

(51) International Patent Classification:
F16H 7/12 (2006.01)(21) International Application Number:
PCT/US2014/039630(22) International Filing Date:
27 May 2014 (27.05.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
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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, LT, 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, 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))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: TENSIONER WITH OIL MANAGEMENT FEATURES

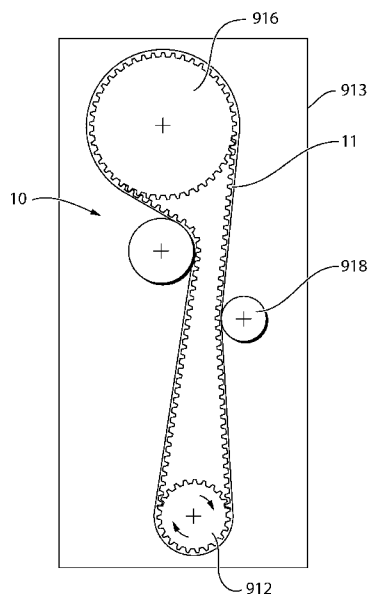


FIG.1

(57) Abstract: A tensioner is provided for tensioning an endless drive member. The tensioner comprises a base, a tensioner arm, a pivot bushing, a drive member engagement member, and a spring. The base comprises a pivot shaft, a spring cup and a rear plate. The pivot shaft has a basal end and a distal end, and defines a pivot shaft axis.

TENSIONER WITH OIL MANAGEMENT FEATURES

CROSS-REFERENCE TO RELATED APPLICATIONS:

[0001] This application claims the benefit of U.S. Provisional Patent Application
5 No. 61/827,345, filed May 24, 2013, the contents of which are incorporated by reference
as if fully set forth in detail herein.

FIELD OF THE INVENTION

[0002] The present invention relates to belt tensioners and in particular a
10 tensioner that is used in a belt-in-oil application on an engine.

BACKGROUND OF THE INVENTION

[0003] It is known to provide tensioners on timing belt drives on vehicular
engines. In recent years it has become more common to provide belts in an oil
15 environment so that the belts can be used as an alternative to using a timing chain drive
on an engine, without requiring a major redesign of this portion of the engine. While
much work has been done to improve the performance of belt-in-oil timing belt drives,
there is a continuing need for further improved performance. One aspect in particular
that would benefit from improvement is the operating life of the tensioners on such
20 timing belt drives.

SUMMARY

[0004] In an aspect, a tensioner is provided that is configured to direct oil and
other contaminants away from a sliding surface of a bushing that is positioned between
25 a pivot shaft and a tensioner arm. In some embodiments, the tensioner is configured to
direct oil and other contaminants away from a bearing between a pulley and a tensioner

arm of the tensioner. In other embodiments, the tensioner is configured to encourage oil towards the bearing.

[0005] In another aspect, a tensioner is provided that is configured to direct oil and other contaminants away from a bearing between a pulley and a tensioner arm of the tensioner.

[0006] In another embodiments, the tensioner is configured to encourage oil towards a bearing between a pulley and a tensioner arm of the tensioner.

[0007] In another aspect, a tensioner is provided for tensioning an endless drive member. The tensioner comprises a base, a tensioner arm, a pivot bushing, a drive member engagement member, and a spring. The base comprises a pivot shaft, a spring cup and a rear plate. The pivot shaft has a basal end and a distal end, and defines a pivot shaft axis. The pivot shaft has a pivot shaft aperture therethrough that permits the pass-through of a mounting fastener for mounting the tensioner to a stationary structure. The spring cup is fixedly connected to the pivot shaft and having an axially and circumferentially extending spring cup wall having a radially inner surface and a radially outer surface. The rear plate is fixedly connected to the pivot shaft and is configured for orienting the base relative to the stationary structure. The tensioner arm is pivotally mounted on said pivot shaft for pivotal movement about the pivot shaft axis. The pivot bushing is positioned between the tensioner arm and the pivot shaft. The pivot bushing is frictionally engaged with a radially outer surface of the pivot shaft. The drive member engagement member is mounted to the tensioner arm and positioned to engage the endless drive member. The spring is positioned to urge the tensioner arm in a take-up direction. The tensioner arm has an axially and circumferentially extending skirt that overlaps the spring cup wall axially to axially enclose a spring chamber, wherein one of the spring cup wall and the skirt surrounds the other of the spring cup wall and the skirt. At least one deflector wall extends radially outward from said other of the spring cup wall and the skirt towards said one of the spring cup wall and the skirt. The at least one deflector wall is free of contact with said one of the spring cup wall and the skirt.

[0008] In another aspect, a tensioner is provided that has a tensioner arm with a skirt that is tapered in a direction towards a bearing that is mounted on the tensioner arm, so as to encourage the flow of oil towards the bearing, particularly in a belt-in-oil application. In some embodiments, oleophilic properties may be provided to surfaces
5 at an interface between the bearing and the skirt.

[0009] In another aspect, a tensioner is provided that has a tensioner arm with a skirt that is tapered in a direction to direct oil away from a spring chamber that is exposed to a sliding surface of a bushing with either the tensioner arm or with a pivot shaft about which the tensioner arm pivots.

10 **[00010]** Other features and advantages will be apparent by following the description with references to the drawings.

BRIEF DESCRIPTION ON THE DRAWINGS

[00011] Figure 1 is an elevation view of an engine with a timing belt drive, that
15 includes a timing belt tensioner in accordance with an embodiment of the present invention;

[0010] Figure 2 is a perspective view distally of the tensioner shown in Figure 1;

[0011] Figure 3 is a perspective basally of the tensioner shown in Figure 1;

[0012] Figure 4 is a side elevation view of the tensioner shown in Figure 1;

20 **[0013]** Figure 5 is a side elevation view of a spring cup from the tensioner shown in Figure 1;

[0014] Figure 6 is a sectional side view of the tensioner shown in Figure 1;

[0015] Figure 7 is a side elevation view of the spring cup from the tensioner with an optional additional oil run-off channel on the spring cup;

25 **[0016]** Figure 8 is a perspective view of a portion of the tensioner to illustrate the run-off of oil that drips onto the tensioner;

[0017] Figure 9 is a sectional side view of the tensioner including several oleophobic coatings at selected locations;

[0018] Figure 10 is a top view of the tensioner shown in Figure 1 with another optional oil run-off channel in a tensioner arm of the tensioner;

[0019] Figure 11 is a magnified sectional side view of the tensioner with several oleophobic coatings at selected locations.

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DETAILED DESCRIPTION

[0020] Figure 1 is a plan view of an embodiment of a tensioner 10 usable for tensioning an endless drive member 11 that is part of an endless drive on a vehicle engine 913. The engine 913 is shown as a simple rectangle for illustrative purposes. It
10 will be understood that the engine 913 may have any suitable shape.

[0021] The endless drive may use a pulley 912 on a crankshaft of the engine 913 to drive at least one component via the endless drive member 11. In the example shown a cam shaft pulley 916 is the component driven via the endless drive member 11. An idler 918 is also shown in engagement with the endless drive member 11.

15 **[0022]** The endless drive member 11 may be a timing belt, or it may be any other suitable type of endless drive member. The endless drive member 11 may, simply for convenience and readability, be referred to herein as a belt 11 or a timing belt 11.

[0023] Reference is made to Figures 2-6, which show the tensioner 10 in greater detail. The tensioner 10 includes a base 12, a tensioner arm 14, a pivot bushing 16
20 (which provides a source of damping to movement of the tensioner arm 14), a bearing 18, a pulley 20, a tensioning spring 22, an installation shaft 27 and a mounting fastener 28.

[0024] The tensioner 10 shown in Figures 2-6 is configured to inhibit the migration of oil (shown at 100) into selected regions of the tensioner 10, as described further
25 below. In dry applications (i.e. in applications where the belt 11 is not immersed in an oil bath, referred to as a belt-in-oil application), oil 100 may come from sources such as leakage from the engine, or leakage from other oil-lubricated components. The oil 100 may carry contaminants therein, such as particulate from the engine, dirt that is in the engine compartment, or liquid contaminants such as engine coolant, power steering
30 fluid, brake fluid, and water. The oil 100, regardless of whether it contains

contaminants, is not desired to migrate into regions of the tensioner 10 that are intended to dampen movement of the tensioner arm 14 during operation, since the oil and/or the contaminants carried in it could change the friction characteristics of the damping elements which would affect the amount of damping that takes place. It is desirable to have predictable, consistent damping in the tensioner 10. This is because there can be negative consequences to damping that is too large or too small. If there is too much friction during movement of the arm 14 (i.e. too much damping), there is a possibility of locking of the tensioner arm 14, which prevents the tensioner arm 14 from sufficient movement during tension fluctuations of the belt 11, which can result in insufficiently mitigated tension fluctuations in the belt 11, leading to potentially reduced service life of the belt 11. If there is too little friction, the tension fluctuations in the belt 11 can increase to the point where momentarily there can be a 'negative' tension in the belt 11 (i.e. the belt 11 can be slack), which permits the teeth of the belt 11 to skip over pulley teeth on one or more of the various pulleys driven by the belt 11. Such tooth skip can result in a loss of valve timing, which can result in significant damage to the engine 913. Thus it is advantageous to maintain a sufficient amount of friction in the tensioner 10.

[0025] With reference to Figure 6, the base 12 includes a pivot shaft 12a, a spring cup 12b and a rear plate 12c. In the embodiment shown in Figure 6 these components 12a, 12b and 12c may be separate components. However, some or all of the components 12a, 12b and 12c may be integrally formed together with each other. The pivot shaft 12a is mountable to a stationary structure such as a first region on the frame or block of the engine 913 (Figure 4). For greater clarity, the stationary structure is the entirety of all suitable structural portions of the vehicle (or of the tensioner's environment in the case of a non-vehicular application) that is considered stationary for the purposes of mounting portions of the tensioner 10. In a vehicular application, this would correspond to the frame of the vehicle, the engine block and engine support frame, the vehicle body and any non-moving structural elements and components. The stationary structure typically has a vertical surface on which the tensioner 10 is mounted so that the tensioner 10, in use, has an orientation as shown in Figures 1 and 2, however, the surface may have any orientation that provides the tensioner 10 with an orientation similar to that shown in Figures 1 and 2.

[0026] The pivot shaft 12a has a basal end 30 (i.e. an end that is proximate the stationary structure to which the pivot shaft 12a is mounted) and a distal end 32 and defines a pivot shaft axis Aps (Figures 2 and 6).

[0027] The pivot shaft 12a has a pivot shaft aperture 34 therethrough that receives the installation shaft 27 therethrough. The installation shaft 27 has an installation shaft aperture 37 therethrough that permits the pass-through of the mounting fastener 28 for mounting the base 12 and the entire tensioner 10 to the stationary structure. The installation shaft aperture 37 may be eccentric (i.e. offset from the pivot shaft aperture 34) thereby permitting adjustment of the position of the pivot shaft axis Aps when installing the tensioner 10 on the stationary structure. In the embodiment shown, the offset is best seen in Figure 2. In some embodiments the installation shaft 27 need not be provided. In such embodiments, the pivot shaft aperture 34 may directly receive the mounting fastener 28.

[0028] The pivot shaft 12a may be made from any suitable material such as, for example, a suitable steel.

[0029] The rear plate 12c is fixedly mounted to the basal end 30 of the pivot shaft 12a (e.g. by press-fit, staking, welding, glue or any other suitable means). In the embodiment shown the rear plate 12c has a collar 40 that is press-fit to the outer surface (shown at 42) of the pivot shaft 12a. The collar 40 extends through a central aperture 45 in the spring cup 12b, into the interior (shown at 44) of the spring cup 12b. The rear plate 12c further includes cupping elements 46 and 48 that cooperate with the cupping elements 46 and 48 to fix the spring cup 12b to the rear plate 12c and thus to the pivot shaft 12a. The spring cup 12b has an axially and circumferentially extending spring cup wall 50 that has a radially inner surface 52 and a radially outer surface 54. When the base 12 is mounted to the stationary structure, a locating feature 59 on the rear plate 12c cooperates with a corresponding locating feature on the stationary structure to orient the base 12 relative to the stationary structure. In the example embodiment, the locating feature on the rear plate 12c is a basally extending projection that engages a slot (not shown) in the stationary structure.

[0030] The tensioner arm 14 is pivotally mounted on the pivot shaft 12a for pivotal movement about the pivot shaft axis Aps. The pivot bushing 16 is positioned between

the tensioner arm 14 and the pivot shaft 12a. The pivot bushing 16 may be fixedly connected to an inner surface 53 of the tensioner arm 14 and frictionally engaged at its own radially inner surface (shown at 63) with the radially outer surface 42 of the pivot shaft 12a. Thus, inner surface 63 is the sliding surface of the pivot bushing 16. The pivot bushing 16 thereby provides frictional damping to the tensioner 10, which assists the tensioner 10 to dampen fluctuations in belt tension that arise in the belt 11 from vibration sources such as the movement of the valves that are driven by the camshaft that is driven by pulley 916. This frictional damping permits the tensioner 10 to absorb these tension fluctuations and to control the belt tension. While the pivot bushing 16 may advantageously be positioned fixedly on the inner surface of the tensioner arm 14 so as to have sliding contact with the outer surface 42 of the pivot shaft 12a, it is alternatively possible for the bushing 16 to be fixedly connected to the pivot shaft 12a and to have sliding contact with the inner surface 53 of the tensioner arm 14.

[0031] The bushing 16 may be made from any suitable material, such as a suitable nylon that is impregnated with PTFE or some other suitable material, or that is coated on surface 63 with PTFE or some other suitable material.

[0032] The spring 22 is positioned to urge the tensioner arm 14 in a first direction, which drives the pulley 20 into the belt 11. The first direction, which is shown by D1 in Figure 2 may be referred to as the take up direction. This is a direction of decreasing potential energy in the spring 22. Movement of the tensioner arm 14 in the opposite direction increases the potential energy in the spring 22. That direction may be referred to as the spring loading direction. The spring 22 has a first end 22a that is engaged with a base stop 60 structure and a second end 22b that is engaged with a tensioner arm stop structure 62. The base stop structure 60 may be a slot in the spring cup 12b. The structure of the slot 60 is described further below. The tensioner arm stop structure 62 may be an abutment surface that is abutted by the end 22b of the spring 22.

[0033] The spring 22 may be any suitable type of spring, such as, for example, a helical coil torsion spring.

[0034] The tensioner arm 14 is pivotably movable in the take up and spring loading directions based on the forces on the arm 14 from engagement of the belt 11 with the pulley 20, from the spring 22, and from frictional forces, such as the damping force

provided by the bushing 16. The tensioner arm 14 may be made from any suitable material such as a suitable aluminum.

[0035] A limiter slot 55 optionally provided in the tensioner arm 14 has first and second ends 55a and 55b that are engageable with a projection 57 on the rear plate 12c to set limits for the pivotal movement of the tensioner arm 14 relative to the base 12. The first end 55a sets a limit that is referred to as a free arm stop, which is the position of minimum permitted potential energy in the spring 22. The second end 55b sets a limit referred to as the load stop, which is the position of maximum permitted potential energy in the spring 22. The positions of the stops 55a and 55b may be selected for operability and longevity of the spring 22 and the tensioner 10 overall.

[0036] In the embodiment shown in Figures 2-6, the pulley 20 is rotatably mounted to the tensioner arm 14 via the bearing 18 for rotation about a pulley axis A_p that is spaced from the pivot shaft axis A_{ps} . The pulley 20 is shown as having a flanged belt engagement surface 56, however the surface 56 may alternatively be free of flanges. The pulley 20 may be made from any suitable material, such as, for example a metallic material, such as a suitable steel.

[0037] The bearing 18 includes an inner race 18a that is mounted to the tensioner arm 14, an outer race 18b that is mounted to the pulley 20, a plurality of rolling elements 18c (e.g. balls), a distal shield 18d and a basal shield 18e.

[0038] The tensioner arm 14 has an axially and circumferentially extending skirt 64 having a radially outer surface 65 and a radially inner surface 67. The skirt 64 overlaps the spring cup wall 50 axially to axially enclose a spring chamber 66 (i.e. a chamber for the spring 22). One of the spring cup wall 50 and the skirt 64 surrounds the other of the spring cup wall 50 and the skirt 64. In the embodiment shown, the skirt 64 surrounds the spring cup wall 50.

[0039] At least one deflector wall 68 extends radially outward from said other of the spring cup wall 50 and the skirt 64 towards said one of the spring cup wall 50 and the skirt 64. In this embodiment, the deflector wall 68 extends outward from the spring cup wall 50 towards the skirt 64. Also, in the embodiment shown there are two deflector walls 68 that are axially adjacent one another.

[0040] It will be noted that the deflector walls 68 are free of contact with the skirt. As a result, there is no frictional engagement between the spring cup wall 50 and the skirt 64. This permits an undesirable potentially significant increase in the amount of frictional damping that is provided during pivoting movement of the tensioner arm 14.

5 **[0041]** With reference to Figure 6, the walls 68 have a basal side 70 and a distal side 72. The basal side 70 may extend substantially radially, thereby inhibiting any oil that drips onto the outer surface 54 of the spring cup wall 50 from climbing the walls 68. Additionally, in the event that there is oil on the outer surface 54 of the spring cup wall 50 providing walls 68 with radially extending basal sides 70 inhibits climbing of the oil up
10 the basal sides 70. The distal side 72 extends outward radially at an inclined angle towards the basal side. By providing the inclined angle, the distal surface 72 facilitates the migration of oil from the distal side 72 of the wall 68 over to the basal side 70. Thus, if some oil does somehow migrate over to the distal side of the wall 68, it is possible (e.g. through vibration) for the oil to climb over the wall 68 to reach the basal side 70.

15 **[0042]** The deflection walls 68 each have a tip 74 that is proximate the skirt 64 but is spaced from the skirt 64 by a selected gap G shown in Figure 5. More specifically the tip 74 is proximate but spaced from the radially inner surface 67 of the skirt 64 by the gap G. The gap G may be, for example, in the range of about 0.5mm or less, or it may be any other suitable amount.

20 **[0043]** While the walls 68 are shown as having a generally right-triangular cross-sectional profile, it will be understood that any other suitable profile may be provided. For example, the basal side 70 of the wall 68 need not extend substantially radially outwardly. It could extend outward with an inclined angle toward the distal side 72.

[0044] It will be noted that, while the spring cup wall 50 is shown in Figures 5 and 6
25 as being generally cylindrical, such that the walls 68 clearly project from the outer surface 54, the spring cup wall 50 itself may have any other suitable shape such that a tip 74 is provided that is proximate the inner surface 67 of the skirt 64 but is spaced from the skirt 64 by a selected amount, such as by about 0.5mm or less. For example the spring cup wall 50 could alternatively be generally conical, tapering radially inwardly
30 in the basal direction. Its outer end (which would constitute its distal end) could end at a tip that would have a selected gap G in relation to the inner surface 67 of the skirt 64.

[0045] The walls 68 cooperate with the skirt 64 to inhibit the migration of oil into the spring chamber 66 thereby inhibiting oil from reaching the interface between the pivot shaft 12a and the bushing 16.

[0046] In some embodiments, as shown, the skirt 64 extends sufficiently basally
5 that it axially overlaps the cupping elements 46 and 48 and is spaced from the outer surface (shown at 78) of the cupping elements 46 and 48 by a selected gap G2 (Figure 6). The gap G2 may be within any suitable range such as 0.5mm or less. Alternatively the gap G2 may be larger than 0.5mm, such as, for example, about 0.65mm or less. By
10 extending the skirt 64 to axially overlap the cupping elements 46 and 48 so as to provide the gap G2 therebetween, in addition to providing at least one wall 68 that extends radially outwardly and is spaced from the inner surface 67 of the skirt 64 by the gap G, oil is further inhibited from reaching the spring chamber 66 and more particularly from reaching the interface between the pivot bushing 16 and the pivot shaft 12a.

[0047] Referring to Figure 6, the basal end of the spring cup 12b abuts the rear
15 plate 12c. By providing a large radius corner edge where the spring cup wall 50 joins a basal wall 80 of the spring cup 12b, a channel 82 is formed between the spring cup 12b and the rear plate 12c. This channel 82 is a spring cup oil run-off channel. When oil drips onto the spring cup 12b during operation of the engine 913, the oil is encouraged by the radius corner edge to fall into the channel 82. The oil then follows the channel 82
20 by gravity along the path 84 shown in Figure 4 around the outside of the spring cup 12b to the bottom of the tensioner 10, where it can then drip off the spring cup 12b.

[0048] In an alternative embodiment shown in Figure 7, the outer surface 54 of the spring cup wall 50 may have a channel 86 directly formed therein that is closer to the deflection walls 68. This channel 86 may thus act as the spring cup oil run-off channel
25 so that oil follows the path shown at 87 around the outside of the spring cup wall 50 to the bottom and drips off.

[0049] Figure 8 shows selected components from the tensioner 10. As can be seen, in Figure 8, the collar 40 may have a raised distal lip 88. As a result, any oil that migrates into the spring chamber 66 between the spring cup 12b and the rear plate 12c
30 will be on the collar 40 and will drop along the collar channel (shown at 90) formed by

the lip 88. The oil will then fall from the channel 90 right above the slot 60 so that the oil can then leave the spring chamber 66.

[0050] Referring to Figure 6, the outer surface 65 of the skirt 64 may have a lip 92 distally spaced from the basal end of the skirt 64. The lip 92 acts to inhibit oil from migrating into the basal side of the bearing 18. The skirt 64 is tapered in the distal direction so oil would tend to fall towards the lip 92, and would then run down along the basal side of the lip 92 to fall off the bottom of the skirt 64. The oil path is shown at 93 in Figure 4, although the lip 92 is obscured in this figure by the pulley 20. Optionally, as shown in Figure 10, the outer surface 65 of the skirt 64 may have a skirt oil channel 94 provided thereon to assist in keeping oil from migrating to the bearing 18.

[0051] A thrust washer 95 may be provided on the distal end of the tensioner arm 14 and may extend radially to the pulley 20 so as to inhibit oil from migrating between the thrust washer 95 and the pulley 20 and reaching the distal side of the bearing 18. The thrust washer 95 acts to resist an axial force exerted on tensioner arm 14 by the spring 22.

[0052] Referring to Figure 9, one or more surfaces may be provided with oleophobic coatings so as to help control the flow of oil throughout. Example positions of the oleophobic coatings can be seen in Figure 9: oleophobic coating 98a is between the installation shaft 27 and the thrust washer 95; oleophobic coating 98b is between the thrust washer 95 and the tensioner arm 14; oleophobic coating 98c is on the outer surface 65 of the skirt 64 near the distal end of the skirt 64; oleophobic coating 98d is in the channel 90 on the collar 40; and oleophobic coatings 98e and 98f are on the outer surface 42 of the pivot shaft 12 basally and distally of the bushing 16 respectively. The coatings 98a, 98b and 98f cooperate to inhibit oil from collecting at interfaces between elements at the distal end of the tensioner 10 so as to inhibit oil from migrating in at those interfaces and reaching the sliding surface 63 of the bushing 16. The coating 98c is provided to inhibit oil from reaching the substantially vertical, distal portion of the skirt 64 where the oil could fall and migrate into the bearing 18. The coating 98d is provided to assist the oil 100 that collects in the collar channel 90 to encourage the oil 100 to follow the path around the collar 40 and fall off the collar 40. The coating 98e is provided to inhibit oil from collecting on the outer surface 42 on the basal side of the

space between the surface 53 of the arm 14 and the surface 42 of the pivot shaft 12 (in which the bushing 16 resides). If oil 100 reaches the entrance to that space, there is a possibility of capillary action drawing the oil 100 into it. By providing the coating 98e the oil 100 is encouraged to fall off the pivot shaft 12a prior to reaching that entrance or to avoid migrating onto the surface coated by coating 98e in the first place.

[0053] It will be noted that oleophobic coatings are just one way of rendering a material to be oleophobic. In some instances, the material itself may be sufficiently oleophobic inherently that a coating is not needed.

[0054] Reference is made to Figure 11 with shows some features for the tensioner 10 that would assist in a belt-in-oil application. In such an application, it may be desired to encourage oil to reach the bearing 18 (although it may still be desired to keep oil from reaching the sliding surface of the bushing 16). To encourage oil flow to the bearing 18, the outer surface 65 of the skirt 64 may remain tapered in the distal direction (i.e. towards the bearing 18), and there may be no lip or oil channel on the outer surface 65 of the skirt 64. Additionally, there may also be no shields on the bearing 18. As a result, oil flows down the skirt 64 and into the bearing 18, along path 105. In the example shown in Figure 11, oleophyllic coatings are used in two places. Oleophyllic coating 99a is provided at the interface between the basal side of the bearing 18 and the skirt 64; and oleophyllic coating 99b is provided at the interface between the distal side of the bearing 18 and the thrust washer 95. In this embodiment, the thrust washer 95 may extend radially beyond the inner race 18a to the space between the inner and outer races 18a and 18b, and may have an edge 101 that has a basal side 102 that is sloped towards the bearing 18 to encourage oil on the basal side 102 to drip into the bearing 18. The edge 101 may further have a distal side 103 that is reduced in the radial dimension compared to the basal side 102, so as to avoid interfering with oil from splashing up and reaching the bearing (e.g. along path 106).

[0055] While Figure 11 shows the use of channel 86 which would serve to inhibit oil flow to the sliding surface 63 of the bushing 16.

[0056] The pulley 20 is but an example of an endless drive member engagement member that is used to engage the belt 11 to maintain tension therein. Alternative endless drive member engagement members may include, for example, a shoe that is

fixedly mounted to the tensioner arm 14 and that slidably engages the belt 11. In such an embodiment a bearing 18 would not be included, and accordingly, any structure that relates to preventing or promoting oil flow to the bearing would not be needed.

[0057] While the above description constitutes a plurality of embodiments of the present invention, it will be appreciated that the present invention is susceptible to further modification and change without departing from the fair meaning of the accompanying claims.

CLAIMS:

1. A tensioner for tensioning an endless drive member, said tensioner comprising:

a base comprising a pivot shaft, a spring cup and a rear plate, wherein the pivot shaft has a basal end and a distal end, and defines a pivot shaft axis, the pivot shaft having a pivot shaft aperture therethrough that permits the pass-through of a mounting fastener for mounting the tensioner to a stationary structure, wherein the spring cup is fixedly connected to the pivot shaft and having an axially and circumferentially extending spring cup wall having a radially inner surface and a radially outer surface, and wherein the rear plate is fixedly connected to the pivot shaft and is configured for orienting the base relative to the stationary structure;

a tensioner arm pivotally mounted on said pivot shaft for pivotal movement about the pivot shaft axis;

a pivot bushing positioned between the tensioner arm and the pivot shaft, wherein the pivot bushing is fixedly connected to one of the pivot shaft and the tensioner arm, and is frictionally engaged with the other of the pivot shaft and the tensioner arm;

an endless drive member engagement member mounted to the tensioner arm and positioned to engage the endless drive member; and

a spring positioned to urge the tensioner arm in a take-up direction,

wherein the tensioner arm has an axially and circumferentially extending skirt having a radially outer surface and a radially inner surface, wherein the skirt overlaps the spring cup wall axially to axially enclose a spring chamber, wherein one of the spring cup wall and the skirt surrounds the other of the spring cup wall and the skirt,

wherein at least one deflector wall extends radially outward from said other of the

spring cup wall and the skirt towards said one of the spring cup wall and the skirt, wherein the at least one deflector wall is free of contact with said one of the spring cup wall and the skirt and is spaced from the other of the spring cup and the skirt by a selected gap.

2. A tensioner as claimed in claim 1, wherein the endless drive member engagement member is a pulley that is rotatably mounted to the tensioner arm via a bearing for rotation about a pulley axis that is spaced from the pivot shaft axis.

3. A tensioner as claimed in claim 1, wherein the at least one deflector wall includes two deflector walls that are axially adjacent one another.

4. A tensioner as claimed in claim 1, wherein each deflector wall includes a basal side and a distal side and wherein the basal side extends substantially radially.

5. A tensioner as claimed in claim 4, wherein the distal side extends outwards radially at an inclined angle towards the basal side.

6. A tensioner as claimed in claim 1, wherein the spring cup is separate from the rear plate and has a basal end that is radiused and that engages and cooperates with the rear plate to form a spring cup oil run-off channel that extends circumferentially about the spring cup.

7. A tensioner as claimed in claim 1, wherein a slot that passes through the spring cup wall and extends axially from the basal end of the spring cup, wherein a first end of

the tensioner spring extends through the slot to fix the first end of the spring relative to the base, and wherein the slot is positioned at a bottom of the spring cup when the tensioner is mounted to the stationary structure so that oil in the spring cup can leave the spring cup by gravity through the slot.

8. A tensioner as claimed in claim 1, wherein the skirt surrounds the spring cup wall and wherein the spring cup wall has a radially outer surface with a first, circumferentially extending oil run-off channel thereon that is basal relative to the at least one deflector wall, wherein the first oil-run off channel is positioned to capture oil on the outer surface of the spring cup wall so as to inhibit the migration of oil to the at least one deflector wall.

9. A tensioner as claimed in claim 1, wherein the skirt surrounds the spring cup wall and has a skirt outer surface having a basal end, wherein the outer surface of the skirt tapers distally away from the basal end, wherein the outer surface has a skirt deflection wall that extends radially away from the outer surface of the skirt and is spaced from the basal end of the skirt.

10. A tensioner as claimed in claim 9, wherein the endless drive member engagement member is a pulley that is rotatably mounted to the tensioner arm via a bearing for rotation about a pulley axis that is spaced from the pivot shaft axis,

and wherein the skirt is positioned at a basal end of the bearing such that the skirt deflection wall inhibits oil from contacting the basal end of the bearing,

and wherein the tensioner further comprises a thrust washer fixedly connected to a distal end of the tensioner arm, wherein the thrust washer extends radially to substantially cover a distal end of the bearing.

11. A tensioner as claimed in claim 7, wherein the rear plate has a collar that is fixedly engaged with a radially outer surface of the pivot shaft and that extends into an interior space of the spring cup, wherein the collar has a circumferential lip thereon that is spaced distally from a basal interface region between the spring cup so as to form a collar oil run-off channel, wherein when the tensioner is mounted on the stationary structure, the collar oil run-off channel has a bottom that is positioned directly above the slot.

12. A tensioner as claimed in claim 11, wherein the collar oil run-off channel has a surface that is oleophobic.

13. A tensioner as claimed in claim 1, wherein a radially outer surface of the pivot shaft both basally and distally of the pivot bushing is oleophobic.

14. A tensioner as claimed in claim 9, wherein the skirt outer surface distally of the skirt deflection wall is oleophobic.

15. A tensioner as claimed in claim 2, wherein the bearing includes inner and outer races and is free of distal and basal side shields between the inner and outer races to inhibit migration of oil into the bearing,

wherein the skirt surrounds the spring cup wall and has a skirt outer surface having a distal end that is basally adjacent the inner race of the bearing, and having a basal end, wherein the outer surface of the skirt tapers distally away from the basal end towards a basal side of the bearing.

16. A tensioner as claimed in claim 15, wherein the tensioner further comprises a

thrust washer fixedly connected to a distal end of the tensioner arm and positioned distally adjacent the bearing, wherein the thrust washer extends radially outwards to beyond the inner race of the bearing, and wherein the thrust washer has a radial edge that tapers basally towards the bearing.

17. A tensioner as claimed in claim 15, wherein an interface between the distal end of the outer surface of the skirt and the inner race of the bearing is oleophillic.

18. A tensioner as claimed in claim 16, wherein an interface between the thrust washer and the inner race of the bearing is oleophillic.

19. A tensioner as claimed in claim 1, wherein the gap is in the range of not more than about 0.5mm.

20. A tensioner as claimed in claim 1, wherein pivot bushing is fixedly connected to the tensioner arm and is frictionally engaged with the radially outer surface of the pivot shaft.

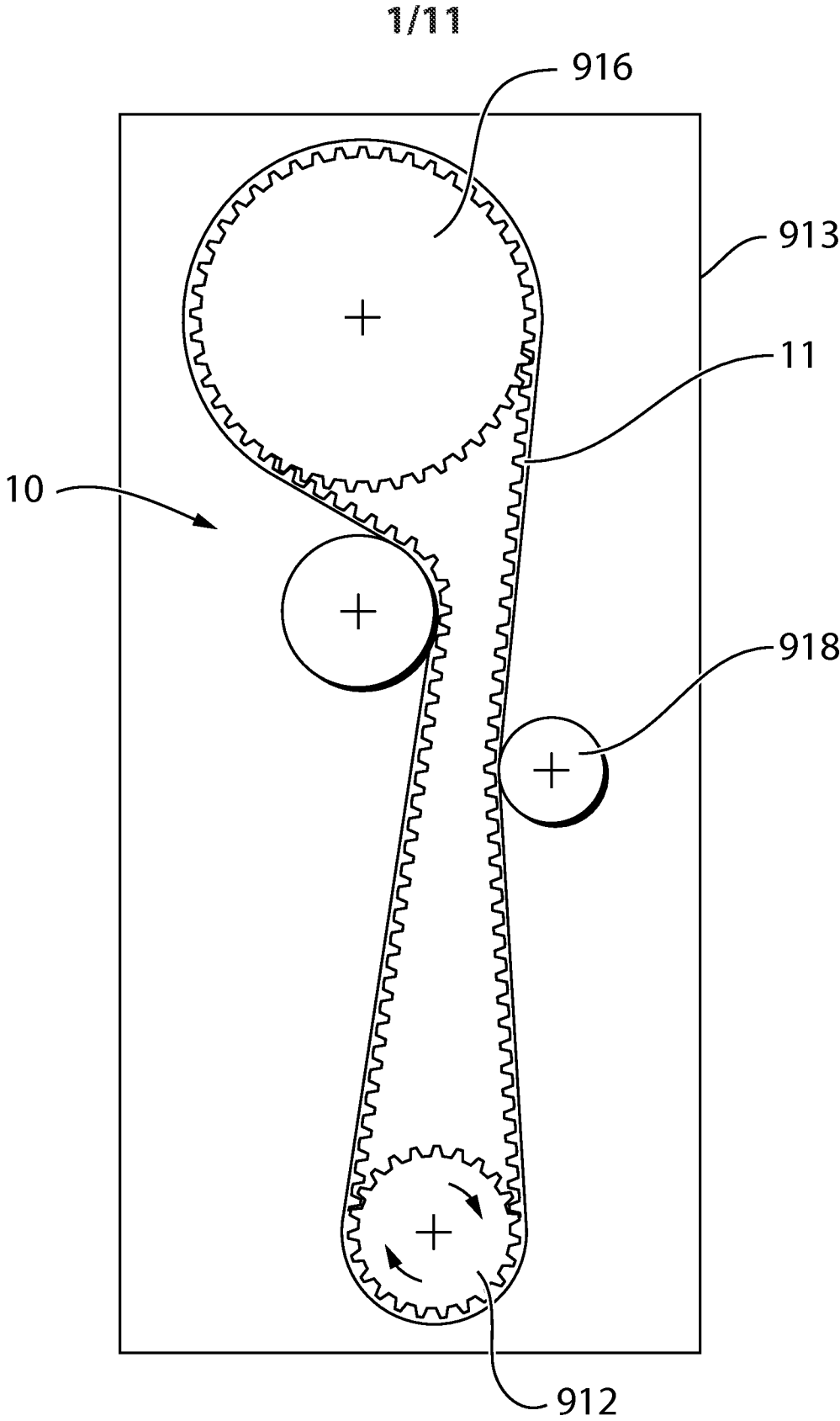


FIG.1

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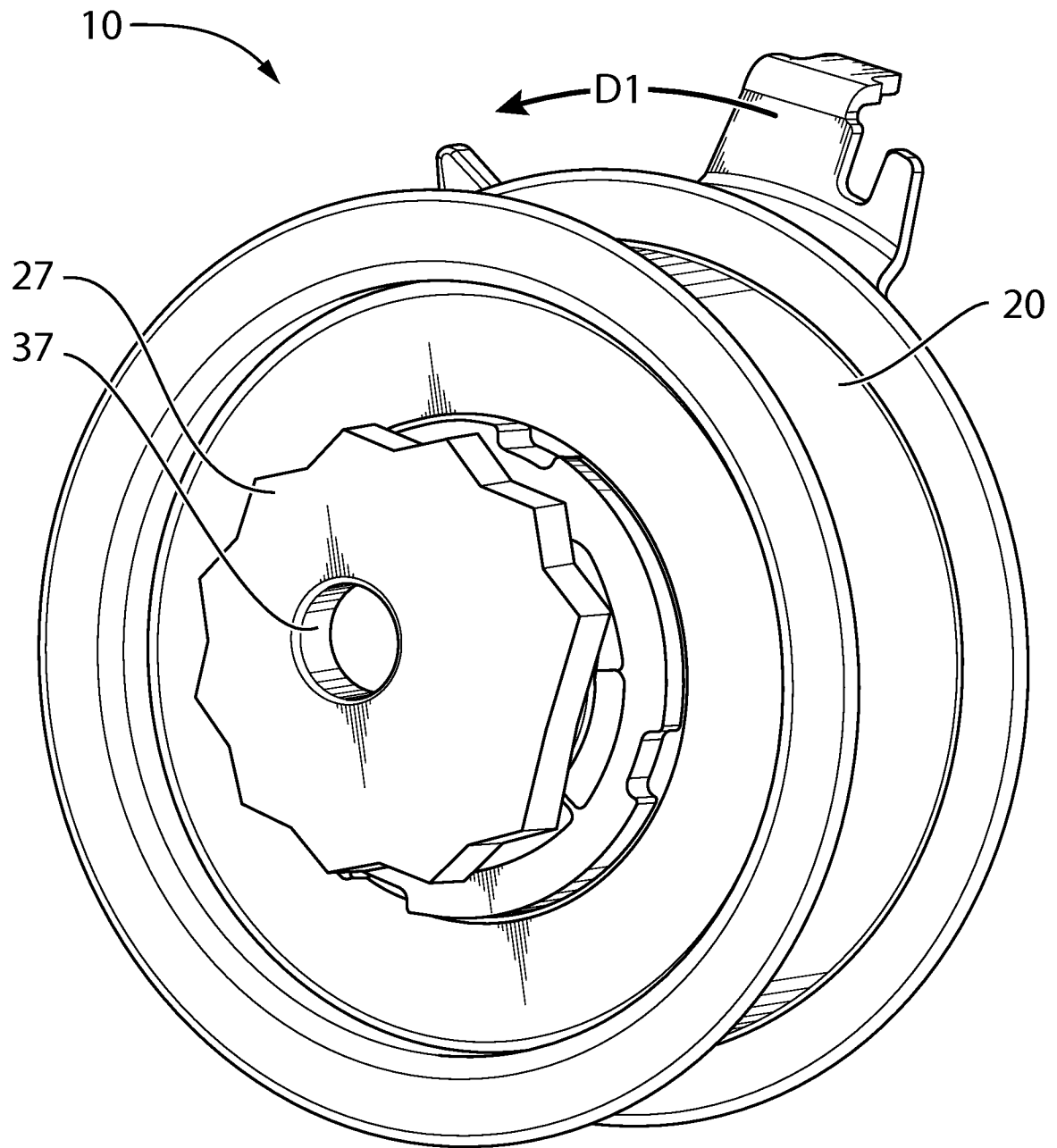


FIG.2

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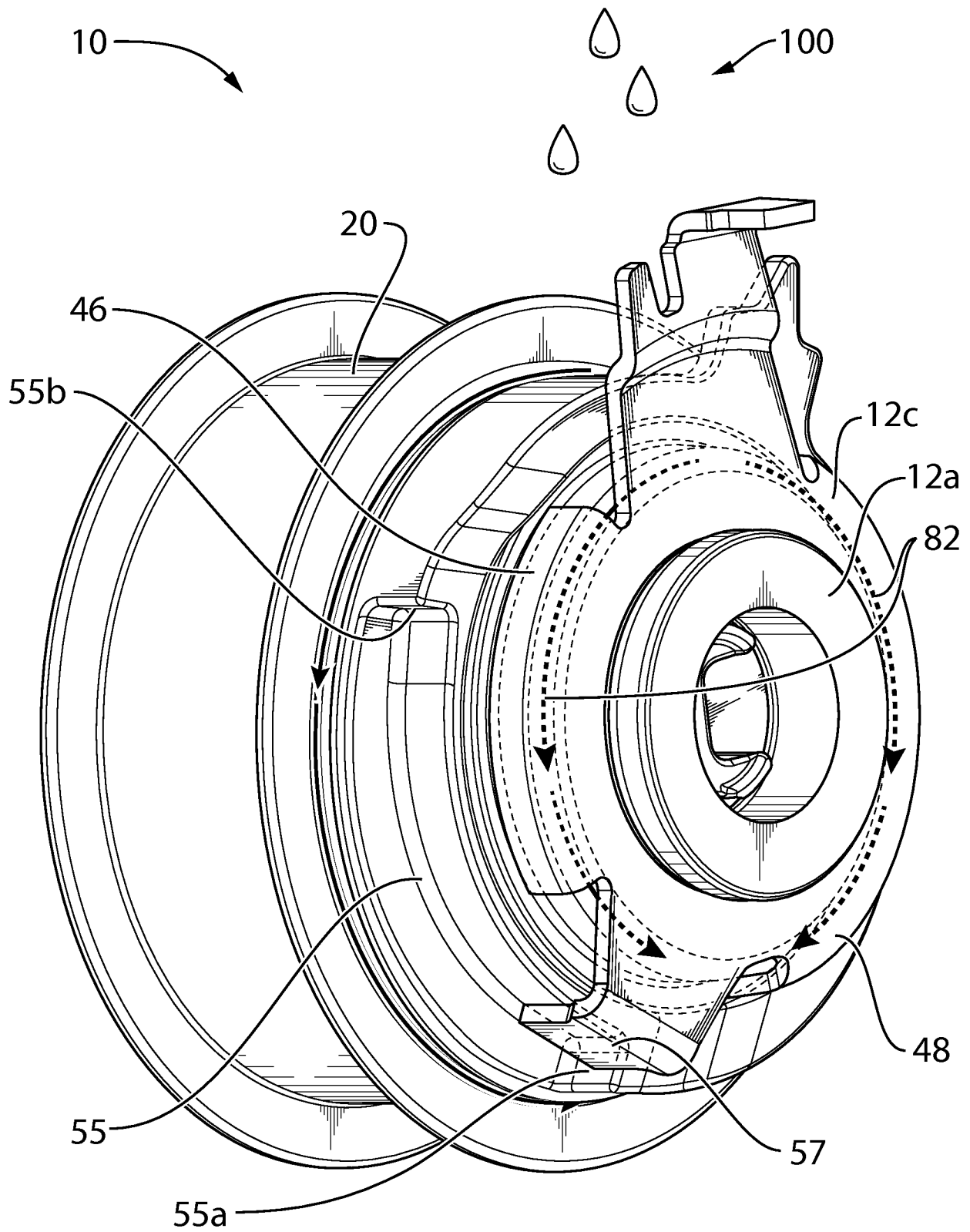


FIG.3

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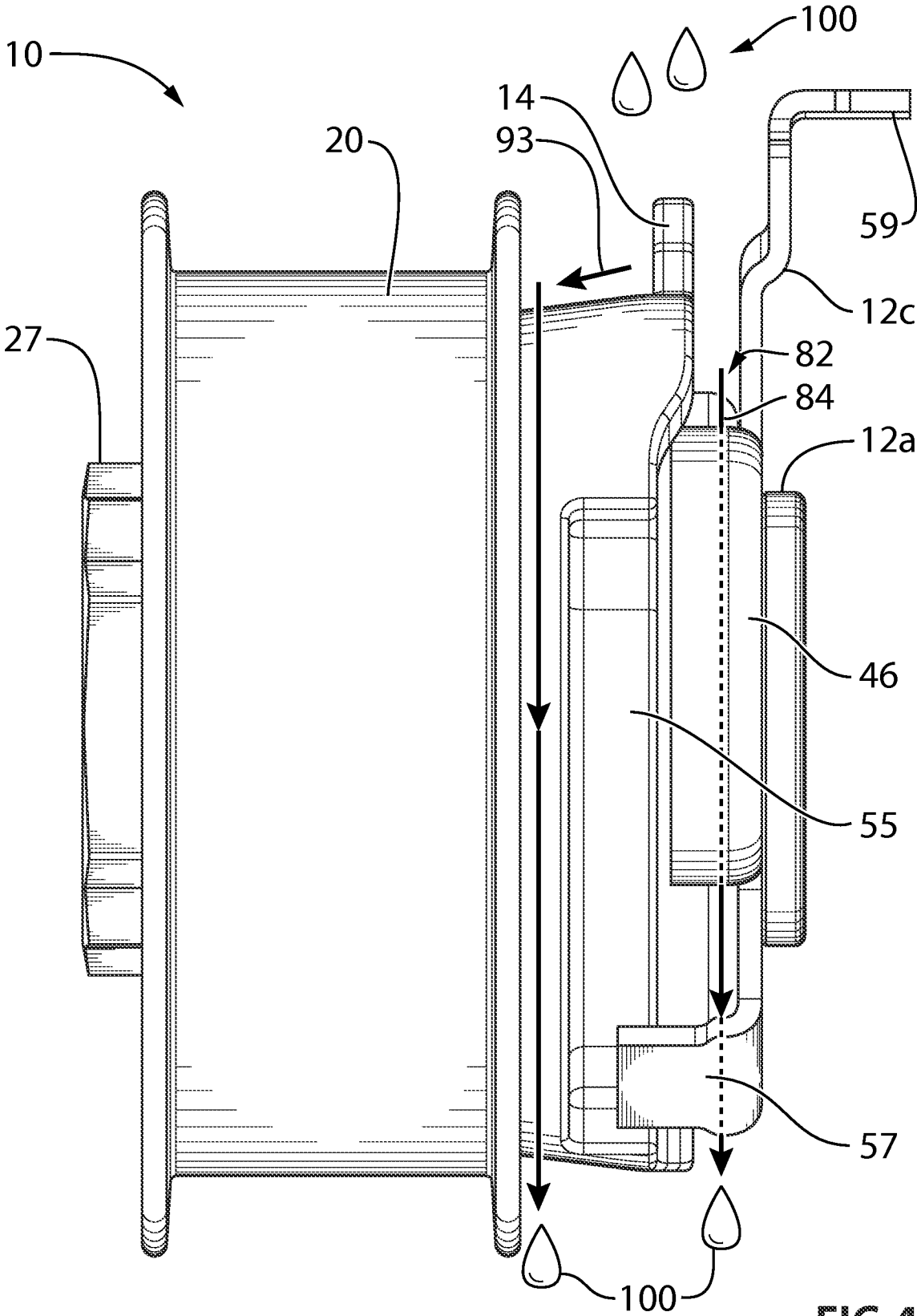


FIG.4

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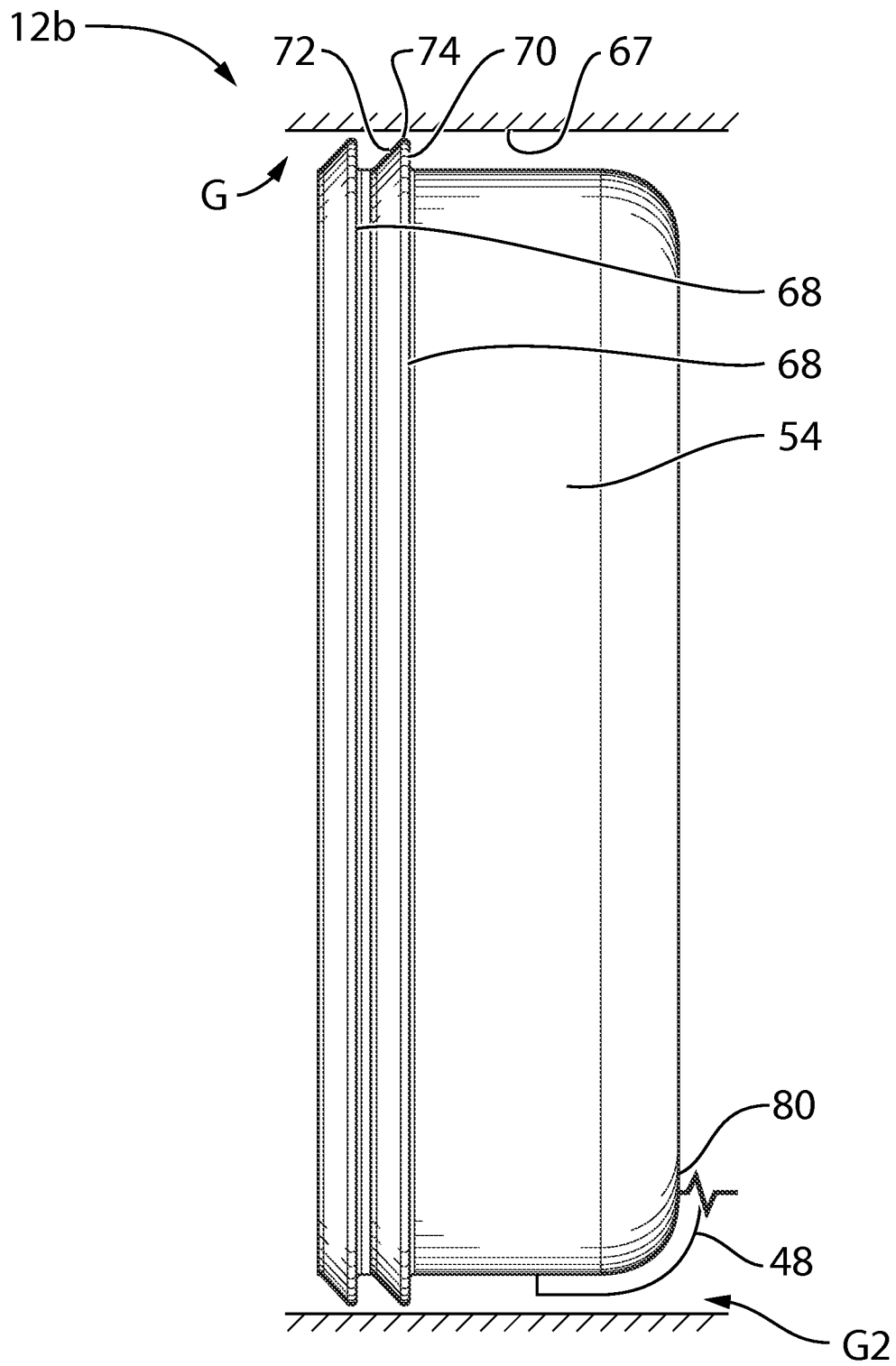


FIG.5

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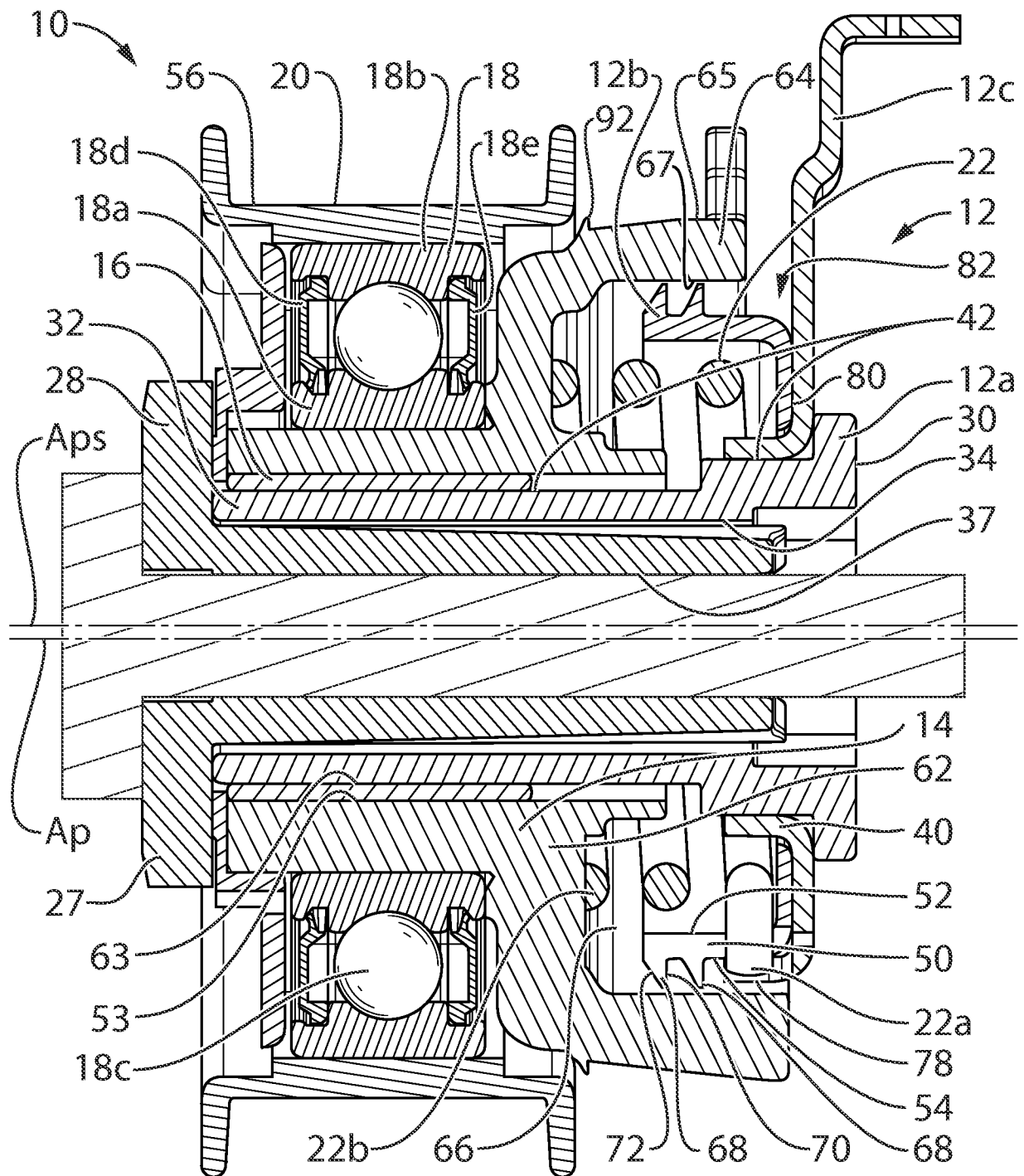


FIG. 6

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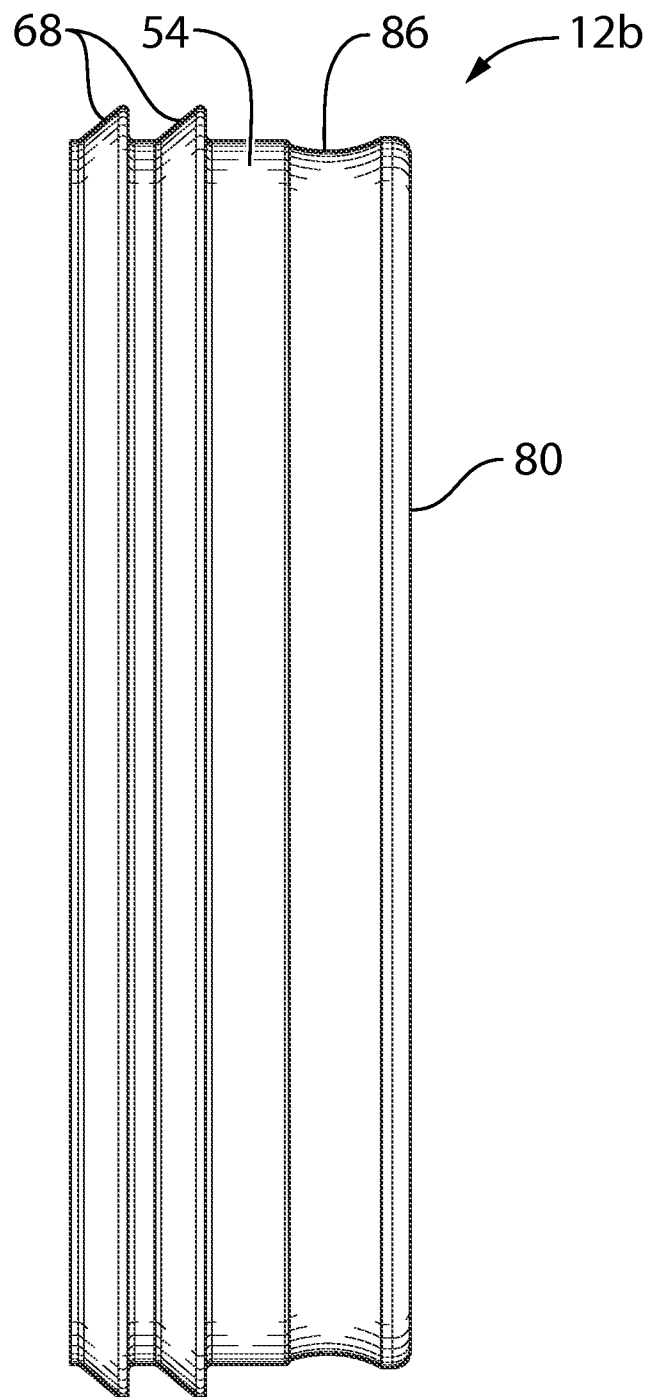


FIG. 7

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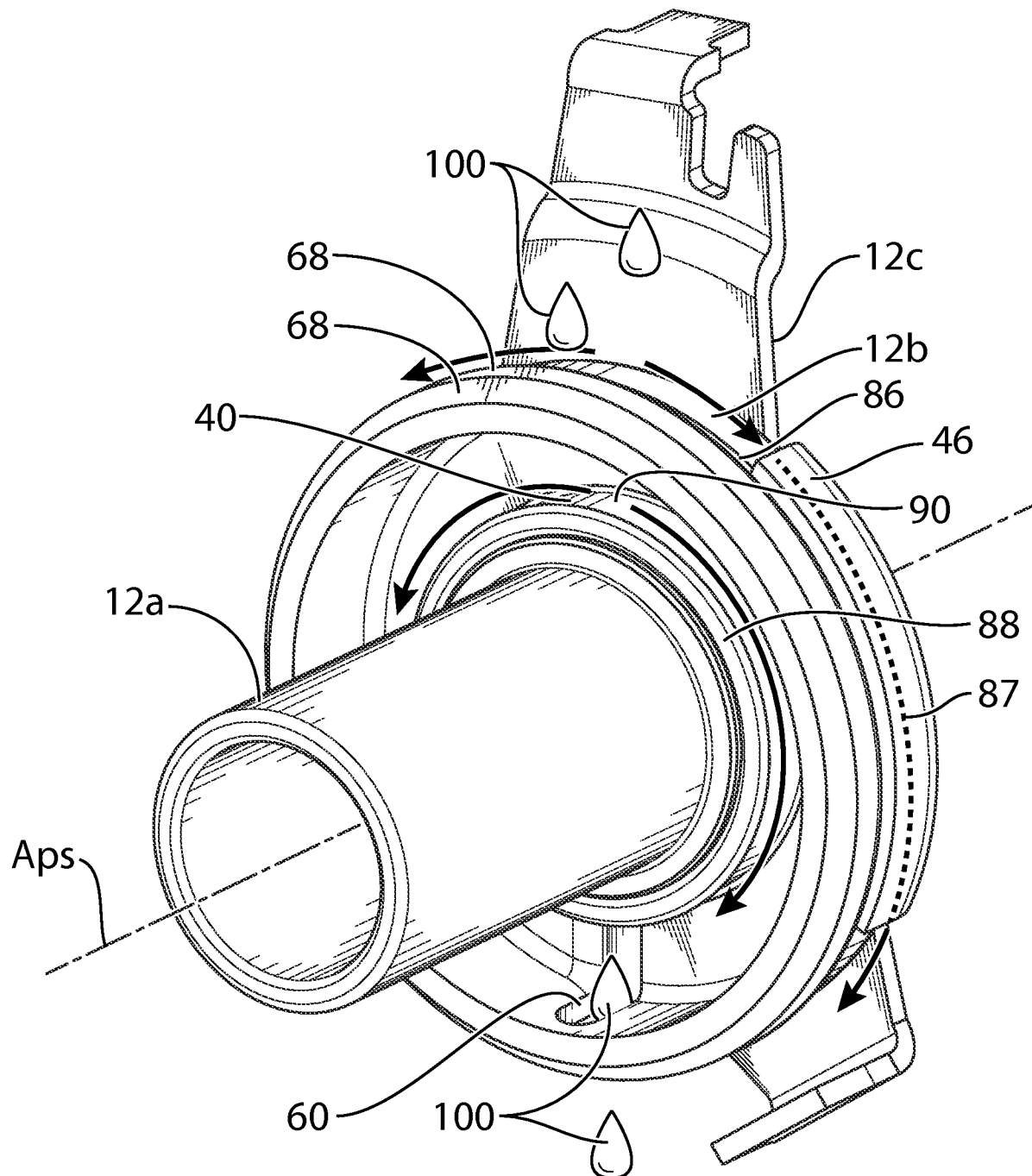


FIG.8

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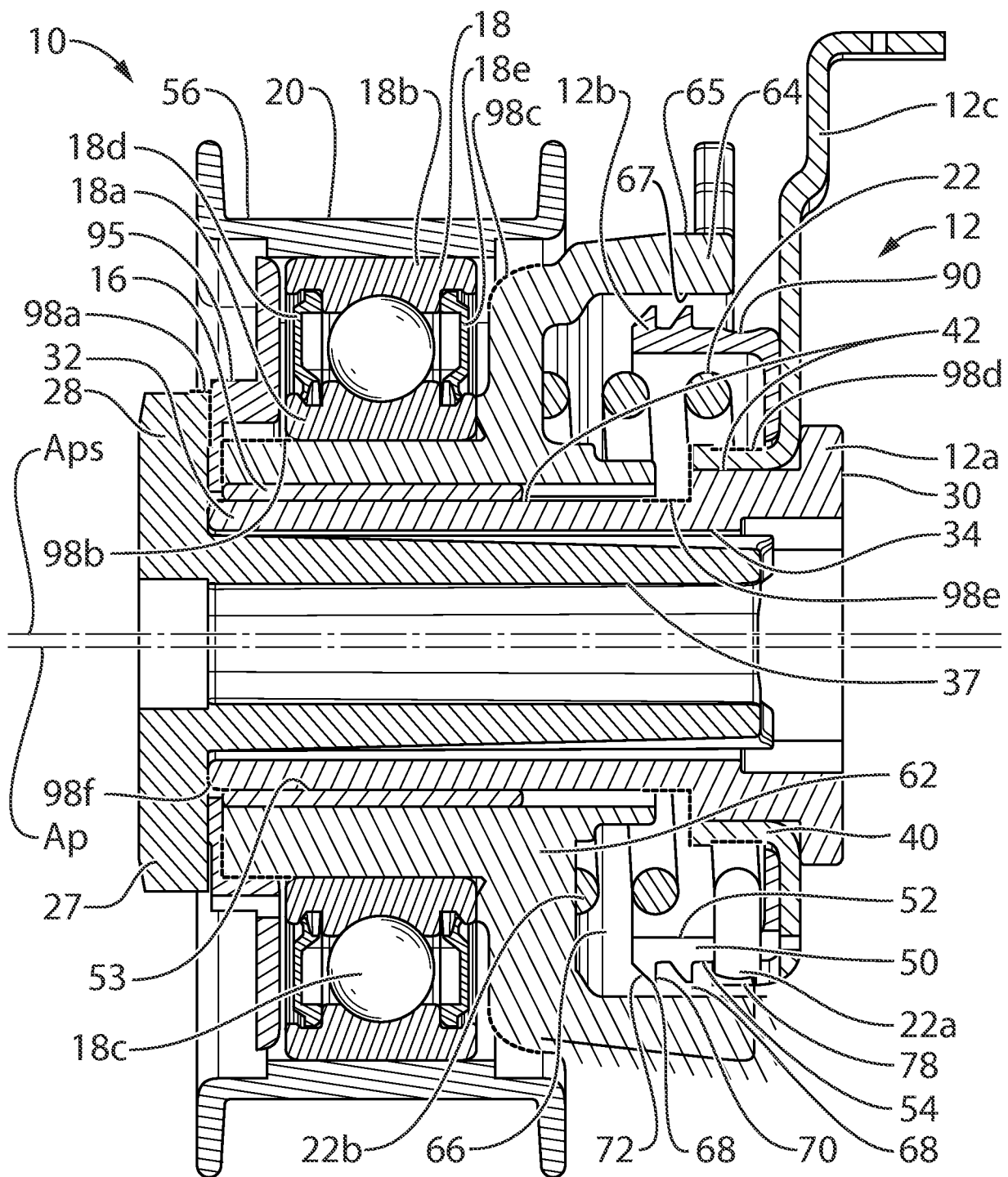


FIG. 9

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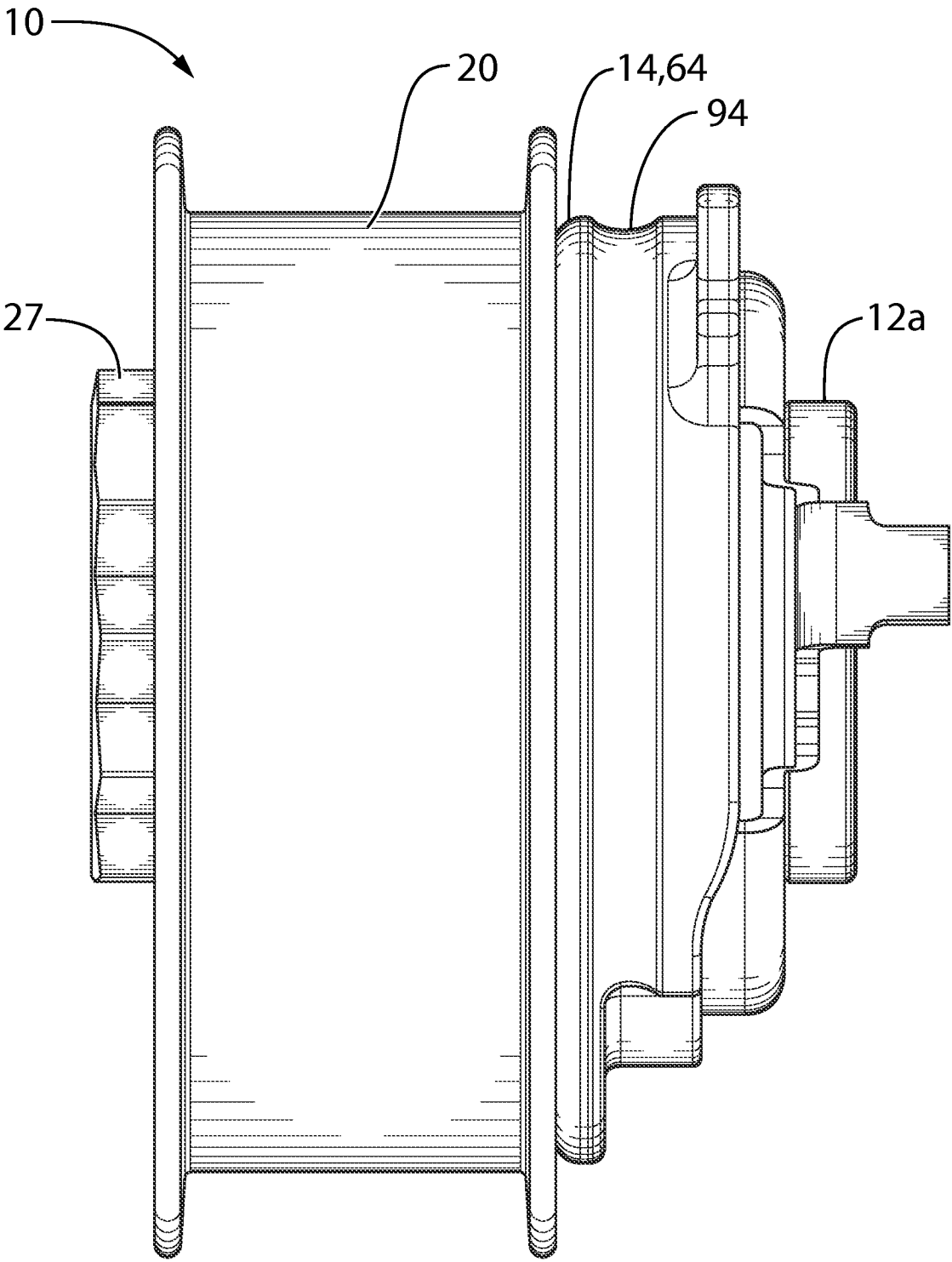


FIG.10

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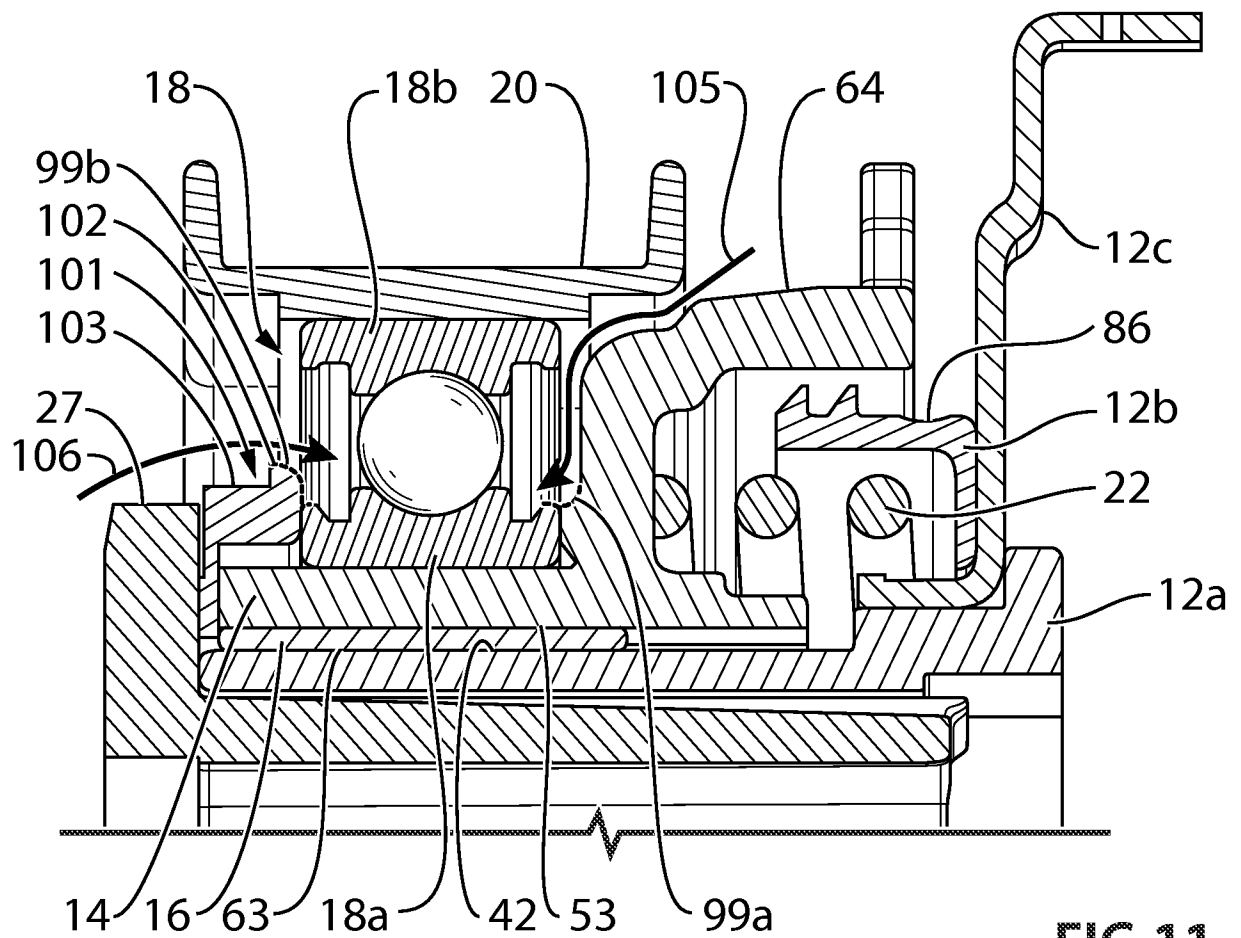


FIG.11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/039630

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F16H 7/12 (2014.01)

CPC - F16H 7/1281 (2014.09)

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)

IPC(8) - F16H 7/08, 7/10, 7/12, 7/14 (2014.01)

CPC - F16H 7/1218, 7/1281, 2007/081, 2007/084 (2014.09)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 474/109, 112, 117, 135

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patent, Google

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0176609 A1 (LEHTOVAARA et al) 09 July 2009 (09.07.2009) entire document	1-4,6-10,13,14,19,20
Y	US 5,964,674 A (SERKH et al) 12 October 1999 (12.10.1999) entire document	1-4,6-10,13,14,19,20
Y	US 2008/0176687 A1 (SCHEVER) 24 July 2008 (24.07.2008) entire document	1-4,6-10,13,14,19,20
Y	US 5,620,385 A (CASCIONALE et al) 15 April 1997 (15.04.1997) entire document	6
Y	US 4,384,725 A (NENOV) 24 May 1983 (24.05.1983) entire document	13,14

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"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

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Date of the actual completion of the international search

15 September 2014

Date of mailing of the international search report

14 OCT 2014

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