

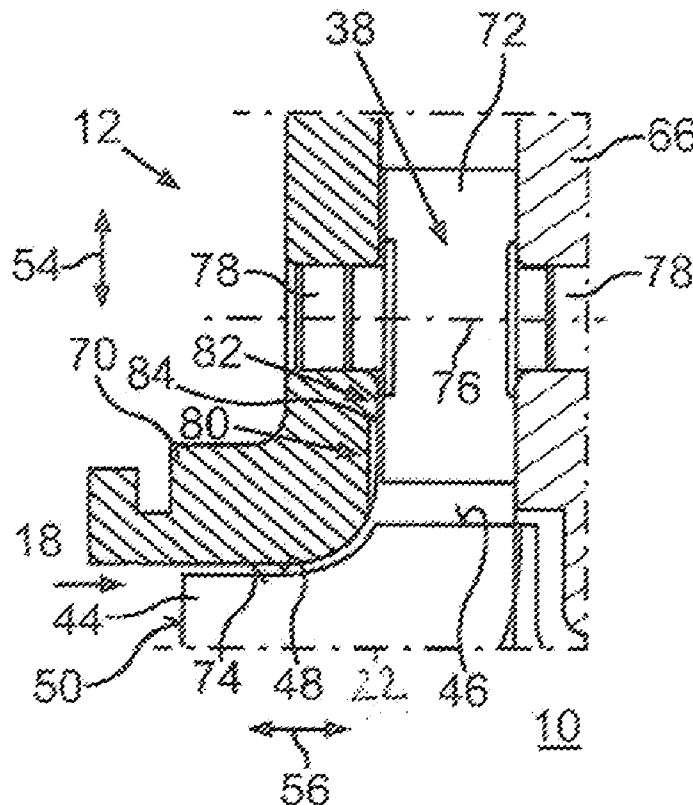


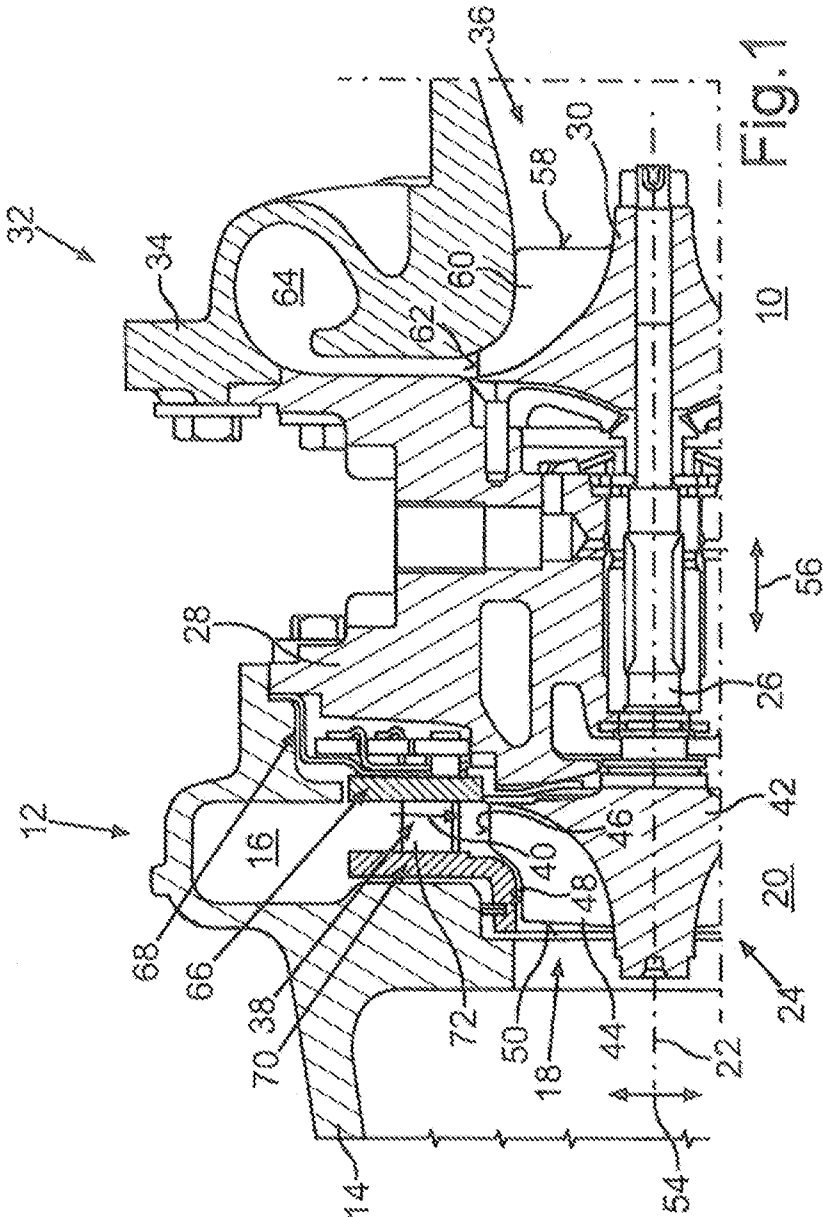
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(19) **United States**(12) **Patent Application Publication**
KOTZBACHER(10) **Pub. No.: US 2014/0099191 A1**(43) **Pub. Date: Apr. 10, 2014**(54) **TURBINE FOR AN EXHAUST GAS
TURBOCHARGER****Publication Classification**(71) Applicant: **IHI CHARGING SYSTEMS
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Heidelberg (DE)(51) **Int. Cl.**
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USPC **415/159; 415/151**(73) Assignee: **IHI CHARGING SYSTEMS
INTERNATIONAL GMBH,**
Heidelberg (DE)(57) **ABSTRACT**(21) Appl. No.: **14/106,745**(22) Filed: **Dec. 14, 2013****Related U.S. Application Data**(63) Continuation-in-part of application No. PCT/EP2012/
002637, filed on Jun. 22, 2012.(30) **Foreign Application Priority Data**

Jul. 20, 2011 (DE) 10 2011 108 195.3

In a turbine for exhaust gas turbocharger of a combustion engine with a turbine casing forming an installation space in which a turbine wheel is arranged so as to be rotatable about an axis of rotation and into which exhaust gas of the combustion engine may be supplied via at least one flow duct in which a guide vane structure is arranged, the guide vane structure includes vanes, which are pivotably supported relative to the turbine casing and form an axial inlet nozzle structure adjacent a wall portion of the turbine which extends along the guide vane structure, the wall portion comprising at least a first guide wall area which overlaps the guide vane structure, and which is set back relative to a second guide wall area in which the vanes are pivotably supported and which adjoins the first wall area.





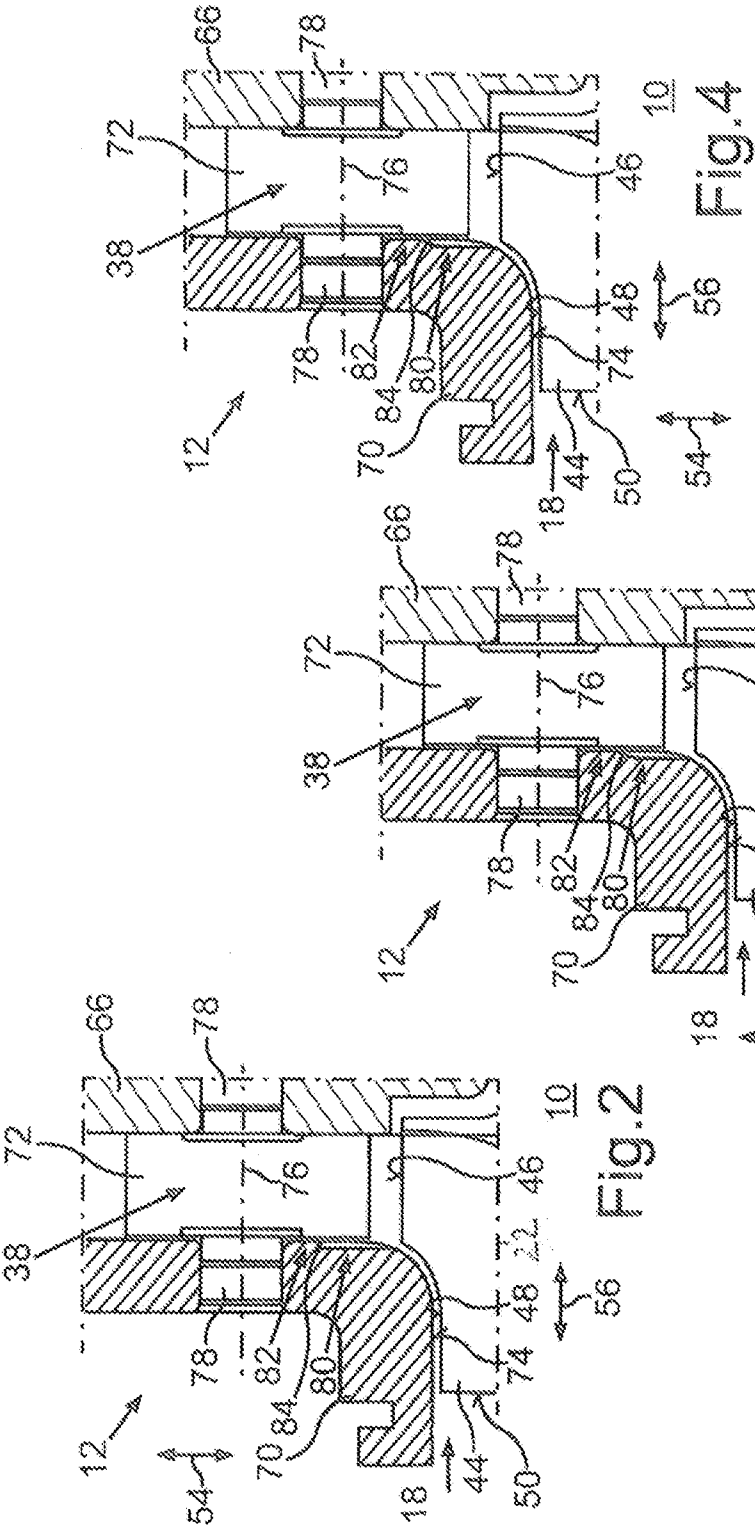


Fig. 2

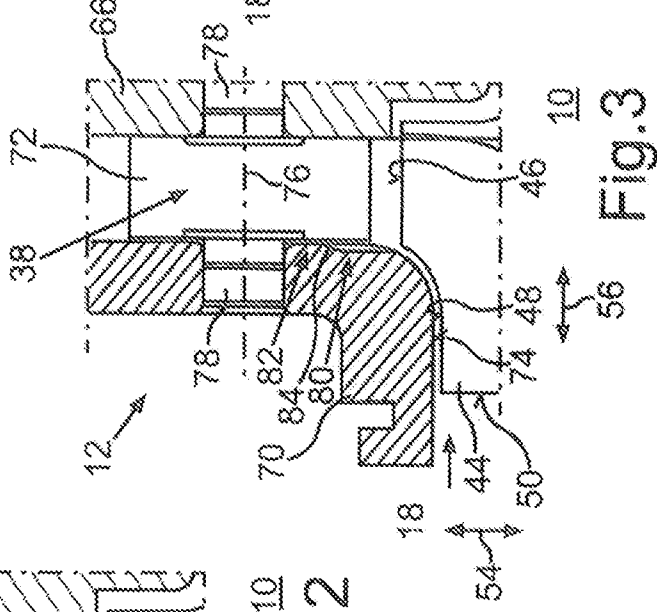


Fig. 3

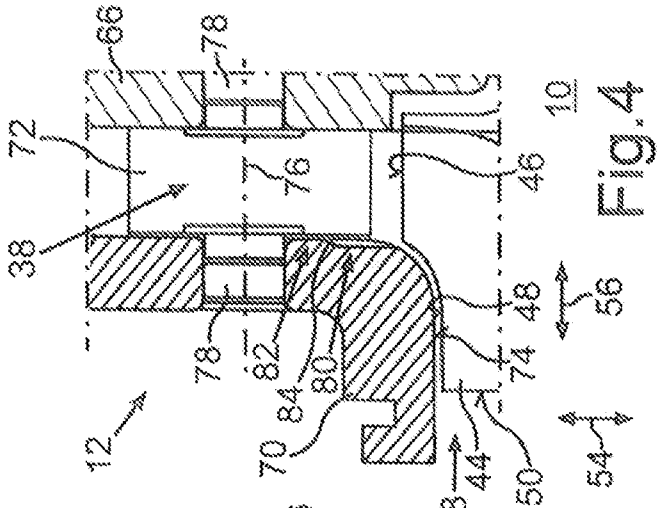


Fig. 4

TURBINE FOR AN EXHAUST GAS TURBOCHARGER

[0001] This is a Continuation-in-Part application of pending international patent application PCT/EP2012/002637 filed Jun. 22, 2012 and claiming the priority of German patent application 10 2011 108 195.3 filed Jul. 20, 2011.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to a turbine for an exhaust gas turbocharger including a turbine casing with a turbine wheel rotatably disposed therein and guide vanes which are adjustably supported for controlling the exhaust gas flow to the turbine wheel.

[0003] DE 10 2008 034 751 A1 discloses a turbocharger for a combustion engine with a turbine casing and a turbine comprising a turbine wheel arranged therein, wherein the turbine is equipped with adjustable guide vanes for varying a flow cross-section via which the exhaust gas is directed onto the turbine wheel. A floating spacer ring is provided between the adjustable guide vanes and the turbine casing, which is in contact with the incoming exhaust gas via a pressure duct, and the rear side of which may be exposed to the exhaust gas. During operation of the turbocharger, a force resultant is generated which acts axially upon the spacer ring and pushes the spacer ring against the end faces of the guide vanes by this force resultant.

[0004] It is the object of the present invention to provide a turbine for an exhaust gas turbocharger with an improved variability or adjustability, respectively.

SUMMARY OF THE INVENTION

[0005] In a turbine for an exhaust gas turbocharger of a combustion engine with a turbine casing forming an installation space in which a turbine wheel is arranged so as to be rotatable about an axis of rotation and into which exhaust gas of the combustion engine may be supplied via at least one flow duct in which a guide vane structure is arranged, the guide vane structure includes vanes, which are pivotably supported relative to the turbine casing and form an axial inlet nozzle structure adjacent a wall portion of the turbine which extends along the guide vane structure, the wall portion comprising at least a first guide wall area which overlaps the guide vane structure, and which is set back relative to a second guide wall area in which the vanes are pivotably supported and which adjoins the first wall area.

[0006] Such a turbine for an exhaust gas turbocharger of a combustion engine comprises a turbine casing which at least partially defines an installation space in which a turbine wheel may be arranged so as to be rotatable about an axis of rotation relative to the turbine casing. Exhaust gas of the combustion engine may be supplied to the installation space via at least one flow duct in which a guide vane structure is arranged which is movable relative to the turbine casing. The flow duct is defined in the axial direction of the installation space and thus of the turbine wheel at least partially by at least one wall portion of the turbine which is at least partially overlapping the guide vane. In other words, the second wall area is closer to the guide vane than the first wall area. Therefore, the wall areas do not extend in a common plane. Rather, the wall areas extend e. g. in two different planes which are arranged in the axial direction on different levels, and which

e. g. at least essentially extend parallel to each other and/or which e. g. at least essentially extend vertically to the axial direction.

[0007] Because of this special design of the wall portion, in particular of the outer contour facing towards the guide vane, the inventive turbine exhibits especially low friction and an improved variability or adjustability, respectively. In particular, the guide vanes may be moved with very low friction and thus operate extremely smoothly, in order to variably establish proper flow conditions for the exhaust gas of the combustion engine entering the flow duct and to precisely adapt the vane positions to different operating points of the combustion engine. This results in an improved operability which keeps the fuel consumption and the CO₂ emission of the combustion engine low.

[0008] The guide vanes are, for example, pivotable about a pivot axis relative to the turbine casing in order to e. g. adjust a flow cross-section of the inlet flow duct for the exhaust gas. This means that the flow cross-section may be at least partially fluidly blocked or unblocked.

[0009] Since the first wall area is set back relative to the second wall area, the inventive turbine exhibits extremely low friction when the guide vane is at least partially opened. This is accompanied by a low hysteresis which in turn enhances the efficient operation and a high efficiency of the turbine.

[0010] Since the first wall area is set back relative to at least the second wall area, the inventive turbine, in particular with opened guide vane, has an extremely high absorption capacity, so that a high exhaust gas mass flow may pass the turbine. In the upper load and/or speed ranges and thus at high exhaust gas mass flow, the inventive turbine allows a particularly efficient operation of the combustion engine and the realisation of particularly high power and/or torque values, because it permits an extremely high exhaust gas mass flow. The turbine does not represent an undesired high flow resistance for the high exhaust gas mass flow, so that charge changing losses are kept particularly small. This enhances the fuel-efficient operation of the combustion engine and is accompanied by low CO₂ emission.

[0011] The inventive turbine further comprises a particularly advantageous controllability when installed on a combustion engine, so that the latter can be particularly efficiently operated. Moreover, no negative effects on the efficiency of the turbine and the exhaust gas turbocharger in low speed and/or load ranges occur, so that the inventive turbine provides for a fuel-efficient operation of the combustion engine almost in the entire operating range.

[0012] Another advantage of the set-back of the first wall area is that it results in an advantageously low acceleration between the guide vane and the turbine wheel. The inventive turbine may be employed for combustion engines in the form of gasoline engines or diesel engines, which are reciprocating engines. It may also be employed for other combustion engines which are operated e. g. with gaseous and/or liquid fuels.

[0013] In an advantageous embodiment of the invention, the wall portion with the wall areas is arranged on the side facing the turbine wheel outlet area of the turbine of the guide vane. In other words, the flow duct through the wall portion with the two appropriately formed wall areas is arranged on the side facing the turbine wheel outlet area of the turbine. Thereby, the friction of the inventive turbine, in particular

with the at least partially opened guide vane, may be kept extremely low, which in turn is beneficial for the wear of the inventive turbine.

[0014] In a particularly advantageous embodiment of the invention, the first and second wall areas are joined via a third wall area of the wall portion, which is arranged between the first and second wall area. The third wall area extends at an angle of essentially 90° max, each between the first and second wall area. This means that a transition area between the first and second wall area is formed essentially step-shaped. This allows advantageous flow conditions for the exhaust gas flowing through the flow duct, which brings about a particularly high efficiency of the inventive turbine. At the same time, the manufacturing costs for the inventive turbine are kept low, which in turn is accompanied by low costs for the entire combustion engine.

[0015] In another particularly advantageous embodiment of the invention, the third wall area is formed essentially arc-shaped, in particular in the radial direction of the installation space thus of the turbine wheel. This enables favourable flow conditions for the exhaust gas through the flow duct. In particular, turbulences and/or other negative effects for an efficient flow of the exhaust gas into the installation space may be avoided. This contributes to a particularly high efficiency and a particularly efficient operation of the inventive turbine.

[0016] The appropriate design of the first and second wall area as well as, in particular, of the third wall area disposed therebetween has to be adapted to the corresponding requirements and applications. The inventive turbine may be employed, for example, in a combustion engine for a passenger car as well as in a combustion engine for a commercial motor vehicle or another motor vehicle.

[0017] In another advantageous embodiment of the invention, the first wall area, with the turbine wheel of the turbine arranged at least partially in the installation space, extends at least in the radial direction of the installation space and thus of the turbine wheel at least to the level of the leading edge of a rotor blade of the turbine wheel. The exhaust gas is conveyed to the rotor blade and thus the turbine wheel across the leading edge, with the leading edge extending e. g. at least essentially in the axial direction of the installation space and thus of the turbine wheel. By this design of the first wall area which is set back relative to the second wall area, the first wall area preferably has a particularly long radial extension which contributes to particularly low friction and an advantageous operability and a particularly advantageous operation of the inventive turbine.

[0018] Preferably, the second wall area adjoins the first wall area at least in the radial direction of the installation space and the turbine wheel. This means that starting from the installation space towards the flow duct, at first the first wall area is provided followed by the second wall area. This contributes to a particularly high efficiency of the inventive turbine.

[0019] In another advantageous embodiment of the invention, the wall portion is formed by a cover element, in particular a cover plate, of the turbine, which is an insert component which is formed separately from the turbine casing is arranged at least partially in the installation space and by means of which at least one leading edge, in particular a blade edge of the rotor blade of the turbine wheel which is at least partially arranged in the installation space may be at least partially covered or is covered, respectively. Thereby, particularly favorable and advantageous flow conditions for the

exhaust gas flowing through the turbine and in particular through the flow duct may be realised, which in turn enhances the efficient operation and the efficiency of the inventive turbine.

[0020] Further, the provision of the insert component enables a particularly simple and cost-efficient manufacture and assembly of the inventive turbine, which keeps the costs of the entire combustion engine low.

[0021] It may be provided that the guide vane is held movable, in particular pivotable, about the pivot axis, on the cover element relative to the turbine casing and the cover element. This enhances a simple and cost-efficient assembly of the inventive turbine.

[0022] Preferably, the cover element has a cover contour by means of which the leading edge, in particular the blade edge, is at least partially covered and which is formed at least partially as an at least essentially corresponding complementary contour to the outer contour of the leading edge. Thereby, a particularly advantageous cover of the leading edge, in particular of the blade edge, may be realized. This generates particularly advantageous flow conditions for the exhaust gas flowing to and flowing off the turbine wheel or its rotor blades, respectively. Thereby, the inventive turbine exhibits a particularly efficient operation and a particularly high efficiency, which enhances an efficient and fuel-efficient operation of the combustion engine.

[0023] In another advantageous embodiment of the invention, the guide vanes are supported by a retaining component which is formed separately from the turbine casing, in particular on a nozzle ring, wherein the retaining component is an insert component, which is accommodated in the turbine casing. This enables a particularly simple, time-saving and cost-efficient assembly of the inventive turbine as well as a particularly cost-efficient manufacture.

[0024] Further advantages, features and details of the invention will become apparent from the following description of preferred exemplary embodiments with reference to the accompanying drawings. The features and feature combinations as previously mentioned in the description as well as the features and feature combinations which will be mentioned in the following description of the figures and/or which are solely illustrated in the figures are not only applicable in the respective indicated combination but also in other combinations or isolated, without deviating from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] FIG. 1 is an axial cross-sectional view of part of an exhaust gas internal combustion engine;

[0026] FIG. 2 is another and enlarged schematic longitudinal sectional view showing portions of the exhaust gas turbocharger according to FIG. 1;

[0027] FIG. 3 shows portions of a schematic longitudinal sectional view of still another embodiment of the exhaust gas turbocharger according to FIG. 2; and

[0028] FIG. 4 shows portions of a schematic longitudinal sectional view of another embodiment of the exhaust gas turbocharger according to FIGS. 2 and 3.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0029] FIG. 1 shows an exhaust gas turbocharger 10 for a combustion engine which is in the form for example of a

reciprocating piston engine. The exhaust gas turbocharger 10 comprises a turbine 12 with a turbine casing 14 which houses a turbine wheel 20 and comprises a spiral duct 16 through which the exhaust gas of the combustion engine is supplied to the turbine wheel 20. The spiral duct 16 is fluidly connected with at least one cylinder of the combustion engine so that exhaust gas from the cylinder may enter the spiral duct 16.

[0030] The turbine casing 14 also at least partially defines an installation space 18 in which the turbine wheel 20 of the turbine 12 is accommodated. The turbine wheel 20 is arranged in the installation space 18 and rotatable about an axis of rotation 22 relative to the turbine casing 14.

[0031] The turbine wheel 20 is part of a rotor 24 of the exhaust gas turbocharger 10, which comprises a shaft 26. The turbine wheel 20 is non-rotatably connected to the shaft 26 which is supported in a bearing housing 28 of the exhaust gas turbocharger 10 so as to be rotatable about the axis of rotation 22 relative to the turbine casing 14 and the bearing housing 28. The turbine casing 14 and the bearing housing 28 are connected to each other.

[0032] The rotor 24 also comprises a compressor wheel 30 of a compressor 32 of the exhaust gas turbocharger 10. The compressor wheel 30 is also non-rotatably connected to the shaft 26. The compressor 32 comprises a compressor casing 34 which is also securely connected to the bearing housing 28 and by which an installation space 36 is at least partially defined in which the compressor wheel 30 which is supported rotatably about the axis of rotation 22 relative to the compressor casing 34 is at least partially accommodated.

[0033] The exhaust gas flowing through the spiral duct 16 is guided by the spiral duct 16 to a nozzle 38 of the turbine 12, via which the exhaust gas may flow at least essentially in the radial direction to, and impinge on, the turbine wheel 20. This is indicated in FIG. 1 by a direction arrow 40. The turbine wheel 20 comprises a hub body 42 provided with a plurality of rotor blades 44. The rotor blades 44 are arranged at least essentially equally spaced about the circumference of the turbine wheel 20 and securely connected to the hub body 42. FIG. 1 shows only one of the pluralities of rotor blades 44.

[0034] The rotor blade 44 comprises a leading edge 46 which extends at least essentially in the axial direction, via which the turbine wheel 20 is exposed to the exhaust gas flow. The rotor blade 44 further has a blade edge 48 and a trailing edge 50 via which the exhaust gas may flow off the turbine wheel 20 or the rotor blade 44, respectively. In other words, the exhaust gas flows across the leading edge 46 onto the turbine wheel 20 or its rotor blades 44, respectively, and flows off at least essentially past the trailing edge 50 into a turbine wheel outlet area 52. The radial direction of the installation space 18 and thus of the turbine wheel 20 or of the turbine 12, respectively, is indicated in FIG. 1 by a direction arrow 54, while the axial direction is indicated by a direction arrow 56 in FIG. 1.

[0035] By this application of the exhaust gas, the turbine wheel 20 rotates about the axis of rotation 22, which in turn rotates the shaft 26 as well as the compressor wheel 30 about the axis of rotation 22. The turbine 12 is a radial turbine and drives the compressor 32, which is a radial compressor that takes in and compresses air. The sucked-in air flows across a leading edge 58 of a compressor blade 60 of the compressor wheel 30 and flows off across a trailing edge 62 of the compressor blade 60. The compressed air is then guided through

a compressor spiral duct 64 which is formed by the compressor casing 34 to the at least one cylinder of the combustion engine.

[0036] As can be seen from FIG. 1, the nozzle 38 extension in the axial direction of the turbine 12 or of the installation space 18, respectively, (direction arrow 56) at the side facing the bearing housing 28 is delimited at least partially by a nozzle ring 66. The nozzle ring 66 is formed as a separate insert component relative to the turbine casing 14 and accommodated in the turbine casing 14. For fixing the nozzle ring 66 in place relative to the turbine casing 14, a mounting ring 68 is provided, by which the nozzle ring 66 is retained. The mounting ring 68 is arranged in the axial direction between the turbine casing 14 and the bearing housing 28 and clamped between them. In this manner, the nozzle ring 66 may be indirectly supported by the turbine casing 14 via the mounting ring 68 in a spaced relationship to turbine casing 14 and secured relative thereto.

[0037] At the side facing the turbine wheel outlet area 52, the nozzle 38 is at least partially defined by a cover plate 70. The cover plate 70 is in the form of an insert component separate from the turbine casing 14 and arranged at least partially in the installation space 18. Thus, the cover plate 70 acts as wall portion which delimits the nozzle 38 in the axial direction of the installation space 18 and thus of the turbine 12 at the side facing the turbine wheel outlet area 52.

[0038] Moreover, as shown in FIG. 1, guide vanes 72 are supported in the turbine casing 14 between the cover plate 70 and the nozzle ring 66 so as to be pivotable about an axis 76, which extends at least essentially in the axial direction and thus essentially parallel to the axis of rotation 22. This allows a variable adjustment of the flow cross-section of the nozzle 38, through which the exhaust gas of the combustion engine flows from the spiral duct 16 to the turbine wheel 20. This permits to adjust the turbine 12 to different operating or load points, respectively, of the combustion engine as required, so that the turbine 12 and thus the entire exhaust gas turbocharger 10 may be operated particularly efficiently.

[0039] As can be seen, in particular in conjunction with FIG. 2, the trailing edge 48 of the rotor blade 44 is at least partially, in particular completely, covered or overlapped by the cover plate 70. The exhaust gas can therefore mainly, in particular exclusively, flow off the rotor blade 44 across the trailing end 50. This provides for particularly advantageous flow conditions for the exhaust gas entering the turbine wheel 20. The cover plate 70 comprises an outer contour 74 around the trailing edge 48 which at least essentially corresponds to the shape of the blade edge 48.

[0040] In FIG. 2, the pivot axis 76 can be seen, about which the guide vane 72 may be pivoted. The guide vane 72 is supported pivotably about the pivot axis 76 by the cover plate 70 and the nozzle by bearing journals 78 connected to the guide vane. The bearing journals 78 are seated at least partially in corresponding seats of the cover plate 70 and the nozzle ring 66.

[0041] As shown in particular in FIG. 2, the cover plate 70 comprises, in the radial direction of the turbine 12 starting from the axis of rotation 22, a first wall area 80 as well as a second wall area 82 adjoining the first wall area in the radial direction. The first wall area 80 which in the axial direction at least partially overlaps the guide vane 72 is set back relative to the second wall area 82 which in the axial direction at least partially overlaps the guide vane 72. In other words, this means that the second wall area 82 in the axial direction is

closer to the guide vane 72 than the first wall area 80. The first wall area 80 extends in the radial inward direction at least essentially to the same level as the leading edge 46 of the rotor blade 44. Thereby, the turbine 12 exhibits an extremely low hysteresis, in particular when the guide vane 72 is at least partially opened that is in a position which opens the flow cross-section of the nozzle 38 partially.

[0042] The first wall area 80 and the second wall area 82 are joined via a third wall area 84, wherein the third wall area 84 is arranged between the first wall area 80 and the second wall area 82. In a first exemplary embodiment, the third wall area 84 extends at an angle of essentially 90° each between the first wall area 80 and second wall area 82. This means that the first wall area 80, the second wall area 82 and the third wall area 84 are arranged and formed at least essentially step-shaped.

[0043] FIG. 3 shows an exemplary embodiment of the exhaust gas turbocharger 10 different from that of FIGS. 1 and 2. Whereas the third wall area 84 according to FIG. 2 extends essentially parallel to the axial direction (direction arrow 56) and includes an angle of essentially 90° with the radial direction (direction arrow 54), the third wall area 84 according to FIG. 3 extends obliquely to the axial direction at an angle with the radial direction different from 90°. Likewise, the third wall area 84 includes an angle different from 90° both with respect to the first wall area 80 and the second wall area 82. The third wall area 84 is formed straight, i. e. not arc-shaped, round or the like.

[0044] FIG. 4 shows still another exemplary embodiment of the exhaust gas turbocharger 10 according to FIGS. 1 to 3. As can be seen from FIG. 4, the third wall area 84 is formed at least essentially arc-shaped in the radial direction (direction arrow 54).

[0045] The appropriate design of the first wall area 80, the second wall area 82 and the third wall area 84 may be adapted to the requirements and particular applications. In particular, the respective radial extension (length) and/or axial extension (depth of the first wall area 80, the second wall area 82 and the third wall area 84) may be appropriately dimensioned and varied and deviate from the corresponding extensions shown in FIGS. 2 to 4. also contours of the first wall area 80, the second wall area 82 and the third wall area 84 may be provided which are different from those shown in FIGS. 2 to 4.

What is claimed is:

1. A turbine for an exhaust gas turbocharger of a combustion engine, comprising a turbine casing (14) including an installation space (18), a turbine wheel (20) arranged in the

installation space (18) so as to be rotatable about an axis of rotation (22) at least one inlet flow duct (38) via which exhaust gas of the combustion engine may be supplied to the turbine wheel (20), a guide vane structure (72) arranged in the inlet flow duct (38) and including vanes which are pivotably supported relative to the turbine casing (14), the vane structure (72) being delimited in the axial direction of the installation space (18) at least partially by at least one wall portion (70) of the turbine (12) which is at least partially overlapping the guide vane structure (72), the wall portion (70) comprising a first wall area (80) which is arranged adjacent the guide vane (72), and which is set back relative to a second wall area (82) of the wall portion (70) adjoining the first wall area (80).

2. The turbine according to claim 1, wherein the wall portion (70) with the first wall area (80) and the second wall area (82) is arranged at the side of the guide vane structure (72) facing the turbine wheel outlet area (52) of the turbine (12).

3. The turbine according to claim 1, wherein the first wall area (80) and the second wall area (82) are joined via a third wall area (84) of the wall portion (70), which is arranged between the first wall area (80) and the second wall area (82), and forms with the first wall area (80) and the second wall area (82) an angle of essentially 90°.

4. The turbine according to claim 1, wherein the first wall area (80) and the second wall area (82) are joined via a third wall area (84) of the wall portion (70), which extends between the first wall area (80) and the second wall area (82), and is essentially arc-shaped.

5. The turbine according to claim 1, wherein the wall portion (70) is in the form of a cover plate (70), which is an insert component formed separately from the turbine casing (14) and which is at least partially accommodated in the installation space (18), and which extends at least over part of the blade edges (48) of the turbine wheel (20).

6. The turbine according to claim 5, wherein the cover plate (70) has a cover contour (74) which is essentially complementary to the contour of the blade edges (48).

7. The turbine according to claim 1, wherein the guide vane structure (72) abuts a retaining component which is formed separately from the turbine casing (14), in the form of a nozzle ring (66) which is supported in the turbine casing (14).

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