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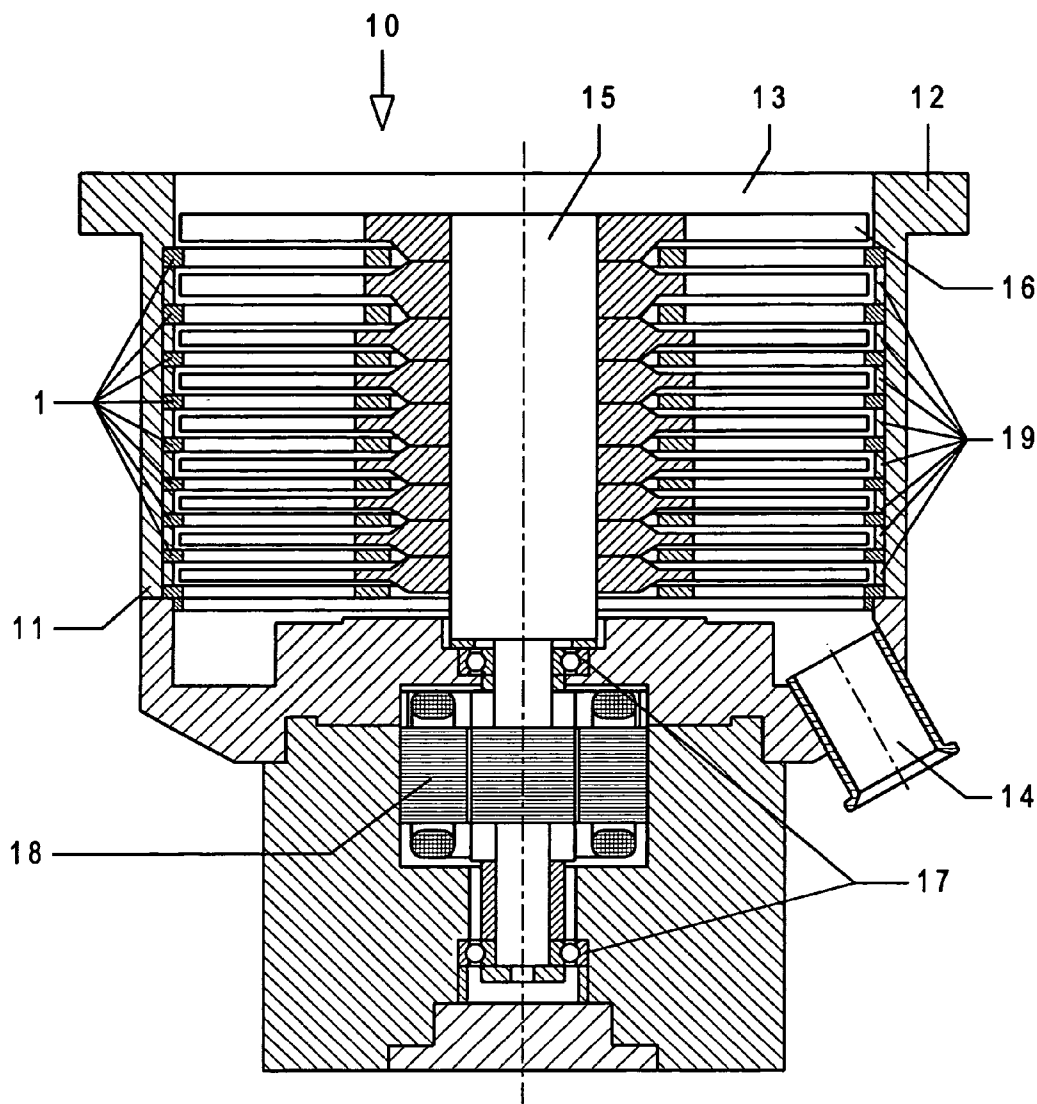
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(57)

ABSTRACT

A stator disc for a turbomolecular pump has an inner ring (3), an outer ring (4), and a plurality of vanes (2) formed of a stator disc plane, extending between the inner and outer rings (3, 4), and having, in connection regions of the vanes with the inner and outer rings, respective radial webs (5) a circumferential width (S) of which is smaller than a vane width (T).

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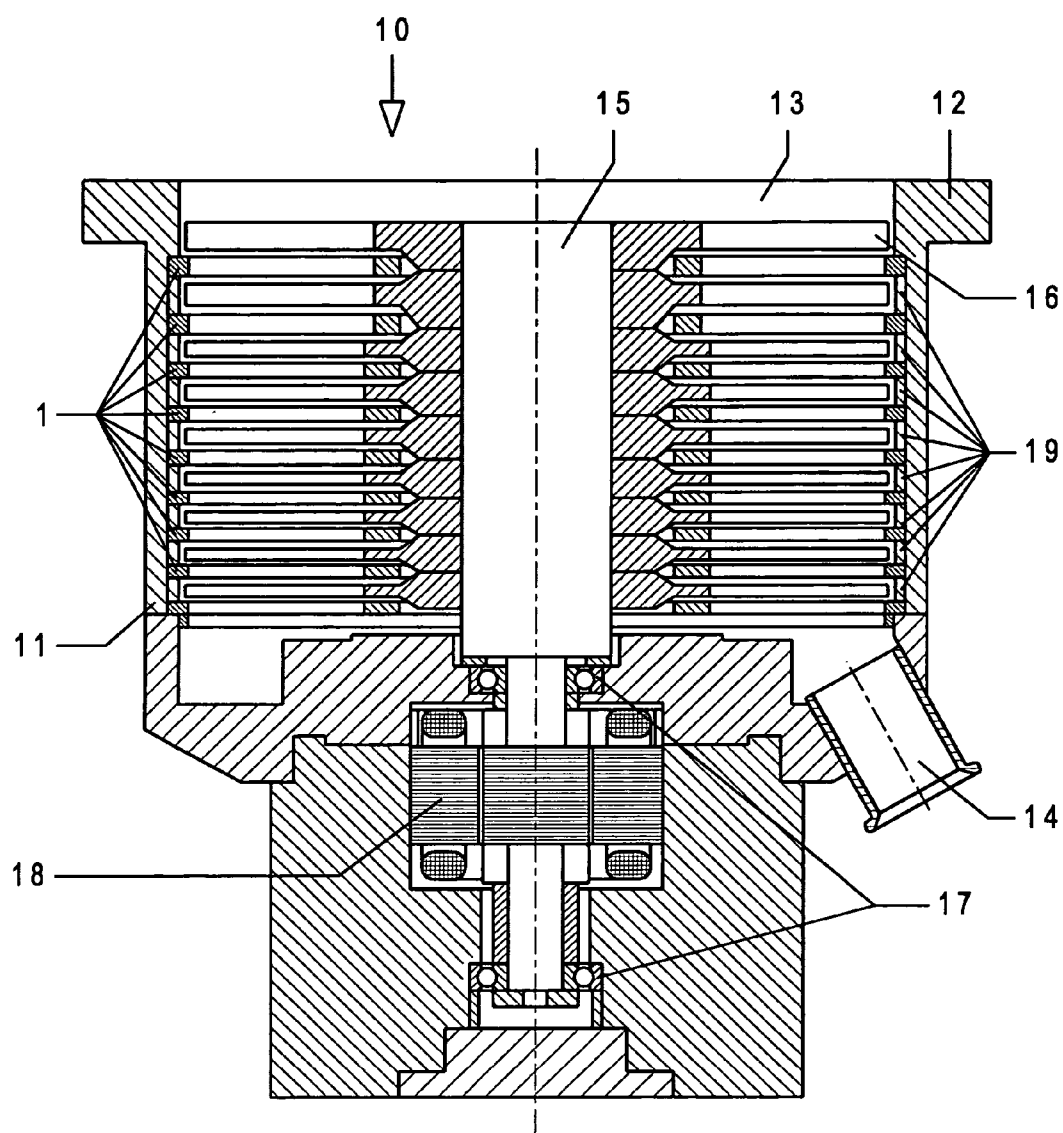


Fig. 1

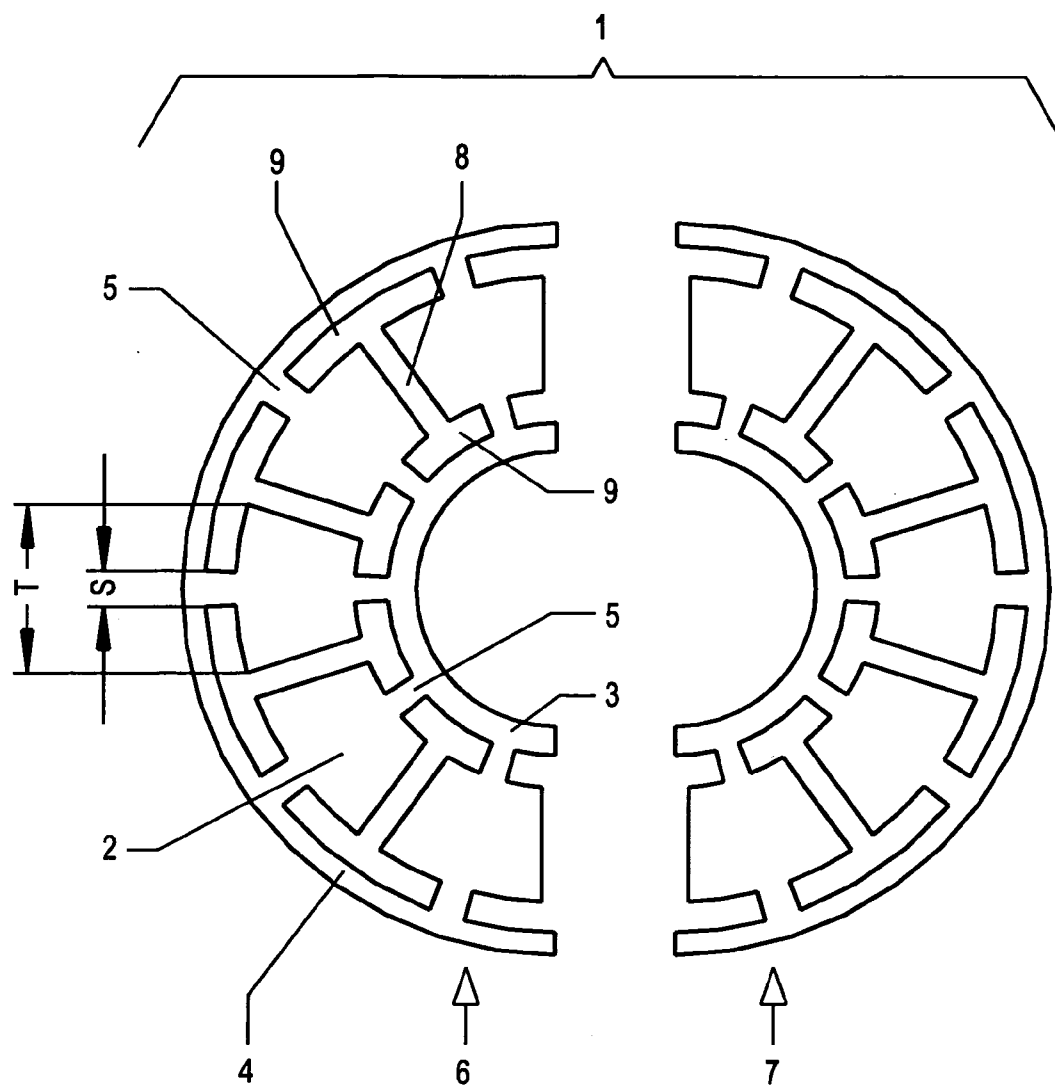


Fig. 2

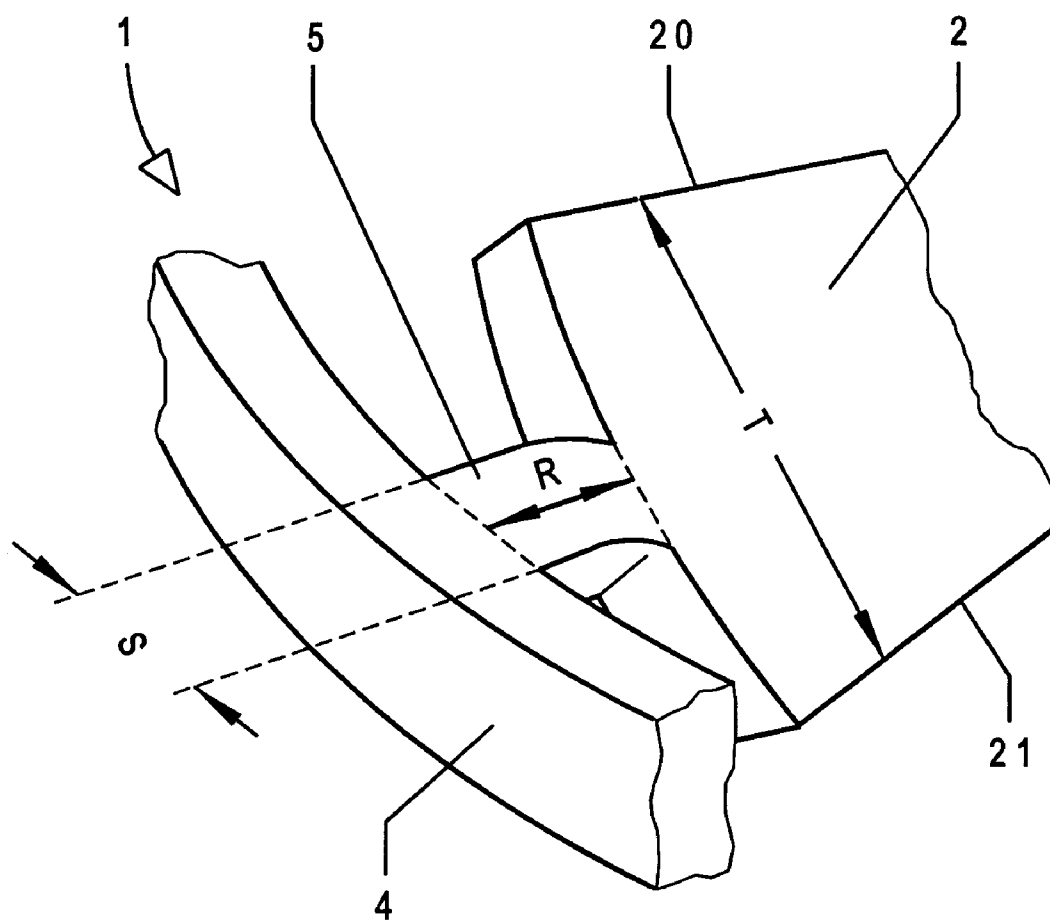


Fig. 3

STATOR DISC FOR A TURBOMOLECULAR PUMP**BACKGROUND OF THE INVENTION****[0001] 1. Field of the Invention**

[0002] The present invention relates to a stator disc for a turbomolecular pump and having a plurality of vanes curved out of the disc plane and having their opposite ends connected with the outer and inner rings of the disc.

[0003] 2. Description of the Prior Art

[0004] In turbomolecular pumps rotor and stator discs are alternatively arranged, with the rotor discs being arranged on a rapidly rotatable shaft. The stator discs are fixedly secured in the pump housing. Both types of discs have vanes, and their cooperation, together with a rapid rotation, produces the pumping effect. It is known to produce the vanes of both types of discs by milling them out of solid discs. This process is time-consuming and expensive. That is why stamped stator discs are used. Such discs are disclosed, e.g., in German Laid-Open Application DE-OS 37 22 164. In the disclosed process, solid discs are stamped out of sheet metal. Then, radial slots are stamped out in the discs. In the last step, the regions between the slots are set so that disc material is squeezed out of the disc plane so that vanes are formed. The regions, which are not set in inner and outer regions remain as rings.

[0005] The drawback of the known state of the art technology consists in that in connection regions between the inner ring and the vanes or between the vanes and the outer ring, a large degree of deformation takes place. In addition, the forces with which the necessary degree of deformation can be achieved, are very large. This type of deformation leads to high stresses in the material which results in the distortion of the disc and the necessary process of straightening the disc. This adversely affects the achievable precision of the disc shape. However, the disc shape precision is very important when small clearances between the rotor, stator and housing components need be achieved. The pump output of turbomolecular pumps depends on the clearance dimensions.

[0006] A further drawback of the known process consists in that the process requires use of extravagant and, therefore, very expensive tools. A flexible dimensioning of discs, which should be optimally adapted to the operative range of a pump, i.e., to vacuum-technical requirements, cannot be realized with justifiable costs at a small number of work-pieces.

[0007] The object of the invention is to eliminate these drawbacks of the state of the art, to provide for use of cost-effective manufacturing tools, and to achieve a high precision of stator discs.

[0008] Another object of the invention is to eliminate the high degree of the deformation.

SUMMARY OF THE INVENTION

[0009] These and other objects of the present invention, which will become apparent hereinafter, are achieved by providing a stator disc in which the vanes extending between the inner and outer rings have in connection regions of the vanes with the inner and outer rings, respective radial webs a circumferential width of which is smaller than a vane width.

[0010] In comparison with the state of the art, the inventive stator disc has a smaller deformable material region which, moreover, requires a smaller degree of deformation. As a result, stresses in the component are reduced, which eliminates straightening costs. With the elimination of a need for straightening, a higher precision of the disc measurements can be achieved. Because of smaller deformation forces and fewer operational steps are required, cheaper tools can be used. The portion of the tool costs within overall manufacturing costs is reduced, which makes adaptation of the stator disc to the vacuum-technical requirements economical.

[0011] Because with the inventive stator disc, the disc dimensions can be retained better than in the state of the art, the use of the inventive stator disc in a turbomolecular pump results in reduction of the clearances within the pumps and, thereby, in improvement of the pumping action.

[0012] According to the inventive manufacturing method or process, firstly, semi-circular disc members with substantially radial slots are produced by stamping or laser cutting. Then, circumferential slots are formed at opposite ends of the radial slots. Finally, the material between the radial slots is curved out so that it is squeezed out of planes of the discs in such a way that vanes with a web between a respective vane and at least one of the outer and inner disc edges are formed. This inventive manufacturing process permits to achieve the above-described advantages regarding deformation expenses and material stresses.

[0013] Arrangement of the web at a half distance between opposite edges of a vane provides for a uniform loading of the web. The web loading is caused by the different gas pressure above and beneath the stator disc. Because of a symmetrical arrangement, the torques which act on the web, have the same power but opposite signs. As a result, no resulting torque appears on the radial axis of the vane and the web. This reduces the loading of the material.

[0014] The maximum width of the web in the circumferential direction or the circumferential width of the web is limited by the fact that deformation and material stresses are increased with an increased width. The minimum width is limited by the required strength and heat transfer. The strength should insure that the web is able to withstand the mechanical loads applied to the web as a result, e.g., by an increased pressure drop across the stator disc. In addition, the web has to have an appropriate cross-section that would insure a satisfactory heat transfer. Advantageously, the ratio of the web width to the vane width is selected within a range from one/tenth to one/second.

[0015] A further manufacturing advantage results from forming the stator disc of a plurality of identical disc sections. In this case, only a single form for the disc section is necessary. This also facilitates assembly as the disc sections cannot be mixed and/or improperly combined.

[0016] A further manufacturing advantage is achieved by forming the vanes in a single step, all at once, curving simultaneously all of the vanes of a disc out of the disc plane. This permits to significantly reduce the operational time.

[0017] The novel features of the present invention, which are considered as characteristic for the invention, are set forth in the appended claims. The invention itself, however,

both as to its construction and its mode of operation, together with additional advantages and objects thereof, will be best understood from the following detailed description of preferred embodiment, when read with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The drawings show:

[0019] **FIG. 1** a cross-sectional view of a turbomolecular pump with stator discs according to the present invention;

[0020] **FIG. 2** a plan view of a stator disc according to the present invention; and

[0021] **FIG. 3** a perspective view of a section of a stator disc according to the present invention, with the cut-out showing a web between a vane and an outer disc.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] A turbomolecular pump 10, which is shown in **FIG. 1**, has a housing 11 with a flange 12 for connecting the pump 10 with a pumped-out recipient. The flange 12 contains a suction region 13. The turbomolecular pump 10 has an outlet 14 from which the compressed gas is expelled. The turbomolecular pump 10 has a rotor shaft 15 which is supported in bearings 17 and is driven, with high speed, by a drive 18. The rotor shaft 15 carries a plurality of discs 16, each carrying vanes. Stator discs 1, which are likewise provided with vanes, are arranged between the rotor discs 16 and are fixedly secured in the housing 11. The stator discs 1 are held at a distance from each other by spacer rings 19. The pumping action produced by a rapid rotation of the rotor discs 16 and their cooperation with the stator discs 1.

[0023] The stator disc 1 according to the present invention, which is used in the turbomolecular pump 10 and a plan view of which is shown in **FIG. 2**, is formed of two half-discs 6 and 7 which are mounted about the rotor shaft from opposite sides upon assembly of the turbomolecular pump. The stator disc 1 has an outer ring 4 with which it is held in the housing of the turbomolecular pump, and an inner ring 3. Between the outer ring 4 and the inner ring 3, there are arranged a plurality of vanes 2. The vanes are formed upon formation, in a solid material, substantially radial slots 8 and slots 9 in the circumferential direction. As a result of formation of slots 8 and 9, webs 5 are formed in connection regions between the outer and inner rings and the vanes. The circumferential width of the webs is designated with S, and the vane width is designated with T. The vane width T is greater than the web depth S.

[0024] **FIG. 3** shows a perspective view of a cut-out of the stator disc 1 that clarifies how the vanes are formed in a disc plane. In the connection region between the outer ring 4 and the vane 2, the plane of which is inclined relative to the disc plane, the web 5 is formed. With the web, the circumferential width S of which is smaller than the vane width T, the amount of the to-be-deformed material is reduced. The radial dimension of the web is designated with R. Conventionally, the deformation region along the circumference is as large as the depth T. At a large inclination of the vane relative to the disc plane, a very significant deformation of the material takes place, with the above-discussed drawbacks. With formation of the web 5, a significant deforma-

tion is not any more necessary. The deformation is essentially limited to the shorter region S, which permits to obtain the above-discussed advantages. The dimensions S and R cannot be made arbitrary small. The geometrical dimensions of the web are selected based on a load carrying ability and a maximum possible heat transfer. Within the pump, in particular in the rotor, a large amount of heat is generated as a result of compression and friction of the compressed gasses. Another source of heat is the drive which operates not without losses. This heat is transferred from the rotor to the stator discs by radiation, and it should be able to be removed by the webs. A ratio of S to T of 1:10 to 1:2 proved itself to be favorable and practical.

[0025] Additional advantages are achieved when the web 5 is arranged at a half distance between the vane edges 20 and 21.

[0026] In the first step of the process of forming the stator disc 1, first, semi-circular discs with the substantially radial slots 8 are produced by stamping or laser cutting. The further treatment is carried out in such a way that at the ends of the radial slots, further slots 9 in the circumferential direction, are produced, so that a web 5 is formed between the vane 2 and at least the inner ring 3 or the outer ring 4. Finally, the material between the radial slots is so curved that it is squeezed out of the disc plane in such a way that a vane 2 is formed. For squeezing the material out, the disc, e.g., is placed between upper and lower forms, with the two forms being pressed against each other.

[0027] Though the present invention was shown and described with references to the preferred embodiment, such is merely illustrative of the present invention and is not to be construed as a limitation thereof and various modifications of the present invention will be apparent to those skilled in the art. It is therefore not intended that the present invention be limited to the disclosed embodiment or details thereof, and the present invention includes all variations and/or alternative embodiments within the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A stator disc for a turbomolecular pump, comprising an inner ring (3); an outer ring (4); and a plurality of vanes (2) formed of a stator disc plane, extending between the inner and outer rings (3, 4), and having, in connection regions of the vanes with the inner and outer rings, respective radial webs (5) a circumferential width (S) of which is smaller than a vane width (T).

2. A stator disc according to claim 1, wherein the radial web (5) is arranged at a half distance between opposite edges (20, 21) of a respective vane.

3. A stator disc according to claim 1, wherein the circumferential width (S) of a web (5) varies from about one-tenth to about one/second of the vane depth (T).

4. A stator disc according to claim 1, wherein the stator disc is formed of at least two identical disc sections.

5. A turbomolecular pump, comprising a housing including a flange for connecting the pump with a pump-out recipient and having a suction region, and an outlet; a rotor shaft arranged in the housing and carrying a plurality of rotor discs provided with vanes; a drive for driving the rotor shaft; and a plurality of stator discs fixedly secured in the housing and arranged between the rotor discs, at least one of the stator discs having a plurality of vanes formed of a stator

disc plane, extending between the inner and outer rings (3, 4), and having, in connection regions of the vanes with the inner and outer rings, respective radial webs (5) a circumferential width (S) of which is smaller than a vane width (T).

6. A method of forming a stator disc for a turbomolecular pump, comprising the steps of producing semi-circular discs with substantially radial slots by one of stamping and laser cutting; forming circumferential slots at opposite ends of the radial slots; and thereafter, curving out material between the

radial slots so that it is squeezed out of planes of the discs in such a way that vanes with a web between a respective vane and at least one of the outer and inner disc edges are formed.

7. A method according to claim 6, wherein all of the vanes are formed at once.

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