Sept. 22, 1970 A. J. SCALZO ET AL 3,529,903

NOZZLE BLADE STRUCTURE

Filed Nov. 29, 1968

FIG. 1.

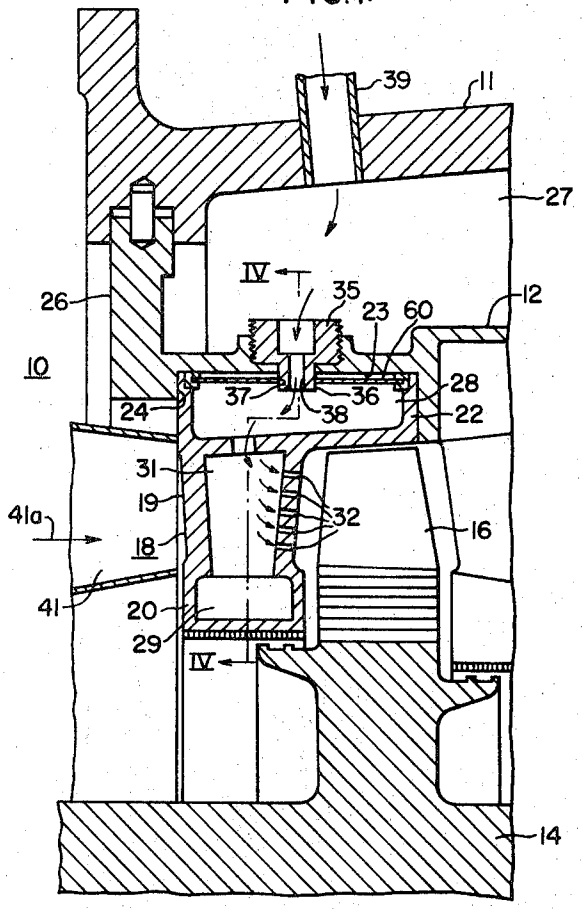
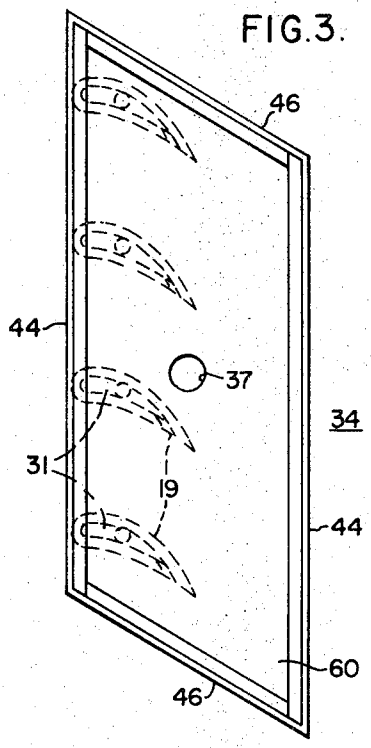


FIG. 3.



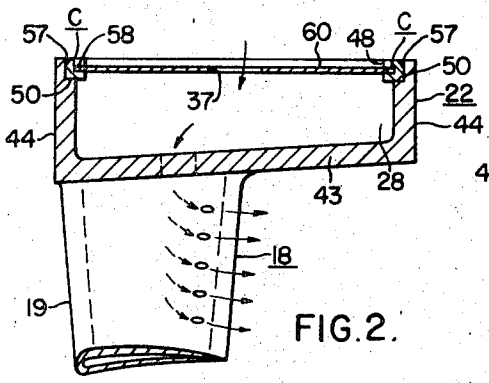


FIG. 2.

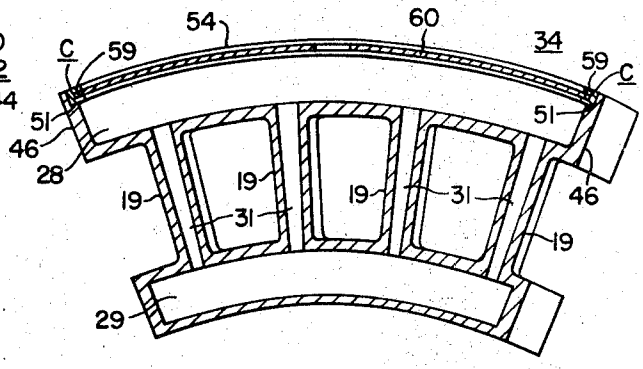


FIG. 4.

WITNESSES

Theodore F. Wrobel

James F. Young

INVENTORS
Augustine J. Scalzo
and Andrew Zabrodsky

BY

Frank Costanzo Jr

United States Patent Office 3,529,903
Patented Sept. 22, 1970

3,529,903

NOZZLE BLADE STRUCTURE

Augustine J. Scalzo, Philadelphia, and Andrew Zabrodsky, Boothwyn, Pa., assignors to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed Nov. 29, 1968, Ser. No. 780,057
Int. Cl. F01d 25/12
U.S. Cl. 415—115 5 Claims

ABSTRACT OF THE DISCLOSURE

An improved nozzle blade structure for an axial flow gas turbine, or the like, comprising one or more blades arranged in an arcuate group and having a plenum chamber portion for admitting air or other coolant fluid to the blade in operation. The plenum chamber structure is an open channel of quadrilateral shape, with a pair of side walls and a contiguous bottom wall forming a U, and a pair of opposed end walls formed integrally with the other walls and the blade, and the sixth wall or closure being provided by a cover plate of mating quadrilateral shape slidably received in encompassing rail members, which members are, in turn secured to the marginal portions of the side walls and the opposed end walls, by continuous leakproof weld joints.

BACKGROUND OF THE INVENTION

The operating temperatures of gas turbines are constantly being increased to attain the present day goals of increase in operating efficiency. Such increase in operating temperature is primarily being attained by introduction of cooling fluid, such as air, into the turbine hot components such as the rotor blades and blade roots, and the stationary nozzle blade structure.

One of the most effective, yet the most simple, ways of introducing coolant fluid into the turbine is by way of the stationary nozzle blades. Such nozzle blades are preferably formed in integral arcuate groups with inner and outer hollow shroud segments and hollow vane portions, and the coolant fluid is admitted to the outer shroud through a passage in a suitable securing means. Such an arrangement is disclosed in patent application 593,992, filed Nov. 14, 1966, now Pat. 3,427,000, in behalf of Augustine J. Scalzo (one of the present inventors) and assigned to the same assignee as this invention. Although in the above mentioned application, the nozzle blade segments are shown as having a plenum chamber defined by integral enclosing outer hollow shroud portions, in actual practice such as an arrangement is difficult to manufacture.

It has been proposed to form the hollow outer shroud portions (defining the coolant fluid plenum chamber) as an open channel structure with end walls, and welding a closure or cover plate to the channel structure. This arrangement is unsatisfactory since the large temperature gradients imposed thereon during operation greatly stress the structure and result in warping and distortion of the entire blade group.

A further proposal, to overcome the stress and warpage problem of the above proposal, resided in first forming the hollow outer shroud structure as an open channel structure with end walls, and providing a circumferential shoulder about the inner periphery of the open channel. The cover plate was then seated on the circumferential shoulder and retained in position by circumferential strips welded to the channel structure. This arrangement induced high residual weld stresses that rotated the strips outwardly, destroying the slidable sealing and resulting in large uncontrolled air gaps around the periphery of the

cover plate with attendant excessive leakage of the coolant fluid.

The object of this invention is to provide an improved nozzle blade structure having a hollow outer shroud structure defining a plenum chamber for the coolant fluid, in which the outer shroud structure includes a cover plate that is slidably retained with a minimum of thermal stress and in which sealing of the cover plate against leakage of coolant fluid is assured.

BRIEF SUMMARY OF THE INVENTION

In accordance with the invention, there is provided an improved, fluid cooled stationary nozzle blade structure for a hot elastic fluid utilizing machine, such as an axial flow gas turbine. As well known in the art, the stationary nozzle blades for an axial flow gas turbine are formed as vanes of generally air-foil cross-section disposed in an annular array about the turbine rotor and disposed upstream of their associated rotary blades carried by the rotor. The nozzle blades are disposed in the hot motive gas passageway and are effective to direct the motive gas past the rotary blades to motivate the latter and drive the turbine rotor.

As motive gas temperatures higher than the nozzle blades, rotary blades and rotor can safely withstand, are employed, the stationary nozzle structure is maintained within its safe operating temperature limits by directing pressurized coolant fluid therethrough. This pressurized coolant is preferably directed into the nozzle blade structure through the outer shroud structure in radially inwardly direction through the vanes and then discharged into the motive gas stream.

The stationary nozzle structure is divided into a plurality of arcuate groups of vanes, each group having common inner and outer arcuate shroud segments, and the groups are disposed in end-to-end relation to form the annular array, mentioned previously.

The outer shroud segments are of open U or channel shape with integral opposed end walls and having a circumferential shoulder about the inner periphery of the opening. An arcuate cover plate conforming to the shape of the opening is slidably received in peripheral rail members having inwardly facing slots to accommodate and hold captive the cover plate, and the rail members are inserted in the opening in abutment with the shoulders and welded about their periphery to walls of the outer shroud segments to form a plenum chamber.

The cover plate is of slightly less width and breadth than the width and breadth of the slots, so that it is free to expand in operation without stressing and/or distorting the structure, thereby retaining its sliding seal characteristics, and obviating the possibility of leakage of the coolant fluid in operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of a portion of an axial flow gas turbine having a stationary nozzle structure in accordance with the invention;

FIG. 2 is an enlarged sectional view of the nozzle structure shown in FIG. 1;

FIG. 3 is a plan of the nozzle structure; and

FIG. 4 is a radial sectional view of one of the arcuate nozzle groups, taken on line IV—IV of FIG. 2.

PREFERRED EMBODIMENT

Referring to the drawing in detail, in FIG. 1 there is shown a portion of an axial flow gas turbine **10**. Only the upper half of the turbine is shown, since the lower half is identical to the upper half. The turbine **10** comprises an outer casing **11** of generally tubular or annular shape, an inner casing **12** of annular shape encompassed by the outer casing **11**, and a rotor **14** rotatably supported

within the inner casing **12** in any suitable manner and having at least one annular row or array of blades **16**.

Cooperatively associated with the rotor blades **16** to form a motive fluid expansion stage is an annular row of stationary nozzle blades **18** supported within the casing **12**.

The stationary blades **18** are provided with a radially inwardly extending vane portion **19** of air-foil shape, a base portion **20** and an outer shroud portion **22** abutting the annular inner surface portion **23** of an annular groove **24** formed in the inner casing **12**.

The inner casing **12** is suitably secured to the outer casing **11** by an annular flange **26** and jointly therewith defines an annular air space **27**.

The stationary blades **18** are of hollow form, with the outer shroud portion **22** of box-like form and defining an arcuately shaped plenum chamber **28**, and the base portion **20** of box-like form and defining an arcuately shaped plenum chamber **29**. The chambers **28** and **29** are disposed in fluid communication with each other by passages **31** formed in the vane portions **19**, and the vane portions **19** are provided with a radial series of outlet orifices **32** in their trailing edge portions.

The blades **18** are preferably formed in arcuate groups **34** (as best shown in FIGS. 3 and 4) with a plurality of the vane portions **19** connected in parallel flow communication with the common outer and inner plenum chambers **28** and **29**. As illustrated, the arcuate group extends through a central angle of 45°, hence the annular row of stationary blades would include eight such groups disposed end-to-end, as well known in the art (example: $8\times45°=360°$).

The blade groups **34** are held in the groove **24** by a tubular fitting **35** threadedly received in the inner casing **12** and having a cylindrical portion **36** extending through a mating opening **37** in the outer plenum chamber **28**. The fitting **35** has a central bore **38** extending therethrough providing a fluid communication between the intercasing space **27** and the plenum chamber **28**, and a tube or pipe **39** received in the outer casing **11** provides pressurized coolant fluid, such as pressurized air from any suitable source (not shown) to the space **27**, during operation.

The structure thus far described has been previously proposed and is more fully shown and described in the Scalzo patent application 595,992, previously mentioned. As explained therein, in operation, hot motive fluid, such as pressurized combustion gas generated in a suitable fuel combustion chamber (not shown), is directed through an inlet passageway **41** past the stationary blades **18** and rotor blades **16**, in the direction indicated by the arrow **41***a*, with resulting expansion of the motive fluid to rotate the rotor **14**.

Since the motive gases employed are hotter than the blades can safely withstand, pressurized coolant air is continuously provided to the stationary blades **18**, as previously described, to maintain them within safe temperature limits and then ejected through the outlet orifices **32** into the stream of hot motive fluid.

In accordance with the invention, the outer shroud portion **22** of the blade group **34** is formed with a U or channel shape in cross section, as seen in FIG. 2, and comprises a central bottom wall **43**, a pair of side walls **44**, and a pair of opposed end walls **46** (FIGS. 3 and 4). The walls **43**, **44** and **46** define an outer peripheral opening **48** of arcuate shape for the plenum chamber **28** and are integral with the vane portions **19** and the base portions **20**, and may be formed by any suitable method, as by casting.

The inner marginal portions of the side walls **44** and **46** that form the opening **48** are formed with inwardly extending peripheral shoulder portions **50** and **51**. Upon the shoulders **50**, **51** there is a rail structure comprising side rails **54** and end rails **56**, nested therein and secured

to the side walls **44** and the end walls **46**, respectively, by a continuous weld joint **57**.

The side and end rails are provided with longitudinal slots **58** and **59**, respectively, disposed in end-to-end registry with each other and hold a cover plate **60** captive therein.

The rails are preferably of rectangular cross section and are linearly shaped to conform to the size and shape of the opening **48**. It will be noted that, in the example, the opening **48** to the plenum chamber is of quadrilateral shape, more particularly a parallelogram. The end rails **56** are rectilinear to conform to the shape of the associated shoulders **51**, while the side rail members **54** are of arcuate longitudinal shape to conform to the arcuate longitudinal shape of the shoulders **51**. The cover plate **60**, in a like manner, is of parallelogram shape, curved to an arcuate longitudinal cross-sectional shape to slidably fit in the associated slots **58**, **59**.

The cover plate **60** is of substantially the same thickness as the width of the slots to prevent leakage of coolant fluid therepast in operation and is fitted in the slots with a small end clearance space C peripheral in nature, so that during operation as the cover plate **60** expands lengthwise and breadthwise due to the high operational temperatures, it can do so freely without stressing the adjacent structure, and/or without buckling or distorting.

Since the cover plate **60** is closely, yet slidably, received in the peripheral rail structure slots and, since the side and end rails are welded to the neighboring walls **44** and **46** with the continuous weld connection **57**, a good leakage restricting arrangement is provided, so that the pressurized coolant is prevented from leaking around the cover.

While the invention has been shown in one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

We claim as our invention:

1. A nozzle blade structure for a hot elastic fluid utilizing machine, comprising

a vane portion of generally air foil cross-section,

a base portion connected to one end of said vane portion, and

a plenum chamber structure connected to the opposite end of said vane portion,

said chamber structure having wall structure integral with said vane portion,

said wall structure having peripheral marginal portions defining an open ended cavity,

said marginal portions being formed with shoulders,

a cover plate having the same shape as the open end of the cavity,

a rail structure supported by said shoulders about its periphery, said rail structure having a slot disposed in its inner periphery and facing inwardly,

said cover plate having its peripheral marginal portions slidably received in said slot and held captive therein,

means including an aperture in said plate to admit pressurized coolant fluid to said plenum chamber, and

means including passage structure in said vane portion disposed in communication with said plenum chamber for directing coolant fluid from said chamber through said vane portion to cool the latter.

2. The structure recited in claim **1**, wherein the rail structure is integrally connected about its outer periphery to the marginal wall portions by a continuous weld connection in a susbtantially fluid flow restricting manner.

3. The structure recited in claim **1**, wherein the marginal portions of the cover plate define a clearance space with the end of the slot to permit relative thermal expansion and contraction to occur without interference.

4. The structure recited in claim **1** and further including

a second vane portion of generally air foil cross-section integrally connected to the plenum chamber and the base portion, and

means including second passage structure in said second vane portion disposed in communication with the plenum chamber for directing a portion of the coolant fluid from the plenum chamber through said second vane portion to cool the latter.

5. The structure recited in claim 4, wherein

the plenum chamber structure is quadrilateral in cross-section and of arcuate shape in longitudinal section,

the rail structure includes a pair of rectilinear cross rails and a pair of arcuate longitudinal rails, and

the cover plate is of arcuate longitudinal cross-section.

References Cited

UNITED STATES PATENTS

3,427,000	2/1969	Scalzo	415—115
3,301,527	1/1967	Kercher	415—115
3,295,823	1/1967	Waugh et al.	415—115
3,275,294	9/1966	Allen et al.	415—115
2,836,393	5/1958	Payne et al.	415—115
2,625,367	1/1953	Rainbow et al.	415—115

HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

415—116, 180