(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 December 2016 (22.12.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/205108 A1

(51) International Patent Classification:
F16H 41/28 (2006.01) *F16H 41/24* (2006.01)

(21) International Application Number:
PCT/US2016/037171

(22) International Filing Date:
13 June 2016 (13.06.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14/744,751 19 June 2015 (19.06.2015) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: TORQUE CONVERTER HAVING A COVER AND IMPELLER WELD WITH A CONSTRAINED DIAMETER AND METHOD OF WELDING THE COVER AND IMPELLER

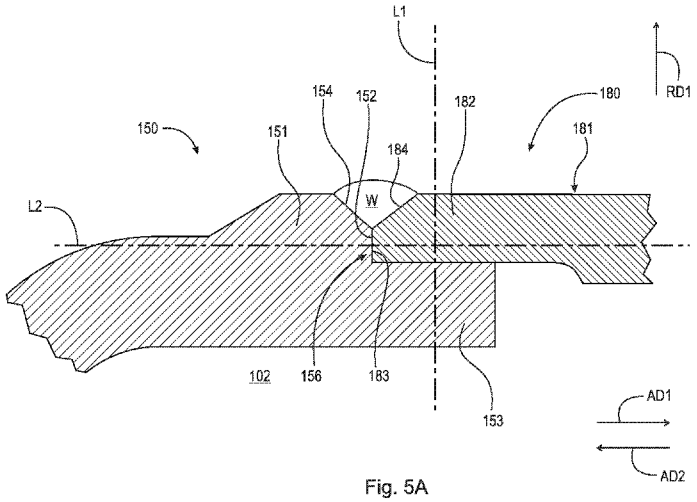


Fig. 5A

(57) Abstract: A torque converter, including: a cover including: a first portion having a first surface facing at least partially in a first axial direction and a second portion extending past the first surface in the first axial direction; an impeller including: an impeller shell with a third portion: disposed radially outward of the second portion; overlapping the second portion in a radial direction such that a first line passes through the second and third portions and having a second surface: facing in a second axial direction and adjacent to and aligned with the first surface in the first axial direction such that a second line passes through the first and second surfaces; at least one blade connected to the impeller shell; and a weld fixedly securing the cover to the impeller and in contact with the first and third portions.

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TORQUE CONVERTER HAVING A COVER AND IMPELLER WELD WITH A CONSTRAINED DIAMETER AND METHOD OF WELDING THE COVER AND IMPELLER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under Articles 4 and 8 of the Stockholm Act of the Paris Convention for the Protection of Industrial Property and under 35 U.S.C. §120 of United States Nonprovisional Patent Application No. 14/744,751, filed on June 19, 2015, which application is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a torque converter, and, more specifically, to a cover and impeller weld for a torque converter featuring a constrained diameter. The present disclosure also relates to a method of welding a cover and an impeller for a torque converter featuring a constrained diameter.

BACKGROUND

[0003] Typically, the cover of a torque converter is welded to the impeller of the torque converter. The respective rims of cover and the impeller are machined such that there is sufficient overlap or weld trap at the joint and the space is suitable for welding, for example, using metal inert gas welding (MIG). Machining is expensive and requires additional material. In order to weld the cover and the impeller, a welding torch is typically employed. Due to the "L"-shaped surface area of the joint between the cover and the impeller to be welded, typically the welding torch must be applied at an angle. Unfortunately, due to the angle of the welding torch, contamination from the welding can infiltrate the impeller beyond the overlap or weld trap due to stamping tolerances. The cover and impeller can also be cold formed however, a significant amount of raised material results and such raised material, for example, a sharp point, can create safety hazards. Additionally, such raised material can pose problems for providing a torque converter within a transmission envelope having limited space requirements.

BRIEF SUMMARY

[0004] According to aspects illustrated herein, there is provided a torque converter, including: an axis of rotation; a cover arranged to receive torque and including: a first portion having a first surface facing at least partially in a first axial direction and a second portion

extending past the first surface in the first axial direction; an impeller including: an impeller shell with a third portion: disposed radially outward of the second portion; overlapping the second portion in a radial direction such that a first line, orthogonal to the axis of rotation, passes through the second and third portions and having a second surface: facing in a second axial direction, opposite the first axial direction and adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction, passes through the first and second surfaces; at least one blade connected to the impeller shell; and a weld fixedly securing the cover to the impeller and in contact with the first and third portions.

[0005] According to aspects illustrated herein, there is provided a torque converter, including: an axis of rotation; a cover arranged to receive torque and including: a first portion having a first surface facing at least partially in a first axial direction and a second portion extending past the first surface in the first axial direction; an impeller including: an impeller shell with a third portion: disposed radially inward of the second portion; overlapping the second portion in a radial direction such that a first line, orthogonal to the axis of rotation, passes through the second and third portions; and, having a second surface: facing in a second axial direction, opposite the first axial direction; and, adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction, passes through the first and second surfaces; and, at least one blade connected to the impeller shell; and, a weld fixedly securing the cover to the impeller and in contact with the second and third portions.

[0006] According to aspects illustrated herein, there is provided a method of welding a cover and an impeller shell for a torque converter including: fabricating the cover for the torque converter including: a first portion having a first surface and a second portion; fabricating the impeller shell for the torque converter with a third portion including a second surface; assembling the cover and the impeller shell such that: the first surface faces at least partially in a first axial direction, the second portion extends past the first surface in the first axial direction, the third portion is: radially outward of the second portion and aligned with the second portion so that a first line orthogonal to an axis of rotation for the torque converter passes through the second and third portions, the second surface faces a second axial direction, opposite the first axial direction, the second surface is adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction,

passes through the first and second surfaces; positioning welding material proximate the first and second surfaces; aligning an energy source radially outward of the cover and impeller shell; transmitting energy from the energy source to the welding material in a direction parallel to the first line; and melting the welding material against the cover and the impeller shell.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0007] The nature and mode of operation of the present disclosure will now be more fully described in the following detailed description taken with the accompanying figures, in which:

Figure 1 is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used herein;

Figure 2 is left side elevational view of a cover and an impeller of a torque converter having a constrained outer diameter without welding;

Figure 3 is a front view of Figure 2;

Figure 4 is a cross-sectional view taken generally along line 4-4 in Figure 3;

Figure 5A is an enlarged view of the portion shown in Figure 4, showing welding and a deadstop;

Figure 5B shows Figure 5A with the deadstop removed;

Figure 5C is an enlarged view showing a cover and an impeller welded with a deadstop;

Figure 5D shows Figure 5C with the deadstop removed; and,

Figure 5E is an enlarged view showing a cover and an impeller welded with a deadstop.

DETAILED DESCRIPTION

[0008] 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.

[0009] 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.

[0010] 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 pertains. 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. It should be appreciated that the term "substantially" is synonymous with terms such as "nearly", "very nearly", "about", "approximately", "around", "bordering on", "close to", "essentially", "in the neighborhood of", "in the vicinity of", etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby", "close", "adjacent", "neighboring", "immediate", "adjoining", etc., and such terms may be used interchangeably as appearing in the specification and claims.

[0011] Figure 1 is a perspective view of cylindrical coordinate system **10** demonstrating spatial terminology used in the present application. The present application is at least partially described within the context of a cylindrical coordinate system. System **10** includes longitudinal axis **11**, used as the reference for the directional and spatial terms that follow. Axial direction **AD** is parallel to axis **11**. Radial direction **RD** is orthogonal to axis **11**. Circumferential direction **CD** is defined by an endpoint of radius **R** (orthogonal to axis **11**) rotated about axis **11**.

[0012] To clarify the spatial terminology, objects **12**, **13**, and **14** are used. An axial surface, such as surface **15** of object **12**, is formed by a plane co-planar with axis **11**. Axis **11** passes through planar surface **15**; however any planar surface co-planar with axis **11** is an axial surface. A radial surface, such as surface **16** of object **13**, is formed by a plane orthogonal to axis **11** and co-planar with a radius, for example, radius **17**. Radius **17** passes through planar surface **16**; however any planar surface co-planar with radius **17** is a radial surface. Surface **18** of object **14** forms a circumferential, or cylindrical, surface. For example, circumference **19** is passes through surface **18**. As a further example, axial movement is parallel to axis **11**, radial movement is orthogonal to axis **11**, and circumferential movement is parallel to circumference **19**. Rotational movement is with respect to axis **11**. The adverbs "axially," "radially," and "circumferentially" refer to orientations parallel to axis **11**, radius **17**, and circumference **19**, respectively. For example, an axially disposed surface or edge

extends in direction **AD**, a radially disposed surface or edge extends in direction **R**, and a circumferentially disposed surface or edge extends in direction **CD**.

[0013] Figure 2 is left side elevational view of cover **150** and impeller **180** of torque converter **100** having a constrained outer diameter without welding.

[0014] Figure 3 is a front view of torque converter **100** shown in Figure 2.

[0015] Figure 4 is a cross-sectional view of torque converter **100** taken generally along line 4-4 in Figure 3.

[0016] Figure 5A is an enlarged view of portion **5A** shown in Figure 4, showing welding and a deadstop.

[0017] Figure 5B shows Figure 5A with the deadstop removed. The following should be viewed in light of Figures 2 through 5B. Torque converter **100** includes axis of rotation **101**, cover **150**, impeller **180** and weld **W**. Torque converter **100** is arranged to rotate about axis of rotation **101**. Cover **150** is arranged to receive torque and includes portion **151** having surface **152** facing at least partially in axial direction **AD1** and portion **153** extending past surface **152** in axial direction **AD1**. Impeller **180** includes impeller shell **181** with portion **182** disposed radially outward of portion **153** and overlapping portion **153** in radial direction **RD1** such that line **L1**, orthogonal to axis of rotation **101**, passes through portions **153** and **182**. Portion **182** also includes surface **183** facing in axial direction **AD2**, opposite axial direction **AD1** and adjacent to and aligned with surface **152** in axial direction **AD1** such that line **L2**, in axial direction **AD1**, passes through surfaces **152** and **183**. Impeller **180** further includes at least one blade **190** (shown in Figure 4) connected to impeller shell **181**. Weld **W** fixedly secures cover **150** to impeller **180** such that cover **150** is non-rotatably connected to impeller **180** and weld **W** is in contact with portions **151** and **182**. By "non-rotatably connected", we mean that the elements are connected so that whenever one element rotates, the other elements rotate and vice versa. Radial and/or axial movement of one or all of the elements with respect to each other is possible, but not required, when the elements are non-rotatably connected. In an example embodiment, metal inert gas (MIG) or tungsten inert gas (TIG) welding is used to form weld **W**.

[0018] In an example embodiment, when cover **150** is welded to impeller **180**, interior **102** is formed and surfaces **152** and **183** are separated from interior **102** by portion **153**.

[0019] In an example embodiment, chamfer **154** extends radially outward from surface **152** and at least a portion of chamfer **154** is in contact with weld **W**. In an example embodiment, chamfer **184** extends radially outward from surface **183** and at least a portion of chamfer **184** is in contact with weld **W**. In an example embodiment, chamfer **154** extends in axial direction **AD2** and chamfer **184** extends in axial direction **AD1**. Chamfers **154** and **183** each provide additional surface area for weld **W**. In an example embodiment, chamfers **154** and **184** are arranged at an angle of approximately 45 degrees to provide space for a weld torch to access the weld joint. By the term "the weld joint" we mean where the weld is applied to fixedly secure the cover to the impeller.

[0020] In an example embodiment, cover **150** has outer diameter **OD1** and impeller **180** has outer diameter **OD2** and outer diameters **OD1** and **OD2** are substantially equal.

[0021] In the example embodiment of Figure 5A, surfaces **152** and **183** are in contact forming deadstop **156**. Since surfaces **152** and **183** are in contact and due to the overlapping of portions **153** and **182**, the negative effects from welding, for example, splatter, are reduced. In the example embodiment of Figure 5B, surface **152** is not in contact with surface **183** and weld **W** is disposed between at least respective portions of surfaces **152** and **183**.

[0022] In the example embodiment of Figure 5B, portion **153** includes surface **155** facing radially outward in radial direction **RD1** and weld **W** is in contact with at least a portion of surface **155**. When surfaces **152** and **183** are not in contact, there is a greater chance of contamination from welding. However, the overlapping of portions **153** and **182** and the orientation of energy source **103**, for example, a weld torch, reduce the chances of contamination reaching interior **102**.

[0023] In an example embodiment (not shown), surface **152** extends in radial direction **RD1** further than surface **183**. In an example embodiment (not shown), surface **183** extends in radial direction **RD1** further than surface **152**.

[0024] Figure 5C is an enlarged view showing cover **250** and impeller **280** with weld **W** and a deadstop.

[0025] Figure 5D shows Figure 5C except the deadstop is removed. The following should be viewed in light of Figures 2 through 4, 5C and 5D. The discussion above pertaining to torque converter **100** and weld **W** and their structural features applies to cover **250** and impeller **280** except as noted. Cover **250** is arranged to receive torque and includes portion

251 having surface **252** facing in axial direction **AD1**. Cover **250** also includes portion **253** extending past surface **252** in axial direction **AD1**. Impeller **280** includes impeller shell **281** with portion **282** disposed radially outward of portion **253**, overlapping portion **253** in radial direction **RD1** such that line **L1**, orthogonal to axis of rotation **101**, passes through portions **253** and **282**. Impeller shell **281** also includes surface **283** facing in axial direction **AD2**, opposite axial direction **AD1**, and adjacent to and aligned with surface **252** in axial direction **AD1** such that line **L2**, in axial direction **AD1**, passes through surfaces **252** and **283**. Weld **W** fixedly secures cover **250** to impeller **280** and is in contact with portions **251** and **282**.

[0026] In the example embodiment of Figure 5C, surfaces **252** and **283** are in contact forming deadstop **256**. In an example embodiment, surface **252** extends radially outward between portion **253** and outer diameter **OD1** (shown in Figure 4).

[0027] In an example embodiment, portion **282** includes surface **284** radially inward of outer diameter **OD1**, facing radially outward in radial direction **RD1** and in contact with weld **W**. In an example embodiment, surface **284** extends in axial direction **AD1** further than portion **253**. In an example embodiment, surface **284** includes arcuate surface **284A**.

[0028] In the example embodiment of Figure 5D, portion **253** includes surface **255** facing radially outward in radial direction **RD1** and weld **W** is in contact with at least a portion of surface **255**. In an example embodiment (not shown), surface **252** extends in radial direction **RD1** further than surfaces **284** and **284A**. In an example embodiment (not shown), surfaces **284** and **284A** extend in radial direction **RD1** further than surface **252**.

[0029] Figure 5E is an enlarged modified view of portion **5A** shown in Figure 4, showing cover **350** and impeller **380** including weld **W** and a deadstop. The following should be viewed in light of Figures 2 through 4 and 5E. The discussion above pertaining to torque converter **100** and weld **W** and their structural features applies to cover **350** and impeller **380** except as noted. Cover **350** includes portion **351** having surface **352** facing in axial direction **AD1**. Cover **350** includes portion **353** extending past surface **352** in axial direction **AD1**. Impeller **380** includes impeller shell **381** having portion **382** disposed radially inward of portion **353**, overlapping portion **353** in radial direction **RD2** such that line **L1**, orthogonal to axis of rotation **101**, passes through portions **353** and **382**. Impeller shell **381** includes surface **383** facing in axial direction **AD2**, opposite axial direction **AD1**, and adjacent to and aligned with surface **352** in axial direction **AD1** such that line **L2**, in axial direction **AD1**, passes

through surfaces **352** and **383**. Weld **W** fixedly secures cover **350** to impeller **380** and is in contact with portions **353** and **382**.

[0030] In an example embodiment, when cover **350** is welded to impeller **380**, interior **102** is formed and portion **353** is separated from interior **102** by portion **382**.

[0031] In an example embodiment, surfaces **352** and **383** are in contact forming deadstop **356**. In an example embodiment (not shown), surfaces **352** and **383** are separated by a space in direction **AD1**. In an example embodiment, surface **352** extends radially inward between portion **353** and interior **102**.

[0032] In an example embodiment, portion **353** includes surface **354** facing radially inward extending in axial direction **AD1** from surface **352**. In an example embodiment, portion **382** includes surface **384** facing radially outward at least partially in contact with surface **354** and weld **W**. In an example embodiment, surface **384** includes arcuate surface **384A** in contact with weld **W**. In an example embodiment, surface **384** extends in axial direction **AD1** further than portion **353**. In an example embodiment, weld **W** is in contact with the entirety of arcuate surface **384A**.

[0033] In an example embodiment, weld **W** is arranged a distance from surfaces **352** and **383** in axial direction **AD1**.

[0034] Advantageously, the configurations shown for the combinations of cover **150** and impeller **180**, cover **250** and impeller **280**, and cover **350** and impeller **380** address the problems noted above with respect to weld splatter and contamination of an interior of a torque converter. For example, a welding torch is usable at a direction orthogonal to the axis for the torque converter. Thus, the torch is orthogonal to the radial overlap of the cover and the impeller, which limits or eliminates the ability of the torch to push welding splatter through the radial overlap and into the interior of the torque converter. The radial alignment of the torch is enabled by chamfers and arcuate surfaces described above. Deadstops **156**, **256**, and **356** present an even further physical barrier to weld splatter reaching the interior. Even without the deadstop, the reduced axial distance, between surfaces such as **152** and **183**, works to further reduce the energy available to push weld splatter through the radial overlap of the cover and the impeller.

[0035] An example method of welding a cover and impeller is described below. Although the method is presented as a sequence of steps for clarity, no order should be

inferred from the sequence unless explicitly stated. The following discussion should be viewed in light of Figures 5A and 5B showing the welding of cover **150** and impeller **180** but this discussion also pertains to the welding of cover **250** and impeller **280**, respectively. An example first step involves fabricating the cover for the torque converter including: portion **151** having surface **152** and portion **153**. An example second step involves fabricating the impeller shell for the torque converter with portion **182** including surface **183**. These steps may be interchanged. After the cover and impeller shell are formed, an example subsequent step involves assembling the cover and the impeller shell such that: surface **152** faces at least partially in axial direction **AD1**, portion **153** extends past surface **152** in axial direction **AD1**, portion **183** is: radially outward of portion **153** and aligned with portion **153** so that line **L1**, orthogonal to axis of rotation **101** for torque converter **100**, passes through portions **153** and **182**, surface **183** faces axial direction **AD2**, opposite axial direction **AD1**, surface **183** is adjacent to and aligned with surface **152** in axial direction **AD1** such that line **L2**, in axial direction **AD1**, passes through surfaces **152** and **183**. An example subsequent step involves positioning welding material **W** proximate surfaces **153** and **183**. An example subsequent step involves aligning energy source **103** radially outward of the cover and impeller shell and transmitting energy from energy source **103** to welding material **W** in a direction parallel to line **L1** and melting welding material **W** against the cover and the impeller shell.

[0036] In an example embodiment, to weld the cover and impeller weld as described herein, no machining is required for fabricating outer circumferential surface **164** (shown in Figure 5B) of cover **150**. Referring to Figure 5E, in an example embodiment, no machining is required for fabricating inner circumferential surface **355** of cover **350**.

[0037] In an example embodiment and referring to Figure 5B, when fabricating cover **150** for torque converter **100**, dies are used to form cover **150** having thicknesses **160**, **161** and **162** where thickness **160** is the distance between the stamped yet constrained outer circumferential surface **164** (**OD1**) and inner circumferential surface **165**. Thickness **161** is the original thickness of cover **150** formed by stamping a circular blank into a bowl-shaped cover. Thickness **161** is less than thickness **160**. Thickness **162** is the distance between surface **155** and inner circumferential surface **165**. Thickness **162** shows that when cover **150** is stamped during formation, material is displaced proximate portion **153** and displaced to portion **151**. Thickness **162** is less than both thicknesses **160** and **161**.

[0038] It will be appreciated that various features of the above-described disclosure 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.

CLAIMS

What Is Claimed Is:

1. A torque converter, comprising:

an axis of rotation;

a cover arranged to receive torque and including:

a first portion having a first surface facing at least partially in a first axial direction; and,

a second portion extending past the first surface in the first axial direction;

an impeller including:

an impeller shell with a third portion:

disposed radially outward of the second portion;

overlapping the second portion in a radial direction such that a first line, orthogonal to the axis of rotation, passes through the second and third portions; and,

having a second surface:

facing in a second axial direction, opposite the first axial direction; and,

adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction, passes through the first and second surfaces; and,

at least one blade connected to the impeller shell; and,

a weld fixedly securing the cover to the impeller and in contact with the first and third portions.

2. The torque converter as recited in Claim 1, wherein the welded cover and impeller form an interior and the first and second surfaces are separated from the interior by the second portion of the cover.

3. The torque converter as recited in Claim 1, further comprising a first chamfer extending radially outward from the first surface wherein:

at least a portion of the first chamfer is in contact with the weld.

4. The torque converter as recited in Claim 3, further comprising a second chamfer extending radially outward from the second surface wherein:

at least a portion of the second chamfer is in contact with the weld.

5. A torque converter, comprising:

an axis of rotation;

a cover arranged to receive torque and including:

a first portion having a first surface facing at least partially in a first axial direction; and,

a second portion extending past the first surface in the first axial direction;

an impeller including:

an impeller shell with a third portion:

disposed radially inward of the second portion;

overlapping the second portion in a radial direction such that a first line, orthogonal to the axis of rotation, passes through the second and third portions; and,

having a second surface:

facing in a second axial direction, opposite the first axial direction; and,

adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction, passes through the first and second surfaces; and,

at least one blade connected to the impeller shell; and,

a weld fixedly securing the cover to the impeller and in contact with the second and third portions.

6. The torque converter as recited in Claim 5, wherein the welded cover and impeller form an interior and the second portion is separated from the interior by the third portion of the impeller.

7. The torque converter as recited in Claim 5, wherein the first and second surfaces are in contact.

8. The torque converter as recited in Claim 5, wherein the third portion further comprises a third surface facing radially outward, extending past the second portion in the first axial direction wherein:

at least a portion of the third surface is in contact with the weld.

9. A method of welding a cover and an impeller shell for a torque converter, comprising:

fabricating the cover for the torque converter including:

a first portion having a first surface; and,

a second portion;

fabricating the impeller shell for the torque converter with a third portion including a second surface;

assembling the cover and the impeller shell such that:

the first surface faces at least partially in a first axial direction;

the second portion extends past the first surface in the first axial direction;

the third portion is:

radially outward of the second portion; and,

aligned with the second portion so that a first line orthogonal to an axis of rotation for the torque converter passes through the second and third portions;

the second surface faces a second axial direction, opposite the first axial direction;

the second surface is adjacent to and aligned with the first surface in the first axial direction such that a second line, in the first axial direction, passes through the first and second surfaces;

positioning welding material proximate the first and second surfaces;

aligning an energy source radially outward of the cover and impeller shell;

transmitting energy from the energy source to the welding material in a direction parallel to the first line; and,

melting the welding material against the cover and the impeller shell.

10. The method of welding a cover and an impeller shell recited in Claim 9, wherein the fabricating of the cover for the torque converter includes fabricating an outer circumferential surface or an inner circumferential surface without machining the outer or inner circumferential surface.

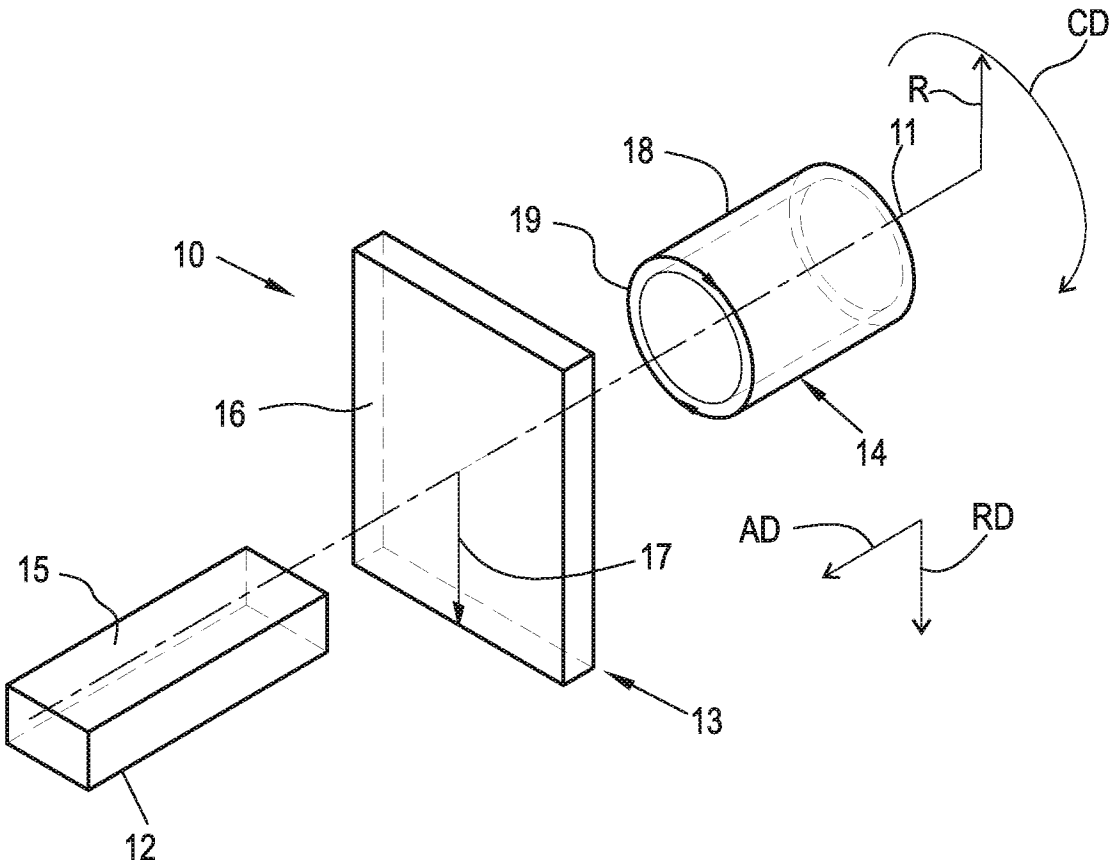


Fig. 1

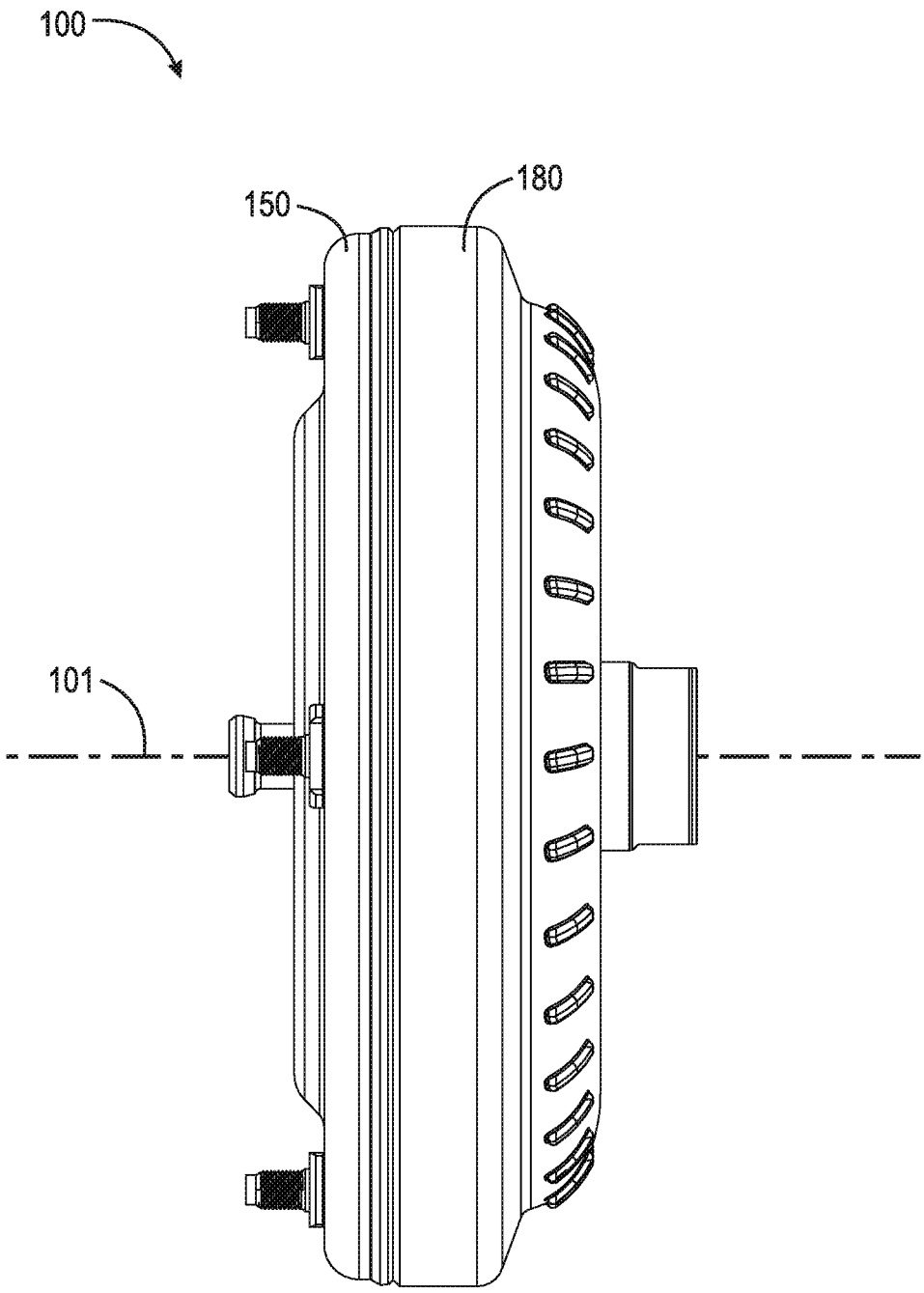


Fig. 2

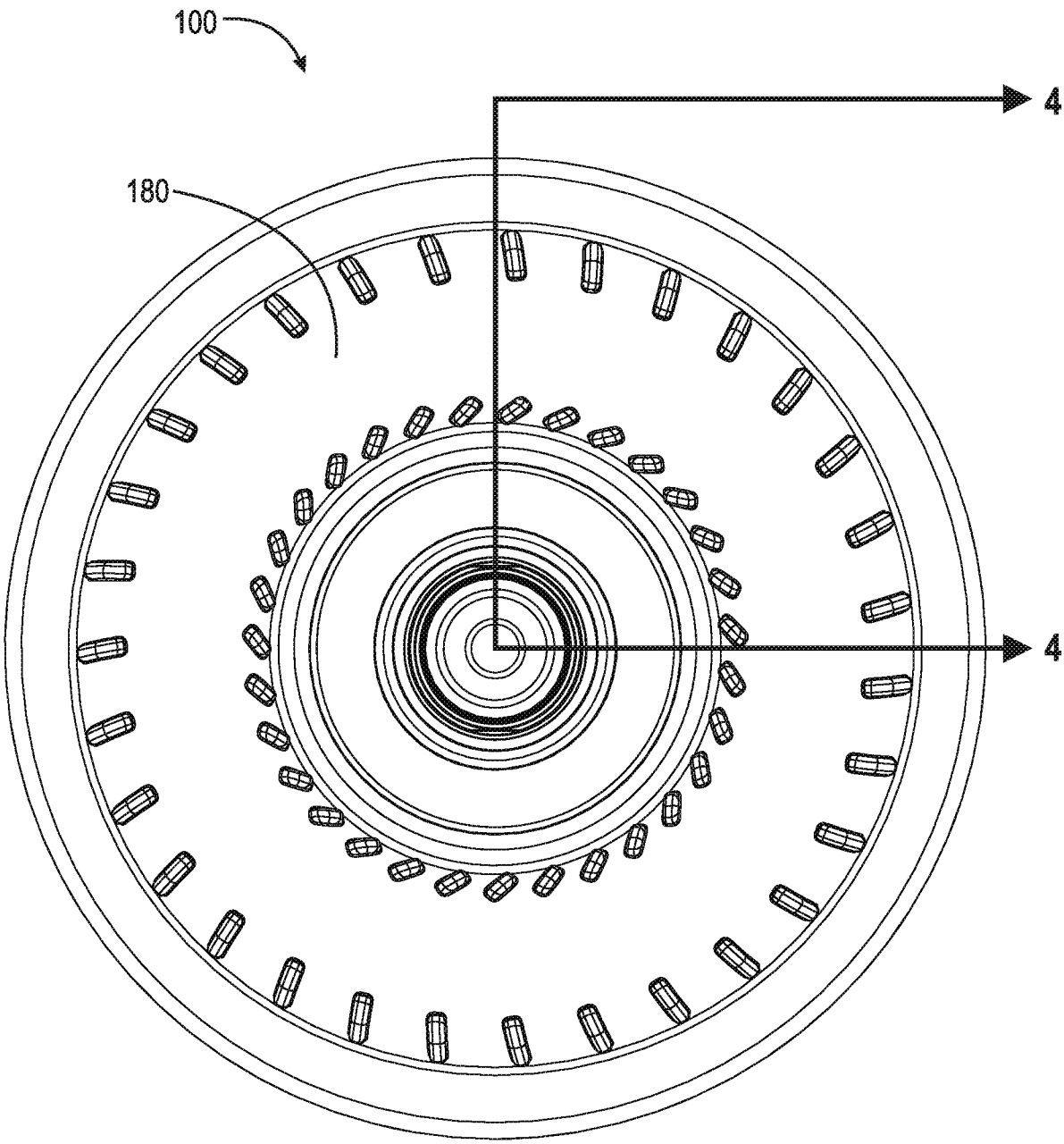


Fig. 3

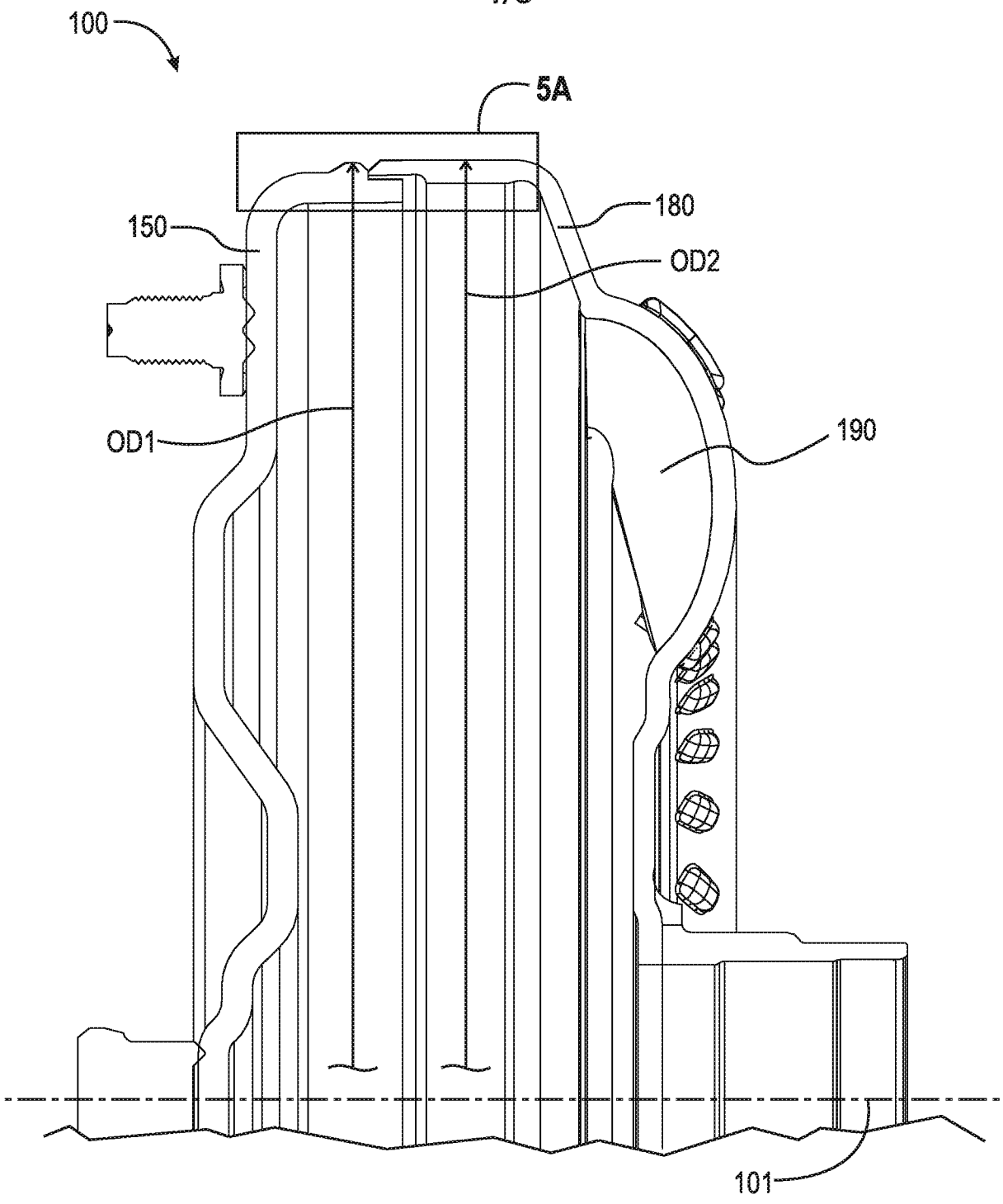


Fig. 4

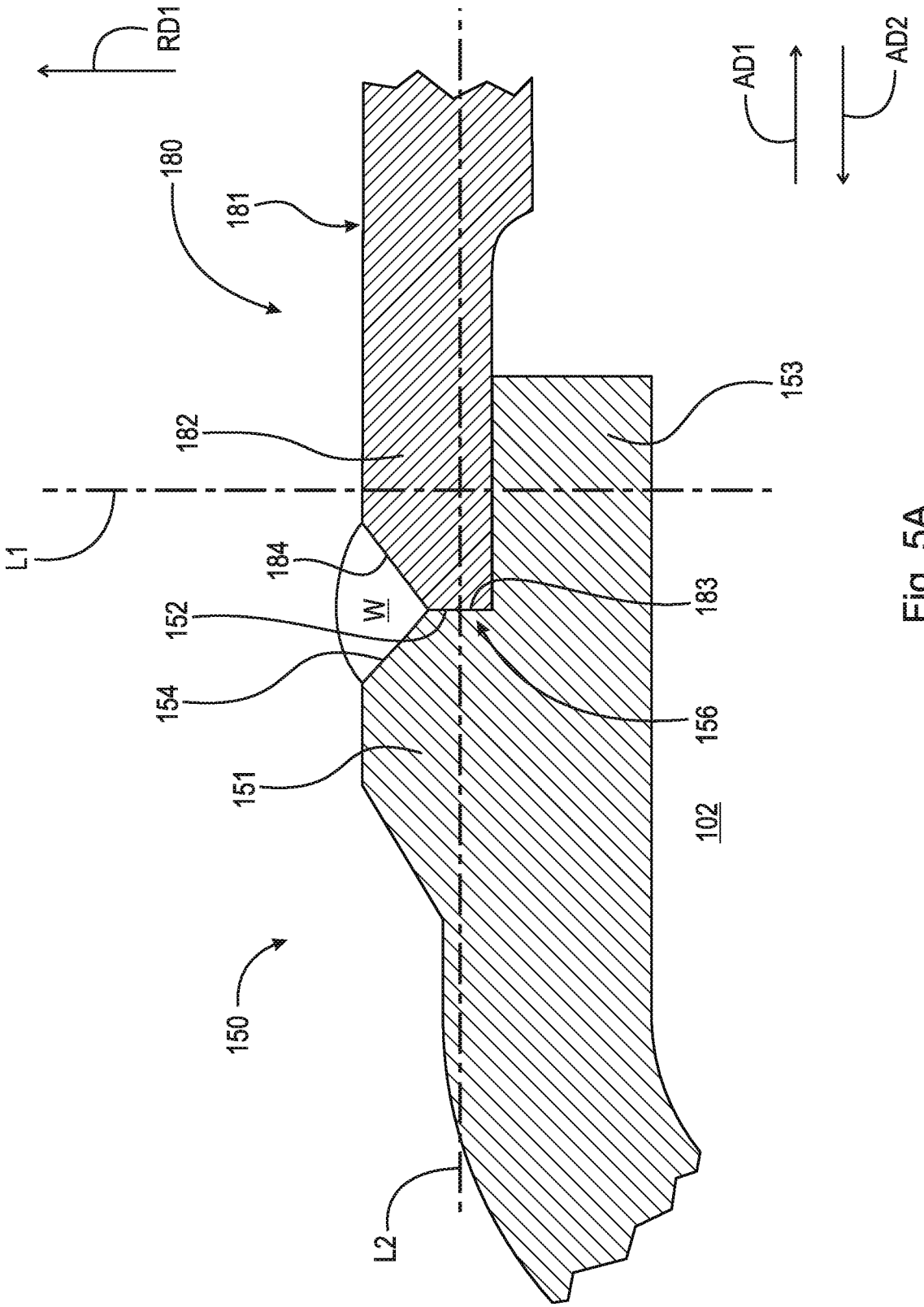

RD1
AD1
AD2
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181
182
153
L1
184
183
W
152
154
156
151
102
150
L2

Fig. 5A

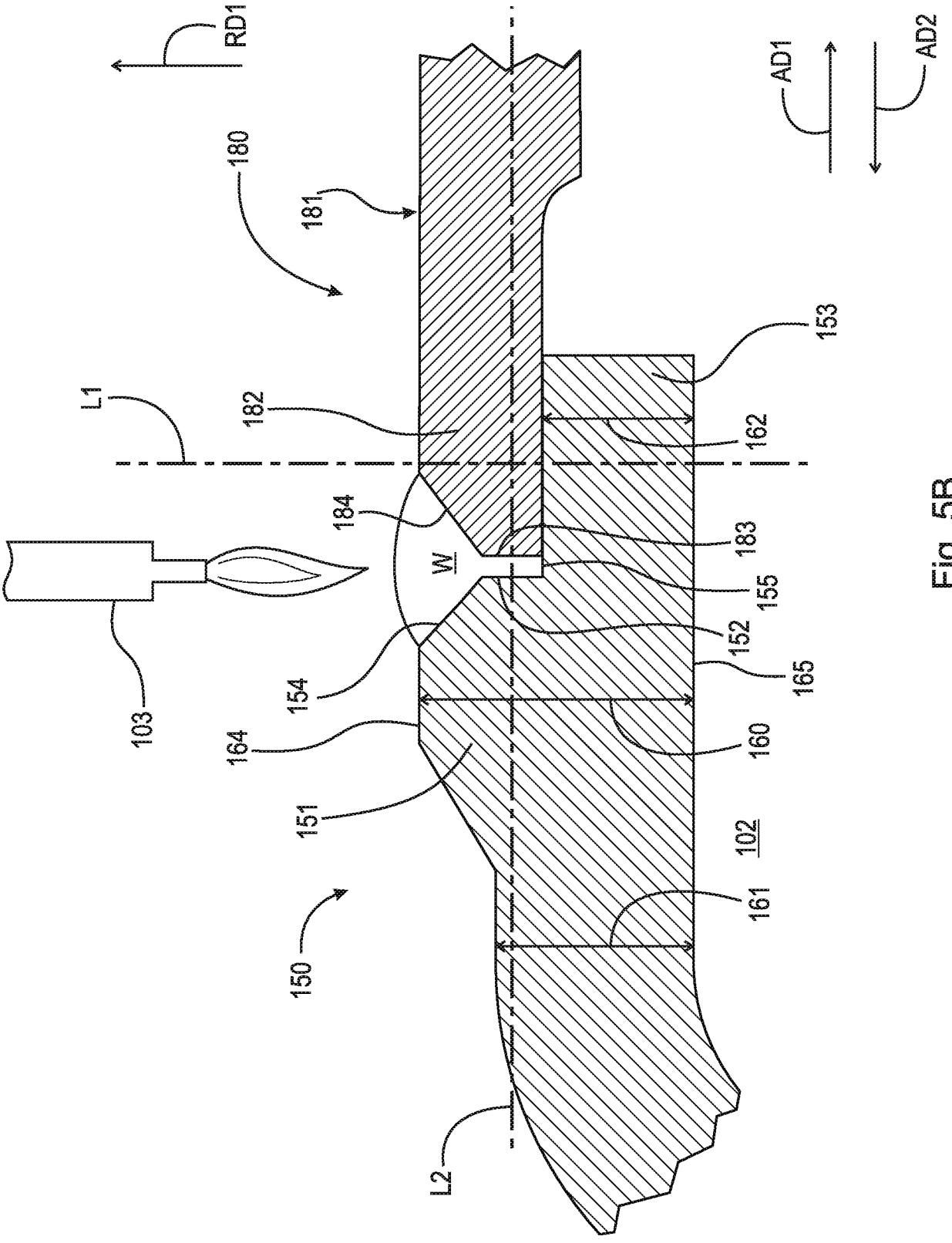

RD1
AD1
AD2
180
181
153
L1
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W
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154
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164
160
151
102
161
150
L2

Fig. 5B

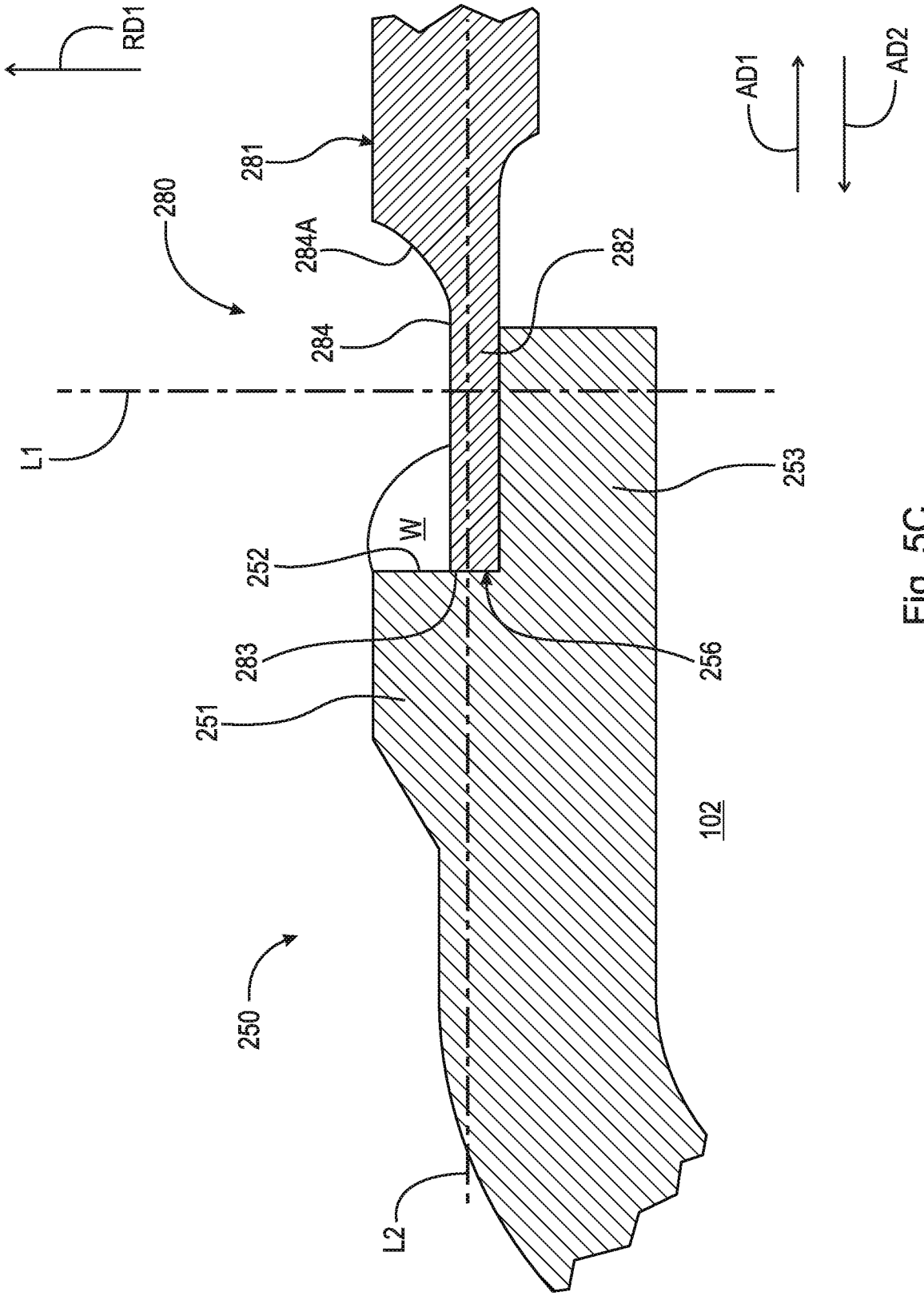

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284A
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284
L1
253
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W
283
256
251
102
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L2

Fig. 5C

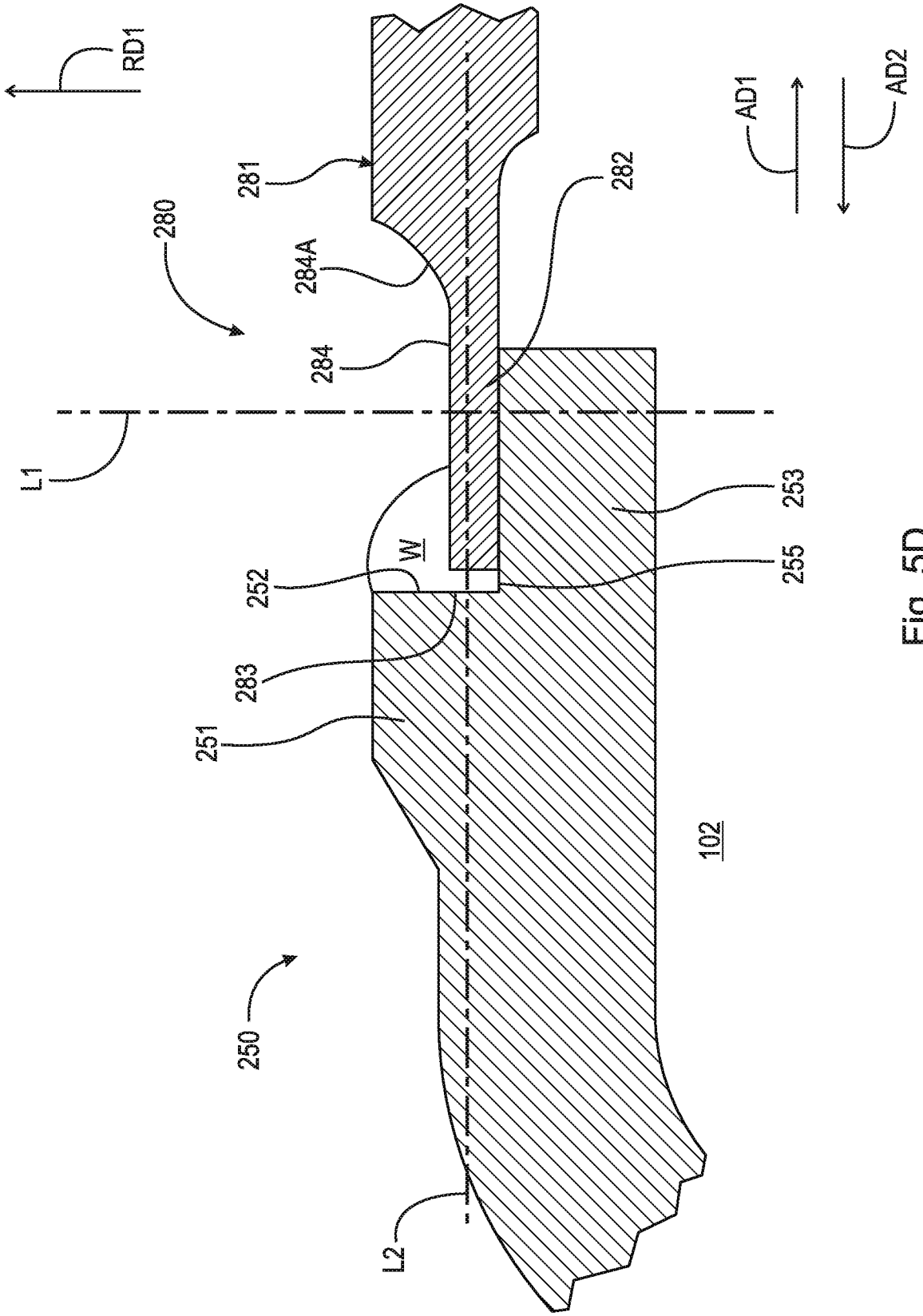

RD1
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284A
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L1
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252
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L2

Fig. 5D

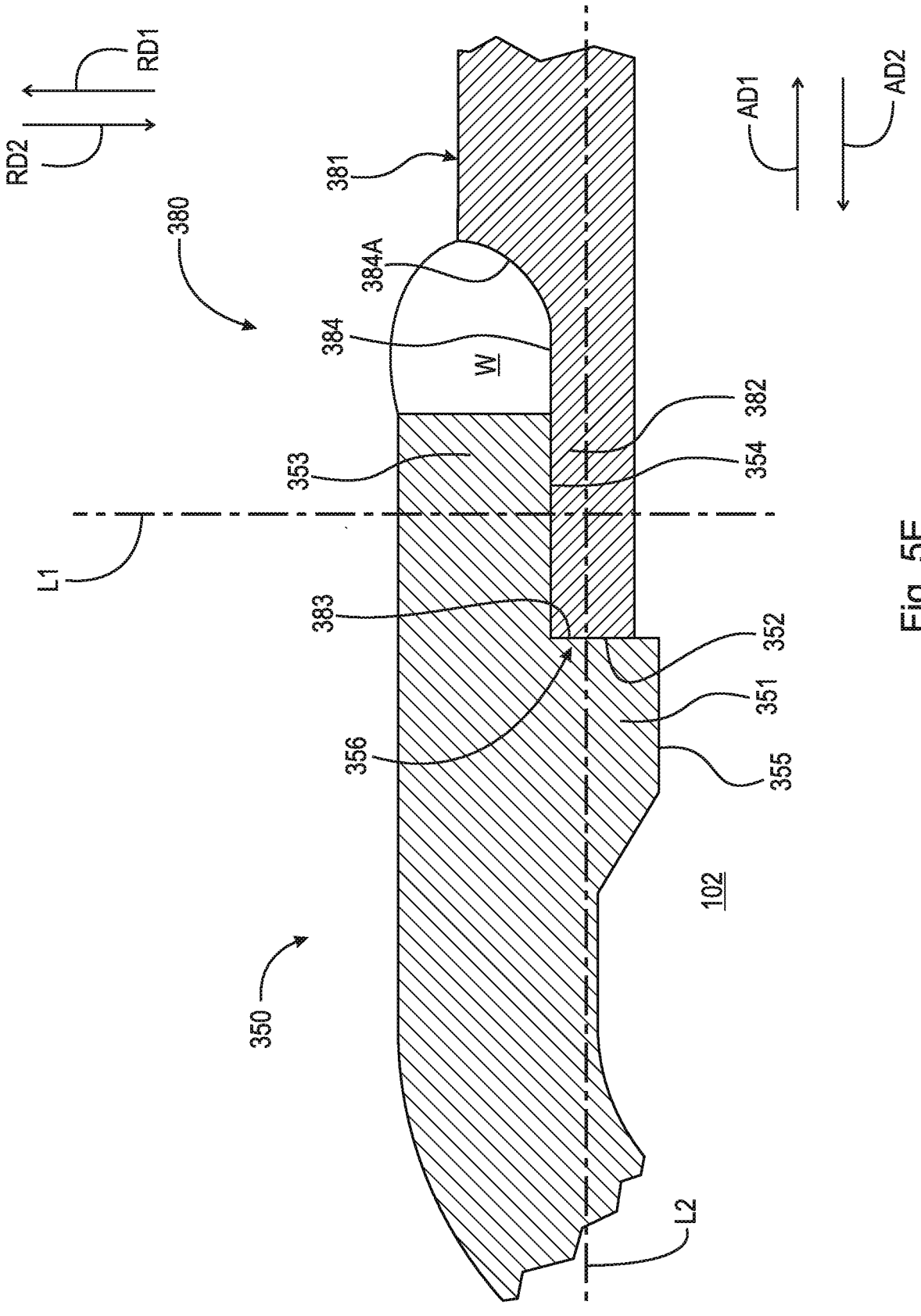

RD1
RD2
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381
AD1
AD2
384A
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W
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353
354
L1
383
352
351
356
355
102
350
L2

Fig. 5E

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/037171

A. CLASSIFICATION OF SUBJECT MATTER

F16H 41/28(2006.01)I, F16H 41/24(2006.01)I

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H 41/28; C21D 1/34; F16H 45/02; F01D 25/24; F16D 23/00; B23K 31/02; B23P 15/00; F16H 41/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: torque converter, cover, impeller, shell, overlap, weld, blade, contamination, and chamfer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5839643 A (INOUE, KOJI et al.) 24 November 1998 See column 3, line 56 - column 4, line 11 and figures 1, 2A-2B.	9-10
Y		1-4
A		5-8
Y	US 2005-0061596 A1 (TSUZUKI, YUKIHISA et al.) 24 March 2005 See paragraph [0020] and figures 1, 7.	1-8
Y	US 4867641 A (OKUNO, YOSHIHIRO et al.) 19 September 1989 See column 3, lines 17-41 and figures 1, 7.	5-8
A	US 5384958 A (O`DANIEL, GREGORY F. et al.) 31 January 1995 See column 3, line 10 - column 4, line 30 and figure 3.	1-10
A	US 2008-0251345 A1 (ZAHNER, DERRICK et al.) 16 October 2008 See paragraphs [0024]-[0032] and figures 1-8.	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2016 (27.09.2016)	**30 September 2016 (30.09.2016)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/037171

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		CA 2103948 C	09/07/1996
		EP 0612937 A1	31/08/1994
US 2008-0251345 A1	16/10/2008	DE 102007059406 A1	26/06/2008