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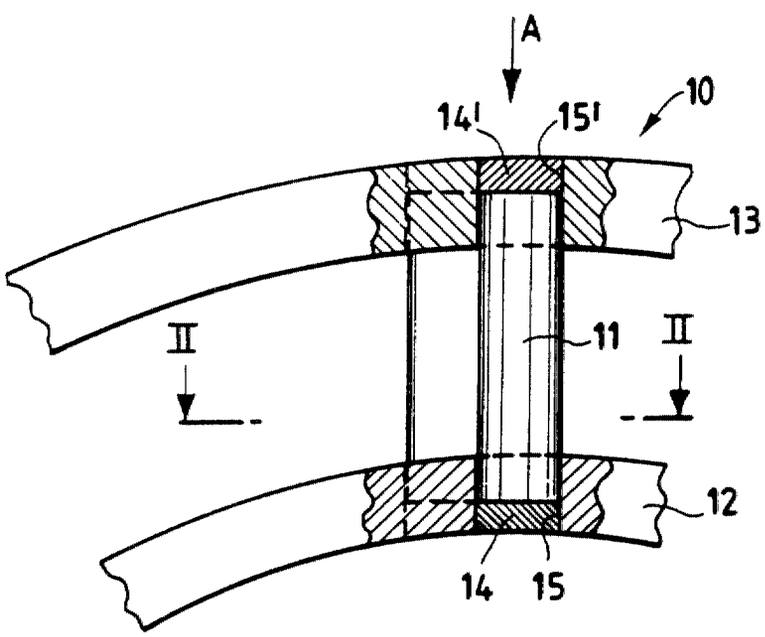
(54) Turbine stator

(57) A process for producing a stator diaphragm (10) in a steam turbine or gas expander, which provides a preparation phase of two rings (12, 13), machined separately to obtain radial slots (15, 15') having the profile of the blades (11) of a stator stage of the steam turbine or of the gas expander and suitable for the subsequent housing of the blades (11), in which an appropriate quantity of brazing material (14, 14'), in the form of paste, is inserted into the cavities (15, 15') and the diaphragm (10) is subjected to a furnace brazing operation in vacuo. The invention further relates to a stator diaphragm (10) for steam turbine or gas expander.

Fig.1



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Description

[0001] The present invention relates to a process for producing a stator diaphragm in a steam turbine or gas expander.

[0002] The present invention further relates to a stator diaphragm for steam turbine or gas expander.

[0003] As is known, steam turbines are machines supplied by vapour, generally water vapour, and suitable for converting into mechanical work part of the kinetic energy obtained following the expansion of the steam or of a previously compressed gas.

[0004] In particular, in such machines, the previously superheated or saturated steam, or a compressed gas, is caused to expand in the turbine by passing through several alternate stator and rotor stages.

[0005] The rotor stages are integral with the motor shaft to which they transmit the overall torque, whereas the stator stages serve to present the flow of steam or gas in suitable conditions at the inlet of the rotor blades.

[0006] The stator is constituted by a set of stator blades, between each pair of which a corresponding nozzle is located.

[0007] All the stator blades of a stage are fixed to the case of the turbine and internally to an appropriate fixing element, normally called a canopy.

[0008] The current technique for constructing and mounting the stator parts of the steam turbines or gas expanders of known construction is based on the following machining cycle.

[0009] Firstly, the blade is obtained from a drawn bar, cut to size and machined at the ends to create a coupling to the case and a pin for fixing the canopy.

[0010] More specifically, the case has a C-shaped cavity inside which the blades are introduced circumferentially.

[0011] The pitch between the blades is ensured by a spacer heel which undergoes the same end machining as the blade for anchorage to the case.

[0012] Blades and heels are thus mounted alternately in a slot obtained on the case of the turbine.

[0013] An appropriately perforated ring is then mounted on the other end of the blade and its anchorage is ensured by the riveting of the pins of the blades on the ring.

[0014] However, it will be noted that the system for mounting the stator stage described above requires considerable manual skill, so that it comprises long assembly times and a qualitative outcome which depends on the ability of the individual operator.

[0015] Furthermore, although this production method has proved valid over the years, nowadays it is less compatible with current requirements for reduced construction times and process repeatability which are characteristic of the typical specific conditions of the current competitive market.

[0016] Finally, it will be noted that the optional dismantling of this type of stator stage, when replacement is required for example, also requires a considerable amount of time, precisely because of the large number of component parts.

[0017] The object of the invention is therefore to provide a process for producing a stator diaphragm in a steam turbine or in a gas expander which permits a reduction of the construction and assembly time and the associated machining work, with consequent major financial advantages.

[0018] A further object of the invention is to provide a process for constructing and brazing stator diaphragms of steam turbines or gas expanders which enables construction errors to be substantially reduced.

[0019] Another object of the invention is to provide a process for constructing and brazing stator diaphragms of steam turbines or gas expanders which enables subsequent repair or replacement operations to be considerably simplified.

[0020] These and further objects are achieved by a process for producing a stator diaphragm in a steam turbine or in a gas expander, characterized in that it provides a preparation phase of two rings, machined separately to obtain radial cavities having the profile of the blades of a stator stage of the above-mentioned steam turbine or of the above-mentioned gas expander and suitable for the subsequent housing of the above-mentioned blades, in which an appropriate quantity of brazing material, in the form of paste, is inserted into the above-mentioned cavities and the above-mentioned diaphragm is subjected to a furnace brazing operation in vacuo.

[0021] According to a preferred embodiment of the present invention, the preparation phase of the rings is achieved by machining the rings separately by means of water jet cutting, for the purpose of obtaining the radial cavities having the profile of the blades, all with the aid of a numerically controlled machine tool.

[0022] According to another preferred embodiment of the present invention, the preparation phase of the cavities of the rings is achieved by cutting the cavities by laser.

[0023] Alternatively, the preparation phase of the cavities of the rings is achieved by cutting the cavities by electron discharge machining.

[0024] According to another preferred embodiment of the present invention, the brazing material, in the form of paste, is inserted into the cavities having the profile of the blades. The subsequent furnace brazing operation in vacuo promotes the penetration of the brazing material into the clearance between the profile of the blades and the said cavities.

[0025] According to a further preferred embodiment of the present invention, subsequent to the brazing operation the diaphragm is machined according to the final dimensions and is cut into two half-rings by electron discharge machining for final mounting in the case of the above-mentioned steam turbine or the above-mentioned gas expander.

[0026] The present invention also relates to a stator diaphragm for steam turbine or for gas expander, characterized in that it comprises two rings, machined separately to obtain radial cavities having the profile of the blades and suitable for the subsequent housing of the above-mentioned blades, in which an appropriate quantity of brazing material, in the form of paste, is inserted in the above-mentioned cavities.

[0027] Further features of the invention are defined in the claims accompanying the present patent application.

[0028] Further objects and advantages of the present invention will be evident from a study of the description which follows and of the accompanying drawings which are provided purely by way of non-exhaustive explanatory example, and in which:

- Fig. 1 shows a schematic front view, partially in section according to plane I-I of Fig. 2, of a stator blade, belonging to a set of stator blades relating to a stator diaphragm, fixed in position by means of the process according to the present invention;

- Fig. 2 shows a schematic view, partially in section according to plane II-II of Fig. 1, of the stator blade shown in Fig. 1; and

- Fig. 3 shows a schematic view, according to direction A of Fig. 1, of the cavity filled with brazing material and relating to a stator blade.

With particular reference to the drawings mentioned, the assembly comprising the stator diaphragm, and the blades fixed thereto, is denoted overall by the reference numeral 10.

[0029] In substance, in the machining process according to the present invention, each blade 11 is fixed at the ends by two rings 12 and 13, so as to create a diaphragm 10.

[0030] In particular, a first end of each blade 11 is fixed to an internal ring 12 whereas another end of each blade 11 is fixed to an external ring 13.

[0031] The diaphragm 10 thus formed is then mounted in the case of the steam turbine, or of the gas expander, in which a cavity of rectangular cross-section has previously been produced.

[0032] The diaphragm 10 is thus obtained with two rings 12 and 13, preferably forged, which are machined separately with a water jet cutting process.

[0033] In this way radial slots are created with the profile of the blades 11 for the subsequent housing of the said blades.

[0034] Cutting is carried out with a numerically controlled machine tool.

[0035] According to a number of alternative variants of the present invention, the cutting process may be carried out with laser or by means of electron discharge machining.

[0036] The blades 11 are always obtained from a drawn bar and are cut to size as previously carried out, but are not machined to have the upper cavity for anchoring them to the case and the pin at the other end is therefore no longer present.

[0037] The brazing material 14, 14', in the form of paste, is inserted into the cavities 15, 15' and into the clearance between the profile of the blades 11 and the cavities 15, 15' of the external 13 and internal 12 rings.

[0038] Brazing takes place in a furnace in vacuo, at controlled temperature, according to the parameters outlined below.

[0039] The blades 11 are fixed by making a small welding bead with welding material (on the internal side of the ring only) so as to ensure a stable position for the subsequent operations.

[0040] An auxiliary adhesive linen-finish tape for the injection of the brazing paste is applied to the external and internal diameter of the rings.

[0041] The brazing material in the form of paste 14 and 14' is then injected into the cavities 15 and 15' located on the rings from both the side of the internal 12 and external 13 diameter, care being taken to control the injection pressure so as to cause the paste 14, 14' to ascend as far as the limit of the corners of the edge of the slot facing the steam flow channel.

[0042] Brazing takes place in a furnace in vacuo at a pressure less than $5x10^{-3}$ TORR.

[0043] After brazing, the diaphragm 10 is machined according to the final dimensions and is then cut into two half-rings, by means of electron discharge machining by wire or laser.

[0044] Final assembly in the case is thus reduced to the sole phase of installing the two half-rings.

[0045] The features of the process for producing a stator diaphragm in a steam turbine to which the present invention relates will be evident from the description given, as will the advantages thereof.

[0046] The following concluding remarks are intended to define these advantages more precisely.

[0047] The invention described above makes it possible to install, in a single diaphragm, two rings inside which the blades of the stator are rendered integral by brazing.

[0048] This solution allows the use of a reduced number of component parts and permits a considerable simplification of the operations to replace the diaphragm 10 when this becomes necessary.

[0049] In fact, a truly important aspect of the stator diaphragm 10 of the invention is provided by the fact that it gives rise to only two elements to be handled, the upper half-ring and the lower half-ring, instead of all the blades 11 as in the systems according to the prior art.

[0050] This means that final assembly and any replacement which may be necessary can be carried out in a greatly reduced time, with reduced machine shutdown times and consequent financial savings.

[0051] Furthermore, the structural strength of the di-

aphragm is increased, and the manufacturing tolerances are also reduced, thanks also to the automation of the production process and the elimination of manual adjustments.

[0052] The technology of water jet cutting, and in particular of a numerically controlled machine, has been adapted to the cutting of the slots and enables there to be an average clearance of 0.05-0.2 mm on the profile of the blades 11, ensuring economy of machining and accurate results.

[0053] It is evident that numerous variants may be introduced to the process for producing a stator diaphragm in a steam turbine, to which the present invention relates, without thereby departing from the principles of novelty inherent in the inventive idea described.

[0054] Finally it is evident that in the practical implementation of the invention, the materials, forms and dimensions of the components described may be of any kind, according to requirements, and they may be replaced by others which are equivalent from the technical point of view.

Claims

1. Process for producing a stator diaphragm (10) in a steam turbine or gas expander, **characterized in that** it provides a preparation phase of two rings (12, 13), machined separately to obtain radial cavities (15, 15') having the profile of the blades (11) of a stator stage of the above-mentioned steam turbine or gas expander and suitable for the subsequent housing of the above-mentioned blades (11), in which an appropriate quantity of brazing material (14, 14'), in the form of paste, is inserted into the above-mentioned cavities (15, 15') and the above-mentioned diaphragm (10) is subjected to a furnace brazing operation in vacuo.

2. Process according to Claim 1, **characterized in that** the above-mentioned preparation phase of the above-mentioned rings (12, 13) is achieved by machining the above-mentioned two rings (12, 13) separately by means of water jet cutting, for the purpose of obtaining the above-mentioned radial cavities (15, 15') having the profile of the blades (11), with the aid of a numerically controlled machine tool.

3. Process according to Claim 1, **characterized in that** the above-mentioned preparation phase of the cavities (15, 15') of the above-mentioned rings (12, 13) is achieved by cutting the above-mentioned cavities (15, 15') by laser.

4. Process according to Claim 1, **characterized in that** the above-mentioned preparation phase of the cavities (15, 15') of the above-mentioned rings (12, 13) is achieved by cutting the above-mentioned cavities (15, 15') by electron discharge machining.

5. Process according to Claim 1, **characterized in that** the brazing material (14, 14'), in the form of paste, is inserted into the above-mentioned cavities (15, 15') and into the clearance between the profile of the blades (11) and the above-mentioned cavities (15, 15') of the rings (12, 13).

6. Process according to one of the preceding Claims, **characterized in that**, subsequent to the brazing operation, the above-mentioned diaphragm (10) is machined according to the final dimensions and is cut into two half-rings by electron discharge machining or by laser for final mounting in the internal case of the above-mentioned steam turbine or the above-mentioned gas expander.

7. Process according to one of the preceding Claims, **characterized in that** the above-mentioned brazing operation takes place in a furnace in vacuo.

8. Stator diaphragm (10) for steam turbine, **characterized in that** it comprises two rings (12, 13), machined separately to obtain radial cavities (15, 15') having the profile of the blades (11) and suitable for the subsequent housing of the above-mentioned blades (11), in which an appropriate quantity of brazing material (14, 14'), in the form of paste, is inserted in the above-mentioned cavities (15, 15').

Fig.1

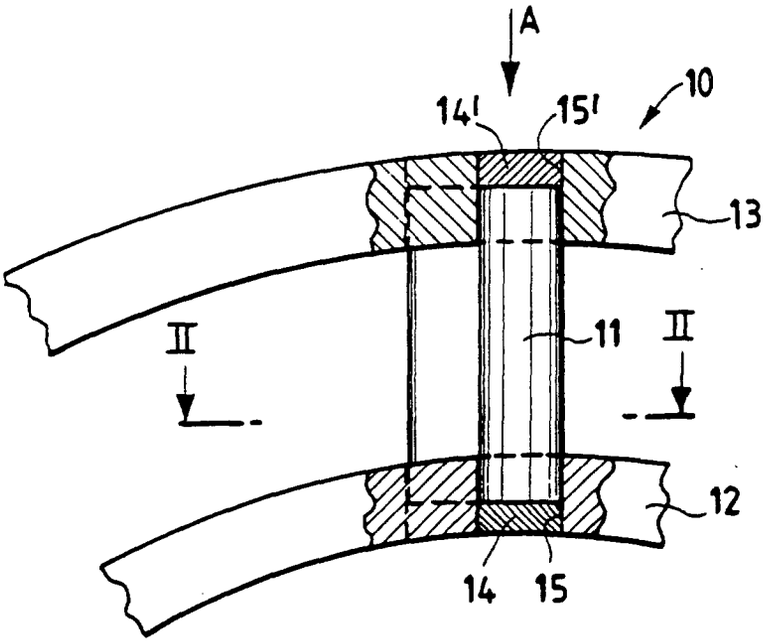

Fig.2

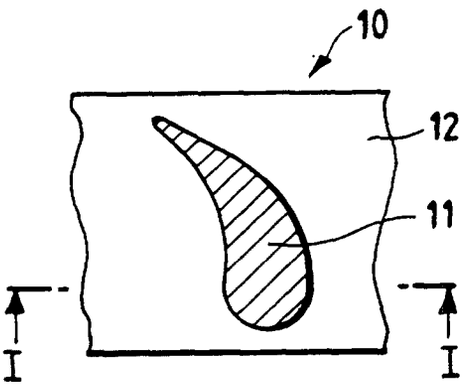

Fig.3