Dec. 1, 1970 F. ZERLAUTH 3,544,231

STATOR-BLADE ASSEMBLY FOR TURBOMACHINES

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Fig. 1

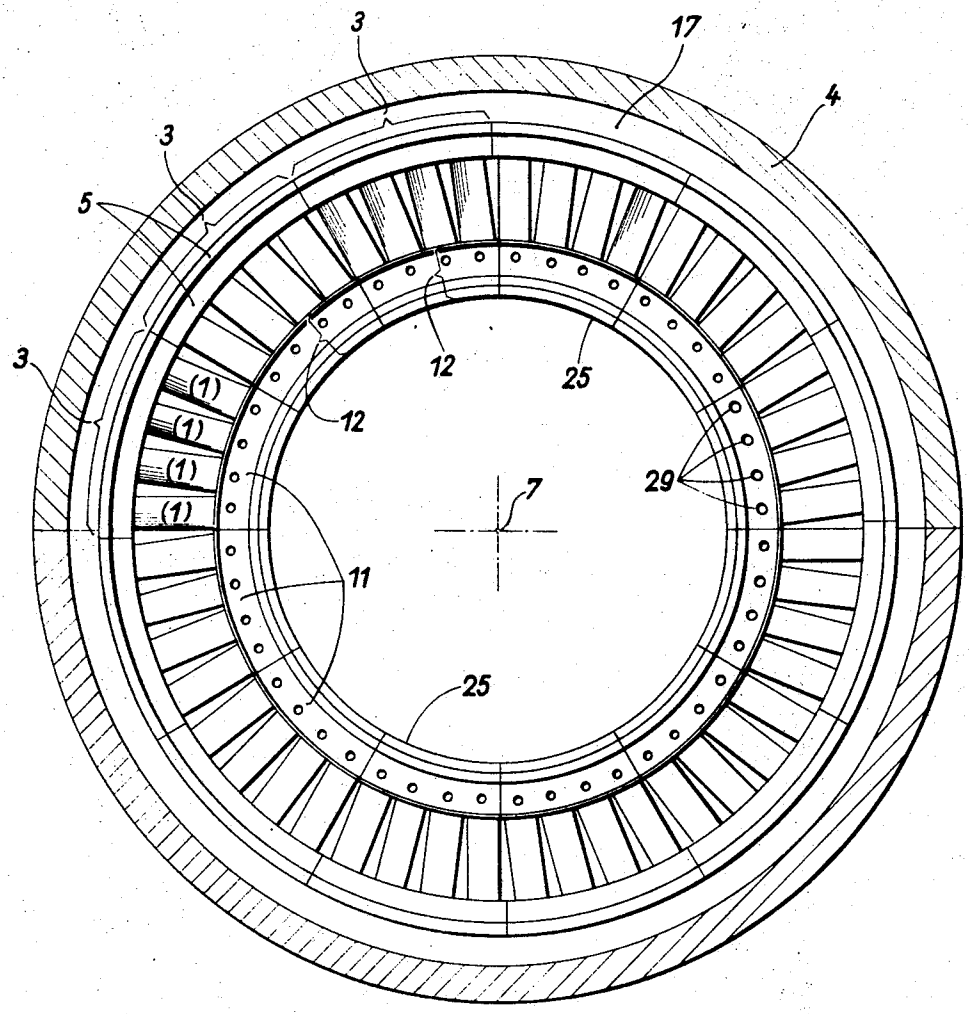

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Fig. 2

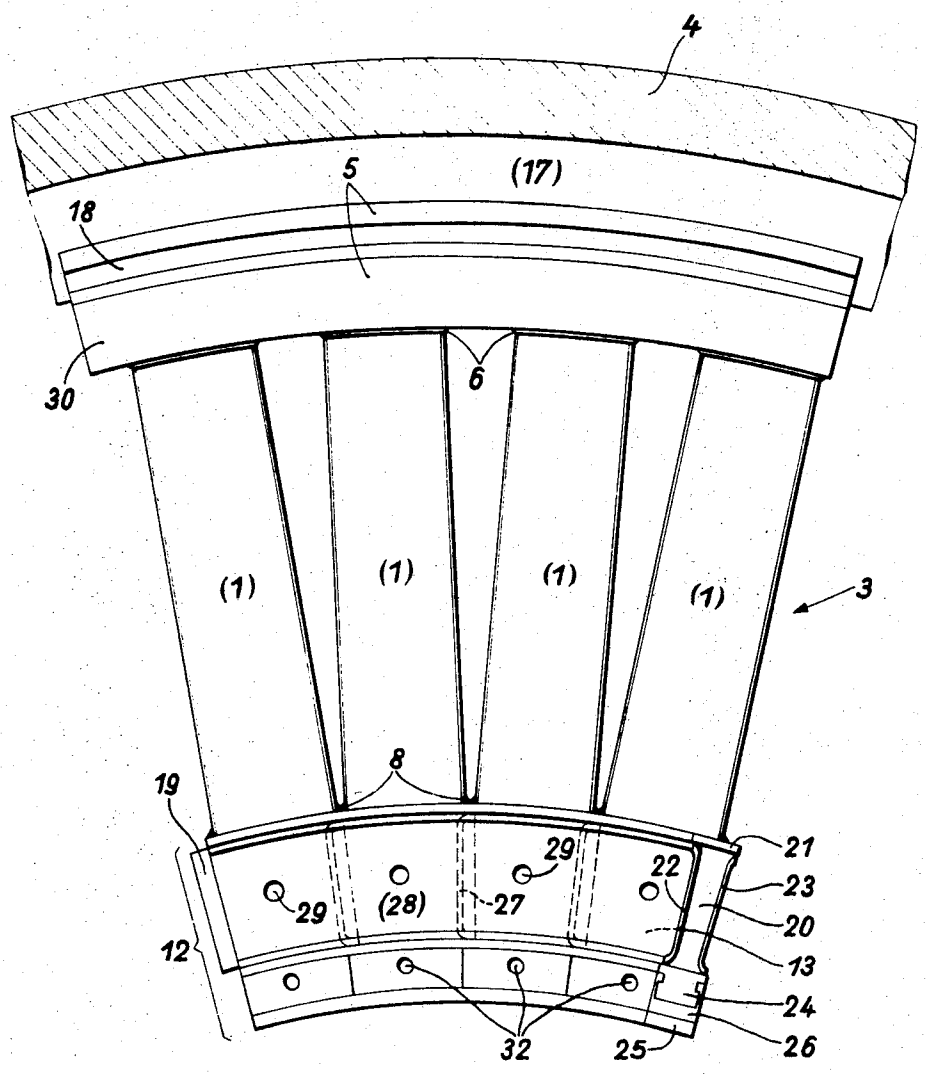

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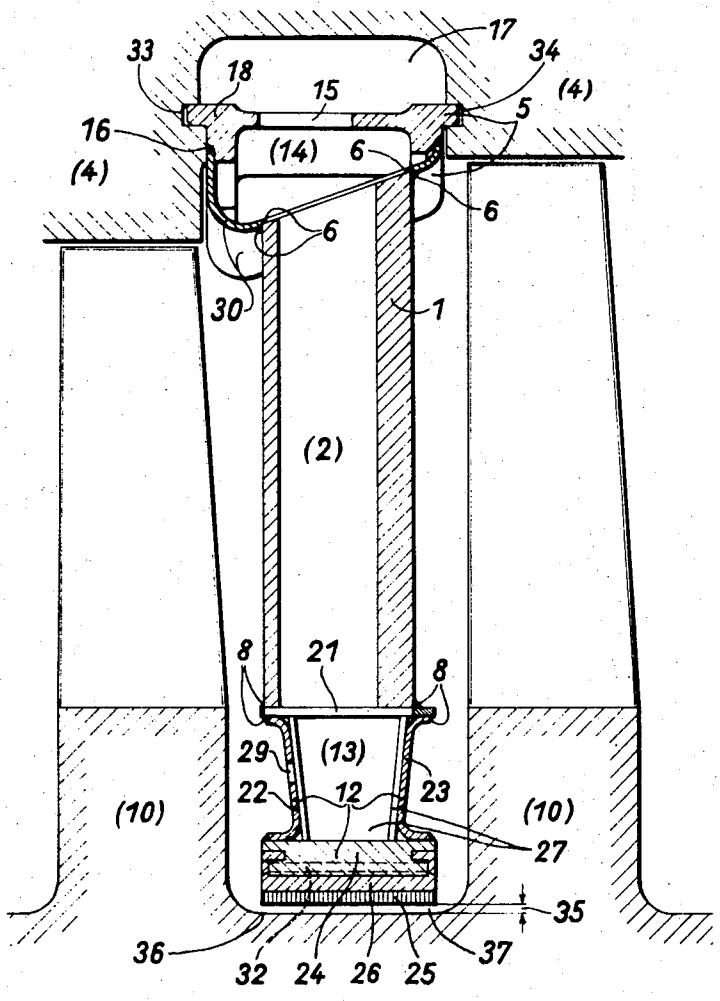
Fig. 3



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United States Patent Office

3,544,231

Patented Dec. 1, 1970

3,544,231

STATOR-BLADE ASSEMBLY FOR TURBOMACHINES

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Filed Oct. 11, 1968, Ser. No. 766,843

Claims priority, application Switzerland, Mar. 22, 1968, 4,329/68

Int. Cl. F01d 1/00, 25/12

U.S. Cl. 415—115 2 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed a stator-blade assembly for axial-flow turbomachines (e.g., turbines, or pumps or compressors) in which the stator blades of any one stage are divided into a plurality of segments making up an annular array. The blades are hollow, and those of each segment are connected at their radially outer ends to a hollow root member and at their radially inner ends to a hollow head member, for the flow of a temperature-control fluid such as air therethrough.

The present invention pertains to a stator-blade assembly for turbomachines traversed by the working fluid approximately parallel to the axis of rotation of the machine. The term turbomachine is intended to denote a turbine-type machine whether for development of mechanical energy at a rotating shaft from a fluid flowing through the machine as in a turbine, or for the delivery of energy from a rotating shaft to the fluid, as in a pump or compressor.

In accordance with the invention the stator blades are provided with coolant channels approximately parallel to the axes of those blades, and the blades are divided into groups or blading elements in each of which the blades are fastened together at the radially outer end thereof to a root or base which serves to hold the blading element in the stator blade carrier. Each blading element thus makes up a segment of a stator blade ring. At their radially inner end the blades of each blading element are joined to a hollow head member with the coolant channels in the blades opening into the hollow space of that head member. The head members of the blading elements or segments making up the stator blade ring or assembly of one stage of the machine form together a ring fitting between the roots or feet of the rotor blades of adjacent stages.

Advantageously all of the blading segments of a single stator blade ring are made up in the same way. In particular cases however it may be desirable to make the individual segments of a ring of different dimensions or with a different number of blades thereon.

The stator blade carrier may be provided either by the housing of the machine itself, or by means of a separate element provided within that housing. The blade segments may be made on a pattern, so that they can be fitted without play into the support therefor. In addition the blade segments, fastened as they are at their roots on a larger circumference than the outer circumference of the individual blades, are better supported especially against axial stresses.

Cooling of the stator blades, as in application of the invention to high temperature turbines, can be readily effected by causing a coolant to flow through the feet of the blade segements, through the channels in the blades and into the hollow space of the blade segment head members. Alternatively, a heating medium can be caused to flow through the blades.

According to an advantageous further feature of the

invention the root portion or foot of each blade segment can likewise be made hollow and provided with at least one opening. Through this opening a heating or cooling fluid can be uniformly distributed to the blades. The foot of each blade segment may advantageously take the form of a fastening or support element, made of suitably shaped sheet metal welded to the blades, together with a profile member welded to that support element, fitting in a groove of the stator-blade carrier and enclosing with that support element a hollow space or cavity. The profile member may have radial as well as axial locating surfaces by means of which centering of the guide blade array can be effected in the blade carrier or turbine housing.

In accordance with the invention, the hollow space in the head member can be closed at the radially inner end of the head member by means of a member having a shape matching with and complementary to a rotor member disposed between the rotor blades of adjacent stages. Further, to close that hollow space there may be employed sheet metal walls on three sides of a rectangular cross-section of that space with a profile member at the radially inner end of the head member on the fourth side. A wear member may be provided at the radially innermost point of the blade segment. With the help of such a wear member, and by proper control of the flow of coolant, the heating up of the stator blading can be so controlled on start-up and operation of the machine as to hold the rotor to stator-blade assembly clearance as small as possible. If however, for example on start-up, there should be contact between the rotor and the head members of a stator-blade array, damage will be avoided. Rather, the contacting surfaces will so shape each other that upon steady-state operation a small clearance will be preserved. By cooling of the blade segments, further expansion of the blades due to the heat generated by such frictional contact will be avoided.

The bearing surface of each head member is advantageously provided on a replaceable support. At least one boundary of the hollow space in each head member, and notably the sheet metal wall toward the high pressure end of the machine, can be provided with an opening directed toward the root of an adjacent rotor-blade set. The hollow space of each head member can also be subdivided by one or more partitions in order to promote uniform flow of temperature-control fluid. At least one opening directed toward the foot of an adjacent set of rotor blades can be provided to at least one of these compartments defined by the transverse partitions.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be further described in terms of a nonlimitative exemplary embodiment and by reference to the accompanying drawings in which:

FIG. 1 is a plan axial view showing an array of stator-blades according to the invention;

FIG. 2 is a view again in axial direction showing at an enlarged scale a plan view of one segment of the stator-blade array of FIG. 1; and

FIG. 3 is a section through the segment of FIG. 2 taken in a plane containing the axis of rotation of the machine.

In FIG. 1, the annular stator-housing is indicated at **4**. It includes for at least some stages of the machine a groove **17** into which the segments **3** of the stator-blade ring or array of that stage are received. To this end, the stator-housing is split along a horizontal plane, i.e., a plane containing the rotor axis. On assembly of the stator, with the stator-housing opened along this split, the blade segments of each stage can be inserted and fastened in the lateral grooves **33** and **34**, extending axially of the machine from the groove **17**, as illustrated in FIG. 3.

In the embodiment illustrated, each blade segment comprises four blades **1**, a root or foot **5** at the radially outer limit of the blades, and a hollow head member **12** at the radially inner end thereof.

The blades **1** include a longitudinal channel **2** therein which possesses a cross section corresponding to the exterior shape of the blade and to the cooling effect to be applied, so that upon exposure of the blades to hot gases in operation of the machine their exterior surface will so far as possible exhibit everywhere the same temperature.

At the root end away from the machine axis **7** (FIG. 1), the blades of each segment **3** are united by weld seams **6** to a sheet metal member **30** (FIGS. 2 and 3). Together, with the profile member **18**, to which it is welded at **16**, the sheet metal member **30** forms the blade segment foot **5**. The profile member **18** fits, as shown, into the side grooves **33** and **34** of the groove **17**. The hollow space **14** defined within the foot **5** communicates with the hollow groove **17** through the opening **15** in the member **18**.

At the radially inner ends thereof, the blades of each segment are welded, as indicated at **8**, to a head member **12** common to the blades of that segment, so that the channels **2** of those blades open into the cavity **13** of this head member. The head member is provided with sheet metal walls **21**, **22** and **23** on three sides of its rectangular cross-section (in planes containing the machine axis). On the fourth side adjacent the rotor axis, space **13** is closed off by means of a profile member **24**. A body **25** of suitable material, mounted on a support **26** fastened to the member **24**, constitutes a wear element, this element being replaceable with its support or shoe **26** on withdrawal of the pins **32**. By proper adjustment of coolant flow, the radial expansion and contraction of the blades **1** can be controlled to maintain under steady-state running conditions of the machine an extremely narrow clearance **35** from the rotor, generally indicated at **38**. Upon initial start-up there may indeed be contact with the rotor. By reason however of the wear which then ensues, a very narrow clearance **35** will be established for steady-state operating conditions.

The hollow space **13** of the head member **12** possesses bores **29** directed toward the feet **10** of the rotor-blades of the adjacent stages. It can be seen that a suitable gaseous, vaporous or even liquid cooling medium can be caused to flow out of the hollow stator-blade retaining grooves **17**, through the openings **15**, the cavities **14**, the blade passages **2** and thence into the hollow space **13** and therefrom to flow as free jets through the openings **29** against the rotor-blade roots. The head members **12** of the stator-blade segments **3** thus constitute together a ring **11** (FIG. 1) closely surrounding the rotor-surface **36**, this ring serving to minimize to negligible levels circulation of the machine working fluid through the flow passages **2** of the stator-blades.

As is shown in FIG. 2, the hollow space **13** of each head member **12** is closed at one peripheral end by means of a plug **19** which protrudes and extends into a matching cavity of a complementary plug **20** in the head member **12** of the adjacent stator-blade segment. The result is to hold the segments rigidly in the plane of the stator-blade array and also to seal off from each other the cavities **13** of the various blade segments making up the array. By this isolation of the hollow chambers **13**, there is achieved a homogenization in the flow of coolant through the blades of the various segments

The cavity **13** in the head of each of the stator-blade segments can be subdivided by means of transverse partitions **27** disposed between successive blades, the partitions extending axially of the machine. If then an opening **29** is provided in the wall **22** for each of the compartments thus formed, the streams of coolant through the

individual blades can likewise be evened out. The cross section of the exit apertures **29** in the head portion **12**, much smaller than that of the openings **15** in the root portions **5**, has as a consequence that the same quantity of heating or cooling medium will flow through each blade, but at increased pressure. The exit apertures **29** should have such a cross section as to permit the flow of a quantity of coolant suitable to the temperature at the stage in question and also to the material employed for the blades thereof. After exit out through the openings **29**, the cooling air flows for the most part in a surface layer over the walls **21** and **22** and thereby reduces contact between the head members **12** and the hot working gases flowing between the blades. Another portion of the cooling air passes through the clearance **35** and thereby closes that clearance to the hot working gases, thus preventing contact of those gases with the wear members **25**, the shoes **26** and the profile members **24**. The result is that these parts are protected from too high temperatures and too fast a heating up on start-up of the machine.

More than four blades, or on the contrary a smaller number than four, can be provided in the individual segments. Choice of the number of blades for this purpose is determined by the temperature conditions obtaining on start-up from a cold start, on the number of segments into which the whole array of stator-blades is subdivided, on the material employed and on the cooling circumstances obtaining when the machine is started.

While the invention has been described herein in terms of a presently preferred embodiment, the invention is not limited thereto but rather comprehends all variations on and departures from that embodiment properly falling within the spirit and scope of the appended claims.

What is claimed is:

1. A stator-blade assembly for axial-flow turbomachines, said assembly comprising a plurality of arcuate blade segments each including a plurality of blades having a radially extending channel therein, a root member affixed to the radially outer ends of said blades, and a hollow arcuate head member affixed to the radially inner ends of said blades with communication between said channels and the interior of said head member, said head members constituting a substantially closed ring, each of said head members possessing a substantially quadrilateral section in planes containing the axis of said ring and being bounded on the radially outer end and on the axial ends of said section by sheet metal walls and by a profile member on the radially inner end of said section, each of said head members including at least one partition dividing the hollow interior thereof into plural compartments between adjacent blades thereof.

2. A blade assembly according to claim **1** wherein each of said partitions has an opening formed therein.

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415—180