partitions 7 forming nozzle passages between them for directing gases into the bucket passages of the wheel. The nozzle box has a waste conduit 8 through which some of the gases supplied to the box through the inlet conduit 6 may be wasted, that is, discharged directly into the atmosphere. The load output of the turbine may be controlled in known manner by controlling the flow of gases through the waste conduit 8. The nozzle box 5 is supported on a curved baffle 9 concentrically spaced between the bearing 4 and the box and defining two annular channels 10 and 11 therewith which serve to conduct cooling medium to the turbine, as will be explained hereafter.

In order to cool the bucket wheel, cooling channels are formed on opposite sides of the disk 1 by means of two rotary shields, a shield 12 dis-

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posed on the outlet side of the disk and having an inner edge secured to a hub portion of the disk by means of a weld 13. The outer edge of the rotary shield 12 is fused to a shroud 14 formed at the base of the buckets by means of a weld 15. A similar rotary shield 16 is located on the inlet side of the disk and fused to the hub portion of the disk by an annular weld 17 and to the shroud 14 by an annular weld 18, Fig. 2.

The buckets have base portions fused to the rim of the disk by welds 19. In addition to the shroud 14 formed at the base of each bucket two radially spaced shrouds 20, 21 are formed at the tip of each bucket, together forming a channel or passageway 22. The buckets are hollow, each having a radially extending channel 23 which extends through the tip of the bucket and near the base of the bucket is connected by two branch channels 24, 25 with annular cooling spaces 26, 27 respectively formed between the wheel disk and the rotary shields 16 and 12 respectively. The disk has a plurality of axial channels 28 connecting the annular cooling spaces 26, 27. Cooling air is conducted from the channel 10 between the baffle 9 and the bearing 4 through circumferentially spaced openings 29 in the inner portion of the rotary shield 16. Some of this cooling air in the space 26 flows radially outward through the channels 24, 23 in the buckets. Another part of the cooling air flows through axial channels 28 in the disk and then radially outward through the space 27 into the channels 25, 23, to be discharged from the tips of the buckets.

In order to prevent cooling air in the annular channel 10 from leaking into the clearance space between the buckets and the nozzles, means are provided to seal the nozzle box to the disk 16. This means comprises a stationary sealing plate 30 fused at its outer edge to the wall of the nozzle box and having sealing engagement at its inner edge with a double-deck labyrinth packing 31 having a portion or outer disk forming sealing engagement with a cylindrical extension 32 of the shield 16 to reduce leakage of air to the clearance space between the nozzle box and the buckets. Said double-deck labyrinth packing is secured to the end cap of the bearing housing 4 and has another portion forming sealing engagement with the hub of the wheel to reduce leakage of air along the shaft 3 into the bearing housing 4. The double-deck labyrinth packing has a plurality of openings 33 establishing communication between the cooling channel 10 and the openings 29 in the rotary shield 16.

Somewhat similar sealing plate arrangements

are disclosed in applications Serial No. 594,626, filed May 19, 1945, now Patent No. 2,414,841, in the name of Dale D. Streid, and Serial No. 541,244, filed June 20, 1944, in the name of Claude H. Auger.

Some of the air in the cooling channel 10 flows around the inner edge of the baffle 9 through the channel 11 to reduce heat transfer from the nozzle box to the bearing. In case of an aircraft the cooling air may be forced into the channel 10 in known manner by means of a ram (not shown) facing the slipstream and the cooling air in the channel 11 may be discharged into the slipstream.

Gases discharged from the bucket wheel are directed into the atmosphere by means of an exhaust hood 34 which has an outer wall 35 with an edge closely spaced with the outer shrouds 21 of the buckets and an inner dished wall 36 with an edge portion closely spaced with the inner or base shroud 14. The walls 35, 36 form a smooth annular discharge passage for the bucket wheel, the wall 36 being supported on the wall 35 by a plurality of circumferentially spaced vanes 37. The exhaust hood also includes a flanged collector ring 38 concentrically spaced from the bucket wheel and the wall 35 and secured to the nozzle box by a plurality of bolts 39. The ring 38 supports the wall 35 by means of a plurality of circumferentially spaced vanes 40 secured between concentric portions of the ring 38 and the wall 35. An annular space 41 is thus formed between the bucket wheel and a portion of the wall 35 on one side, and the ring 38 on the other side for directing cooling air discharged from the bucket tips into the atmosphere and to preclude leakage of air from the atmosphere into the turbine.

During operation, cooling air flows through the channel 10 into the spaces 26, 27, cooling both sides of the wheel disk and from those spaces the cooling air flows through the channels 24, 25, 23 of the buckets cooling the latter and to be discharged from the tips of the buckets through the annular channel 41 into the atmosphere. The space 22 formed between the radially spaced shrouds 20, 21 of the buckets has two important functions: first, it aids in balancing the pressures across the tips of the buckets, thus reducing leakage around said tips; and, second, it reduces the danger of after-burning of gases by air leaking into the exhaust hood 35. The fluid passageway between the shrouds 20 and 21 should be designed for a minimum pressure drop and in some cases even a small amount of pumping action may be desirable in order to serve its purpose of keeping the leakage gas in the clearance space between the nozzle exit and the bucket entrance from flowing into the air space region. Some of the gases discharged from the nozzles towards the bucket wheels leak radially outward in the clearance space between the nozzles and the bucket passages. These leakage gases flow in part through the annular channel 22, whence they are passed into the exhaust hood. In part such leakage gases may flow into the annular channel or air space 41, whence they are discharged into the atmosphere. The major part of the gas leaking radially along the clearance space between nozzle and buckets, however, is diverted through the passageway 22 formed between the double shroud band into the exhaust gas passage inside the wall 34. The smaller part of gas that leaks radially into the channel 41 inside the cooling ring 38 is mixed therein with the cooling air dis-

charged from the channels 23 of the buckets and thereby cooled to a temperature below the combustion point, thus precluding after-burning in the channel 41 in the proximity of the wheel. The mixture of gases discharged from the passage 41 is at a sufficiently low temperature as to be non-luminous and non-injurious to adjacent aircraft structure.

Having described the method of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, I wish to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. In a high temperature axial flow gas turbine, the combination of a rotor having a circumferential row of radially extending buckets secured thereto, radially spaced shroud means associated with each bucket near the tips thereof and forming an axial passageway between each pair of adjacent buckets, a nozzle box including nozzle means for conducting motive fluid to the buckets radially inward from the shroud means, walls defining a turbine discharge conduit having an edge forming a small clearance with the discharge side of the outer shroud means, and walls defining an annular cooling air passage surrounding the outer shroud means, said axial passageways being located radially beyond the nozzle means and adjacent and in parallel flow relation with the motive fluid path through the buckets, said nozzle box having an annular wall portion forming small clearance spaces with the inlet side of the shrouds, whereby motive fluid leaking radially outward from the nozzle means through said clearance spaces is caused to pass through said axial passageways to substantially equalize the pressure across the bucket tips and reduce mixing of the leakage fluid with the cooling air in said annular passage.

2. Gas turbine comprising a bucket wheel having a disk and a plurality of circumferentially spaced buckets attached thereto, a shaft secured to the disk, a bearing for the shaft, a nozzle box concentrically surrounding the bearing and having a ring of nozzles for conducting operating gases to the buckets, means for cooling the bearing and the disk including a cooling plate having inner and outer edges secured to the disk and forming a cooling space therewith, and means for circulating air through said space including channels formed in the buckets, each bucket having an outer portion with two radially spaced shrouds defining a passageway for gases leaking radially along the clearance space between the buckets and the nozzles.

3. Gas turbine comprising a bucket wheel having a disk and a plurality of circumferentially spaced buckets attached thereto, a shaft secured to the disk, a bearing for the shaft, a nozzle box concentrically surrounding the bearing and having a ring of nozzles for conducting operating gases to the buckets, means for cooling the bearing and the disk including a cooling plate having inner and outer portions secured to the disk and forming a cooling space therewith, means for circulating air through said space including channels formed in the buckets, each bucket having an outer portion with two radially spaced shrouds defining a passageway for gases leaking radially along the clearance space between the buckets and the nozzles, and a ring concentrically surrounding the bucket wheel for receiving cool-

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ing air discharged from the channels in the buckets and mixing such air with gases leaking radially along the clearance space between the buckets and the nozzles beyond said passageway whereby such gases are cooled to a temperature below the combustion point and after-burning in proximity of the turbine is precluded.

4. Gas turbine for aircraft turbosuperchargers comprising a bucket wheel having a solid disk with axial channels therethrough, cooling plates on opposite sides of the disks rotatably secured thereto and forming cooling spaces therewith, each bucket having a radial channel extending through its tip and communicating with said spaces, means for circulating cooling air through said spaces and channels, a nozzle box located on one side of the wheel and having a ring of nozzles for conducting gases to the buckets, each bucket having a tip portion with two radially spaced circumferentially extending shrouds forming an axial passageway, and an exhaust hood for discharging gases from the bucket wheel into atmosphere, said hood having a wall with an edge forming a close clearance with the outer shrouds, and means supporting said wall including a ring secured to the nozzle box and radially spaced from said wall and the buckets forming an annular

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mixing channel therewith for receiving cooling air discharged from said spaces and gases leaking radially along the clearance space between the nozzles and the buckets, some of said leakage gases passing through said axial passageway into the exhaust hood.

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