A system and method for remanufacturing a turbocharger center housing include performing a machining operation on an original center housing to remove a portion of a parent material from the original center housing. A ring having a generally rectangular cross section is attached to the center housing blank in place of the removed material to produce a rebuilt center housing. In one embodiment, the ring forms an annular surface onto which a seal is engaged to avoid external leakage of turbine exhaust gas through an interface between a turbine housing and the remanufactured center housing.
REMANUFACTURED CENTER HOUSING AND METHOD

TECHNICAL FIELD

[0001] This patent disclosure relates generally to equipment remanufacturing and, more particularly, to a remanufactured turbocharger center housing and a method for remanufacturing.

BACKGROUND

[0002] Internal combustion engines often include components having various moving parts such as turbochargers. A typical turbocharger is customarily made up from three cast components that are interconnecting and accommodate a rotating shaft. Typically, a center housing rotatably supports and lubricates a rotating shaft having a compressor wheel at one end and a turbine wheel at the other end. The compressor wheel is disposed within a compressor housing, which is connected to the center housing, and the turbine wheel is disposed within a turbine housing, which is also connected to the center housing.

[0003] When an engine is rebuilt and/or reconditioned, various worn or damaged components or systems are usually removed and replaced. One such component is the turbocharger, which operates under extreme temperature conditions and is exposed to chemical attack, for example, by contact with exhaust gas, and is thus often subject to corrosion. A typical turbocharger is a costly part of any engine reconditioning or rebuilding operation.

[0004] To reduce the cost of rebuilding engines, particularly relative to replacing the turbocharger(s) of the engine, various techniques have been used in the past to recondition cast turbocharger components that are corroded or otherwise worn. One previous technique includes depositing or plating metal in a worn area of a casting, for example, by a plating technique or by weld accumulation, and then machining or otherwise finishing the deposited material. Such techniques are only partly effective in restoring casting dimensions and involve use of different materials, which have different thermal and chemical properties than the parent, cast material. Moreover, plating and deposition techniques may not be readily possible or feasible for certain casting materials such as aluminum.

SUMMARY OF THE DISCLOSURE

[0005] In one aspect, the disclosure describes a rebuilt turbocharger. The rebuilt turbocharger includes a shaft having a turbine wheel connected at a first shaft end and a compressor wheel connected at a second shaft end. A compressor housing is disposed around the compressor wheel, and a turbine housing forming a central bore is disposed around the turbine wheel. The turbine housing forms an internal scrolled passage that surrounds the turbine wheel and carries gasses during operation. A heat shield is disposed at least partially within the central bore and around the shaft between the compressor and turbine wheels. The heat shield is generally cup-shaped and includes an outer flange. A center housing is disposed between, and is also connected with, the compressor housing and the turbine housing. The center housing forms a bore, through which the shaft extends, and includes at least one bearing that rotatably supports the shaft. A protrusion formed on the center housing extends within the central bore such that the heat shield is disposed between the turbine wheel and the protrusion. In one embodiment, a seal is formed by engagement of the outer flange of the heat shield between the center housing and the turbine housing along an annular area of the center housing that extends radially relative to the shaft and is disposed radially inwardly from an interface between the center housing and the turbine housing. A ring having a generally hollow cylindrical shape with a generally rectangular cross section is connected to the center housing around a base of the protrusion and forms the annular area onto which the outer flange of the heat shield is engaged to form the secondary seal.

[0006] In another aspect, the disclosure describes a center housing for a turbocharger for use on an internal combustion engine. The center housing is configured to interconnect a compressor housing with a turbine housing of the turbocharger. The center housing includes a bore that is formed in the center housing and configured to rotatably support a shaft having a compressor wheel at one end and a turbine wheel at another end. A protrusion is also formed on the center housing and configured to extend within a central bore of the turbine housing. An annular area that extends radially relative to the shaft is disposed radially inwardly from an interface between the center housing and the turbine housing. The center housing further includes a ring having a generally hollow cylindrical shape with a generally rectangular cross section. The ring is connected to the center housing around a base of the protrusion and forms the annular area onto which a gasket may be engaged to form a seal between the center housing and the turbine housing.

[0007] In yet another aspect, the disclosure describes a method for rebuilding or remanufacturing a center housing for a turbocharger. The method includes dis-assembling an original turbocharger to separate an original center housing from remaining turbocharger components, and mounting the original center housing on a machining device. A machining operation is performed using the machining device. The machining operation includes at least one of cutting and grinding to remove a portion of a parent material from the original center housing. The portion of the parent material is disposed within a hollow cylindrical cutting area. When the parent material has been removed, a center housing blank is produced from the original center housing. The center housing blank includes a radially extending annular surface and an axially extending cylindrical surface that orthogonally intersect and are formed by the machining operation. A ring having a generally rectangular cross section is attached to the center housing blank to produce a rebuilt center housing. The ring includes an inner cylindrical surface disposed at an inner diameter, and a generally flat, annular base, such that the annular base of the ring abuts the radially extending annular surface and the inner cylindrical surface engages the axially extending cylindrical surface of the center housing blank at a press-fit clearance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is an outline view of a turbocharger in accordance with the disclosure.

[0009] FIG. 2 is a partially fragmented view of the turbocharger shown in FIG. 1.

[0010] FIG. 3 is an enlarged detail of FIG. 2.

[0011] Each of FIGS. 4-7 is a fragmented view of a portion of a center housing in a particular step of a remanufacturing process.
DETAILED DESCRIPTION

[0012] This disclosure generally relates to component and system remanufacturing techniques and corresponding remanufactured parts, and more specifically to structures and methods for remanufacturing a turbocharger center housing that exhibits pitting and other wear due to use. In the disclosed embodiment, the turbocharger includes a gas-driven turbine and a compressor that is mechanically coupled to the turbine, for use in an internal combustion engine. The disclosed turbocharger has an otherwise typical construction that includes a turbine having a turbine wheel driven by engine exhaust gas. The turbine wheel is connected to a compressor wheel via a shaft. Each of the turbine and compressor wheels has generally radially extending vanes that operate within a scroll-shaped chamber formed within a respective housing.

[0013] The shaft extends through a center housing in which oil is provided for operation, lubrication, cooling and/or for other reasons. In the disclosed embodiments, a possible leak path may be created or exist between the turbine housing and the center housing. Exhaust gas passing through this leak path may corrode and pit the center housing and/or turbine housing material along the path, which damage can advantageously be remedied during a remanufacturing method in accordance with the disclosure. The embodiments disclosed herein relate to turbocharger bearings for use on internal combustion engines, but should not be considered as limited to the structure or application of the turbocharger structures and remanufacturing methods described herein.

[0014] An outline view of a turbocharger 100 is shown in FIG. 1. The turbocharger 100 includes a turbine 102 and a compressor 104. The turbine 102 and compressor 104 are both connected to a center housing 106. In the illustrated embodiment, the turbine 102 includes a turbine housing 103, and the compressor 104 includes a compressor housing 110. The back-plate 108, which is generally disc-shaped, can be connected to the compressor housing 110 using any known arrangement. In the illustrated embodiment, the connection arrangement between the back-plate 108 and the compressor housing 110 includes bolts 112 cooperating with plates 114 to retain the back-plate 108 within a rim surrounding a bore formed in the compressor housing 110. The compressor further includes a compressor wheel 116 housed within the compressor housing 110 in a known fashion. The compressor wheel 116 is not visible in FIG. 1 but is partially illustrated in the fragmentary views of FIGS. 3, 5 and 7. A detailed, fragmentary view of a connection between the turbine housing 103 and the center housing 106 is shown in FIGS. 2 and 3.

[0015] In reference to FIGS. 2 and 3, the turbine housing 103 forms a scrolled passage 118 that is disposed around a turbine wheel 120. The turbine wheel 120 is connected to a shaft 122 and is rotated during operation by engine exhaust gas passing through the scrolled passage 118, over the wheel 120, and which exits the housing 103 through an outlet opening 124. A waste gate 126, which is optional, is operable to bypass the turbine wheel 120 in a known fashion. The shaft 122 is rotatable within a bore of the center housing 106, and is supported by a bearing 128 disposed within the center housing bore. In the illustrated embodiment, the center housing 106 forms an oil passage 130 that supplies engine oil to lubricate and cool the bearing 128 when the shaft 122 is rotating. The oil in the passage 130 is provided from the engine on which the turbine 102 is installed, and drains back to the engine after it washes over the bearing 128.

[0016] In the illustrated embodiment, the turbine housing 103 is connected to the center housing 106 along a breakable connection interface, which can be taken apart for service or component replacement and repair. As shown, the center housing 106 forms a flange 132 that cooperates with a corresponding flange 134 on the turbine housing 103 and matingly connects therewith along an annular mechanical face seal surface 136, which may optionally include a gasket or other seal (not shown). The flanges 132 and 134 are held together by a v-band clamp 138, but other mounting arrangements are known and may be used. In the illustrated embodiment, the center housing 106 includes a protrusion 140 that extends within a central bore 142 of the turbine housing 103.

The central bore 142 is large enough to accommodate insertion and removal of the turbine housing 103 from the center housing 106 while the turbine wheel 120 is installed. To provide a cantilever support to the end of the shaft 122 onto which the turbine wheel 120 is connected, the center housing protrusion 140 has a generally cylindrical shape and extends up to the turbine wheel 120 within the turbine housing 103.

In reference to FIG. 3, a multi-part sealing arrangement is used to prevent external leakage of exhaust gas from the scrolled passage 118. In addition to the face seal 136, a shaft seal 144 is disposed on the shaft 122. The shaft seal 144 rotatably and sealably engages and end portion 146 of the center housing bore. Further, while the oil circulating within the center housing, for example, through the passage 130, further contributes to cooling the center housing 106, a heat shield 148 is disposed between the protrusion 140 of the center housing 106 and the turbine housing 103. The heat shield 148 is generally cup-shaped, and includes an outer flange 150 that is engaged between the flange 132 of the center housing 106 and the corresponding flange 134 of the turbine housing 103 such that a line contact is created at a high pressure, which essentially forms a secondary seal or gasket to seal against external leak of exhaust gases from within the turbine housing 103. The flange 150 is disposed radially inwardly but otherwise adjacent the face seal 136 to help the sealing function thereof. As can be appreciated, the dimensional relationship between the center housing 106, turbine housing 103, and heat shield 148 can have a substantial effect on the sealing effectiveness along the interface between these components.

[0018] An annular area 152 formed on a surface of the center housing 106 that extends radially with respect to a shaft centerline 154 between the protrusion 140 and the turbine housing 103 is exposed and subject to corrosion and pitting. The wear, corrosion and/or pitting on the annular area 152 may be caused from exposure to high temperatures during operation, chemical compounds present in the exhaust gas, moisture and/or condensation when the engine is off, and various other factors. When the annular area 152 corrodes and/or otherwise acquires pits and other surface discontinuities, the sealing function against external leakage of exhaust gas from the interior of the turbine housing 103 is compromised. Moreover, any dimensional defects that the center housing 106 may acquire, especially in the material around the annular area 152, may affect the fit and function of a rebuilt turbocharger.

[0019] To avoid these and other issues, a rebuilt turbocharger in accordance with the disclosure includes a ring 156, which is installed on the center housing 106 adjacent the flange 132 in place of the damaged parent material, which is removed during a rebuilding operation. The ring 156 may be
further machined after installation to achieve the dimensions of the relevant surfaces thereof that duplicate the original machining dimensions of the center housing 106. Moreover, the ring 156 may be made from the same material as the parent component, for example, steel, or may alternatively be made of a different material such as a stainless steel alloy that is better suited to resist damage and corrosion. In the illustrated embodiment, the ring 156 has a generally hollow cylindrical shape having a width in the radial direction with respect to the shaft centerline 154 that sufficiently extends across substantially the entire width of the annular area 152. The ring 156 is connected to the center housing adjacent a base of the protrusion 140. In this way, a possible leak path along an interface of the ring and the center housing and/or the flange 150 of the heat shield 148 is avoided. Moreover, by machining the ring 156, a uniform and flat surface that makes up the annular area 152 can be created, which further improves the sealing capability of the flange 150 in particular, and the interface 136 in general.

[0020] To illustrate the remanufacturing process for the center housing 106, a series of fragmented and outline partial views of the center housing 106 undergoing various remanufacturing process steps is shown in FIGS. 4-7. In the description that follows, features and structures that are the same or similar to corresponding features and structures previously described are denoted by the same reference numerals previously used for simplicity. Accordingly, as shown in FIG. 4, an original center housing 200 is provided. The original center housing 200 is shown removed from an original turbocharger, which is to be remanufactured. The original center housing 200 includes a body portion 202 that forms a bore 204, through which the shaft 122 (FIG. 2) may extend, a flange 132, and an annular area 152. The condition of the annular area 152 of the original center housing 200 may be degraded by pitting, corrosion, deposits, and other defects, which are generally denoted as 206.

[0021] In an initial operation, the original center housing 200 may be cleaned, for example, by chemical or mechanical cleaning agents, and mounted onto a machining device such as a lathe for machining. In a grinding or cutting operation, a portion of the parent material of the body portion 202 of the original center housing 200 may be removed within a hollow cylindrical cutting area, which also removes the contamination and degraded material 206. As shown in FIG. 5, the result of the cutting or grinding operation is a center housing blank 208. The center housing blank 208 results from a generally cylindrical cut performed on the original center housing 200. The cylindrical cut removes parent material from the original center housing 200 at least between an outer radial dimension, D, an inner radial dimension, d, and at a maximum depth, H, from a turbine face 210 of the body portion 202 in an axial direction.

[0022] Following the machining operation, the center housing blank 208 includes on an outer surface thereof a radially extending annular surface 212 and an axially extending cylindrical surface 214, which intersect orthogonally and surround the area where the damaged material 206 was found, and which has now been removed. The center housing blank 208 has an outer diameter across the axially extending cylindrical surface 214 that is equal to the inner radial dimension, d, of the cutting operation. The radially extending annular surface 212 has an inner diameter that is also equal to the inner radial dimension, d, of the cutting operation, and an outer diameter that is at least equal to the outer radial dimension, D, of the cutting operation when the depth of the cut, H, is less than an axial distance of the flange 132 from the turbine face, as shown in FIG. 5. It should be appreciated that, in an alternative embodiment, when the depth of the cutting operation, H, exceeds the axial location of the flange 132, the radial land width of the radially extending annular surface 212 will be at most equal to the outer radial dimension, D, of the cutting operation.

[0023] In a subsequent process, the ring 156 is installed onto the center housing blank 208, as shown in FIG. 6, to produce the remanufactured center housing 106 (FIG. 2). In reference to these figures, the ring 156 has a generally rectangular cross section and is installed onto the body portion 202 of the center housing blank 208 such that it abuts both the radially extending annular surface 212 and the axially extending cylindrical surface 214. Installation of the ring 156 can be accomplished by any appropriate method. In the illustrated embodiment, a press-fit operation is contemplated. Accordingly, the ring 156 has an inner cylindrical surface 216 disposed at an inner diameter that is just less than or equal to the inner radial dimension, d, of the cutting operation to permit a press-fit interference between the components. The ring further has an annular face 218, which is generally flat and abuts the radially extending annular surface 212. During installation, the abutment between the annular face 218 and the radially extending annular surface 212 acts as a stop feature for the insertion depth of the press-fit installation, and also ensures that an outwardly facing annular face 220 is coplanar and flat. To aid during installation, the ring 156 may further include two chamfers or fillets 222 disposed along diagonally opposite edges of the ring 156 at the inner, lower edge and at the outer, upper edge, to aid during installation on the center housing blank 208 and also during installation of the center housing 106 into the turbine housing 103 as an outer peripheral surface 224 or the ring is inserted into the turbine housing bore.

[0024] Following the attachment of the ring 156, the compressor housing 110 may optionally be subjected to an additional machining operation to grind or cut the external surfaces of the installed ring 156 and/or surrounding surfaces of the center housing 106 such that the overall structure and dimensions of the center housing 106 may be brought back to an original specification. For example, the additional machining operation may clean, flatten or deburr the outwardly facing annular face 220, refine an outer diameter of the outer peripheral surface 224, and/or perform other operations.

INDUSTRIAL APPLICABILITY

[0025] The present disclosure is applicable to rebuilding of center housings for compressors such as those used in turbochargers for internal combustion engines. The rebuilding systems and methods described herein advantageously can produce a turbocharger having an interface between the turbine housing and the center housing that is at least as effective as an originally built turbocharger. By inserting a ring of the same parent material or a different material with better anti-corrosion properties in an area of the center housing that interfaces with the turbine housing, a rebuilt turbocharger has a improved fit, form and function.

[0026] It will be appreciated that the foregoing description provides examples of the disclosed system and technique. However, it is contemplated that other implementations of the disclosure may differ in detail from the foregoing examples. All references to the disclosure or examples thereof are
intended to reference the particular example being discussed at that point and are not intended to imply any limitation as to the scope of the disclosure more generally. All language of distinction and disparagement with respect to certain features is intended to indicate a lack of preference for those features, but not to exclude such from the scope of the disclosure entirely unless otherwise indicated.

Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context.

We claim:

1. A rebuilt turbocharger, comprising:
   a shaft having a turbine wheel connected at a first shaft end, and a compressor wheel connected at a second shaft end;
   a compressor housing disposed around the compressor wheel;
   a turbine housing forming a central bore and disposed around the turbine wheel, the turbine housing forming an internal scrolled passage that surrounds the turbine wheel and carries gasses during operation;
   a heat shield disposed at least partially within the central bore and around the shaft between the compressor and turbine wheels, the heat shield being generally cup-shaped, the heat shield including an outer flange;
   a center housing disposed between and connected with the compressor housing and the turbine housing, the center housing forming a bore, through which the shaft extends, and including at least one bearing that rotatably supports the shaft;
   a protrusion formed on the center housing, the protrusion extending within the central bore such that the heat shield is disposed between the turbine wheel and the protrusion;
   a seal formed by engagement of the outer flange of the heat shield between the center housing and the turbine housing along an annular area of the center housing that extends radially relative to the shaft and is disposed radially inwardly from an interface between the center housing and the turbine housing; and
   a ring having a generally hollow cylindrical shape with a generally rectangular cross section, the ring being connected to the center housing around a base of the protrusion and forming the annular area onto which the outer flange of the heat shield is engaged to form the secondary seal.

2. The rebuilt turbocharger of claim 1, wherein the ring is made from a same parent material as the center housing.

3. The rebuilt turbocharger of claim 1, wherein the ring is made from a different material than a parent material of the center housing.

4. The rebuilt turbocharger of claim 1, wherein the ring has an inner diameter that is configured for a press-fit engagement between the ring and the center housing at an area adjacent the base of the protrusion.

5. The rebuilt turbocharger of claim 1, wherein the ring includes two oppositely disposed chamfers or fillets disposed along respective diagonally opposite edges of the ring, a first chamfer or fillet disposed at an inner, lower edge, and a second chamfer or fillet disposed at an outer, upper edge of the ring.

6. The rebuilt turbocharger of claim 1, wherein the interface between the center housing and the turbine housing forms an annular mechanical face seal between cooperating annular surfaces of the center housing and the turbine housing on corresponding flanges that are secured by a clamp.

7. The rebuilt turbocharger of claim 1, wherein the ring has a width in a radial direction relative to the shaft that is larger than an corresponding width of the outer flange such that an entire width of the outer flange of the heat shield is accommodated within the width in the radial direction of the ring.

8. A center housing for a turbocharger for use on an internal combustion engine, the center housing being configured to interconnect a compressor housing with a turbine housing in the turbocharger, the center housing comprising:
   a bore formed in the center housing, the bore configured to rotatably support a shaft having a compressor wheel at one end and a turbine wheel at another end;
   a protrusion formed on the center housing, the protrusion configured to extend within a central bore of the turbine housing;
   an annular area that extends radially relative to the shaft and is disposed radially inwardly from an interface between the center housing and the turbine housing; and
   a ring having a generally hollow cylindrical shape with a generally rectangular cross section, the ring being connected to the center housing around a base of the protrusion and forming the annular area onto which a gasket may be engaged to form a seal between the center housing and the turbine housing.

9. The center housing of claim 8, wherein the ring is made from a same parent material as the center housing.

10. The center housing of claim 8, wherein the ring is made from a different material than a parent material of the center housing.

11. The center housing of claim 8, wherein the ring has an inner diameter that is configured for a press-fit engagement between the ring and the center housing at an area adjacent to the base of the protrusion.

12. The center housing of claim 8, wherein the ring includes two oppositely disposed chamfers or fillets disposed along respective diagonally opposite edges of the ring, a first chamfer or fillet disposed at an inner, lower edge, and a second chamfer or fillet disposed at an outer, upper edge of the ring.

13. The center housing of claim 8, wherein the interface between the center housing and the turbine housing forms an annular mechanical face seal between cooperating annular surfaces of the center housing and the turbine housing on corresponding flanges that are secured by a clamp.

14. The center housing of claim 8, wherein the ring has a width in a radial direction relative to the shaft that is larger than an corresponding width of the gasket such that an entire width of the gasket is accommodated within the width in the radial direction of the ring.

15. A method for rebuilding a center housing for a turbocharger, comprising:
   dis-assembling an original turbocharger to separate an original center housing from remaining turbocharger components; mounting the original center housing on a machining device;
performing a machining operation using the machining device, the machining operation including at least one of cutting and grinding to remove a portion of a parent material from the original center housing, the portion of the parent material disposed within a hollow cylindrical cutting area and, when the parent material has been removed, producing a center housing blank from the original center housing, the center housing blank including a radially extending annular surface and an axially extending cylindrical surface that orthogonally intersect and are formed by the machining operation; and attaching a ring having a generally rectangular cross section to the center housing blank to produce a rebuilt center housing, the ring including an inner cylindrical surface disposed at an inner diameter, and a generally flat, annular base, such that the annular base of the ring abuts the radially extending annular surface and the inner cylindrical surface engages the axially extending cylindrical surface of the center housing blank at a press-fit clearance.

16. The method of claim 15, further comprising performing an additional machining operation to grind or cut portions of the ring such that an overall structure and dimensions of the rebuilt center housing duplicate those of a new, original center housing.

17. The method of claim 16, wherein the additional machining operation is performed to at least one of (a) clean, flatten or deburr an outwardly facing annular face of the ring, and (b) refine an outer diameter of an outer peripheral surface of the ring.

18. The method of claim 15, further comprising cleaning the original center housing by chemical and/or mechanical agents to remove loose debris.

19. The method of claim 15, wherein attaching the ring to the center housing is accomplished by a press-fit operation.

20. The method of claim 15, further comprising reassembling a rebuilt turbocharger using the rebuilt center housing.

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