



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.02.2020 Bulletin 2020/09

(51) Int Cl.:
H01H 19/11 (2006.01) H01H 19/14 (2006.01)

(21) Application number: **18190707.2**

(22) Date of filing: **24.08.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME
 Designated Validation States:
KH MA MD TN

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(54) **ROTARY KNOB**

(57) A rotary knob (10) comprises a rotary body (14) comprising a rotary body portion of conical configuration (28) extending to a rotary bottom body portion of cylindrical configuration (30), both rotary portions (28, 30) extending along the rotational axis (A) of the rotary knob (10); the rotary conical body portion (28) extending from its large end to its small end, said small end being merged into the rotary cylindrical body portion (30); a fix body (18) comprising a fix body portion of hollow conical configuration (32) extending to a fix body portion of hollow cylindrical configuration (34); the fix conical body portion (32) extending from its large end to its small end, said small end being merged into the fix cylindrical body portion (34); the rotary body portions (28, 30) being arranged inside the fix conical body portions (32, 34); a plurality of upper balls (24) and lower balls (26) respectively uniformly arranged around the rotary conical body portion (28) and around the rotary cylindrical body portion (30), in contact with the rotary body portions (28, 30) and with the fix body portions (32, 34); a balls holder (22) maintaining the upper balls (24) and the lower balls (26) in a free of rotation state, said balls holder (22) arranged free of contact with the rotary body (14).

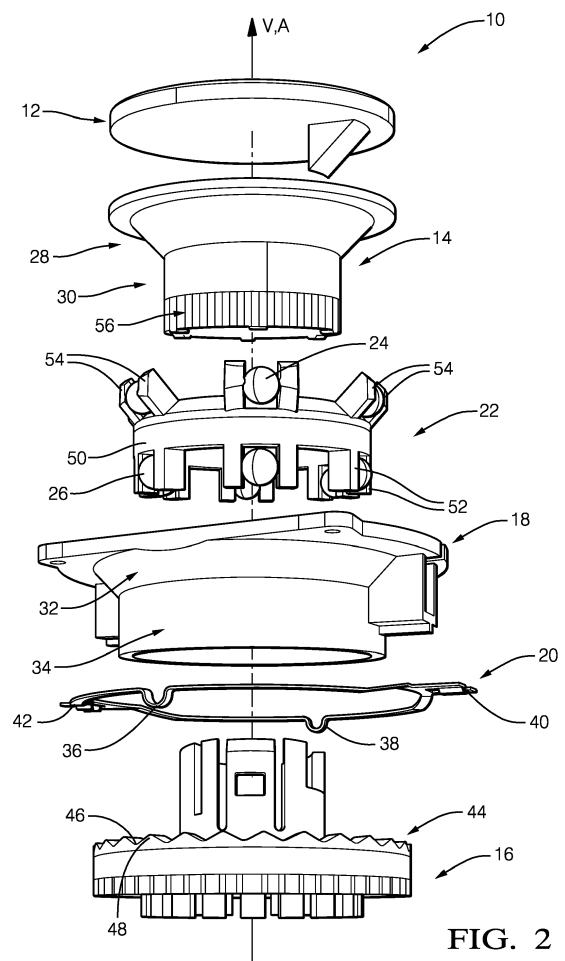


FIG. 2

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to rotary knobs, and more particularly to rotary knobs with inertia effect that serve as input devices for automotive systems.

BACKGROUND OF THE INVENTION

[0002] Multifunctional switches with an indicator, in which a plurality of functions can be selected and validated through rotation of a dial knob exist and are commonly implemented in automotive environment for instance to control the air conditioning or a High Fidelity system. Said switches are typically built on an electronic printed circuit board. A tubular cylindrical core is fixed on the PCB, and serves as a primary guide for a bushing that is placed over said cylindrical core. An external rotary knob, accessible to an operator, is placed over the bushing. The switch is in mechanical and electrical connection with the PCB and the rotation of the knob selects various functions.

[0003] One common problem to all solutions is the lack of inertia effect which simulates massive rotary wheel and in terms provides a high perceive quality

[0004] It is therefore important to propose a new solution to increase safety for pedestrian.

SUMMARY OF THE INVENTION

[0005] According to the invention, a rotary knob comprises a rotary body comprising a rotary body portion of conical configuration extending to a rotary bottom body portion of cylindrical configuration, both rotary portions extending along a vertical axis defining the rotational axis of the rotary knob; the rotary conical body portion extending from its large end to its small end, said small end being merged into the rotary cylindrical body portion; a fix body comprising a fix body portion of hollow conical configuration extending to a fix body portion of hollow cylindrical configuration, both fix portions extending along the vertical axis; the fix conical body portion extending from its large end to its small end, said small end being merged into the fix cylindrical body portion; the rotary conical body portion being arranged inside the fix conical body portion; the rotary cylindrical body portion being arranged inside the fix cylindrical body portion; a plurality of upper balls uniformly arranged around the rotary conical body portion, in contact with the rotary conical body portion, and in contact with the fix conical body portion; a plurality of lower balls uniformly arranged around the rotary cylindrical body portion, in contact with the rotary cylindrical body portion, and in contact with the fix cylindrical body portion; a balls holder maintaining upper and lower balls in a free of rotation state, said balls holder arranged free of contact with the rotary body; such that balls are rotating in the balls holder when the knob is

rotationally operated.

[0006] The balls holder may comprise a ring part arranged around the rotary cylindrical body portion. The balls holder may comprise a plurality of two lowers arms extending vertically from the ring part along the rotary cylindrical body portion, each lower balls being retained between two lower arms by means of bumps, such that each of two lower arms forming a lower ball cage. The balls holder may comprise a plurality of two uppers arms extending from the ring part in a vertical direction along the rotary conical body portion, each upper balls being retained between two upper arms by means of bumps, such that each of two upper arms forming an upper ball cage.

[0007] Each of upper balls may be aligned with a lower ball in the vertical direction along the rotary body, i.e. each of upper balls may be arranged at a same relative angular position around the rotational axis than a lower ball.

[0008] The outer surface of the rotary body may comprise a plurality of uniform grooves extending in the vertical direction along the outer surface of the rotary body, regularly arranged around the outer surface of the rotary body and in direct contact with the plurality of upper balls and/or the plurality of lower balls; such that the rotary body comprises a wavy surface providing haptic effect while the knob is rotationally operated. The plurality of uniform grooves may be arranged on the outer surface of the rotary cylindrical body portion such that said plurality of uniform grooves is in direct contact with the plurality of lower balls.

[0009] The rotary body may comprises a detent ring arranged about the rotational axis at the bottom end of the rotary cylindrical body portion, said detent ring cooperating with a resilient means of the fix body, said resilient means being configured to engage the detent ring, wherein the detent ring comprises a pattern of alternating grooves and ridges, wherein the resilient means are biased towards the pattern, and wherein rolling of the plurality of balls onto the uniform grooves of the rotary body is configured to be synchronized with the movement of resilient means within grooves of the detent ring pattern while the knob is rotationally operated.

[0010] The plurality of upper balls may be a plurality of steel balls and the plurality of lower balls may be a plurality of elastomer balls.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Other features, objects and advantages of the invention will become apparent from reading the detailed description that follows, and the attached drawings, given by way of example and in which:

- Figure 1 is a schematic perspective view of a rotary knob according to one embodiment of the invention.
- Figure 2 is a schematic exploded perspective view of the rotary knob of figure 1.

- Figure 3 is schematic perspective view in a transversal cut of the rotary knob of figure 1.
- Figure 4 is a schematic perspective view of the balls holder of the rotary knob of figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] In order to facilitate the description, and in a non-limiting manner, a vertical axis V is defined. "Low", "High", "Above", "Below", "Lower" and "Higher" orientations are defined in the vertical direction.

[0013] According to figure 1 and figure 2, a rotary knob 10 that serves as input devices for automotive systems, as for instance volume control for audio system or temperature setting for air-conditioning system, is shown. The rotary knob 10 may also be used for any other applications even in other technical domain than the automotive domain.

[0014] The rotary knob 10 comprises along a vertical axis V an upper cap 12 configured to be rotated by a finger of an operator about a rotational axis A, and a rotary body 14 configured to rotate about the rotational axis A. Here the rotational axis A corresponds to the vertical axis V. The upper cap 12 is configured to be attached at the top end of the rotary body 14. The rotary knob 10 further comprises a detent ring 16 configured to be mounted at the bottom end of the rotary body 14 and comprising teeth for angular position detection of the rotary knob 10. The detent ring 16 is configured to be snapped with the rotary body 14. The rotary knob 10 further comprises a rotary detection system (not shown) cooperating with the teeth, as for instance light barrier system.

[0015] The rotary knob 10 comprises a fix body 18, or housing, configured to hold the rotary body 14. The fix body 18 comprises a ring spring 20 in contact with the detent ring 16 that prevents preload in the vertical direction. The ring spring 20 may be replaced by any of resilient means as long as it prevents preload in the vertical direction. The fix body 18 may be a part of a front panel of a vehicle.

[0016] According to one embodiment of the invention, the rotary knob 10 comprises also a balls holder 22 comprising a plurality of upper balls 24 and a plurality of lower balls 26. The plurality of upper balls 24 and the plurality of lower balls 26 are configured to be arranged around the rotary body 14, and configured to roll in the balls holder 22 against the rotary body 14 and the fix body 18 when the rotary knob 10 is operated in rotation. In other words, the plurality of upper balls 24 and the plurality of lower balls 26 are rotating simultaneously in the balls holder 22 when the knob 10 is rotationally operated.

[0017] More in details, according to figure 2 and figure 3, the rotary body 14 comprises a rotary body portion of conical configuration 28 extending to a rotary bottom body portion of cylindrical configuration 30, both rotary 28, 30 portions extending along the vertical axis V defin-

ing the rotational axis A of the rotary knob 10. More particularly, the conical configuration and the cylindrical configuration are the shapes configuration of the outer surface of the rotary body 14.

[0018] The rotary conical body portion 28 extends from its large end to its small end. The large end of the rotary conical body portion 28 is the top end of the rotary body 14 wherein the upper cap 12 can be arranged. The rotary conical body portion 28 is provided at its large end with a short annular outwardly extending flange on which the upper cap 12 is placed. The small end of the rotary conical body portion 28 is merged into the rotary cylindrical body portion 30 such that the small end of the rotary conical body portion 28 defines the diameter of the rotary cylindrical body portion 30.

[0019] The fix body 18 comprises a fix body portion of hollow conical configuration 32 extending to a fix body portion of hollow cylindrical configuration 34, both fix portions 32, 34 extending along the vertical axis V. The fix conical body portion 32 extends from its large end to its small end, said small end being merged into the fix cylindrical body portion 34. In other words, the fix body 18 comprises a vertical opening including a conical cavity merged with a cylindrical cavity; wherein the small end of the conical cavity define the diameter of the cylindrical cavity.

[0020] The rotary body portions 28, 30 are configured to be arranged inside the fix body portions 32, 34.

[0021] More particularly, according to figure 3, the rotary conical body portion 28 is arranged inside the fix conical body portion 32 and the rotary cylindrical body portion 30 is arranged inside the fix cylindrical body portion 34. In order to retain the rotary body 14 inside the fix body 18, and in order to provide rotation of the rotary body 14 within the fix body 18, the plurality of upper balls 24 are uniformly arranged around the rotary conical body portion 28, in contact with the rotary conical body portion 28, and in contact with the fix conical body portion 32. As the plurality of upper balls 24 is retained in between the outer surface of the rotary conical body portion 28 and the inner surface of the fix conical body portion 32, the plurality of upper balls 24 serves as bearing in vertical direction and radial direction, ensuring the rotary body 14 centering and hard stop of the rotary body 14 when pushed down. The plurality of lower balls 26 is uniformly arranged around the rotary cylindrical body portion 30, in contact with the rotary cylindrical body portion 30, and in contact with the fix cylindrical body portion 34 such that the plurality of lower balls 26 serves as bearing in radial direction, transverse to the vertical direction, and provides inertia moment.

[0022] The balls holder 22 maintains the plurality of upper balls 24 and the plurality of lower balls 26 in a free of rotation state. The balls holder 22 is arranged free of contact with the rotary body 14 such that sliding frictions between the balls holder 22 and the rotary body 14 are avoided. Preferably, the balls holder 22 is also free of contact with the fix body 18 for the same reasons. Thus

according to one embodiment, the balls holder 22 is free of contact with other parts of the rotary knob 10, such that sliding frictions of the balls holder 22 when the rotary knob 10 is rotationally operated are avoided.

[0023] Preferably, in order to optimize inertia effect and providing a smooth rotation features, the plurality of upper balls 24 is a plurality of steel balls and the plurality of lower balls 26 is a plurality of elastomer balls as rubber balls. Inertia moment is optimum with lower rubber balls due to the deformation of rubber balls during rotation operation of the rotary knob 10.

[0024] According to one embodiment of the invention, the detent ring 16 is arranged about the rotational axis A at the bottom end of the rotary cylindrical body portion 30. The detent ring 16 cooperates with the resilient means of the fix body 18, said resilient means being configured to engage the detent ring 16.

[0025] More particularly, the resilient means comprises the ring spring 20. The ring spring 20 is arranged about the rotational axis A. The ring spring 20 comprises at least two bumps 36, 38 diametrically opposed engaged with the detent ring 16 and two attach means 40, 42 diametrically opposed configured to be fixed on the fix body 18 (see figure 1). More particularly, the detent ring 16 comprises a pattern 44 of alternating regularly grooves 46 and ridges 48 extending around the rotational axis A, wherein the bumps 36, 38 of the ring spring 20 are biased towards said 44 pattern such that a rotary operation of the knob 10 causes the ring spring bumps 36, 38 to deflect and strike the grooves 46 and ridges 48 of the pattern 44 that provides a haptic effect.

[0026] According to figure 4, the balls holder 22 comprises a ring part 50 arranged around the rotary cylindrical body portion 30. The ring part 50 is arranged at the junction between the rotary cylindrical body portion 30 and the small end of the rotary conical body portion 28.

[0027] In order to maintain the plurality of lower balls 26, the balls holder 22 comprises a plurality of two lower arms 52 extending vertically from the ring part 50 along the rotary cylindrical body portion 30 in direction of the bottom end of the rotary cylindrical body portion 30, each lower balls 26 being retained between two lower arms 52 by means of bumps, such that each of two lower arms 52 forming a lower ball cage. The bumps of each lower cage are oriented to the nest of the cage. The space inside each lower cage, or nest of the lower cage, is a bit larger than each lower ball 26 diameter such that each lower ball 26 is free to rotate inside the lower cage and such that it compensate lower balls 26 deformation during rotation.

[0028] In order to maintain the plurality of upper balls 24, the balls holder 22 comprises a plurality of two upper arms 54 extending from the ring part 50 in a vertical direction along the rotary conical body portion 28, in the direction of the large end of the rotary conical body portion 28, each upper balls 24 being retained between two upper arms 54 by means of bumps, such that each of two upper arms 54 forming an upper ball cage. The bumps

of each upper cage are oriented to the nest of the upper cage. The space inside each upper cage, or nest of the upper cage, is a bit larger than each upper ball 24 diameter such that each upper ball 24 is free to rotate inside the upper cage.

[0029] In the context of the invention, it should be understood that the expression "extending in a vertical direction along the rotary conical body portion 28", means extending in a vertical plan of the rotational axis A, in the direction of the large end of the rotary conical body portion 28 and in an oblique manner relative to the vertical axis V similar to the vertical extension of the conical outer surface of the rotary conical body portion 28.

[0030] According to one embodiment of the invention, the plurality upper balls 24 is arranged around the rotational axis A, in a perpendicular plane of the rotational axis A. There are six upper balls 24 uniformly arranged around the rotational axis A, i.e. each upper ball 24 is spaced by 60° from one another upper ball 24. The plurality of lower balls 26 is arranged around the rotational axis A, in another perpendicular plane of the rotational axis A. There are six lower balls 26 uniformly arranged around the rotational axis A, i.e. each lower ball 26 is spaced by 60° from one another lower ball 26.

[0031] Thus, according to one embodiment of the invention, the balls holder 22 comprises only six upper cages and six lower cages that respectively retained the six upper balls 24 and the six lower balls 26.

[0032] According to one embodiment of the invention, each of upper balls 24 is aligned with a lower ball 26 in the vertical direction along the rotary body 14. It means that each of upper balls 24 is arranged at a same relative angular position around the rotational axis A than a lower ball 26. Thus, according to one embodiment of the invention, each of upper cages is aligned with a lower cage in the vertical direction along the rotary body 14.

[0033] In other words, it means that according to a relative angular position around the rotational axis A, the six upper balls 24 are respectively arranged at a 0°, 60°, 120°, 180°, 240°, and 300° angular position, and according to the same relative angular position around the rotational axis A, the six lower balls 26 are respectively arranged at a 0°, 60°, 120°, 180°, 240°, and 300° angular position.

[0034] According to one embodiment of the invention, the upper balls 24 are all similar, and the lower balls 26 are all similar. More particularly, the upper balls 24 may have the same diameter than lower balls 26 such that the nest of each upper cage and lower cage of the balls holder 22 are all similar.

[0035] To provide a better haptic effect than the one obtained by the ring spring 20 cooperating with the detent ring 16, a plurality of uniform grooves 56 are regularly arranged vertically on the outer surface of the rotary cylindrical body portion 30 and all around the outer surface of the rotary cylindrical body portion 30 such that said plurality of uniform grooves 56 is in direct contact with the plurality of lower balls 26. According to said arrange-

ment of uniform grooves 56, the outer surface of the rotary cylindrical body portion 30 comprises a wavy surface providing haptic effect while the knob 10 is rotationally operated.

[0036] When combined with the haptic effect provided by the detent ring 16 together with the ring spring 20, rolling of the plurality of lower balls 26 onto the uniform grooves 56 of the outer surface of the rotary cylindrical body portion 30 is configured to be synchronized with the movement of the bumps 36, 38 of the ring spring 20 within the grooves 46 of the detent ring pattern 44 while the knob 10 is rotationally operated.

[0037] Optionally, or additionally, other uniform grooves 56 may be also arranged on the outer surface of the rotary conical body portion 28 and all around the outer surface of the rotary conical body portion 28 in a vertical direction, such that the plurality of upper balls 24 is in direct contact with said other uniform grooves 56. According to said arrangement of other uniform grooves 56, the outer surface of the rotary conical body portion 28 comprises a wavy surface providing haptic effect while the rotary knob 10 is rotationally operated.

Claims

1. Rotary knob (10) comprising:

a rotary body (14) comprising a rotary body portion of conical configuration (28) extending to a rotary bottom body portion of cylindrical configuration (30), both rotary portions (28, 30) extending along a vertical axis (V) defining the rotational axis (A) of the rotary knob (10); the rotary conical body portion (28) extending from its large end to its small end, said small end being merged into the rotary cylindrical body portion (30);

a fix body (18) comprising a fix body portion of hollow conical configuration (32) extending to a fix body portion of hollow cylindrical configuration (34), both fix portions (32, 34) extending along the vertical axis; the fix conical body portion (32) extending from its large end to its small end, said small end being merged into the fix cylindrical body portion (34);

the rotary conical body portion (28) being arranged inside the fix conical body portion (32); the rotary cylindrical body portion (30) being arranged inside the fix cylindrical body portion (34);

a plurality of upper balls (24) uniformly arranged around the rotary conical body portion (28), in contact with the rotary conical body portion (28), and in contact with the fix conical body portion (32);

a plurality of lower balls (26) uniformly arranged around the rotary cylindrical body portion (30),

in contact with the rotary cylindrical body portion (30), and in contact with the fix cylindrical body portion (34);

a balls holder (22) maintaining the plurality of upper balls (24) and the plurality of lower balls (26) in a free of rotation state, said balls holder (22) arranged free of contact with the rotary body (14);

such that balls are rotating in the balls holder (22) when the rotary knob (10) is rotationally operated.

2. Rotary knob (10) according to the preceding claim **characterized in that** the balls holder (22) comprises

a ring part (50) arranged around the rotary cylindrical body portion (30);

a plurality of two lower arms (52) extending vertically from the ring part (50) along the rotary cylindrical body portion (30), each lower balls (26) being retained between two lower arms (52) by means of bumps, such that each of two lower arms (52) forming a lower ball cage;

a plurality of two upper arms (54) extending from the ring part (50) in a vertical direction along the rotary conical body portion (28), each upper balls (24) being retained between two upper arms (54) by other means of bumps, such that each of two upper arms (54) forming an upper ball cage.

3. Rotary knob (10) according to any one of the preceding claims **characterized in that** each of upper balls (24) is aligned with a lower ball (26) in the vertical direction along the rotary body (14).

4. Rotary knob (10) according to any one of the preceding claims **characterized in that** outer surface of the rotary body (14) comprising a plurality of uniform grooves (56) extending in the vertical direction along the outer surface of the rotary body (14), regularly arranged around the outer surface of the rotary body (14) and in direct contact with the plurality of upper balls (24) and/or the plurality of lower balls (26);

such that the rotary body (14) comprises a wavy surface providing haptic effect while the rotary knob (10) is rotationally operated.

5. Rotary knob (10) according to claim 4 **characterized in that** the plurality of uniform grooves (56) are arranged on the outer surface of the rotary cylindrical body portion (30) such that said plurality of uniform grooves (56) is in direct contact with the plurality of lower balls (26).

6. Rotary knob (10) according to any one of the claims 4 or 5 **characterized in that** the rotary body (14) comprises a detent ring (16) arranged about the ro-

tational axis (A) at the bottom end of the rotary cylindrical body portion (30), said detent ring (16) cooperating with a resilient means (20) of the fix body (18), said resilient means (20) being configured to engage the detent ring (16), wherein the detent ring (16) comprises a pattern (44) of alternating grooves (46) and ridges (48), wherein the resilient means (20) are biased towards the pattern (44), and wherein rolling of the plurality of balls (24, 26) onto the uniform grooves (56) of the rotary body (14) is configured to be synchronized with the movement of the resilient means (20) within grooves (46) of the detent ring (16) pattern (44) while the rotary knob (10) is rotationally operated.

7. Rotary knob (10) according to any one of the preceding claims **characterized in that** the plurality of upper balls (24) is a plurality of steel balls.

8. Rotary knob (10) according to any one of the preceding claims **characterized in that** the plurality of lower balls (26) is a plurality of elastomer balls.

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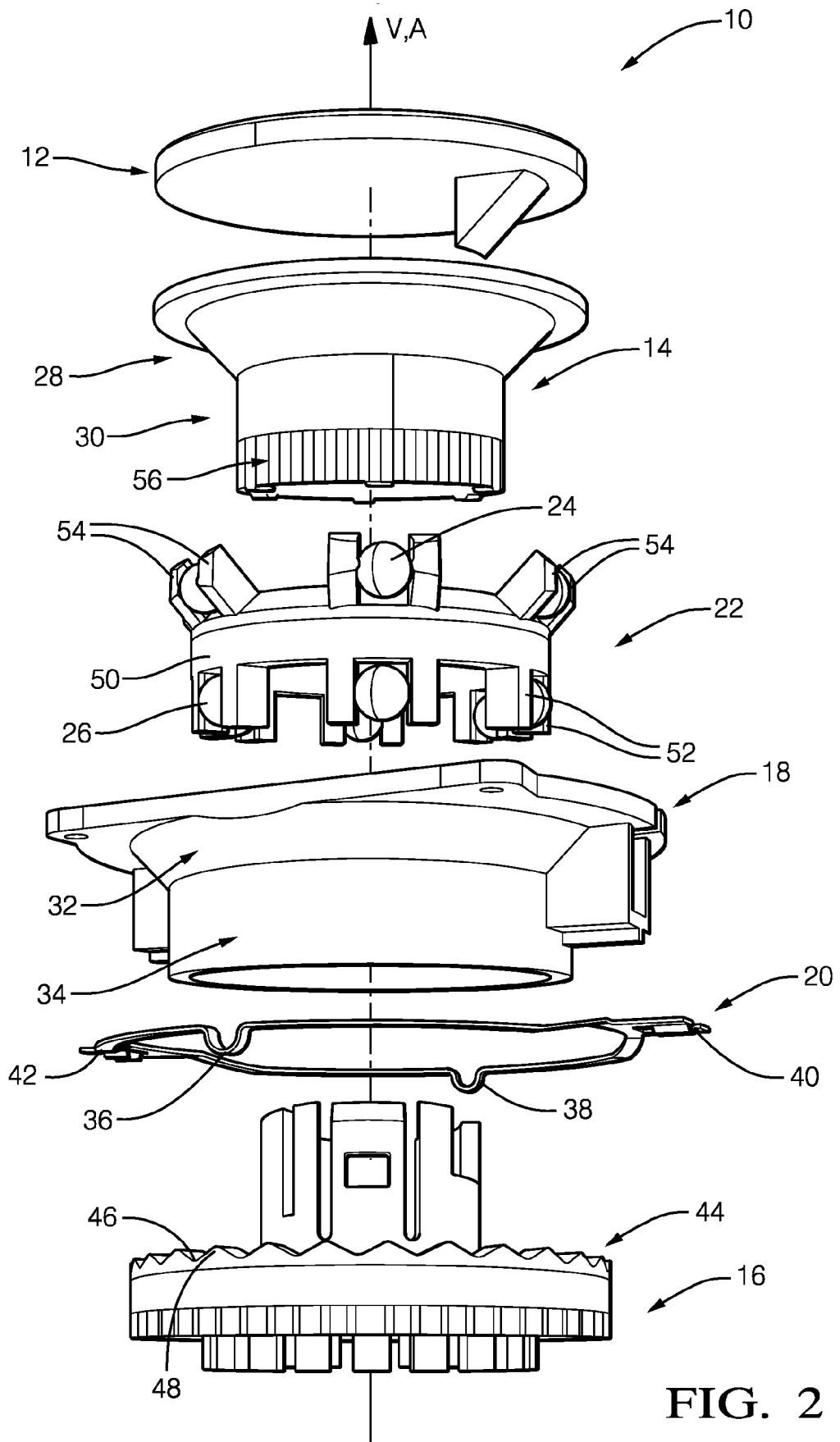


FIG. 2

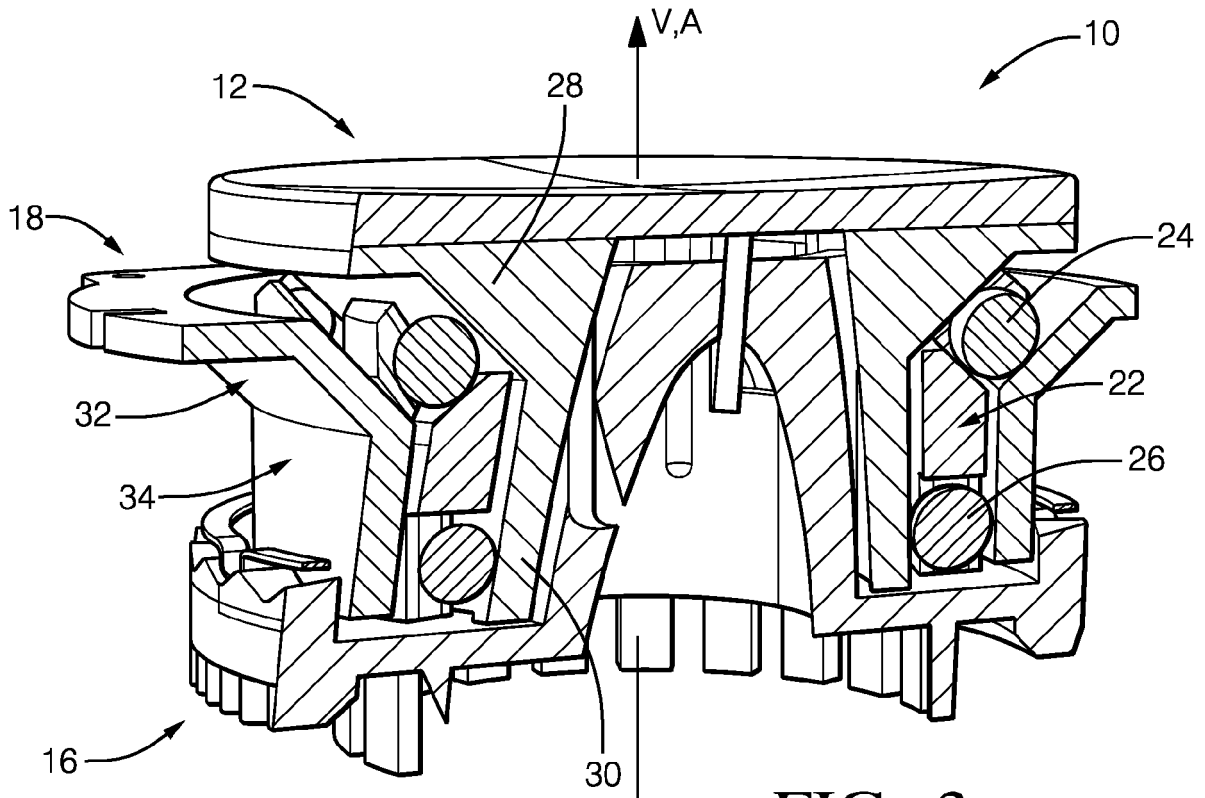


FIG. 3

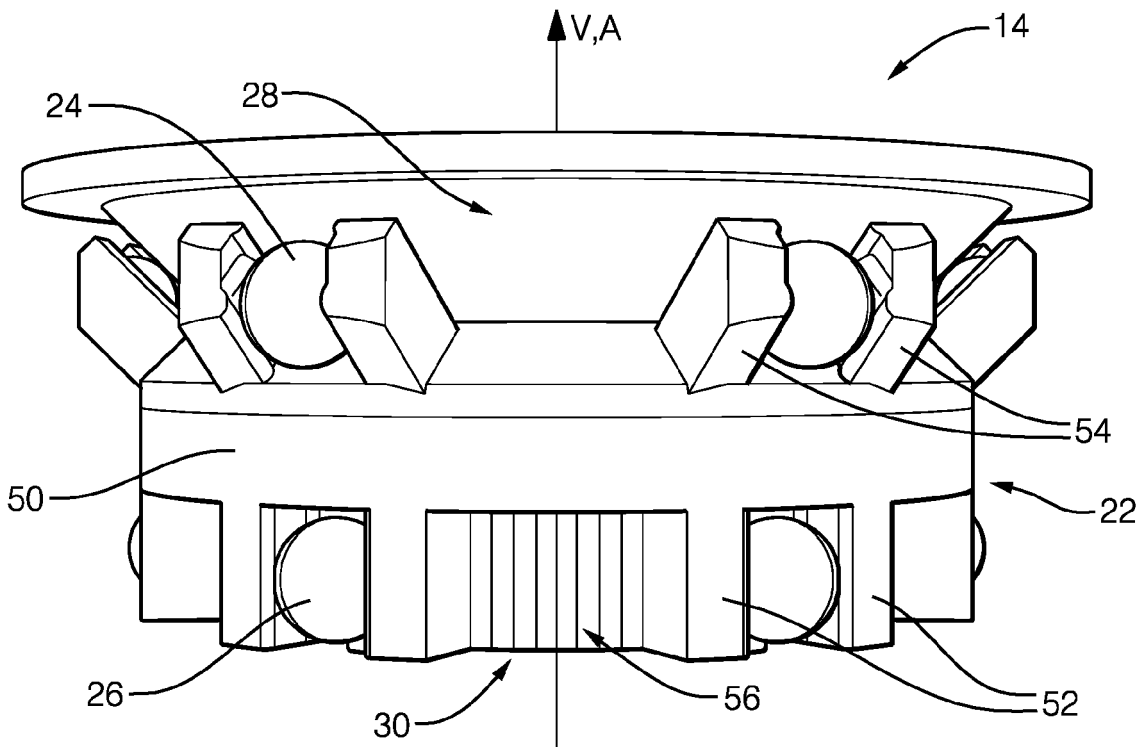


FIG. 4



EUROPEAN SEARCH REPORT

Application Number
EP 18 19 0707

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 January 2019	Examiner Findeli, Luc
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/02 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 18 19 0707

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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