A secondary air charger has a bearing housing and a turbine shaft extending in an axial direction of the bearing housing. A first and a second rolling bearings are arranged in the bearing housing on bearings seats and support the turbine shaft rotatable in the bearing housing. The rolling bearings are positioned at an axial spacing relative to one another and each have an inner ring seated on the bearing seats. A spacer device for determining the axial spacing of the rolling bearings is arranged on the turbine shaft. The turbine shaft has a base member and at least one sleeve. The base member has a cylindrical section that is continuous in the axial direction, wherein the cylindrical section is provided in the area of the bearing seats. The at least one sleeve is pushed onto the cylindrical section for forming the spacer device between the bearing seats.
SECONDARY AIR CHARGER

[0001] The invention relates to a secondary air charger having the features according to the preamble of claim 1.

[0002] A secondary air charging system for internal combustion engines has the task of blowing or charging fresh air into the exhaust gas of the internal combustion engine during cold start. For this purpose, the secondary air charging system has a secondary air charger. The secondary air charger functions in principle like an exhaust gas turbo charger. Such exhaust gas turbo chargers are usually provided with a plain bearing and a circulating oil lubrication system and are located in the exhaust gas manifold of the internal combustion engine. The secondary air charger, on the other hand, is arranged in the intake manifold. Like the exhaust gas turbo charger, it comprises a turbine and a compressor. The turbine is driven by the differential pressure at the throttle for the intake air of the internal combustion engine and drives, in turn, the compressor. The compressor carries out the task of blowing fresh air into the exhaust gas.

[0003] In contrast to exhaust gas turbo chargers of conventional configuration, the secondary air charger is provided with rolling bearings which are arranged between the turbine wheel and the compressor wheel. The corresponding turbine shaft, in the configuration according to FIG. 1, has centrally a section area of greater diameter. Inner rings of the two rolling bearings are arranged on bearing seats on either side of the section with greater diameter and rests in the axial direction against the section of greater diameter. The section of greater diameter serves, on the one hand, as a stop for the inner rings of the two rolling bearings. On the other hand, it generates, in corporation with a bushing that surrounds externally the section of greater diameter and an intermediately positioned minimal seal gap, a sealing action between the compressor side and the turbine side.

[0004] The disadvantage of this configuration resides in that the shaft has different diameters. The two bearing seats have a smaller diameter than the axially intermediately positioned section of greater diameter. The bearing seats and also the section of greater diameter must be ground at their different diameters. At the transition area of the bearing seats to the section of greater diameter a relief groove is required. This leads to high manufacturing expenditure and the thus incurred costs. For a precise manufacture at the free ends of the turbine shaft pins are to be provided that enable clamping during machining. These pins have no function during operation of the secondary air charger and unnecessarily require mounting space.

[0005] The invention has the object to provide a secondary air charger with a simplified configuration.

[0006] This object is solved by a secondary air charger having the features of claim 1.

[0007] It is proposed that the turbine shaft of the secondary air charger has a base member and at least one sleeve wherein the base member in the area of the two bearing seats is configured as a cylindrical section that is continuous in the axial direction and wherein the at least one sleeve is pushed onto the cylindrical section between the two bearing seats for forming a device for determining the axial spacing of the two rolling bearings.

[0008] The base member of the turbine shaft can be produced with significantly reduced expenditure. The cylindrical section is turned and ground continuously with identical diameter in one working step. An interruption of the surface by relief grooves or the like is not required. For forming the required central device for determining the axial spacing, the at least one sleeve is pushed onto the cylindrical section and positioned between the two bearing seats. The mounting expenditure is minimal. Sleeve and base member can be produced as separate parts in a simple way with precise fit; this significantly reduces the manufacturing costs. The arrangement of pins at the end faces of the base member of the turbine shaft is no longer required. The required mounting space is reduced.

[0009] In a preferred embodiment, the inner rings of the rolling bearings and the at least one sleeve are separate parts. The sleeve as a cylindrical pipe member can be manufactured in a simple way with precise fit with minimal expenditure. As rolling bearings, inexpensive standard bearings can be chosen that rest in the axial direction against both ends of the sleeve. Manufacturing expenditure and costs are minimal.

[0010] In an expedient alternative at least one inner ring of the rolling bearing and the sleeve form a monolithic part. In this connection, the sleeve projects the axial direction past the base shape or past the axial extension of the outer ring and takes on the function of the sleeve or the spacer device. The outer and inner surfaces of the sleeve formed integrally with the inner ring of the bearing can be machined or ground in a single working step together with the section of the sleeve that forms the inner ring. The fit is more precise and the mounting expenditure is reduced.

[0011] In an expedient further embodiment, the inner ring of one of the two rolling bearings is integrally formed with the sleeve wherein the integral sleeve extends across the entire axial distance between the bearings. The second bearing is a standard rolling bearing, respectively. For each bearing arrangement with a total of two rolling bearings, only one special configuration with integral sleeve is required. Since the second bearing is an inexpensive standard bearing, the costs for parts are minimal.

[0012] In an advantageous variant, the two inner rings of the two rolling bearings are integrally formed with a sleeve, respectively. In particular, they are essentially identical wherein the two integrally formed sleeves face one another and in the axial direction rests against one another. Accordingly, a total of two sleeves with comparatively minimal axial length are provided. The modular unit of inner ring and sleeve can be manufactured easily with precise fit because of its minimal axial length.

[0013] In an advantageous further embodiment, at least one sleeve is pressed onto the cylindrical section. In addition to a high true running precision there is also a reliable sealing action in the axial direction between the turbine side and the compressor side.

[0014] The at least one sleeve is expeditiously radially outwardly surrounded by a bushing secured to the housing with a sealing gap being formed in between. The sealing gap is just large enough to ensure a free rotation of the turbine shaft relative to the bearing housing with the sleeve. On the other hand, the intermediately positioned sealing gap provides an effective sealing action between the two charger sides.

[0015] The bushing secured to the housing is preferably configured as a spring action support bushing that is acting in the axial direction on the outer rings of the two rolling bearings. In addition to an axial positioning of the outer rings, a suitable elastic pretension is enabled in this way that improves the smooth running of the turbine shaft.
The two rolling bearings are preferably configured particularly as permanent-lubricated ball bearings. The secondary air charger can be mounted away from the motor oil circulation at any suitable location. The permanent-lubricated ball bearings enable very high rotary speeds in connection with a suitable long service life.

Embodiments of the invention will be explained in more detail in the following with aid of the drawing. It is shown in:

**FIG. 1** in a longitudinal section illustration the bearing area of a secondary air charger in a configuration according to the prior art;

**FIG. 2** a first arrangement according to the invention with a sleeve configured as a separate individual part for providing a device for determining the axial spacing between the rolling bearings;

**FIG. 3** a further embodiment of the invention with a standard rolling bearing and a rolling bearing having a sleeve that is integrally formed at the inner ring;

**FIG. 4** a variant of the arrangement according to **FIG. 3** with two identical mirror-symmetrically mounted rolling bearings having at their inner rings a sleeve, respectively, for providing a device for predetermining the axial spacing.

**FIG. 5** shows in longitudinal section the bearing area of a secondary air charger of the prior art for an internal combustion engine in a motor vehicle. The secondary air charger is configured as a turbo charger and comprises a bearing housing 1 with a turbine shaft 2 extending in the axial direction 13. The turbine shaft 2 is rotatably supported by means of two rolling bearings 3, 4 in the bearing housing. On either side of the bearing area, the turbine shaft 2 is provided with a threaded section 23, 24 onto which, on one side, a turbine wheel, and, on the other side, a compressor wheel are screwed.

In order to enable a precise manufacture of the turbine shaft 2, a pin 25, 26 adjoins the two threaded sections 23, 24 at the end faces; they are provided at their free end faces with a centering bore 27, respectively. The two pins 25, 26 serve for producing the turbine shaft 2 and have no function in operation of the secondary air charger.

The two rolling bearings 3, 4 are configured as permanent-lubricated roller bearings. The inner rings 5, 6 of the two rolling bearings 3, 4 are slipped without play onto the correlated bearing seat 7, 8 of the turbine shaft 2, respectively. Outer rings 18, 19 of the two rolling bearings 3, 4 are secured without play at a cylindrical inner surface 22 of the bearing housing 1.

Relative to the axial direction 13 and the facing end faces of the two rolling bearings 3, 4, the rolling bearings 3, 4 are arranged at an axial spacing a relative to one another. Across this axial spacing a, a device 9 in the form of a radially projecting section of greater diameter is provided which device is formed as an integral part of the turbine shaft 2. The outer diameter of the section of greater diameter is greater than the outer diameter of the two bearing seats 7, 8. The circumferential surface of the radial section of greater diameter as well as the circumferential surfaces of the two bearing seats 7, 8 are ground. The two inner rings 5, 6 of the rolling bearings 3, 4 are pressed in the axial direction 13 against the respective end face of the section of greater diameter so that the section of greater diameter serves as an axial stop and thus for determining the axial spacing a for the two inner rings 5, 6. In order for the two inner rings 5, 6 to fit precisely in the axial direction 13 on the bearing seats 7, 8 and to rest against the end faces of the section of greater diameter, the turbine shaft 2 in the transition area between the bearing seats 7, 8 and the section of greater diameter has a relief groove 28, respectively.

Between the two outer rings 18, 19, a bushing 16 is arranged at the cylindrical inner surface 22 of the bearing housing 1 and connected to the bearing housing 1 to rotate therewith. The bushing 16 is slideable in the axial direction 13. At the end faces, spring rings 22 are arranged which together with the bushing 16 form a spring action support bushing that acts on the two outer rings 18, 19 off of the rolling bearing 3, 4. The outermost spring ring 20 in the axial direction 13 rests with its end face against the outer ring 18 of the rolling bearing 3 while the opposite end face of the bushing 16 rests against the opposite end face of the outer ring 19 of rolling bearing 4. In this way, the two outer rings 18, 19 are tightened relative to one another in the axial direction 13.

Between an inner surface of the fixed bushing 16 and the cylindrical outer surface of the section of greater diameter rotating together with the turbine shaft 2, there is a very small sealing gap 17. The sealing gap 17 enables free rotation of the turbine shaft 2 relative to the unit of bearing housing 1 and bushing 16. Particularly in connection with a plurality of circumferential grooves 21 on the outer surface of the section of greater diameter, a gap-type seal is provided in this way that prevents pressure compensation between the turbine side in the area of the threaded section 23 and the compressor side in the area of the threaded section 24.

**FIG. 2** shows a first embodiment of an arrangement according to the invention of the bearing of the secondary air charger. Accordingly, the turbine shaft 2 comprises an integral base member 10 as well as a sleeve 14. The base member 10 extends continuously as a cylindrical section 15 that is continuous in the axial direction 13 between the two threaded sections 23, 24 inclusive of the two bearing seats 7, 8 and the immediately positioned area bridging the axial spacing a. The cylindrical section 15 has a constant diameter across its entire length. Its continuous surface is ground in a single working step.

The sleeve 14 embodied as a cylindrical pipe section is pushed onto the cylindrical section 15 and secured thereon by pressing. The sleeve 14 forms the device 9 for determining the axial spacing a of the two rolling bearings 3, 4 on the turbine shaft 2.

The two inner rings 5, 6 of the rolling bearings 3, 4 and the sleeve 14 are configured as separate parts. The two inner rings 5, 6 rest in the axial direction 13 against abutments 29, 30 of the sleeve 14 provided at the end faces of the device 9. The sleeve 14 is surrounded radially outwardly by the bushing 16 secured to the housing with intermediate sealing gap 17 being maintained.

The sleeve 14 extends in the axial direction 13 across the entire axial spacing a. The two rolling bearings 3, 4 are permanent-lubricated standard bearings.

In deviation from the configuration according to **FIG. 1**, no pins 25, 26 adjoin the end faces of the two threaded sections 23, 24. Instead, on the end faces of the two threaded sections 23, 24, a centering bore 27 is provided directly.

**FIG. 3** shows a further embodiment of the bearing of the secondary air charger in which the rolling bearing 4, as in the embodiment according to **FIG. 2**, is formed as a permanent-lubricated standard ball bearing. The inner ring 5 of the rolling bearing 3 positioned oppositely in the axial direction 13 is an integral part of the sleeve 11 for forming the device 9.
for determining the spacing a. The rolling bearing 3 is thus a special ball bearing whose inner ring 5 is extended by the sleeve 11 in the axial direction 13 and projects in the direction toward the oppositely positioned rolling bearing 4 past the axial extension of the outer ring 18. The rolling bearing 3 is a permanent-lubricated ball bearing like the rolling bearing 4.

In FIG. 4 a variant of the arrangement according to FIG. 3 is shown in which the two inner rings 5, 6 of the two rolling bearings 3, 4 each are configured to have an integral sleeve 11, 12. Starting at the respective axial inner surface of the outer ring 18, 19, the two sleeves 11, 12 extend with a length of half the axial spacing a, respectively. The two rolling bearings 3, 4 are identical relative to one another and arranged mirror-symmetrical to one another so that the two sleeves 11, 12 formed integrally on the inner rings 5, 6 face one another and in the axial direction 13 rest against one another at central abutment location 30.

With regard to other features and reference numerals, the arrangements according to FIGS. 2 to 4 are mutually identical to one another and to the arrangement according to FIG. 1.

What is claimed is:

1. - 10. (canceled)

11. A secondary air charger comprising:

- a bearing housing;
- a turbine shaft extending in an axial direction of the bearing housing and having bearing seats;
- a first and a second rolling bearings arranged in the bearing housing and supporting the turbine shaft rotatably in the bearing housing, wherein the first and second rolling bearings are positioned at an axial spacing relative to one another and wherein the first and second rolling bearings each have an inner ring arranged on the bearing seats of the turbine shaft;
- a spacer device for determining the axial spacing of the first and second rolling bearings arranged on the turbine shaft;
- wherein the turbine shaft comprises a base member and at least one sleeve;
- wherein the base member has a cylindrical section that is continuous in the axial direction, wherein the cylindrical section is provided in an area where the bearing seats are located; and
- wherein the at least one sleeve is pushed onto the cylindrical section for forming the spacer device between the bearing seats.

12. The secondary air charger according to claim 11, wherein the inner rings of the first and second rolling bearings and the at least one sleeve are separate parts.

13. The secondary air charger according to claim 11, wherein at least one of the inner rings of the first and second rolling bearings is integrally formed with the at least one sleeve.

14. The secondary air charger according to claim 13, wherein the inner ring of the first rolling bearing is formed integrally with the at least one sleeve, wherein the at least one sleeve extends across the entire axial spacing, and wherein the second rolling bearing is a standard rolling bearing.

15. The secondary air charger according to claim 13, wherein the inner rings of the first and second rolling bearings each are formed integrally with the at least one sleeve.

16. The secondary air charger according to claim 15, wherein the inner rings with the integrally formed at least one sleeve are substantially identically configured, wherein the integrally formed sleeves face one another and rest against one another in the axial direction.

17. The secondary air charger according to claim 11, wherein the at least one sleeve is pressed onto the cylindrical section.

18. The secondary air charger according to claim 11, wherein the least one sleeve is surrounded radially outwardly by a bushing secured to the bearing housing and forming an intermediate sealing gap.

19. The secondary air charger according to claim 18, wherein the bushing is configured as a spring action support bushing that is acting in the axial direction on outer rings of the first and second rolling bearings.

20. The secondary air charger according to claim 11, wherein the first and second rolling bearings are permanent-lubricated ball bearings.

* * * * *