



(51) International Patent Classification:

F01L 1/18 (2006.01) F01L 13/00 (2006.01)

(21) International Application Number:

PCT/IB2018/000576

(22) International Filing Date:

14 May 2018 (14.05.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

201711016821	12 May 2017 (12.05.2017)	IN
201711017242	17 May 2017 (17.05.2017)	IN

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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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, 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: SWITCHABLEN ROCKER ARM WITH CENTRAL SPRINGS

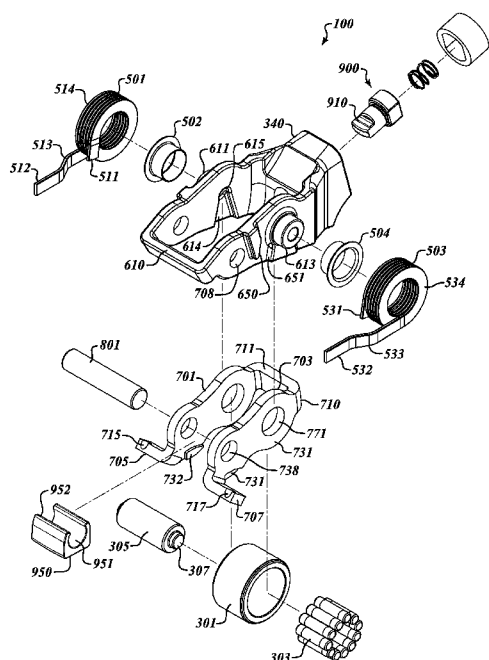


FIG. 5

(57) Abstract: A rocker arm assembly comprises an outer arm assembly comprising a pair of opposed outer arms joined by an outer arm body and joined by a shelf. Each of the pair of opposed outer arms further comprises exterior posts extending out from the outer arm assembly. An inner arm assembly is nested in the outer arm assembly and comprises a pair of opposed inner arms. A latch shelf joins the opposed inner arms. An axle passage is through the opposed inner arms. Respective extensions extend outward from the nested inner arm assembly to selectively abut the shelf joined to the outer arm assembly. A respective pair of springs are coiled on respective exterior posts. The springs are biased to separate the shelf from the respective extensions. A main axle is connected between the opposed outer arms and is connected through the axle passage.



SWITCHABLE ROCKER ARM WITH CENTRAL SPRINGSField

[001] This application provides a rocker arm for a valvetrain comprising centrally located springs.

Background

[001] Customers require more compact engine designs. And, new designs, such as engines having a cylinder head with a middle injector guide, require newer space-saving designs.

[002] Some designs place lost motion springs over the valve end. This increases inertia, as weight over the valve end increases. Lower inertia can be achieved by placing the springs on the pivot end of the rocker arm, but now space for an actuator for the inner arm is limited.

SUMMARY

[003] The methods and devices disclosed herein overcome the above disadvantages and improves the art by way of a rocker arm design that facilitates at least cylinder deactivation. A rocker arm assembly comprises an outer arm assembly comprising a pair of opposed outer arms joined at a first end by an outer arm body and joined at a second end by a shelf. Each of the pair of opposed outer arms further comprises exterior posts extending out from the outer arm assembly. An inner arm assembly is nested in the outer arm assembly and comprises a pair of opposed inner arms. A latch shelf joins the opposed inner arms at a first end. An axle passage is through the opposed inner arms. A respective extension is on each of the opposed inner arms, the respective extensions extending outward from the nested inner arm assembly to selectively abut the shelf joined to the outer arm assembly. A bearing is on a bearing axle, the bearing positioned between the opposed inner arms and between the axle passage and the latch shelf. A respective pair of springs are coiled on respective exterior posts. The springs are biased to separate the shelf from the respective extensions. A main axle is connected between the opposed outer arms and is connected through the axle passage.

[004] Additional objects and advantages will be set forth in part in the description which follows, and in part will be obvious from the description, or may be

learned by practice of the disclosure. The objects and advantages will also be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

- [005] Figure 1 is a view of a valve end of a rocker arm.
- [006] Figure 2 is a side view of an unactuated rocker arm.
- [007] Figure 3 is a cross-section view of the rocker arm of Figure 2.
- [008] Figure 4 is a side view of an actuated rocker arm.
- [009] Figure 5 is an exploded view of a rocker arm.
- [010] Figure 6 is a perspective view of a rocker arm.
- [011] Figure 7 is a top view of a rocker arm.
- [012] Figure 8 is a bottom view of a rocker arm.
- [013] Figure 9 is a top view of an alternative rocker arm.
- [014] Figure 10 is a bottom view of an alternative rocker arm.

DETAILED DESCRIPTION

[015] Reference will now be made in detail to the examples which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. Directional references such as “left” and “right” are for ease of reference to the figures.

[016] Engine designs trend toward smaller, more compact designs. And, one new design places injector guides in the middle of the cylinder head. This places heavy space constraints on valve actuators. In order to accommodate the multiple tradeoffs, rocker arms 100, 200 are disclosed herein with springs 501, 503 located between the valve end 10, 11 and the pivot end 20, 21. The springs 501, 503 can be said to be centered between the valve end 10, 11 and pivot end 20, 21 though some variance in actual placement is permitted. This enables a larger diameter spring for good spring force, enables compact reaction points for the spring arms, frees up space over the valve end and over the pivot end compared to prior art designs, and lowers inertia over valve-end spring designs. The rocker arm increases in a lateral dimension in a central area but facilitates increased response times and more flexibility in engine design.

[017] To reduce the footprint of the rocker arm 100, 200 actuating the valves of an engine cylinder, biasing springs 501, 503 are placed on outer sides of the rocker arm. Also, the travel stop 610 is configured to decrease manufacturing tolerances and to decrease the vertical dimension while increasing the ability to customize the rocker arm for each customer application. The longitudinal dimension, axis X-X or X2-X2, of the rocker arm can be reduced by modifying the latch assembly 900. A stepped inner and outer arm design (Figs 9 & 10) can reduce the latitudinal dimension, Y-Y or Y2-Y2. Having decreased the size of the rocker arm assembly, and hence the sweep of it as it pivots (compare Figures 2 & 4), the length of the valve stems 990 can also be decreased.

[018] Figures 1-8 illustrate a first design of a rocker arm 100 assembly for engine cylinder deactivation techniques. The inner arms 701, 703 and outer arms 601, 603 are parallel. In Figures 9 & 10, the inner arms 7030, 7010 are stepped, and the outer arms can be stepped to track the inner arms. The rocker arm assembly 100 comprises a longitudinal dimension X-X and a latitudinal dimension Y-Y perpendicular to the longitudinal dimension. The pair of opposed outer arms 601, 603 can comprise a stepped profile from the first end (pivot end 20) to the second end (valve end 10) along the longitudinal dimension X2-X2 resulting in a space between the opposed outer arms decreasing in the latitudinal dimension Y2-Y2 along the stepped profile from the first end to the second end. The opposed inner arms 7010, 7030 can comprise a complementary stepped profile to nest between the outer arms. For example, the inner arms 7010, 7030 can comprise a first parallel pair of arm portions surrounding bearing 301. Similar to parallel portions 731, first parallel pair of arm portions can longitudinally and vertically extend to brace the bearing 301 and needle bearings 303, as by comprising a disc-like shape. Travelling towards the valve end 11 from the pivot end 21, mirrored bends 7311 can transition to second parallel pair of arm portions 7312. The second parallel pair of arm portions 7312 can be configured to guide the valve stem on the valve seat 950, and the valve seat 950 can be correspondingly sized. Additional bends 7313 can mirror to form valve guides before further extending to form the respective extensions 7050, 7070.

[019] The rocker arms 100 & 200 are designed for use with an overhead cam lobe (for example, a type II engine). A lash adjuster can be installed in socket

400 of pivot end 20, 21. For example, a dual feed hydraulic lash adjuster (DFHLA), mechanical lash adjuster, or other hydraulic lash adjusters (HLAs) can be used.

[020] A rocker arm assembly 100, 200 can comprise an outer arm assembly, comprising a pair of opposed outer arms 601, 603 joined at a first end (pivot end 20) by an outer arm body 340 and joined at a second end (valve end 10) by a shelf 610.

[021] The pair of opposed outer arms are substantially planar along facing inner surfaces. Travel stops 615, 617 can be formed in travel grooves 614, 616. Then, the bearing axle 305 can comprise extensions 307, 309 that swing in the travel grooves 614, 616 when the inner arm is actuated in lost motion. The extensions 309, 307 are biased by the force of the springs 501, 503 so that travel stops 615, 617 limit the motion of the inner arms with respect to the outer arms. The reaction points of the springs 501, 503 ensure this travel-limited bias. When the bias is strong enough, the arm latch seat 711 is biased above the latch surface 910. Latch surface 910 protrudes from latch port 950. Latch assembly 900 can comprise an electrical latch, hydraulic latch, or mechanical latch. The latch comprising latch surface 910 can be configured to enable the inner arms to pivot on the main axle 801 when the latch is retracted in to the outer arm body, and the latch surface and the latch can be configured to join the inner arms and the outer arms to move together when the latch extends out from the outer arm body. Whether the latch is biased retracted or extended is a design choice, and so “actuated” can be extended and “unactuated” can be retracted, or vice versa as the case may be.

[022] As an additional benefit, the travel stops 610, 615, 617 having been moved to within the outer arms or to the valve end, as the case may be, a travel limit through the outer wall (former “kidney bin”) can be eliminated, reducing machining operations.

[023] The pair of opposed inner arms can be planar along respective exterior surfaces to complement the planar, facing inner surfaces of the pair of opposed outer arms, as om Figures 1-8. Inner arm assembly is nested in the outer arm assembly. Inner arm assembly comprises a pair of opposed inner arms 701, 703. A latch shelf 711 joins the opposed inner arms at a first end (pivot end 20) of the rocker arm 100, 200. On the valve end 10, a respective extension 705, 707 on each of the opposed inner arms 701, 703 extend outward from the nested inner arm

assembly to selectively abut a travel stop surface 611 of the shelf 610 joined to the outer arm assembly. The extensions 705, 707 can comprise respective catches 715, 717 to receive ends 512, 532 of springs 501, 503.

[024] Valve guides 732, 731 can be formed on the inner arms 701, 703. These valve guides 732, 731 can be stepped as by machining, stamping, crimping, among others, to guide the valve stem. A valve seat 950 (e-foot or elephant foot) can be seated between the valve guides, and the valve seat can comprise cusps 952 to encircle a main, or pivot, axle 801.

[025] Inner arms can comprise mirrored axle passage 738 through the opposed inner arms 701, 701. Outer arms 601, 603 can comprise mirrored outer axle passages 708. A main axle 801 (pivot axle) can connect the inner arm assembly to the outer arm assembly by passing between the opposed outer arms and through the axle passages 738 and outer axle passages 708. In the actuated condition, the inner arm assembly can pivot with respect to the outer arms on the main axle 801. When in the unactuated condition, the inner arm assembly and outer arm assembly move together, braced by the main axle 801 and braced by the inner arm latch shelf 711. Inner arm latch shelf 711 comprises an arm latch surface 710 that can be biased by the springs 501, 503 to be above the latch surface 910 of the latch assembly 900. But, an overhead cam can press, via the bearing assembly, the arm latch surface 710 against the latch assembly 900 latch surface 910.

[026] A bearing 301 can be mounted on a bearing axle 305 with or without intervening needle bearings 303. The bearing 301 can be positioned between the opposed inner arms 701, 703. Bearing axle can be between the main axle 801 (and corresponding axle passage 738 and outer axle passages 708) and the latch shelf 711.

[027] The reaction points of the springs 501, 503 enable several space-saving features while enabling sufficient spring force. A respective pair of springs 501, 503 are biased on external posts 611, 613 on respective ones of the pair of opposed outer arms 601, 603. External posts 611, 613 can be cantilevered posts formed with the outer arms. First ends 511, 531 of the springs can be biased against mirrored ledges 650. A second ledge 651 can be included to limit the ability of the first ends to move. The first and second ledges 650, 651 can form a trough or groove to guide the first ends. Second ledge 651 can advantageously be formed in

line with the travel grooves 614, 616 so that the inverse forms the portion of the trough and the obverse forms the travel groove, thus enabling compact manufacturing techniques and optimizing material use. Respective ones of the extensions 705, 707 comprise the opposing reaction points for the second spring ends 512, 532. Respective catches 715, 717 guide the second spring ends and secure the second spring ends from lateral motion. Springs can comprise one or more bend 533 to laterally decrease the footprint of the spring assembly and thus the rocker arm 100 or 200. The pair of springs 501, 503 are biased to separate the shelf 610 and thus travel stop surface 611 from abutting the respective extensions 705, 707. When the latch is actuated to retract and permit the inner arm to pivot with respect to the outer arm, the shelf 610 of the outer arm assembly limits the rotation of the inner arm assembly when the inner arm rotates on main axle 801.

[028] The springs 501, 503 can be said to be centered between the valve end 10, 11 and pivot end 20, 21 though some variance in actual placement is permitted. Another way of phrasing the relationship is that the posts 611, 613 can be in-line with the bearing axle 305, and the springs 501, 501 are coiled on the posts. Or, the coils of the springs are in-line with the bearing axle 603. So, each spring of the pair of springs consists essentially of a coiled spring portion 514, 534, a first straight leg portion with first end 511, 531, and a second straight leg portion with second end 512, 532. The respective pair of springs 501, 503 can be mounted in-line with the bearing axle 305 on opposed outer surfaces of the pair of opposed outer arms 601, 603. Each spring of the pair of springs can consist essentially of a coiled spring portion 514, 534, a first straight leg portion with first end 511, 531, and a second bent leg portion with bends 513, 533 and second ends 512, 532. The coiled portions 513, 534 can be secured to the posts 611, 613 by retainers 502, 504.

[029] In the latched condition, a cam lobe rotates and pushes the inner arms together with the outer arms to move the valve. In the unlatched condition, the inner arms travel and the motion becomes lost motion, and the valve is not moved.

[030] The pair of lost motion torsion springs 501, 503 are outside both the inner arms 701, 703 and the outer arms 601, 603. Each lost motion springs is biased to configure the inner arms towards an overhead cam lobe. As can be seen, a ledge 650 in the outer arm 603 biases a first end 531 of the spring 503, and a

second end 532 of the spring is biased against a hook (extension 707) extending outward from the inner arm 703.

[031] The outer arms 601, 603 comprise a shelf 610 near the ledges 650, the shelf 610 spanning across the latitudinal dimension Y-Y. The shelf 610 can serve for stability or as a lower travel stop for the extensions 705, 707 of inner arms 701, 703. The hooks extending outward from the inner arm can contact the shelf during lost motion and limit critical shift risks for the valve. It is possible in this design to design bent outer and inner arms to permit the use of a coiled spring with straight arms.

[032] A rocker arm assembly 100 for engine cylinder deactivation techniques is shown having parallel inner and outer arms. The outer torsion springs 501, 503 can comprise a straight leg abutting ledges 650, 651 on the outer side of the outer arm and a bent leg (comprising bend 513, 533 and ends 512, 532) in contact with the hook extending outward from the inner arm. The springs are coiled around cantilevered mounts (posts 611, 613) on the outside of the outer arms 701, 703 or 7010, 7030). The springs are aligned with, but not mounted to, the bearing axle 605. Disconnecting the springs from the bearing axle 605 and mounting the springs on posts on the outer sides of the outer arms gives more design flexibility. Moving the springs from mountings on the outer arm body 340 of the outer arms to the outer sides of the outer arms permits more design flexibility for what can be attached to the outer arm body 340 while eliminating a “kidney bin” through the outer arm sides. For example, a greater variety of latching mechanisms can be substituted for the latch assembly 900 because the springs are no longer attached to the outer arm body 340 and are instead attached between the valve end 10,11 and the pivot end 20, 21. The spring placement can be designed based on the valve position and can be optimized without constraining the design to the bearing axle. The spring itself can also have reduced complexity.

[033] The bearing axle 605 spans across the inner arms 701, 703 or 7010, 7030, but does not mount to or pass through the outer arms 601, 603. However, the bearing axle 605 does serve as a travel limit, or upper stop feature, as outlined above. Inside the outer arms, a slot is cast or machined to form travel grooves 614, 616 to guide the bearing axle when the inner arm travels in lost motion. By controlling the top of the slot, as by machining or drilling holes 605, 607 in posts

611, 613, the latch lash can be controlled. Latch lash is the height above the latch that the inner arm achieves due to the spring bias. This height is also related to the ability of the bearing 301 to follow the cam lobe as the cam lobe rotates.

[034] As noted, Figures 9 & 10 comprise a further embodiment comprising parallel outer arms 601, 603, bent inner arms 7010, 7030, and bent inner arm hooks (extensions 7050, 7070). By including bends 7311, 7313 on the inner arms, the e-foot 950 for the valve stem and the valve stem 990 can be restrained using less material on the inner arms 7010, 7030, permitting lightweighting. The hooks (extensions 7050, 7070) hanging down from the inner arms can also be bent inwards to restrain the valve stem. The hooks, from their place near the valve stem, can then extend outward laterally from the device to perform their function of biasing the springs mounted on the outer sides of the outer arms and providing a travel stop.

[035] Other implementations will be apparent to those skilled in the art from consideration of the specification and practice of the examples disclosed herein.

WHAT IS CLAIMED IS:

1. A rocker arm assembly, comprising:
 - an outer arm assembly comprising a pair of opposed outer arms joined at a first end by an outer arm body and joined at a second end by a shelf, each of the pair of opposed outer arms further comprising exterior posts extending out from the outer arm assembly;
 - an inner arm assembly nested in the outer arm assembly comprising:
 - a pair of opposed inner arms;
 - a latch shelf joining the opposed inner arms at a first end;
 - an axle passage through the opposed inner arms; and
 - a respective extension on each of the opposed inner arms, the respective extensions extending outward from the nested inner arm assembly to selectively abut the shelf joined to the outer arm assembly;
 - a bearing on a bearing axle, the bearing positioned between the opposed inner arms and between the axle passage and the latch shelf;
 - a respective pair of springs coiled on respective exterior posts, the springs biased to separate the shelf from the respective extensions; and
 - a main axle connected between the opposed outer arms and connected through the axle passage.
2. The rocker arm assembly of claim 1, wherein the shelf of the outer arm assembly limits the rotation of the inner arm assembly when the inner arm rotates on main axle.
3. The rocker arm assembly of claim 1, wherein each spring of the pair of springs comprises a first end and a second end, wherein each of the pair of opposed outer arms further comprises at least one respective ledge, and wherein each spring is biased between respective ones of the respective ledge and respective ones of the extensions.
4. The rocker arm assembly of claim 1, wherein the exterior posts extending out from the outer arm assembly are in-line with the bearing axle.
5. The rocker arm assembly of claim 1, wherein the exterior posts extending out from the outer arm assembly are centered between the outer arm body and the main axle.

6. The rocker arm assembly of claim 1, comprising a longitudinal dimension with the main axle on a first end and the outer arm body on a second end, and a latitudinal dimension perpendicular to the longitudinal dimension, wherein the exterior posts extending out from the outer arm assembly are longitudinally between the outer arm body and the main axle.
7. The rocker arm assembly of claim 1, comprising a longitudinal dimension with the main axle on a first end and the outer arm body on a second end, and a latitudinal dimension perpendicular to the longitudinal dimension, wherein the exterior posts extending out from the outer arm assembly are laterally in-line with the bearing axle.
8. The rocker arm assembly of claim 1, comprising a longitudinal dimension and a latitudinal dimension perpendicular to the longitudinal dimension, wherein the pair of opposed outer arms comprise a stepped profile from the first end to the second end along the longitudinal dimension resulting in a space between the opposed outer arms decreasing in the latitudinal dimension along the stepped profile from the first end to the second end.
9. The rocker arm assembly of claim 8, wherein the opposed inner arms comprise a complementary stepped profile to nest between the outer arms.
10. The rocker arm assembly of claim 1, comprising a longitudinal dimension and a latitudinal dimension perpendicular to the longitudinal dimension, wherein the pair of opposed inner arms comprise a stepped profile from the first end to the second end along the longitudinal dimension resulting in a space between the opposed inner arms decreasing in the latitudinal dimension along the stepped profile from the first end to the second end, the pair of inner arms comprising respective valve guides configured to restrain the motion of a valve stem seated between the valve guides.
11. The rocker arm assembly of any one of claims 1-10, wherein each spring of the pair of springs consists essentially of a coiled spring portion, a first straight leg portion, and a second straight leg portion.
12. The rocker arm assembly of claim 1, wherein the respective pair of springs are mounted in-line with the bearing axle on opposed outer surfaces of the pair of opposed outer arms.

13. The rocker arm assembly of claim 1, wherein the pair of opposed outer arms are planar along facing inner surfaces, and wherein the pair of opposed inner arms are planar along respective exterior surfaces to complement the planar facing inner surfaces of the pair of opposed outer arms

14. The rocker arm of any one of claims 1- 10, wherein each spring of the pair of springs consists essentially of a coiled spring portion, a first straight leg portion, and a second bent leg portion.

15. The rocker arm of any one of claims 1-10, further comprising a latch mounted to the outer arm body, the latch configured to enable the inner arms to pivot on the main axle when the latch is retracted in to the outer arm body, and the latch configured to join the inner arms and the outer arms to move together when the latch extends out from the outer arm body.

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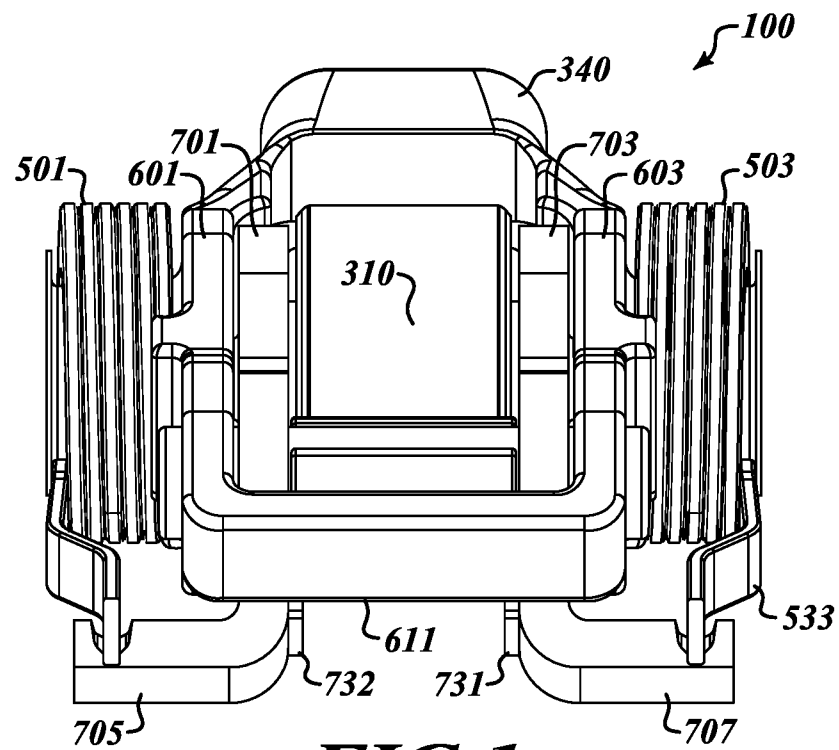


FIG. 1

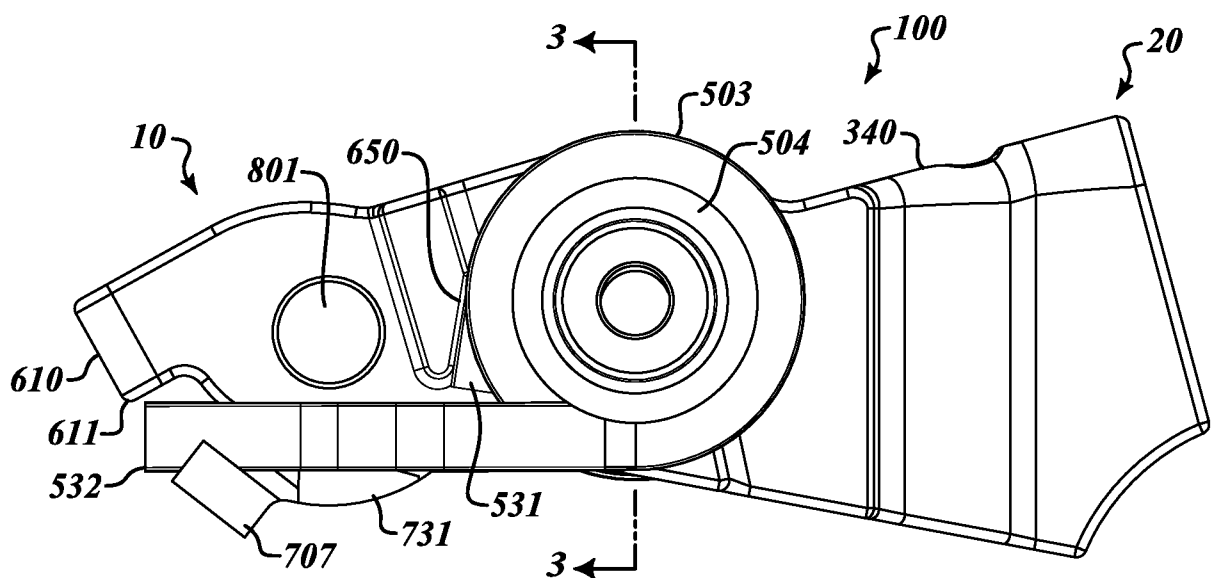


FIG. 2

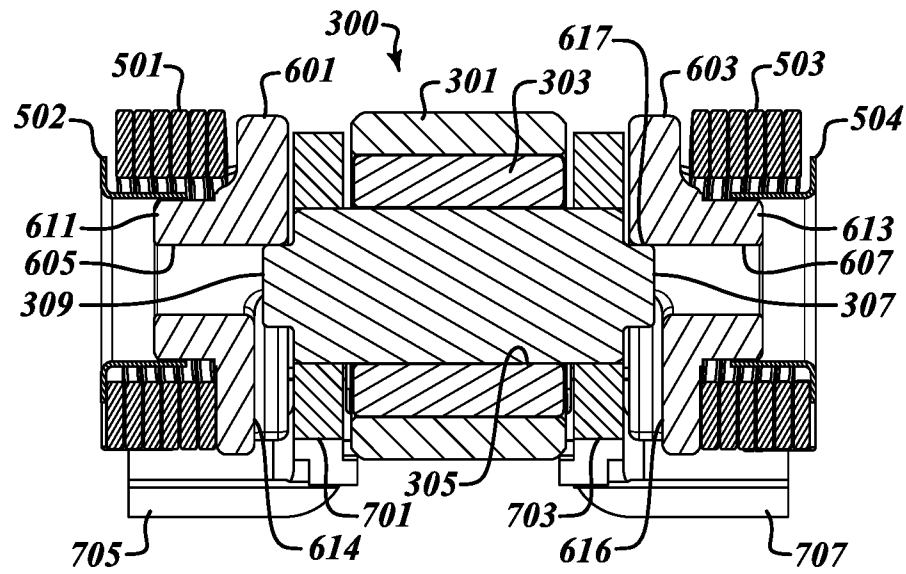


FIG.3

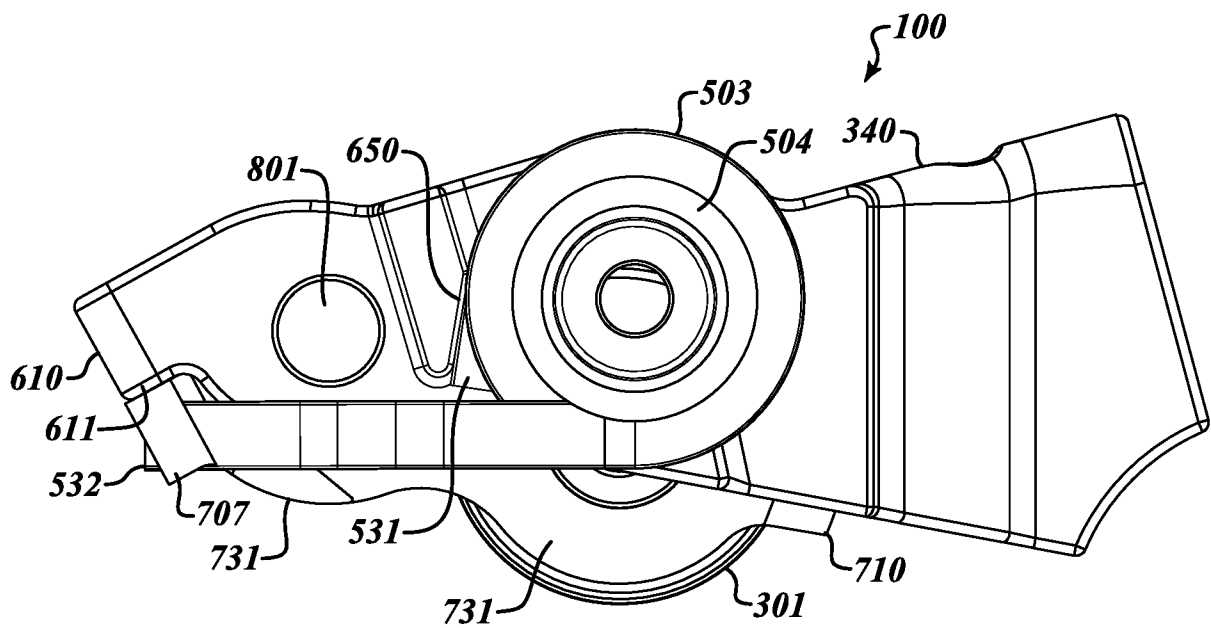


FIG.4

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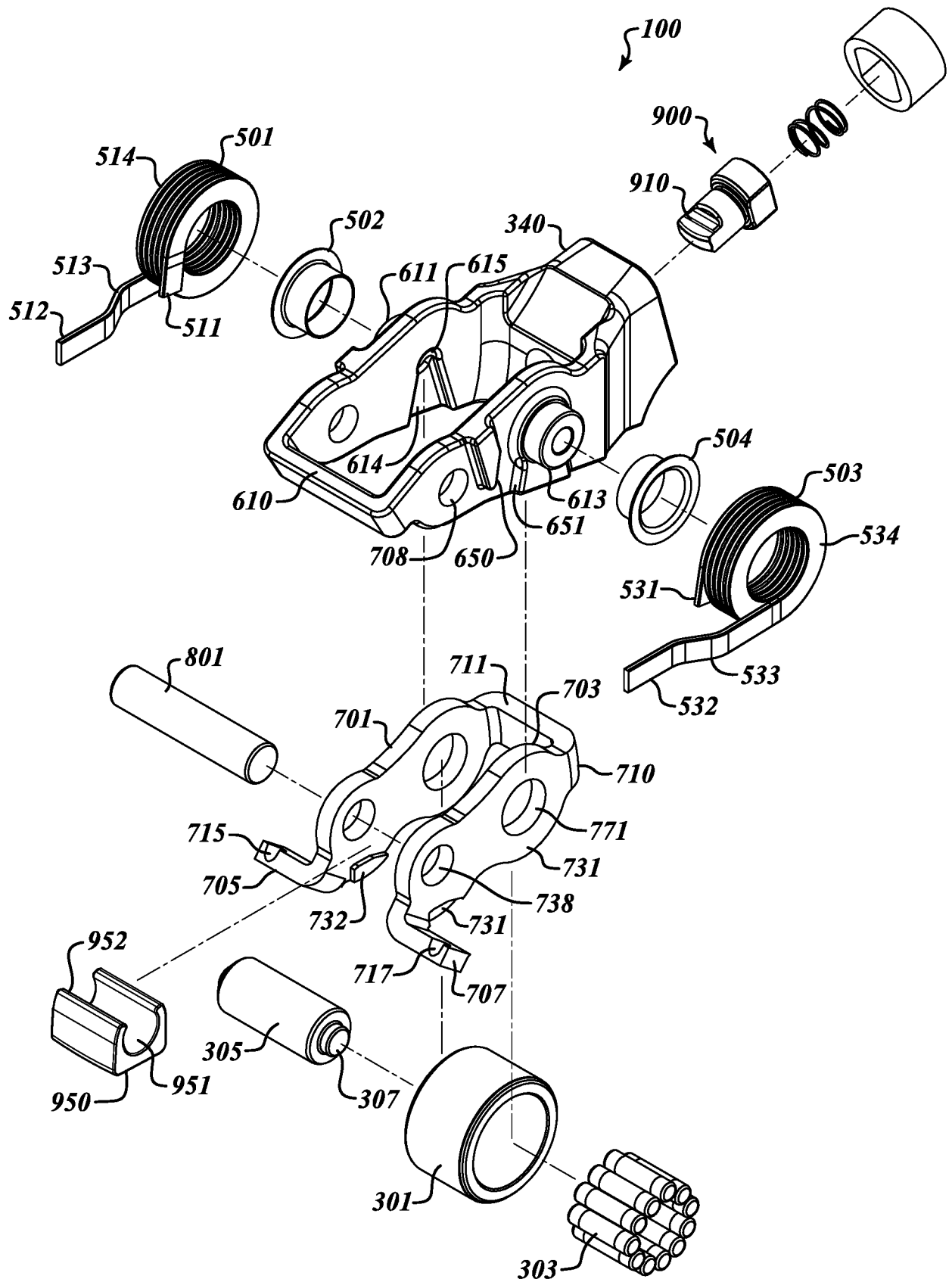
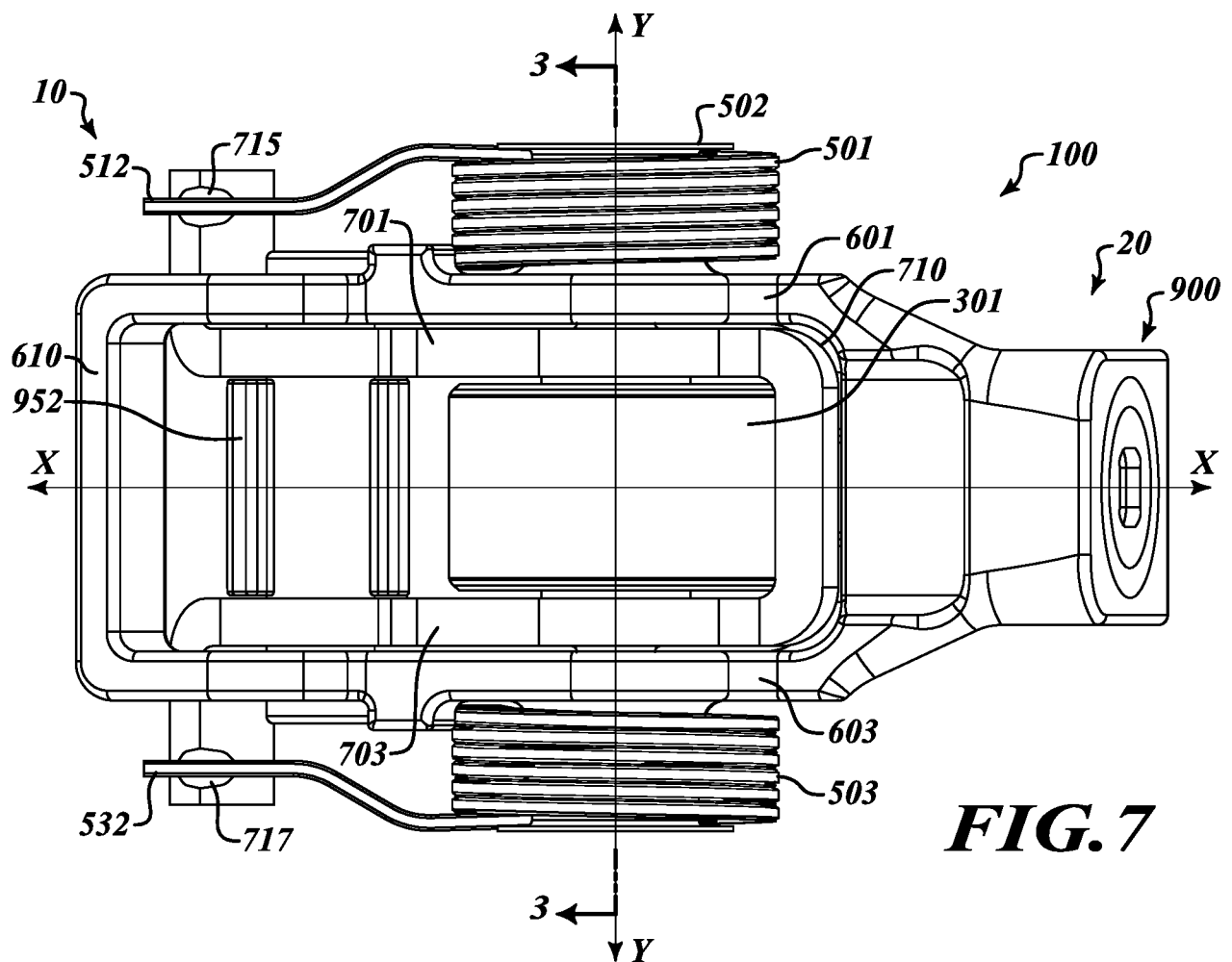
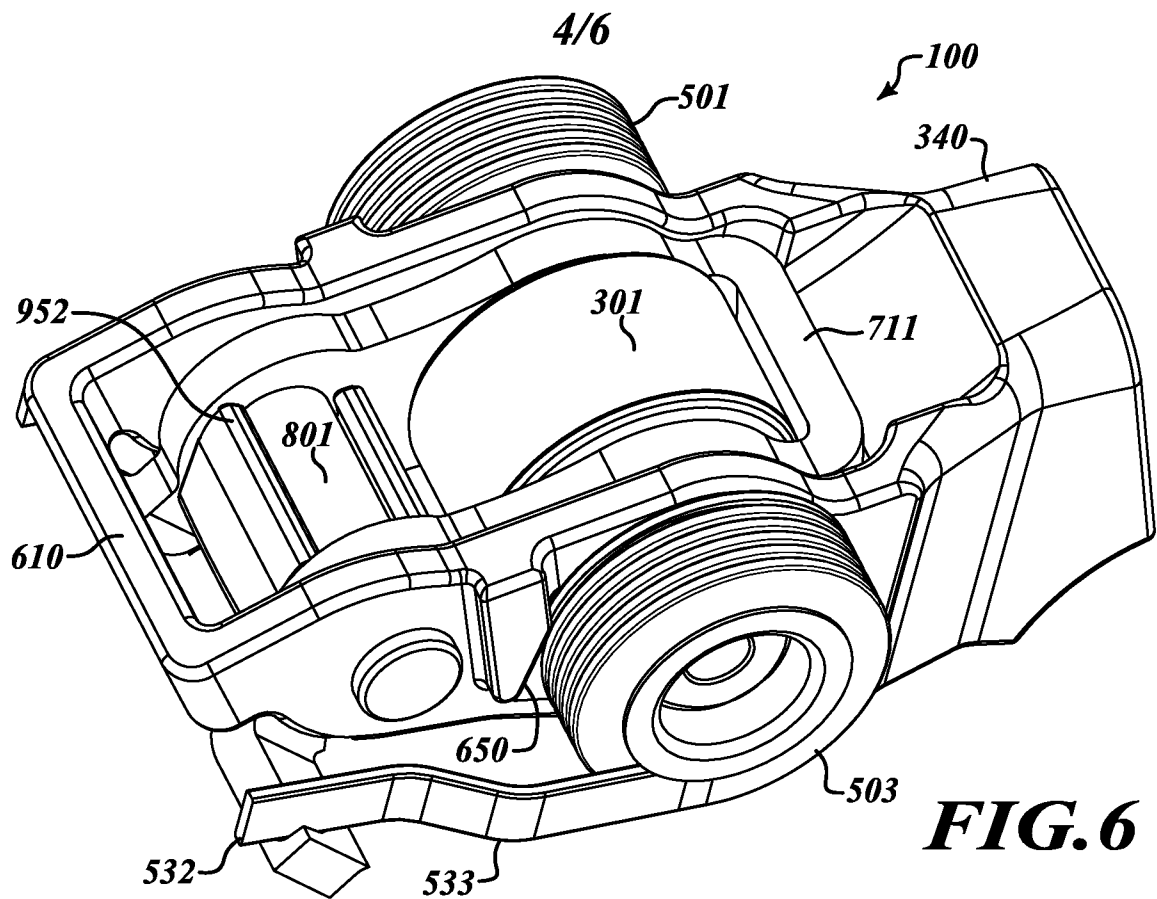


FIG.5



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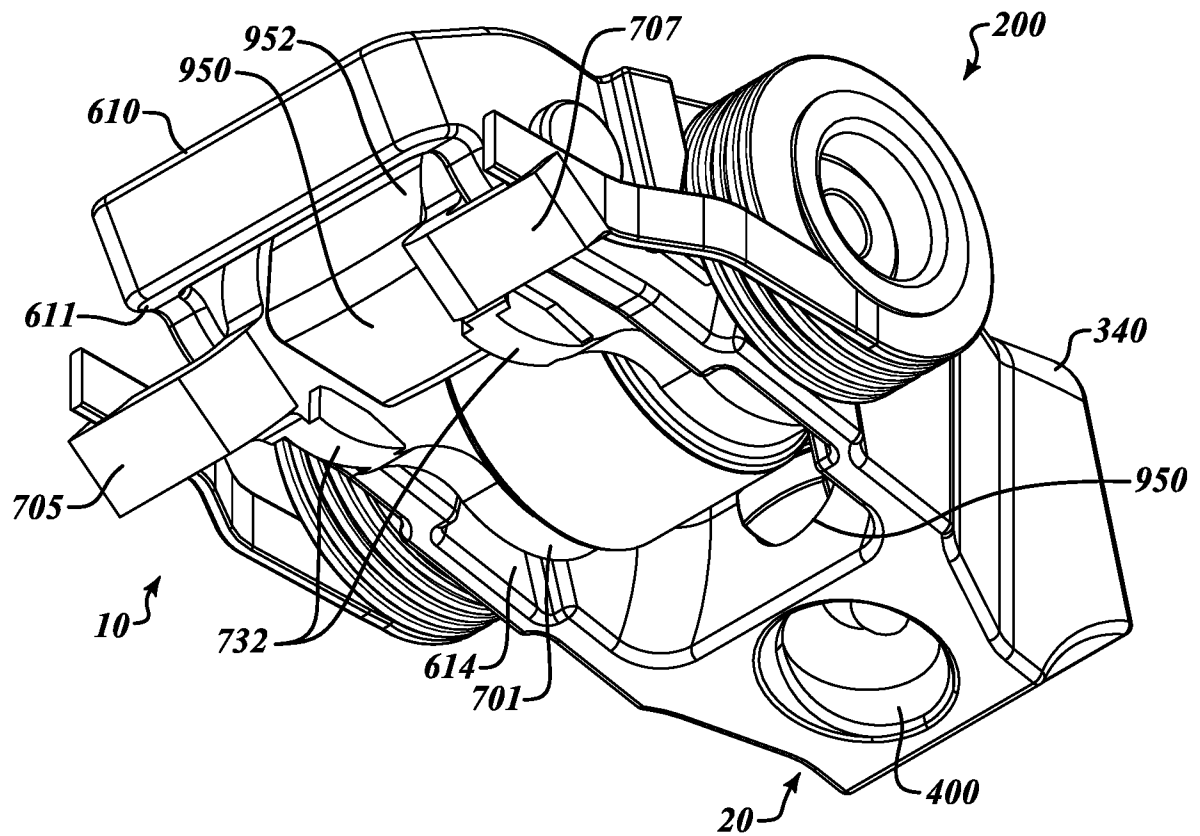


FIG. 8

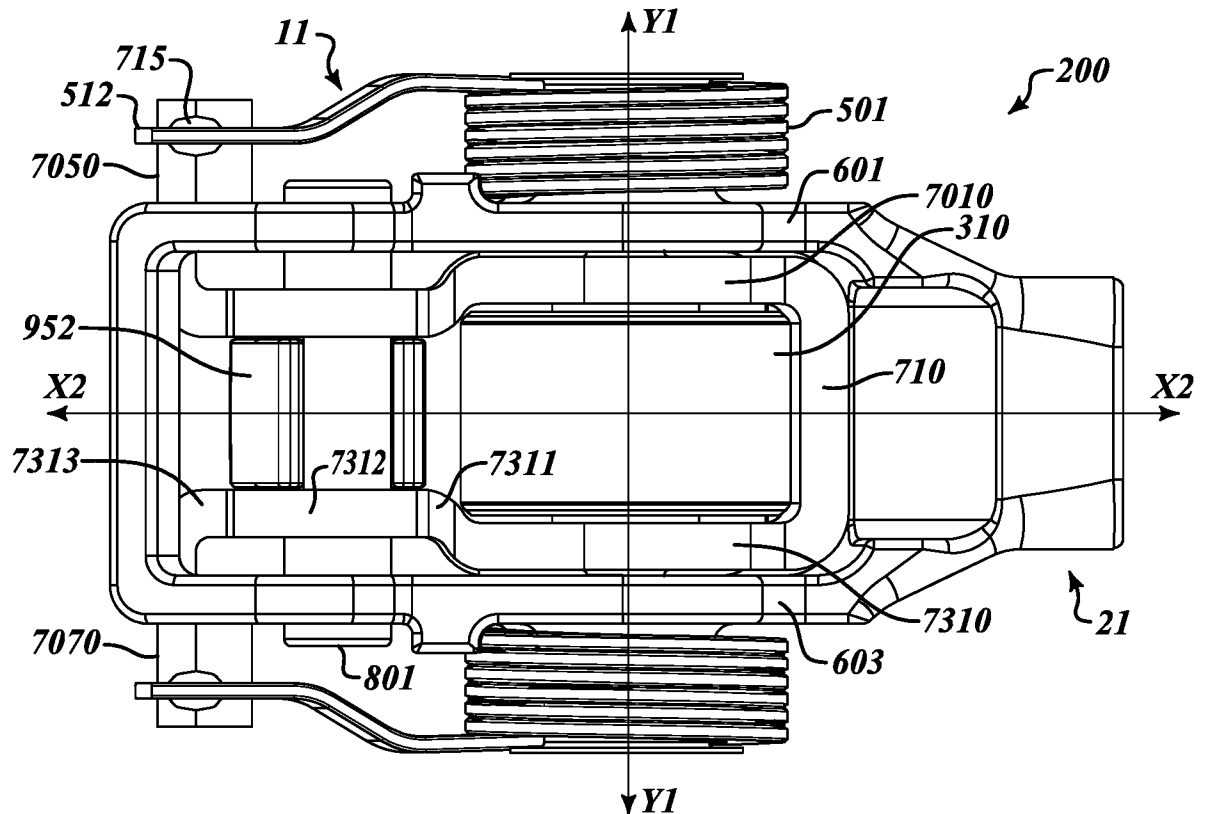


FIG. 9

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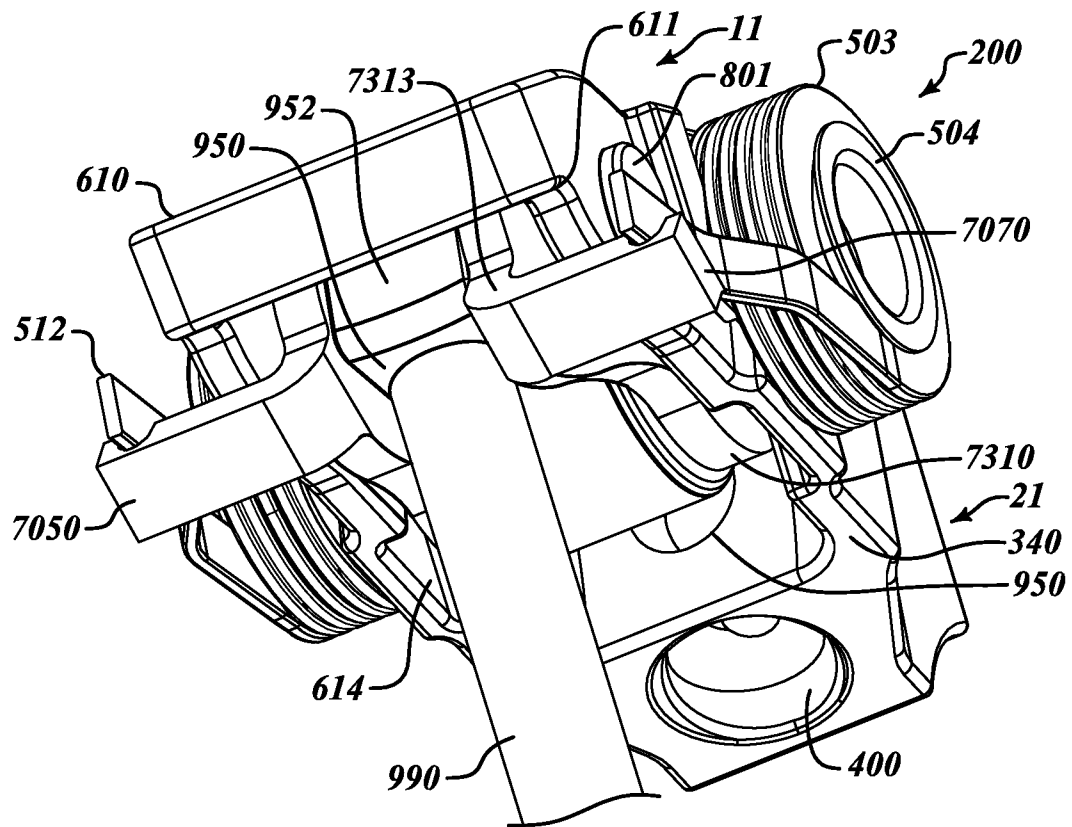


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000576

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01L1/18 F01L13/00
ADD.

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)
F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/031975 A1 (RORIG BODO [DE]) 5 February 2009 (2009-02-05)	1,10,13, 15
Y	the whole document	2-9,11, 12,14
Y	----- US 2003/230270 A1 (SEITZ JOACHIM [DE]) 18 December 2003 (2003-12-18)	2-9,12
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X	----- US 5 544 626 A (DIGGS MATTHEW B [US] ET AL) 13 August 1996 (1996-08-13)	1
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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17 July 2018

Date of mailing of the international search report

06/08/2018

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Klinger, Thierry

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/000576

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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