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Luipold

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(54) **FRICITION PLATE WITH PRESSED CORE PLATES**

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F16D 13/64 (2006.01)
F16D 69/04 (2006.01)

(52) **U.S. Cl.**
USPC **192/107 R**; 192/113.36

(58) **Field of Classification Search**
USPC 192/107 R, 113.36
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,841,452 A	10/1974	Newsock et al.	
5,052,536 A	10/1991	Maeda	
5,934,435 A *	8/1999	Bauer	192/113.34
6,062,367 A	5/2000	Hirayanagi et al.	
2006/0102443 A1	5/2006	Kinoshita et al.	
2007/0000747 A1 *	1/2007	Miyazaki	192/70.12

FOREIGN PATENT DOCUMENTS

KR 20100119193 11/2010

* cited by examiner

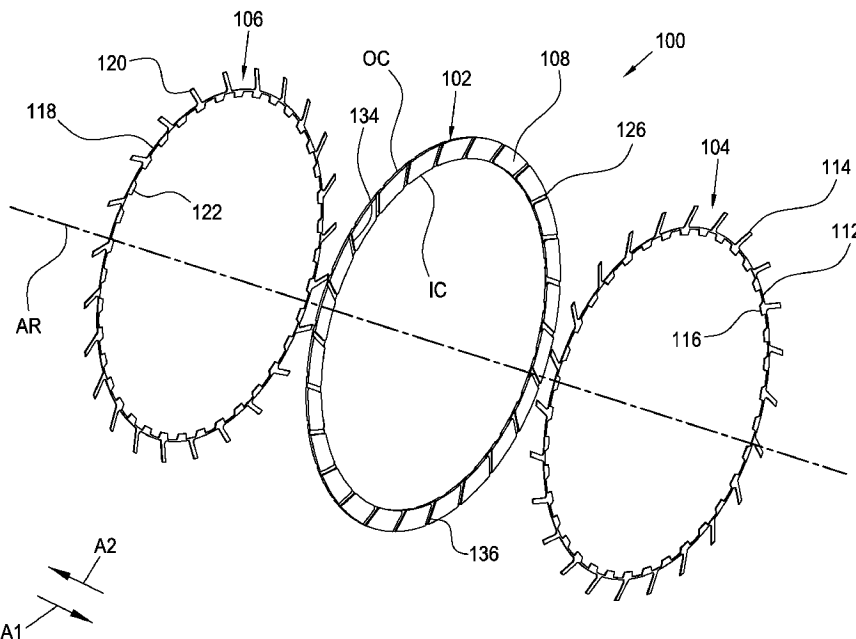
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(57) **ABSTRACT**

A friction plate, including: a ring-shaped piece of friction material with an inner circumference, and first and second surfaces facing in first and second opposite axial directions, respectively; a first core plate with a first ring-shaped body, a first plurality of protrusions extending radially outward from the first ring-shaped body and imbedded in the first surface, and a second plurality of protrusions extending radially inward from the first ring-shaped body; and a second core plate with a second ring-shaped body, a third plurality of protrusions extending radially outward from the second ring-shaped body and embedded in the second surface, and a fourth plurality of protrusions extending radially inward from the second ring-shaped body. The first and second bodies are at least partially disposed radially inward of the inner circumference. The second and fourth pluralities of protrusions are for engagement with a rotatable element.

18 Claims, 5 Drawing Sheets



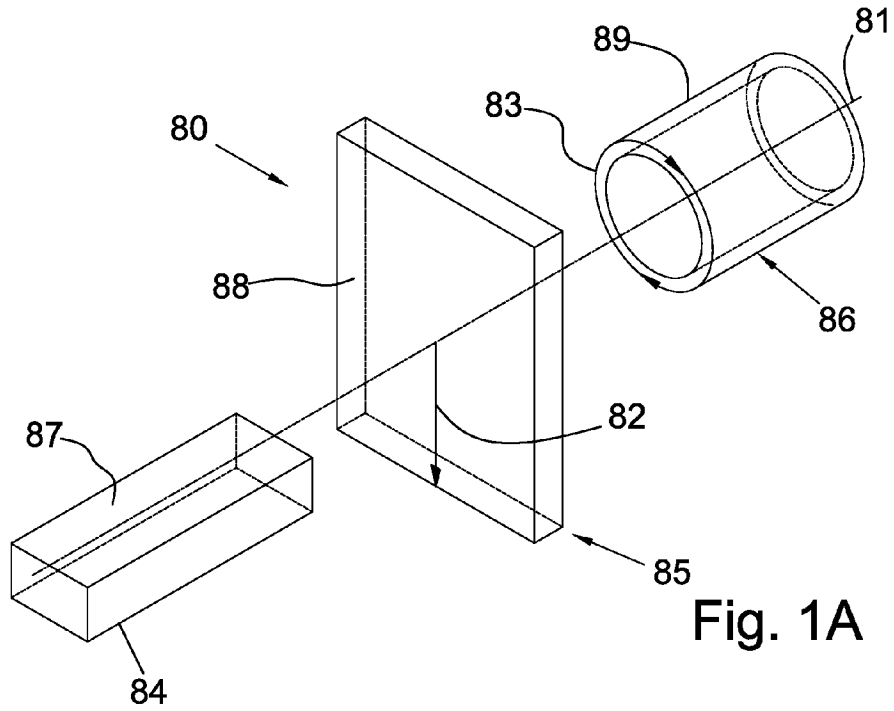


Fig. 1A

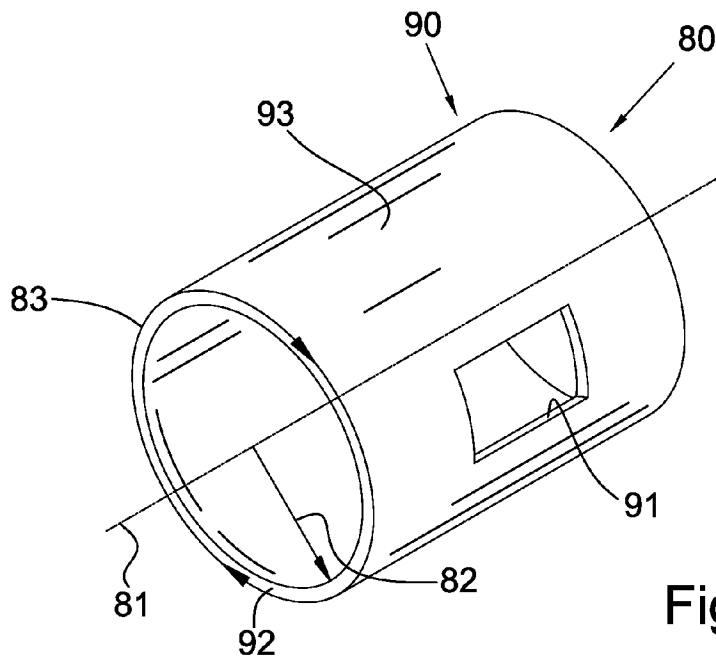


Fig. 1B

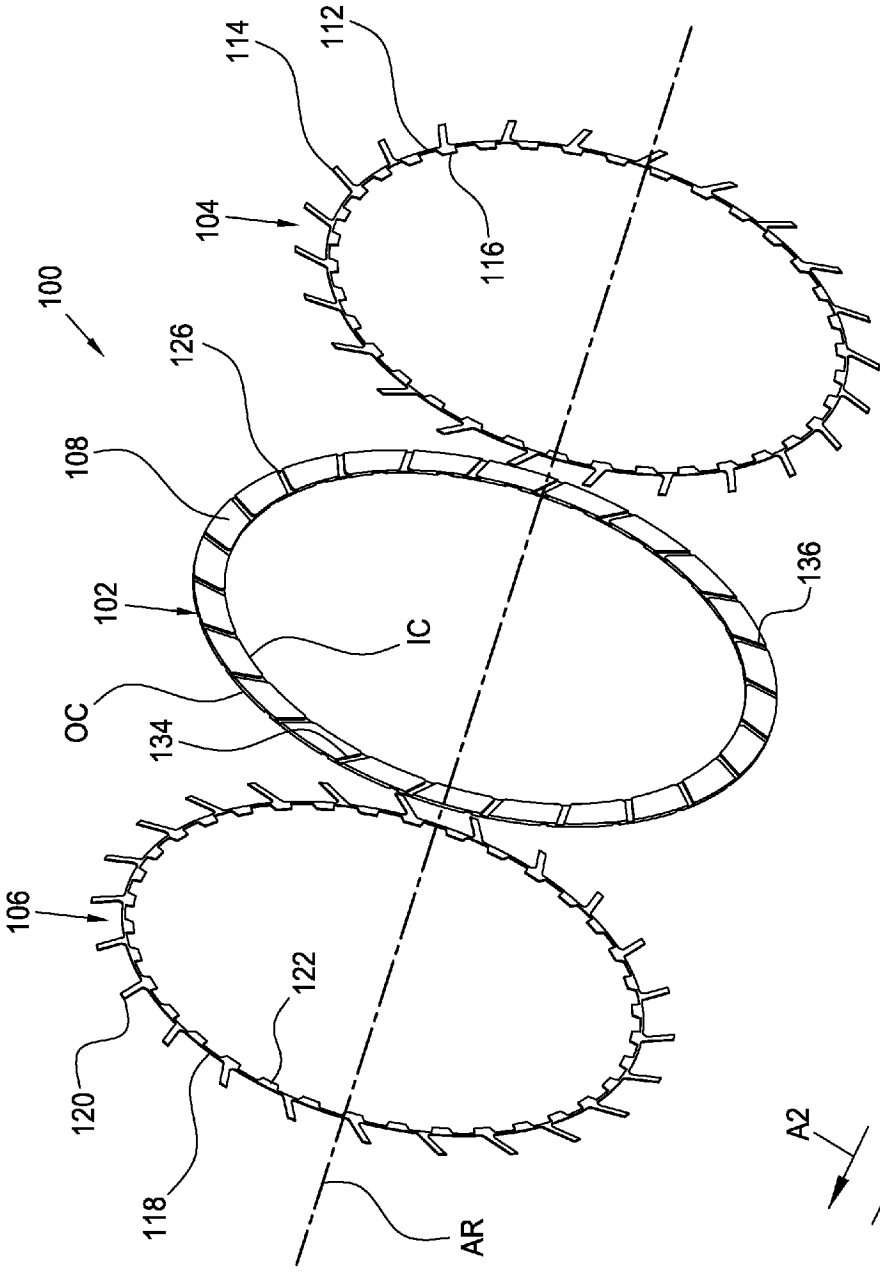


Fig. 2

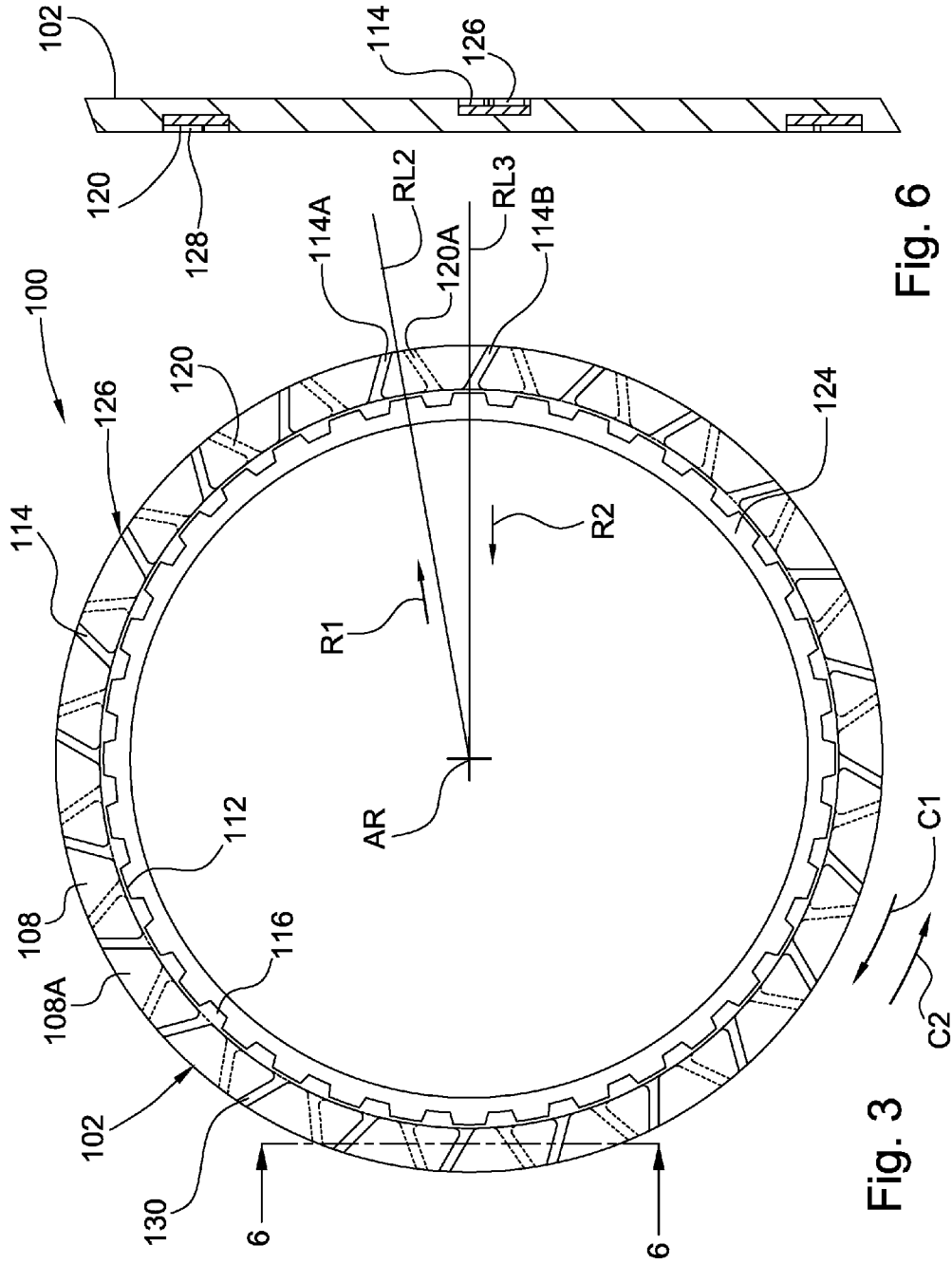


Fig. 6

Fig. 3

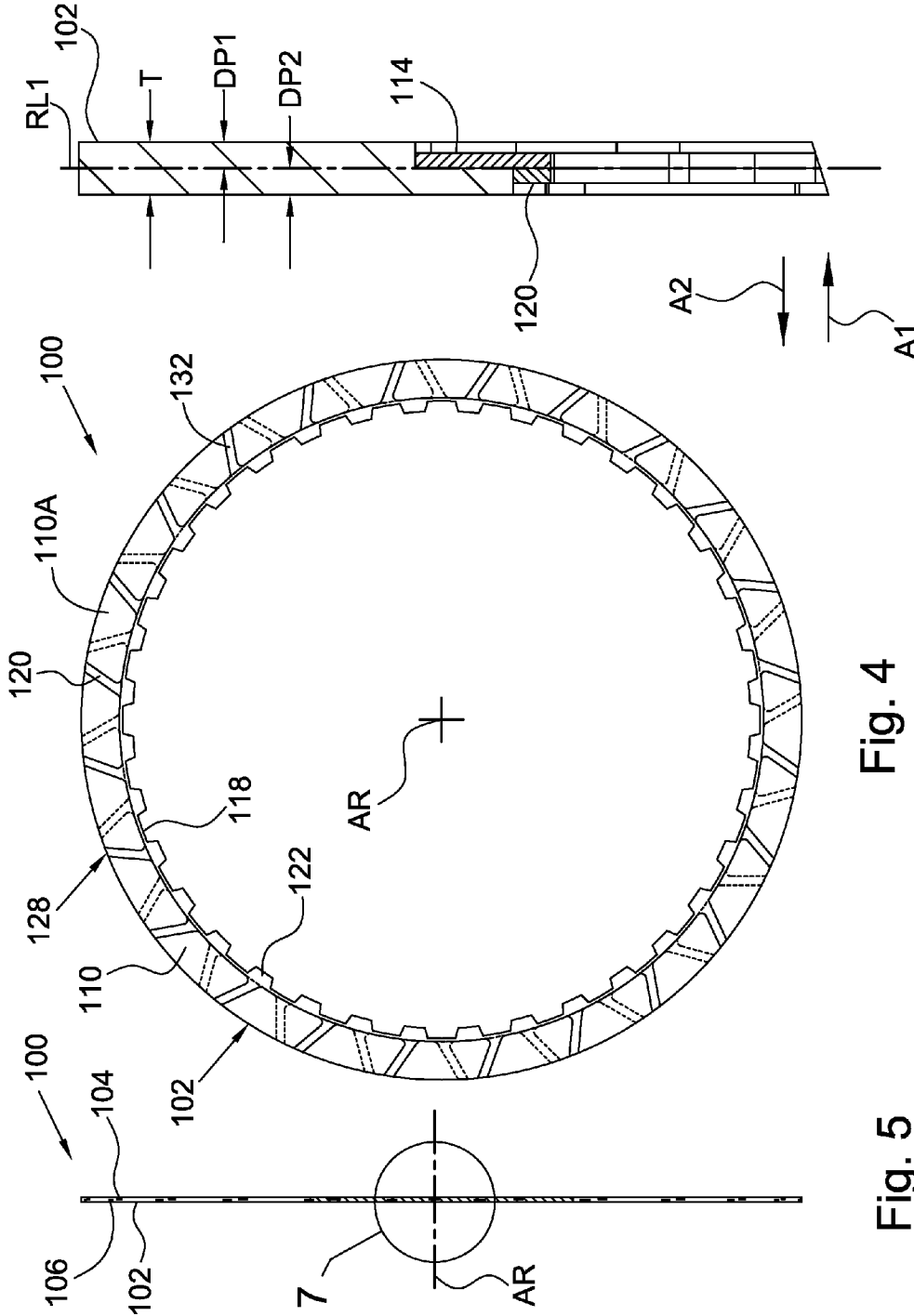


Fig. 7

Fig. 4

Fig. 5

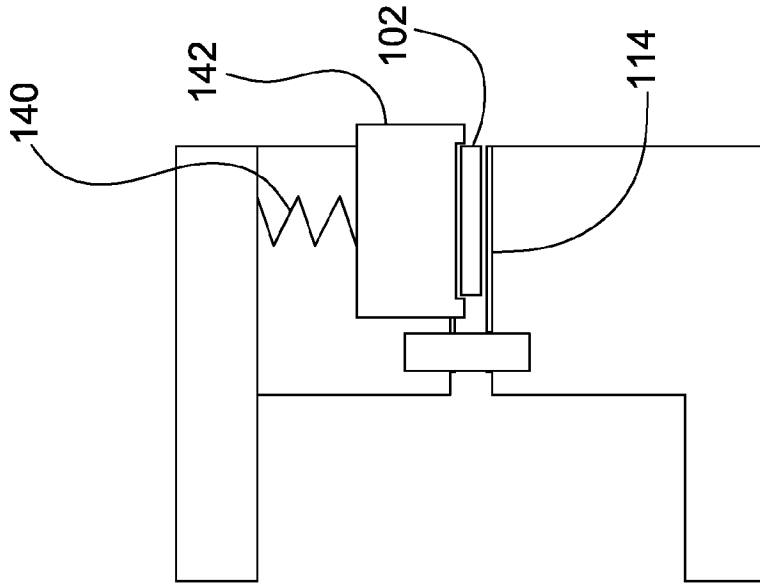


Fig. 8

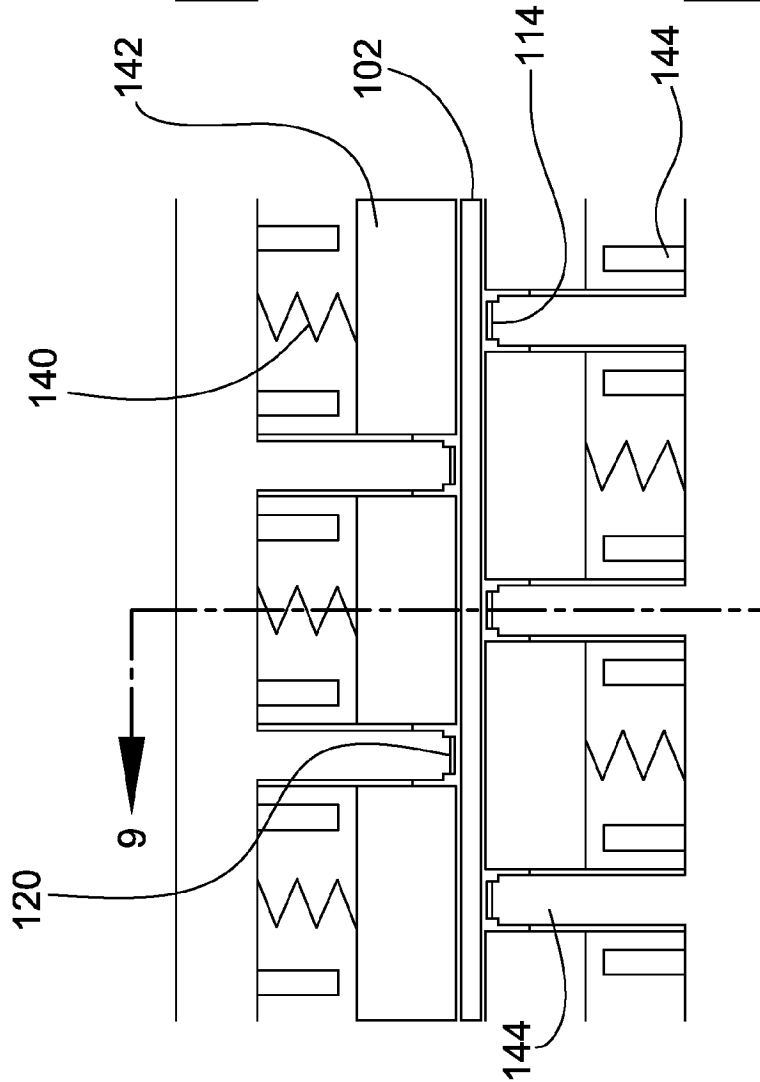


Fig. 9

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FRICION PLATE WITH PRESSED CORE PLATES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 61/548,414, filed Oct. 18, 2011.

TECHNICAL FIELD

The present disclosure relates to friction plates, in particular, friction plates for use in a transmission. Even more particularly, the disclosure relates to friction plates formed of friction paper without the use of adhesive.

BACKGROUND

It is known to fabricate a friction plate for a transmission by using adhesive to adhere two pieces of friction material to a metal plate. Adhesives are relatively costly and the manufacturing and use of adhesives have detrimental environmental impacts. U.S. Pat. No. 3,841,452 teaches a friction unit made of plates faced with friction material and interleaved with steel plates. The plates faced with friction material are formed by two pieces of friction material bonded together. A wire carrier is embedded in the friction material.

SUMMARY

According to aspects illustrated herein, there is provided a friction plate, including: a ring-shaped piece of friction material with an inner circumference, and first and second surfaces facing in first and second opposite axial directions, respectively; a first core plate with a first ring-shaped body, a first plurality of protrusions extending radially outward from the first ring-shaped body and tilted in a first circumferential direction, and a second plurality of protrusions extending radially inward from the first ring-shaped body; and a second core plate with a second ring-shaped body, a third plurality of protrusions extending radially outward from the second ring-shaped body and tilted in a second circumferential direction, opposite the first circumferential direction, and a fourth plurality of protrusions extending radially inward from the second ring-shaped body. The first and third pluralities of protrusions are imbedded in the first and second surfaces, respectively. The first and second bodies are at least partially disposed radially inward of the inner circumference. The second and fourth pluralities of protrusions are aligned in an axial direction and are for engagement with a rotatable element.

According to aspects illustrated herein, there is provided a friction plate, including: a ring-shaped piece of friction material with an inner circumference, and first and second surfaces facing in first and second opposite axial directions, respectively; a first core plate with a first ring-shaped body, a first plurality of protrusions extending radially outward from the first ring-shaped body and imbedded in the first surface, and a second plurality of protrusions extending radially inward from the first ring-shaped body; and a second core plate with a second ring-shaped body, a third plurality of protrusions extending radially outward from the second ring-shaped body and embedded in the second surface, and a fourth plurality of protrusions extending radially inward from the second ring-shaped body. The first and second bodies are disposed at least

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partially radially inward of the inner circumference. The second and fourth pluralities of protrusions are for engagement with a rotatable element.

According to aspects illustrated herein, there is provided a friction plate, including: a ring-shaped piece of friction material with inner and outer circumferences, and first and second surfaces facing in first and second opposite axial directions, respectively; a first core plate with: a first ring-shaped body; a first plurality of protrusions embedded in the first surface, extending radially outward from the first ring-shaped body, and tilted in a first circumferential direction; and a second plurality of protrusions extending radially inward from the first ring-shaped body; a second core plate with: a second ring-shaped body; a third plurality of protrusions embedded in the second surface, extending radially outward from the second ring-shaped body, and tilted in a second circumferential direction, opposite the first circumferential direction; and a fourth plurality of protrusions extending radially inward from the second ring-shaped body; a first plurality of grooves in the first surface connecting the inner and outer circumferences and at least partially formed by the first plurality of protrusions; and a second plurality of grooves in the second surface connecting the inner and outer circumferences and at least partially formed by the third plurality of protrusions. The first and second bodies are at least partially disposed radially inward of the inner circumference. The second and fourth pluralities of protrusions are aligned in an axial direction and are for engagement with a rotatable element.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

FIG. 1A is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

FIG. 1B is a perspective view of an object in the cylindrical coordinate system of FIG. 1A demonstrating spatial terminology used in the present application; and,

FIG. 2 is an exploded view of a friction plate;

FIG. 3 is a front view of the friction plate of FIG. 2;

FIG. 4 is a back view of the friction plate of FIG. 2;

FIG. 5 is a side view of the friction plate of FIG. 2;

FIG. 6 is a cross sectional view generally along line 6-6 in FIG. 3;

FIG. 7 is a detail of area 7 in FIG. 5; and,

FIG. 8 is a schematic representations of tooling for fabricating the friction plate of FIG. 2; and,

FIG. 9 is a cross sectional view generally along line 9-9 in FIG. 8.

DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements of the disclosure. It is to be understood that the disclosure as claimed is not limited to the disclosed aspects. Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the present disclosure.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood

to one of ordinary skill in the art to which this disclosure belongs. It should be understood that any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the disclosure.

FIG. 1A is a perspective view of cylindrical coordinate system **80** demonstrating spatial terminology used in the present application. The present invention is at least partially described within the context of a cylindrical coordinate system. System **80** has a longitudinal axis **81**, used as the reference for the directional and spatial terms that follow. The adjectives “axial,” “radial,” and “circumferential” are with respect to an orientation parallel to axis **81**, radius **82** (which is orthogonal to axis **81**), and circumference **83**, respectively. The adjectives “axial,” “radial” and “circumferential” also are regarding orientation parallel to respective planes. To clarify the disposition of the various planes, objects **84**, **85**, and **86** are used. Surface **87** of object **84** forms an axial plane. That is, axis **81** forms a line along the surface. Surface **88** of object **85** forms a radial plane. That is, radius **82** forms a line along the surface. Surface **89** of object **86** forms a circumferential plane. That is, circumference **83** forms a line along the surface. As a further example, axial movement or disposition is parallel to axis **81**, radial movement or disposition is parallel to radius **82**, and circumferential movement or disposition is parallel to circumference **83**. Rotation is with respect to axis **81**.

The adverbs “axially,” “radially,” and “circumferentially” are with respect to an orientation parallel to axis **81**, radius **82**, or circumference **83**, respectively. The adverbs “axially,” “radially,” and “circumferentially” also are regarding orientation parallel to respective planes.

FIG. 1B is a perspective view of object **90** in cylindrical coordinate system **80** of FIG. 1A demonstrating spatial terminology used in the present application. Cylindrical object **90** is representative of a cylindrical object in a cylindrical coordinate system and is not intended to limit the present invention in any manner. Object **90** includes axial surface **91**, radial surface **92**, and circumferential surface **93**. Surface **91** is part of an axial plane, surface **92** is part of a radial plane, and surface **93** is a circumferential surface.

FIG. 2 is an exploded view of friction plate **100**.

FIG. 3 is a front view of friction plate **100** of FIG. 2;

FIG. 4 is a back view of friction plate **100** of FIG. 2. The following should be viewed in light of FIGS. 2 through 4. Friction plate **100** includes ring-shaped piece of friction material **102** and core plates **104** and **106**. In an example embodiment, the core plates are made of metal, for example, stamped steel. The friction material includes inner and outer circumferences IC and OC, respectively, and surfaces **108** and **110**. Surfaces **108** and **110** face in opposite axial directions **A1** and **A2**, respectively. Core plate **104** includes ring-shaped body **112**, a plurality of protrusions **114** extending radially outward from body **112** and imbedded in side **108**, and a plurality of protrusions **116** extending radially inward from body **112**. Core plate **106** includes ring-shaped body **118**, a plurality of protrusions **120** extending radially outward from body **118** and imbedded in side **110**, and a plurality of protrusions **122** extending radially inward from body **118**. Bodies **112** and **118** are at least partially disposed radially inward of IC. Protrusions **114** and **120** are for engagement with rotatable element **124** (shown only on FIG. 3).

FIG. 5 is a side view of friction plate **100** of FIG. 2.

FIG. 6 is a cross sectional view generally along line 6-6 in FIG. 3.

FIG. 7 is a detail of area 7 in FIG. 5. The following should be viewed in light of FIGS. 2 through 7. Protrusions **114** form respective portions of plurality of grooves **126** in side **108**

connecting the inner and outer circumferences. Protrusions **120** form respective portions of plurality of grooves **128** in side **110** connecting the inner and outer circumferences. For example, grooves **126** and **128** enable flow of cooling fluid between IC and OC. Grooves **126** and **128** also can be described as follows. Radial line RL1 equally divides friction material **102** in an axial direction (**A1** or **A2**). That is, equal portions of friction material **102** are located on either side of RL1. Protrusions **114** and **120** include surfaces **130** and **132**, respectively, facing substantially in directions **A1** and **A2** respectively. Surfaces **130** and **132** are closer to line RL1 than portions of surfaces **108** and **110** not axially aligned with protrusions **114** and **120**, respectively, for example, portions **108A** and **110A**. That is, one side of the grooves is formed by protrusions **114** and **120** and the remaining sides are formed by friction material **102**, for example, by sides **134** and **136**.

In an example embodiment, protrusions **114** and **120** terminate at the outer circumference. In an example embodiment, protrusions **114** and **120** are non-aligned in an axial direction, for example, protrusions **114A** and **120A** are misaligned in the axial direction. In an example embodiment, respective protrusions **114** and **120** alternate in circumferential direction **C1** or **C2**, for example, protrusions **114A**, **120A**, and **114B** alternate in direction **C1**. In an example embodiment, protrusions **114** tilt in one circumferential direction, for example, direction **C1** and protrusions **120** tilt in an opposite circumferential direction, for example, direction **C2**.

In an example embodiment, protrusions **114** and **120** are orthogonal to IC, OC, or axis of rotation AR, that is, the protrusions are co-linear with radial lines. In an example embodiment, protrusions **114** and **120** are symmetrical about radial line RL2 or RL3 passing through axis of rotation AR and between respective protrusions **114** and **120**. In an example embodiment, the respective protrusions **114** and **120**, for example, protrusions **114A** and **120A**, taper toward RL2 in radial direction R1 from the inner circumference to the outer circumference. In an example embodiment, the respective protrusions **114** and **120**, for example, protrusions **120A** and **114B**, taper toward from RL3 in radial direction R2 from the outer circumference to the outer circumference. It should be understood that other shapes are possible for respective portions of protrusions **114** and **120** between IC and OC, for example, jagged or zigzag shapes.

In an example embodiment, bodies **112** and **118** are in contact. In an example embodiment, protrusions **116** and **122** are aligned in an axial direction. In an example embodiment, friction material **102** has thickness T in an axial direction and respective depths of penetration DP1 and DP2 of protrusions **114** and **120** in axial directions **A2** and **A1** beyond surfaces **108** and **110**, respectively, are no greater than one half T. In an example embodiment, T is 1.6 mm.

The core plates are pressed into friction material **102** so that protrusions **114** and **120** form grooves **126** and **128**, respectively. When friction is transmitted to friction material **102** (for example, a clutch including friction material **102** is closed), the torque is transmitted from friction material **102** to rotatable element **124** via protrusions **114** and **120** and protrusions **116** and **122**. The shapes of **114** and **120** act to radially restrain friction material **102** to prevent bursting of the material. Grooves **126** and **128** enable the flow of cooling fluid across protrusions **114** and **120** and friction material **102**, thus, protrusions **114** and **120** are an active part of a cooling system in which plate **100** is included. Further, the core plates act as heat sinks for the cooling fluid, improving performance of plate **100**. In an example embodiment, sur-

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faces **108** and **110** are not broken and the friction material is compressed by protrusions **114** and **120** to form grooves **126** and **128**.

Advantageously, plate **100** does not require the use of adhesive to join friction material **102** to core plates **104** and **106**, which are used to transmit torque from element **124** to friction material **102**. That is, friction material **102** is free of adhesive between friction material **102** and protrusions **114** and **120**.

FIG. **8** is a schematic representation of tooling for fabricating friction plate **100** of FIG. **2**.

FIG. **9** is a cross sectional view generally along line **9-9** in FIG. **8**. The following should be viewed in light of FIGS. **2** through **9**. The following provides example details regarding fabrication of plate **100**. The tooling required to press core plates **104** and **106** into friction material **102** is shaped such that the friction material is fully supported everywhere except where protrusions **114** and **120** are located. The support of the friction material only compress the material after protrusions **114** and **120** are pressed into the friction material. The support of the friction material is provided by springs **140**, a set of stops **142** that control the compressed thickness, and stops **144** that enable the friction material to be compressed. Stops **144** also prevent pressing of protrusions **114** and **120** from only one side. Protrusions **114** and **120** also are fully supported and centered on protrusions **116** and **122**, respectively.

It will be appreciated that various of the above-disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What we claim is:

1. A friction plate, comprising:

a ring-shaped piece of friction material with an inner circumference, and first and second surfaces facing in first and second opposite axial directions, respectively;

a first core plate with a first ring-shaped body, a first plurality of protrusions extending radially outward from the first ring-shaped body and imbedded in the first surface, and a second plurality of protrusions extending radially inward from the first ring-shaped body; and,

a second core plate with a second ring-shaped body, a third plurality of protrusions extending radially outward from the second ring-shaped body and embedded in the second surface, and a fourth plurality of protrusions extending radially inward from the second ring-shaped body, wherein:

the first and second bodies are at least partially disposed radially inward of the inner circumference; and,
the second and fourth pluralities of protrusions are for engagement with a rotatable element.

2. The friction plate of claim **1**, wherein:

the piece of friction material includes an outer circumference;

the first plurality of protrusions form respective portions of a first plurality of grooves in the first surface connecting the inner and outer circumferences; and,

the third plurality of protrusions form respective portions of a second plurality of grooves in the second surface connecting the inner and outer circumferences.

3. The friction plate of claim **1**, wherein:

a radial line equally divides the piece of friction material in an axial direction;

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the first and third pluralities of protrusions include third and fourth surfaces facing substantially in the first and second axial directions, respectively; and,

the third and fourth surfaces are closer to the line than respective portions the first and second surfaces not axially aligned with the first and third pluralities of protrusions, respectively.

4. The friction plate of claim **2**, wherein the first and third pluralities of protrusions terminate at the outer circumference.

5. The friction plate of claim **1**, further comprising an axis of rotation, wherein:

the first and third pluralities of protrusions include first and second protrusions, respectively, in sequence in a circumferential direction; and,

the first and second protrusions are symmetrical about a line passing through the axis of rotation and between the first and second protrusions.

6. The friction plate of claim **5**, wherein the first and second protrusions taper away from the line from the inner circumference to the outer circumference.

7. The friction plate of claim **5**, wherein the first and second protrusions taper toward the line from the inner circumference to the outer circumference.

8. The friction plate of claim **1**, wherein the first and third pluralities of protrusions are non-aligned in an axial direction.

9. The friction plate of claim **1**, wherein respective protrusions from the first and third pluralities of protrusions alternate in a circumferential direction.

10. The friction plate of claim **1**, wherein the first and second bodies are in contact.

11. The friction plate of claim **1**, wherein the second and fourth pluralities of protrusions are aligned in an axial direction.

12. The friction plate of claim **1**, wherein the piece of friction material is free of adhesive between the piece of friction material and the first and third pluralities of protrusions.

13. The friction plate of claim **1**, wherein:

the piece of friction material has a thickness in an axial direction; and,

respective depths of penetration of the first and third pluralities of protrusions in the axial direction in the first and second surfaces, respectively, are no greater than one half the thickness.

14. The friction plate of claim **1**, wherein:

the piece of friction material has a thickness in an axial direction; and,

respective depths of penetration of the first and third pluralities of protrusions in the axial direction in the first and second surfaces, respectively, are greater than one half the thickness.

15. A friction plate, comprising:

a ring-shaped piece of friction material with an inner circumference, and first and second surfaces facing in first and second opposite axial directions, respectively;

a first core plate with a first ring-shaped body, a first plurality of protrusions extending radially outward from the first ring-shaped body and tilted in a first circumferential direction, and a second plurality of protrusions extending radially inward from the first ring-shaped body; and,

a second core plate with a second ring-shaped body, a third plurality of protrusions extending radially outward from the second ring-shaped body and tilted in a second circumferential direction, opposite the first circumferential

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direction, and a fourth plurality of protrusions extending radially inward from the second ring-shaped body, wherein:

the first and third pluralities of protrusions are imbedded in the first and second surfaces, respectively;

the first and second bodies are disposed at least partially radially inward of the inner circumference; and,

the second and fourth pluralities of protrusions are aligned in an axial direction and are for engagement with a rotatable element.

16. The friction plate of claim **15**, wherein the first and third pluralities of protrusions are misaligned in an axial direction.

17. A friction plate, comprising:

a ring-shaped piece of friction material with inner and outer circumferences, and first and second surfaces facing in first and second opposite axial directions, respectively;

a first core plate with: a first ring-shaped body; a first plurality of protrusions embedded in the first surface, extending radially outward from the first ring-shaped body, and tilted in a first circumferential direction; and a second plurality of protrusions extending radially inward from the first ring-shaped body;

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a second core plate with: a second ring-shaped body; a third plurality of protrusions embedded in the second surface, extending radially outward from the second ring-shaped body, and tilted in a second circumferential direction, opposite the first circumferential direction; and a fourth plurality of protrusions extending radially inward from the second ring-shaped body;

a first plurality of grooves in the first surface, connecting the inner and outer circumferences, and at least partially formed by the first plurality of protrusions; and,

a second plurality of grooves in the second surface, connecting the inner and outer circumferences, and at least partially formed by the third plurality of protrusions, wherein:

the first and second bodies are at least partially disposed radially inward of the inner circumference; and,

the second and fourth pluralities of protrusions are aligned in an axial direction and are for engagement with a rotatable element.

18. The friction plate of claim **17**, wherein the first and third pluralities of protrusions are misaligned in an axial direction.

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