May 8, 1962 | E. W. RADTKE | 3,033,519

TURBINE NOZZLE VANE CONSTRUCTION

Filed Sept. 12, 1958

FIG. 1

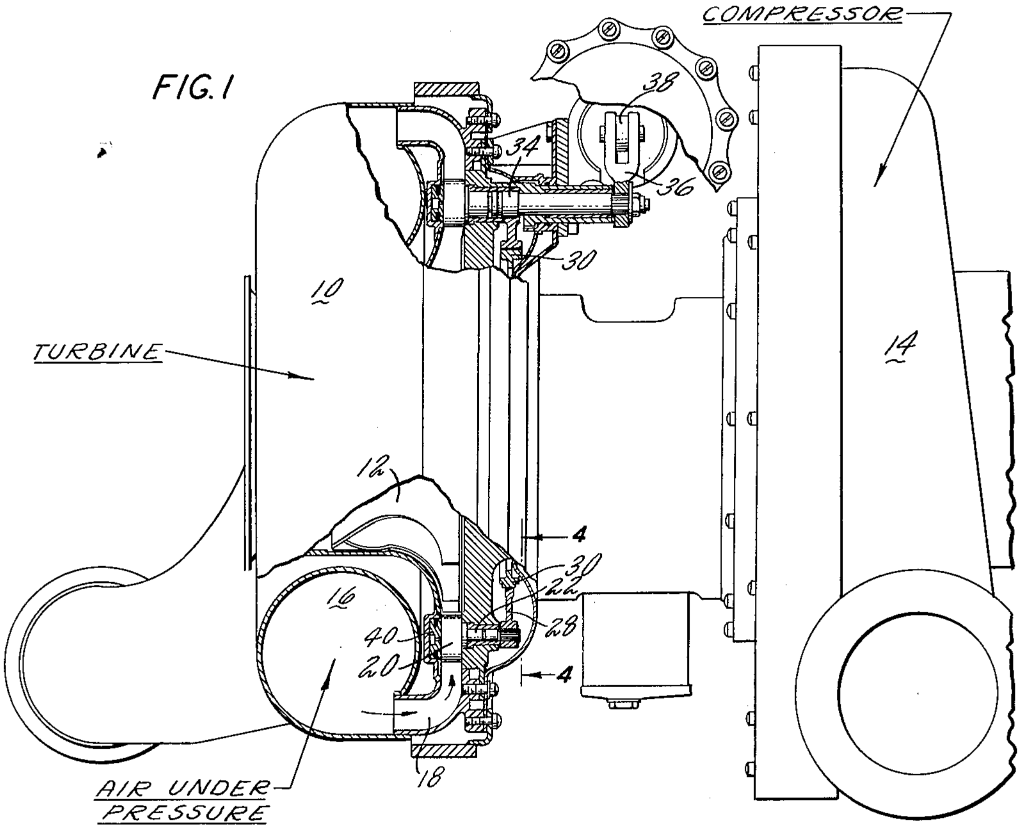


FIG. 2

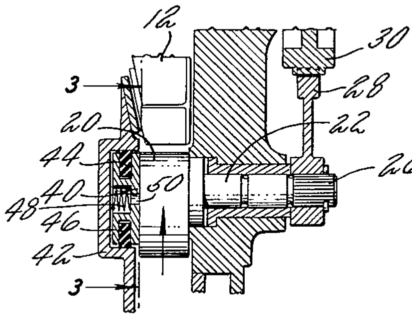


FIG. 4

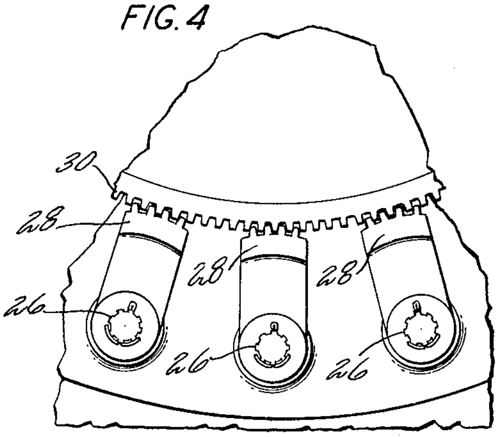
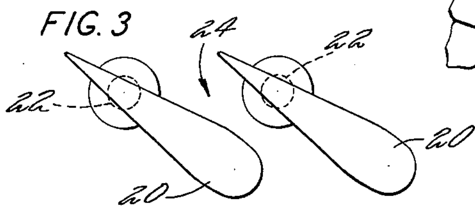


FIG. 3



INVENTOR
EDWARD W. RADTKE

BY

ATTORNEY

United States Patent Office

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TURBINE NOZZLE VANE CONSTRUCTION

Edward W. Radtke, Bloomfield, Conn., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

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1 Claim. (Cl. 253—52)

This invention relates to turbomachinery and more particularly to the nozzle vane arrangement immediately upstream of the turbine.

In turbines which are intended to drive a compressor or the like where the speed or load on the turbine must be controlled, the nozzles leading to the turbine buckets may be of variable geometry. These variable geometry nozzle passages can be provided by means of a plurality of vanes which are pivotable so as to alter the configuration of the passages therebetween. With these pivoted vanes it is necessary to adequately seal the free ends of the vanes so as to avoid leakage of air around the tips of the vanes.

It is therefore an object of this invention to provide a sealing arrangement for pivoted nozzle vanes whereby just the right amount of sealing force is provided thus avoiding excessive friction and excessively high torque necessary for pivoting the vanes.

These and other objects of this invention will become readily apparent from the following detailed description of the drawing in which:

FIG. 1 is a side elevation of a turbine-compressor arrangement with portions partly broken away to show the turbine nozzle vane arrangement;

FIG. 2 is an enlarged detailed partial cross section of the nozzle vane arrangement and its sealing mechanism;

FIG. 3 is a partial cross section taken along the line 3—3 of FIG. 2; and

FIG. 4 is a partial cross section taken along the line 4—4 of FIG. 1.

Referring to FIG. 1 a turbine casing **10** is shown which houses turbine blades or buckets **12**. The blades or buckets **12** are connected to a suitable shaft for driving a compressor housed within the casing **14** or other load. Air under pressure enters the toroid or volute **16** where it is ducted through an annular passage **18**. The flow then moves radially inwardly toward the axis of turbine rotation past a plurality of nozzle vanes **20**. The nozzle vanes **20** are peripherally spaced about the turbine buckets **12** and each includes a pivot shaft **22** which lies substantially parallel to the axis of rotation of the turbine.

As seen in FIGS. 2 and 3, each of the turbine blades **20** is arranged such that a nozzle passage is formed between adjacent blades. By rotating each of the vanes **20** about their pivot shaft **22** the geometry of the passage **24** therebetween can be varied to provide suitable flow into the turbine blades. Thus, the driving force on the turbine can be controlled in accordance with any desired schedule.

As seen in FIGS. 2 and 4, each of the nozzle vanes **20** and the pivot shaft **22** includes a spline **26** which has mounted thereon a gear segment **28**. Each of the gear segments **28** is operatively connected to a ring gear **30** so that upon rotation of the ring gear **30** all of the nozzle vanes **20** will be simultaneously pivoted about their shafts **22** thereby varying the geometry of each of the nozzle passages **24** therebetween.

As best seen at the top of FIG. 1, one of the vanes **20** has a master pivot shaft **34** suitably connected by a yoke **36** to an actuating piston rod **38**. The piston rod **38** may be controlled by mechanism such as shown in U.S. Patent No. 2,752,858 to Berges, or U.S. Patent No. 2,651,492 to Feilden. Motion of the rod **38** rotates the master pivot

34 which through the ring gear **30** rotates all the remaining segmental gears **28** and the respective vanes.

In very small turbine compressor units, as for example for aircraft air conditioning assemblies, the actuating force for pivoting the nozzle vanes must be at a minimum. However, at the same time it is necessary that a good seal be provided at the free ends of the nozzle vanes **20** so that there will be a minimum amount of leakage around the ends of the blades. Such leakage reduces the performance of the machine. In order to provide an adequate seal for the free ends of the nozzle vanes **20**, an annular pressure plate **40** (see FIGS. 1 and 2) is provided which engages the outer free ends of all of the nozzle vanes **20**. The pressure plate **40** fits into an annular recess **42** and also includes inner and outer sealing rings **44** and **46** which engage the inner and outer walls of the annular recess **42**. A light spring **48** may be provided to provide a nominal pressure for holding the plate **40** against the outer ends of the nozzle vanes **20**. However, when there is a flow of air through the nozzle passages **24** formed by the vanes **20**, there is a negative pressure gradient or distribution pattern in a downstream direction through the passage **24** which gradient is due both to the shape of the nozzle and the pressure drop existing between the inlet and the outlet of the turbine.

In any event, when there is flow there will be a pressure gradient. Since there exists along the flow path a pressure gradient or pressure distribution, it is immaterial that the nozzles are pivoted because the new passageway will also exhibit a pressure gradient or distribution along its flow path. This pressure tends to push the plate **40** away from the outer ends of the nozzle vanes **20**. In order to insure proper seating of the pressure plate against the ends of the vanes **20**, one or more pressure taps **50** are provided in the pressure plate **40** so that a predetermined air pressure will be established behind the pressure plate **40**. Since there is a pressure drop in a downstream or chordwise direction past the vanes **20**, the location of the taps **50** along this flow path is chosen so that the pressure at this location, established behind the pressure plate **40** provides a total force greater than the total force tending to push the plate **40** away from the vanes **20**. The net force is just sufficient to insure an adequate sealing engagement of the pressure plate **40** with the ends of the vanes **20**. In this manner the friction caused by the pressure plate engaging the vanes **20** is not excessive yet the force is sufficient to insure adequate sealing throughout the operating range of the turbine.

In reality, the point at which the pressure is picked off and fed behind the pressure plate is a compromise condition which will exert a force on the plate to give substantially its optimum operating range. Thus, it can be seen that the force of the plate pressing against the nozzles will differ for every position of the nozzles, i.e., from its full open to its full closed position.

As a result of this invention a very simple yet highly efficient sealing mechanism has been provided which insures positive sealing of the ends of turbine nozzle vanes while avoiding excessive torque requirements.

Although only one embodiment of this invention has been illustrated and described herein, it will be apparent that various changes may be made in the construction and arrangement of the various parts without departing from the scope of the novel concept.

What it is desired by Letters Patent is:

In a radial entry turbomachine having a rotor having an axis, blades disposed about the periphery of said axis carried by said rotor, a plurality of vanes surrounding said blades and forming a plurality of radial entry nozzle passages for directing fluid under pressure against said blades for driving said rotor, said passages having a shaft which induces a negative pressure gradient in the flow therethrough, said vanes having their spans running parallel to said axis, a pivot shaft carried by one spanwise end of each of said vanes and being parallel to the span, means for rotating said shafts and varying the geometry of said nozzle passages, an annular plate having one side engaging the other spanwise ends of said vanes and having a sealing engagement therewith to define one end wall of said nozzle passages, said plate being in a plane transverse to said axis, a channel having radially inner and outer walls and receiving said plate, said plate and channel forming a substantially closed chamber on the other side of said plate, seal means carried adjacent the inner and outer peripheral edges of said plate and engaging the walls of said chamber, and means for conducting fluid under pressure from at least one of said nozzle passages into said chamber to create a force on the other side of said plate to provide a sealing engagement between said one side of said plate and said vanes, including a duct leading to one of said nozzle passages and terminating at a point between the leading and trailing edge of the adjacent respective vane, said duct terminating at a point located along the flow in said nozzle passage wherein the average pressure of said fluid will provide a total force on said other side of said plate which is slightly in excess of that necessary to maintain a sealing engagement between the plate and the adjacent vane during flow through the nozzle passages.

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