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(54) **NESTED DUAL MOTOR/GENERATOR**

(71) Applicant: **BorgWarner Inc.**, Auburn Hills, MI (US)

(72) Inventors: **Chengyun GUO**, Novi, MI (US); **Joel MAGUIRE**, Hartland, MI (US)

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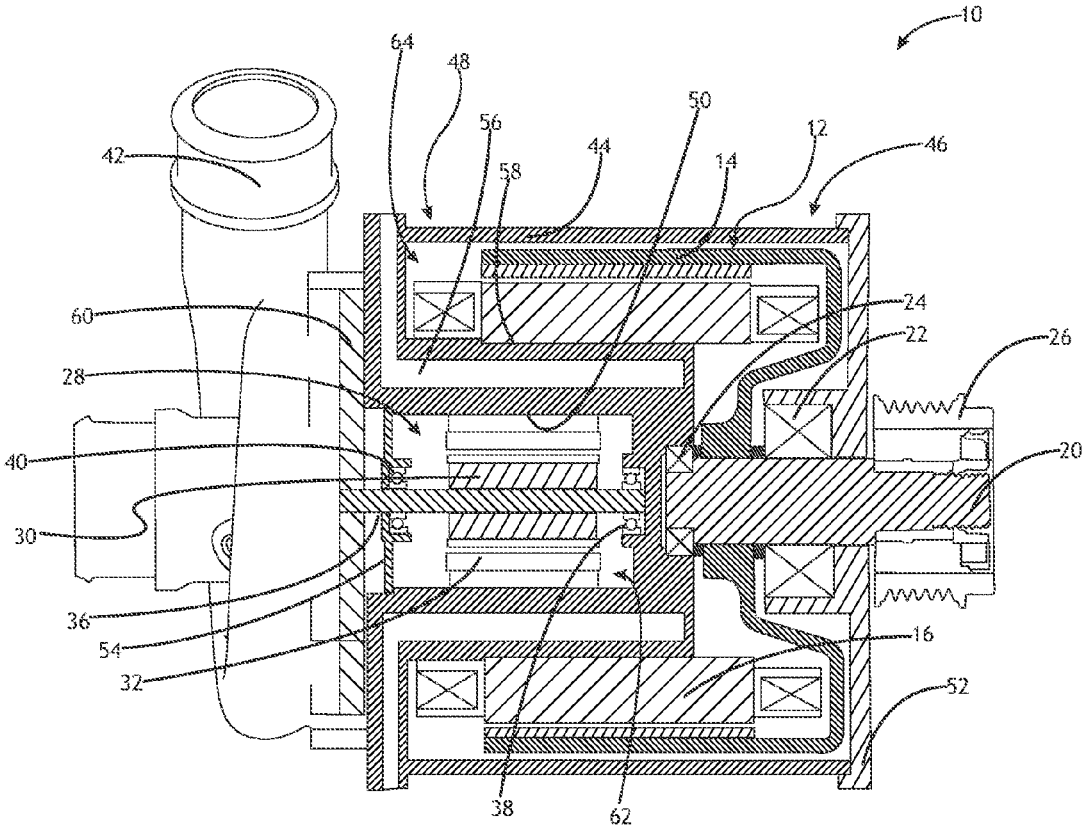
(57) **ABSTRACT**

A number of variations may include a product comprising a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and wherein the second motor is nested within the first motor or generator.



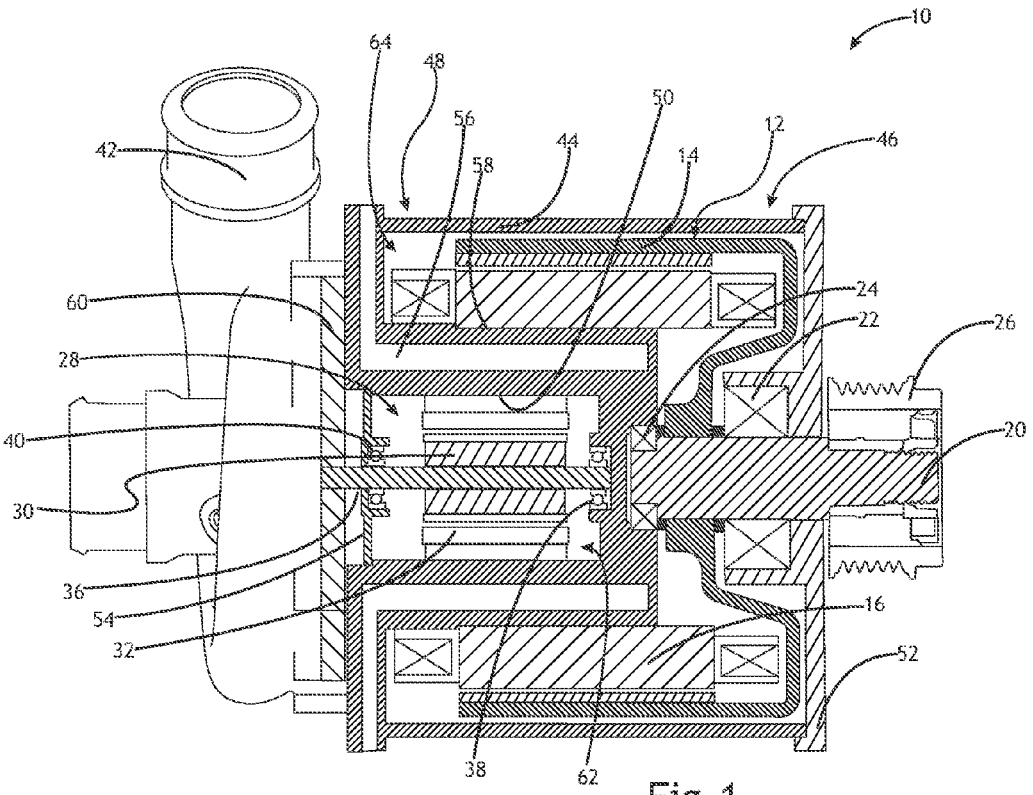

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Fig. 1

NESTED DUAL MOTOR/GENERATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/215,290 filed Sep. 8, 2015.

TECHNICAL FIELD

[0002] The field to which the disclosure generally relates to includes motors/generators.

BACKGROUND

[0003] A motor vehicle or motor driven device may require the use of dual motors.

SUMMARY OF ILLUSTRATIVE VARIATIONS

[0004] A number of variations may include a product comprising a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and wherein the second motor is nested within the first motor or generator.

[0005] A number of variations may include a product comprising an external rotor type motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; an internal rotor type motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; wherein the internal rotor type motor is nested within the external rotor type motor or generator; and a housing surrounding the external rotor type motor or generator and the internal rotor type motor.

[0006] A number of variations may include a method for integrating a dual motor/generator comprising providing a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; providing a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and nesting the second motor within the first motor or generator.

[0007] Other illustrative variations within the scope of the invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while disclosing variations within the scope of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Select examples of variations within the scope of the invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0009] FIG. **1** illustrates a section view of a nested dual motor/generator according to a number of variations.

DETAILED DESCRIPTION OF ILLUSTRATIVE VARIATIONS

[0010] The following description of the variations is merely illustrative in nature and is in no way intended to limit the scope of the invention, its application, or uses.

[0011] Referring to FIG. **1**, in a number of variations, an integrated dual motor/generator **10** may comprise a first motor/generator **12** and a second motor **28** which may be nested within the first motor/generator **12**. The first motor/generator **12** may be an external rotor type motor/generator where the rotor **14** rotates around the outside of the stator **16** and the second motor **28** may be of the internal rotor type where the rotor **30** rotates within the stator assembly **32**. In one variation, the first motor/generator **12** may be a belt driven starter/generator and the second motor **28** may be an electric drive for any number of devices **42**. The integrated dual motor/generator **10** may provide a compact and economic dual motor assembly. This may allow for the use of dual motors/generators in applications where space may be limited.

[0012] In a number of variations, the first motor/generator **12** and the second motor **28** may be contained within a housing **44**. In a number of variations, the housing **44** may include a first side **46** and a second side **48**. In a number of variations, the housing **44** may be cylindrical. In a number of variations, the second side **48** of the housing **44** may comprise a cylindrical bore defined by an inner surface **50** and an outer surface **58**. In a number of variations, the inner surface **50** may form a first cylindrical cavity **62** which may be constructed and arranged to house the second motor **28** and the outer surface **58** may form a second cylindrical cavity **64** which may be constructed and arranged to house the first motor/generator **12**. In a number of variations, a first cover **52** may be attached to the first side **46** of the housing **44** and a second cover **54** may be piloted and secured to the second side **48** of the housing **44**. The first and second covers **52**, **54** may each enclose at least a portion of the first motor/generator **12** and the second motor **28**.

[0013] In a number of variations, the first motor/generator **12** may include a rotor **14**, a stator assembly **16**, and a shaft **20**. As stated above, the first motor/generator **12** may be of an external rotor type motor/generator where the rotor **14** rotates around the outside of the stator assembly **16**. The rotor **14** may be operatively attached to the shaft **20** through a press fit or spline and pilot attachment. The shaft **20** may be supported by a front bearing **22** and a rear bearing **24**. In one variation, the front bearing **22** may be located within the first cover **52** and the rear bearing **24** may be located within the housing **44**. An input pulley **26** may be operatively connected to the shaft **20** in any number of variations including, but not limited to, a spline attachment between the input pulley **26** and the shaft **20**. In a number of variations, the first motor/generator **12** may be constructed and arranged so that there may be adequate space available inside of the first motor/generator **12** to package the second motor **28** inside of the first motor/generator **12**. The first motor/generator **12** may also be constructed and arranged to include a larger diameter air gap for the radial package space and length which may provide higher power and/or torque than a conventional internal rotor type motor with the same diameter and length.

[0014] In a number of variations, the second motor **28** may include a rotor **30**, a stator assembly **32**, and a shaft **36**. The rotor **30** may be operatively connected to the shaft **36** in any number of variations including, but not limited to, a spline attachment. The shaft **36** may be supported by a first bearing **38** and a second bearing **40**. The first bearing **38** may be located within the housing **44** and the second bearing **40** may be located within the second cover **54**. The shaft **36** may

drive any number of devices including, but not limited to, a compressor **42**, a fan, or a pump. In a number of variations, the stator assembly **32** may be installed within the inner surface **50** of the cylindrical bore in the second side **48** of the housing **44**.

[0015] In a number of variations, a cooling jacket/cooling circuit **56** may be integrated within the housing **44** and may be used to cool the first motor/generator **12** and the second motor **28**. In one variation, the cooling jacket **56** may be formed with the housing **44** including, but not limited to, cast with the housing **44**. In a number of variations, the cooling jacket **56** may be nested between the first motor/generator **12** and the second motor **28**. In one variation, the cooling jacket **56** may be integrated within the cylindrical bore between the inner surface **50** and the outer surface **58**. The use of a single cooling jacket **56** shared by each of the first motor/generator **12** and the second motor **28** may significantly reduce the radial space required for the dual motors/generators.

[0016] In a number of variations, the integrated dual motor/generator **10** may also be constructed and arranged to share any number of power electronics (not illustrated). In one variation, the power electronics may be operatively attached to a plate **60** which may be adjacent the second side **48** of the housing **44**.

[0017] The above integrated dual motor/generator **10** may provide a compact design using reduced costs and may provide a high power density.

[0018] The following description of variants is only illustrative of components, elements, acts, products and methods considered to be within the scope of the invention and are not in any way intended to limit such scope by what is specifically disclosed or not expressly set forth. The components, elements, acts, products and methods as described herein may be combined and rearranged other than as expressly described herein and still are considered to be within the scope of the invention.

[0019] Variation 1 may include a product comprising: a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and wherein the second motor is nested within the first motor or generator.

[0020] Variation 2 may include a product as set forth in Variation 1 further comprising a housing, wherein the housing is constructed and arranged to accommodate the first motor or generator and the second motor.

[0021] Variation 3 may include a product as set forth in Variation 2 further comprising a cooling jacket integrated within the housing, and wherein the cooling jacket is constructed and arranged to cool the first motor or generator and the second motor.

[0022] Variation 4 may include a product as set forth in Variation 3 further comprising a first cover and a second cover, wherein the first cover is attached to a first side of the housing and the second cover is attached to a second side of the housing.

[0023] Variation 5 may include a product as set forth in any of Variations 2-4 wherein the housing is cylindrical and wherein the housing comprises a cylindrical bore defined by an inner surface and an outer surface, and wherein the inner surface forms a first cylindrical cavity constructed and arranged to house the second motor and the outer surface forms a second cylindrical cavity constructed and arranged to house the first motor or generator.

[0024] Variation 6 may include a product as set forth in Variation 5 further comprising a cooling jacket located between the inner surface and the outer surface.

[0025] Variation 7 may include a product as set forth in any of Variations 1-6 wherein the first rotor is operatively attached to the first shaft through at least one of a press fit or a spline and pilot attachment.

[0026] Variation 8 may include a product as set forth in any of Variations 1-7 wherein the first shaft is supported by a front bearing and a rear bearing, and wherein the front bearing is located within the first cover and the rear bearing is located within the housing.

[0027] Variation 9 may include a product as set forth in any of Variations 1-8 further comprising an input pulley, wherein the input pulley is operatively connected to the first shaft.

[0028] Variation 10 may include a product as set forth in Variation 9 wherein the input pulley is operatively connected to the first shaft by a spline attachment.

[0029] Variation 11 may include a product as set forth in any of Variations 1-10 wherein the first motor or generator includes an air gap having a diameter which provides for at least one of increased power or torque.

[0030] Variation 12 may include a product as set forth in any of Variations 1-11 wherein the second rotor is operatively connected to the second shaft through a spline attachment.

[0031] Variation 13 may include a product as set forth in any of Variations 4-12 wherein the second shaft is supported by a first bearing and a second bearing, and wherein the first bearing is located within the second side of the housing and the second bearing is located within the second cover.

[0032] Variation 14 may include a product as set forth in any of Variations 1-13 wherein the first motor or generator is a belt driven starter/generator and the second motor is an electric drive for an electric drive device.

[0033] Variation 15 may include a product as set forth in any of Variations 1-14 wherein the first motor or generator and the second motor are constructed and arranged to share at least one power electronic.

[0034] Variation 16 may include a product comprising: an external rotor type motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; an internal rotor type motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; wherein the internal rotor type motor is nested within the external rotor type motor or generator; and a housing surrounding the external rotor type motor or generator and the internal rotor type motor.

[0035] Variation 17 may include a product as set forth in Variation 16 wherein the housing further comprises an integrated cooling jacket between the external rotor type motor or generator and the internal rotor type motor.

[0036] Variation 18 may include a method for integrating a dual motor/generator comprising: providing a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor; providing a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and nesting the second motor within the first motor or generator.

[0037] Variation 19 may include a method as set forth in Variation 18 further comprising enclosing at least a portion of the first motor or generator and the second motor within a housing and at least one cover.

[0038] Variation 20 may include a method as set forth in Variation 19 further comprising integrating a cooling jacket within the housing to cool the first motor or generator and the second motor.

[0039] The above description of select variations within the scope of the invention is merely illustrative in nature and, thus, variations or variants thereof are not to be regarded as a departure from the spirit and scope of the invention.

What is claimed is:

1. A product comprising:

a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor;

a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and

wherein the second motor is nested within the first motor or generator.

2. The product of claim **1** further comprising a housing, wherein the housing is constructed and arranged to accommodate the first motor or generator and the second motor.

3. The product of claim **2** further comprising a cooling jacket integrated within the housing, and wherein the cooling jacket is constructed and arranged to cool the first motor or generator and the second motor.

4. The product of claim **2** further comprising a first cover and a second cover, wherein the first cover is attached to a first side of the housing and the second cover is attached to a second side of the housing.

5. The product of claim **2** wherein the housing is cylindrical and wherein the housing comprises a cylindrical bore defined by an inner surface and an outer surface, wherein the inner surface forms a first cylindrical cavity constructed and arranged to house the second motor, and wherein the outer surface forms a second cylindrical cavity constructed and arranged to house the first motor or generator.

6. The product of claim **5** further comprising a cooling jacket located between the inner surface and the outer surface.

7. The product of claim **1** wherein the first rotor is operatively attached to the first shaft through at least one of a press fit or a spline and pilot attachment.

8. The product of claim **4** wherein the first shaft is supported by a front bearing and a rear bearing, and wherein the front bearing is located within the first cover and the rear bearing is located within the housing.

9. The product of claim **1** further comprising an input pulley, wherein the input pulley is operatively connected to the first shaft.

10. The product of claim **9** wherein the input pulley is operatively connected to the first shaft by a spline attachment.

11. The product of claim **1** wherein the first motor or generator includes an air gap having a diameter which provides for at least one of increased power or torque.

12. The product of claim **1** wherein the second rotor is operatively connected to the second shaft through a spline attachment.

13. The product of claim **4** wherein the second shaft is supported by a first bearing and a second bearing, and wherein the first bearing is located within the housing and the second bearing is located within the second cover.

14. The product of claim **1** wherein the first motor or generator is a belt driven starter/generator and the second motor is an electric drive for an electric drive device.

15. The product of claim **1** wherein the first motor or generator and the second motor are constructed and arranged to share at least one power electronic.

16. A product comprising:

an external rotor type motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor;

an internal rotor type motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor;

wherein the internal rotor type motor is nested within the external rotor type motor or generator; and

a housing surrounding the external rotor type motor or generator and the internal rotor type motor.

17. The product of claim **16** wherein the housing further comprises an integrated cooling jacket between the external rotor type motor or generator and the internal rotor type motor.

18. A method for integrating a dual motor/generator comprising:

providing a first motor or generator comprising a first stator located within a first rotor, and a first shaft operatively connected to the first rotor;

providing a second motor comprising a second stator surrounding a second rotor, and a second shaft operatively connected to the second rotor; and

nesting the second motor within the first motor or generator.

19. A method as set forth in claim **18** further comprising enclosing at least a portion of the first motor or generator and the second motor within a housing and at least one cover.

20. The method of claim **19** further comprising integrating a cooling jacket within the housing to cool the first motor or generator and the second motor.

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