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(54) **Title**: DIFFERENTIAL CASE ASSEMBLY

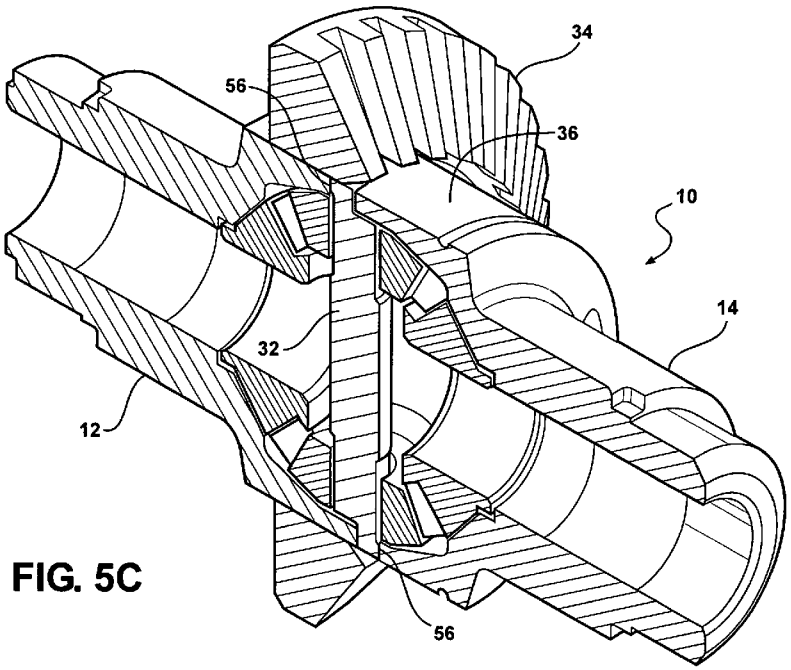


FIG. 5C

(57) **Abstract**: A differential case is operably coupled to a drive pinion of an engine drive shaft. The differential case includes first and second case members each including an inboard edge. The first and second case members are fixedly secured to one another along the respective inboard edges. A ring gear is fixedly secured along at least one of the first and second case members. The ring gear is engageable with the drive pinion of the engine drive shaft to effect rotational movement of the differential case.

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DIFFERENTIAL CASE ASSEMBLY

BACKGROUND

1. Field of the Invention

[0001] The invention relates to differentials for motor vehicles. More particularly, the invention relates to a differential case including first and second case members welded to one another along an inboard edge thereof.

2. Description of Related Art

[0002] A conventional drive axle assembly includes a drive axle housing from which a pair of axle shafts extends to rotatably support one or more wheels on opposite sides of a motor vehicle. Power is input to the drive axle assembly through an input shaft that rotates a drive pinion. The drive pinion engages a ring gear that is coupled to a differential case rotatably supported within the drive axle housing. A plurality of gears, including a pair of pinion gears and a pair of side gears, is mounted within the differential case. Rotation of the differential case (through the action of the drive pinion and the ring gear) causes rotation of a crosspin and the pinion gears mounted therealong. The pinion gears engage the side gears that are coupled to the axle shafts.

SUMMARY

[0003] According to one aspect of the invention, a differential case is operably coupled to a drive pinion of an engine drive shaft. The differential case includes first and second case members each including an inboard edge. The first and second case members are fixedly secured to one another along the respective inboard edges. A ring gear is fixedly secured along at least one of the first and second case members. The ring gear is engageable with the drive pinion of the engine drive shaft to effect rotational movement of the differential case.

[0004] According to another aspect of the invention, a differential case is operably coupled to a drive pinion of an engine drive shaft. The differential case includes a first case member including an inboard edge defining a mounting recess, and a second case member including an inboard edge defining a mounting recess. The first and second case members are fixedly secured to one another along the respective inboard edges. The differential case also includes a differential crosspin having a main body extending between opposing first and second ends each including a mounting tab. One of the mounting tabs is fixedly mounted

within the mounting recess of the first case member and the other of the mounting tabs is fixedly mounted within the mounting recess of the second case member to prevent radial rotation and lateral movement of the differential crosspin relative to the first and second case members.

[0005] According to yet another aspect of the invention, a differential case is operably coupled to a drive pinion of an engine drive shaft. The differential case includes a first case member extending between opposing inboard and outboard edges and having an outer wall, and a second case member extending between opposing inboard and outboard edges and having an outer wall. The first and second case members are fixedly secured to one another along the respective inboard edges. The differential case also includes a ring gear fixedly secured to at least one of the first and second case members. The ring gear is engageable with the drive pinion of the engine drive shaft to effect rotational movement of the differential case. At least one of the first and second case members includes a plurality of recesses extending through the outer wall thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0007] Figure 1A is a perspective view of a differential case according to one embodiment;

[0008] Figure 1B is a perspective view, partially cut away, of the differential case including a differential crosspin and pinion gears mounted therealong;

[0009] Figure 2 is an exploded perspective view of the differential case;

[0010] Figures 3A and 3B are perspective views of the first case member of the differential case;

[0011] Figure 4A is a perspective view of the differential case;

[0012] Figure 4B is an elevational view of the differential case;

[0013] Figure 4C is a cross-sectional view taken along lines C-C in Figure 4B;

[0014] Figure 4D is a cross-sectional view taken along lines D-D in Figure 4B;

[0015] Figures 5A and 5B are perspective views of the differential case including a ring gear fixedly secured therealong;

[0016] Figure 5C is a perspective view, partially cut away, of the differential case and ring gear in Figures 5A and 5B;

[0017] Figure 6A is a front perspective view of the differential crosspin;

[0018] Figure 6B is a side view of the differential crosspin;

[0019] Figure 6C is a rear perspective view of the differential crosspin;

[0020] Figures 7A and 7B are perspective views of a differential case according to another embodiment including a ring gear mounted therealong; and

[0021] Figure 7C is a perspective view, partially cut away, of the differential case and ring gear in Figures 7A and 7B.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] Referring to Figures 1A through 4C, a differential case, generally shown at 10, is provided for a differential assembly including a differential housing (not shown). The differential case 10 includes first 12 and second 14 case members. Each of the first 12 and second 14 case members includes numerous cylindrical sections of varying diameters. In one embodiment, the first 12 and second 14 case members are identical in shape and size. It is, however, appreciated that the particular shape, size, and configuration of the first 12 and second 14 case members may vary, i.e., the first case member 12 may have a length greater than the second case member 14.

[0023] Each of the first 12 and second 14 case members includes an outer wall 15 and defines an interior portion 16. The first 12 and second 14 case members each extend between an inboard edge 18 and an outboard edge 19. The inboard 18 and outboard 19 edges are generally circular. The interior portion 16 extends from the inboard edge 18 to the outboard edge 19. The first 12 and second 14 case members also include a hub 20 formed proximate the outboard edge 19. Each hub 20 defines an opening 22 for receiving an axle shaft therethrough. One end of each axle shaft is fixedly secured to a wheel of a motor vehicle.

[0024] The first 12 and second 14 case members are formed as separate cast iron components and are fixedly secured to one another to form the differential case 10. More specifically, the first case member 12 and the second case member 14 are welded to one another all along the inboard edge 18 of the first 12 and second 14 case members. The welding of the first 12 and second 14 case members to one another may be accomplished by any of numerous welding techniques including laser welding or electronic beam welding. The formation of the differential case 10 from the separate first 12 and second 14 case members allows the assembly of various components, including a pair of side gears 24, 26 operably coupled to the axle shafts, pair of side gear thrust washers 25, 27, a pair of pinion gears 28, 30, a pair of pinion gear thrust washers 29, 31, and a differential crosspin 32, within the interior portion 16 of each of the first 12 and second 14 case members prior to the welding of the first 12 and second 14 case members to one another.

[0025] Referring to Figures 5A through 5C, a ring gear 34 is welded to the differential case 10 along an outer surface 36 thereof. As a result of such fixed engagement, rotation of the ring gear 34 rotates the differential case 10. The ring gear 34 engages a drive pinion (not shown) in order to couple the differential case 10 to an engine drive shaft (not shown). The outer surface 36 of the differential case 10 is the outer walls 15 of the first 12 and second 14 case members. Thus, the ring gear 34 abuts the outer wall 15 of at least one of the first 12 and second 14 case members. It is contemplated that the ring gear 34 may be mounted at any of numerous locations along the outer surface 36 of the differential case 10. The ring gear 34 may be fixedly secured to the differential case 10 by electronic beam welding, laser welding, or the like. In conventional differential cases, the differential case includes a flange, and the ring gear is fastened to the flange by bolts. The direct welding of the ring gear 34 to the differential case 10 in one embodiment eliminates the need for the differential case 10 to include the flange or the bolts. Further, because the placement of the ring gear 34 in the current embodiment is not reliant upon the position of such a flange, the ring gear 34 may, as mentioned above, be welded at any of numerous locations along the outer surface 36 of the differential case 10.

[0026] Referring to Figures 6A through 6C, the differential crosspin 32 includes a main body 40 extending between a first end 42 and a second end 44. The main body 40 is generally cylindrical. Each of the first 42 and second 44 ends includes a notch 46. The notch 46 forms a mounting tab 48 that protrudes from an end wall 50. The mounting tab 48 in one embodiment is generally semi-circular. However, it is contemplated that the particular shape

of the mounting tab 48 may vary. The differential crosspin 32 also includes a plurality of indentations 54 formed along the main body 40.

[0027] Each of the first 12 and second 14 case members includes a mounting recess 56, as shown in Figures 2 and 5C, formed to complement the shape of the mounting tab 48 at the first 42 and second 44 ends of the differential crosspin 32. The complementary engagement between the first 12 and second 14 case members and the differential crosspin 32 prevents both radial rotation of the differential crosspin 32 and lateral movement of the differential crosspin 32 within the differential case 10 to ensure retention of the differential crosspin 32 therewithin.

[0028] Referring to Figures 7A through 7C, an alternate configuration for the differential case 10' has been provided. In the alternate configuration, a plurality of recesses 58 is formed in at least one of the first 12' and second 14' case members. More specifically, in one embodiment the plurality of recesses 58 extends through the outer wall 15' of at least one of the first 12' and second 14' case members. The removal of material to form the plurality of recesses 58 decreases the weight of each of the first 12' and second 14' case members. The plurality of recesses 58 also allows for passage of oil therethrough to allow lubrication of the components housed within the interior portion 16' of each of the first 12' and second 14' case members of the differential case 10'.

[0029] The invention has been described in an illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed:

1. A differential case operably coupled to a drive pinion of an engine drive shaft, said differential case comprising:

a first case member including an inboard edge;

a second case member including an inboard edge, said first and second case members fixedly secured to one another along said respective inboard edges; and

a ring gear fixedly secured along at least one of said first and second case members, said ring gear engageable with the drive pinion of the engine drive shaft to effect rotational movement of said differential case.

2. The differential case as set forth in claim 1 including a differential crosspin received within said differential case and fixedly secured to said first and second case members.

3. The differential case as set forth in claim 2 wherein said differential crosspin extends between opposing first and second ends, each of said first and second ends including a mounting tab formed therealong.

4. The differential case as set forth in claim 3 wherein each of said first and second case members defines a mounting recess formed along said inboard edge to receive one of said mounting tabs therein.

5. The differential case as set forth in claim 4 wherein each of said first and second case members houses a side gear engageable with an axle shaft.

6. The differential case as set forth in claim 5 including a pair of pinion gears housed inside said first and second case members and operably coupled to said side gears.

7. The differential case as set forth in claim 6 wherein each of said first and second case members includes a hub defining an opening proximate said outboard edge for receiving one of the axle shafts.

8. The differential case as set forth in claim 1 wherein said first case member is fixedly secured to said second case member by laser welding.

9. The differential case as set forth in claim 1 wherein said first case member is fixedly secured to said second case member by electronic beam welding.

10. The differential case as set forth in claim 1 wherein each of said first and second case members includes an outer wall.

11. The differential case as set forth in claim 10 wherein said ring gear abuts said outer wall of at least one of said first and second case members.

12. A differential case operably coupled to a drive pinion of an engine drive shaft, said differential case comprising:

a first case member including an inboard edge defining a mounting recess;

a second case member including an inboard edge defining a mounting recess, said first and second case members fixedly secured to one another along said respective inboard edges; and

a differential crosspin having a main body extending between opposing first and second ends each including a mounting tab, one of said mounting tabs fixedly mounted within said mounting recess of said first case member and the other of said mounting tabs fixedly mounted within said mounting recess of said second case member to prevent radial rotation and lateral movement of said differential crosspin relative to said first and second case members.

13. The differential case as set forth in claim 12 wherein said main body has a circular cross-section.

14. The differential case as set forth in claim 13 wherein said main body includes at least one indentation formed therealong.

15. The differential case as set forth in claim 14 including a ring gear fixedly secured along at least one of said first and second case members, said ring gear engageable with the drive pinion of the engine drive shaft to effect rotational movement of said differential case.

16. A differential case operably coupled to a drive pinion of an engine drive shaft, said differential case comprising:

a first case member extending between opposing inboard and outboard edges and having an outer wall;

a second case member extending between opposing inboard and outboard edges and having an outer wall, said first and second case members fixedly secured to one another along said respective inboard edges; and

a ring gear fixedly secured to at least one of said first and second case members, said ring gear engageable with the drive pinion of the engine drive shaft to effect rotational movement of said differential case;

wherein at least one of said first and second case members includes a plurality of recesses extending through said outer wall thereof.

17. The differential case as set forth in claim 16 wherein said ring gear abuts said outer wall of at least one of said first and second case members.

18. The differential case as set forth in claim 17 including a differential crosspin received within said differential case and fixedly secured to said first and second case members.

19. The differential case as set forth in claim 18 wherein said differential crosspin extends between opposing first and second ends, each of said first and second ends including a mounting tab formed therealong.

20. The differential case as set forth in claim 19 wherein each of said first and second case members defines a mounting recess formed along said inboard edge to receive one of said mounting tabs therein.

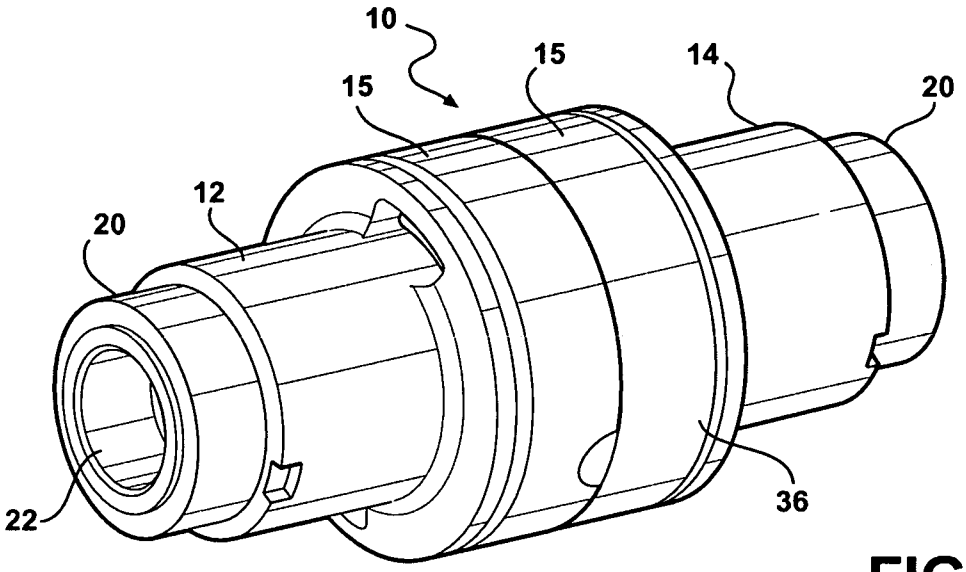


FIG. 1A

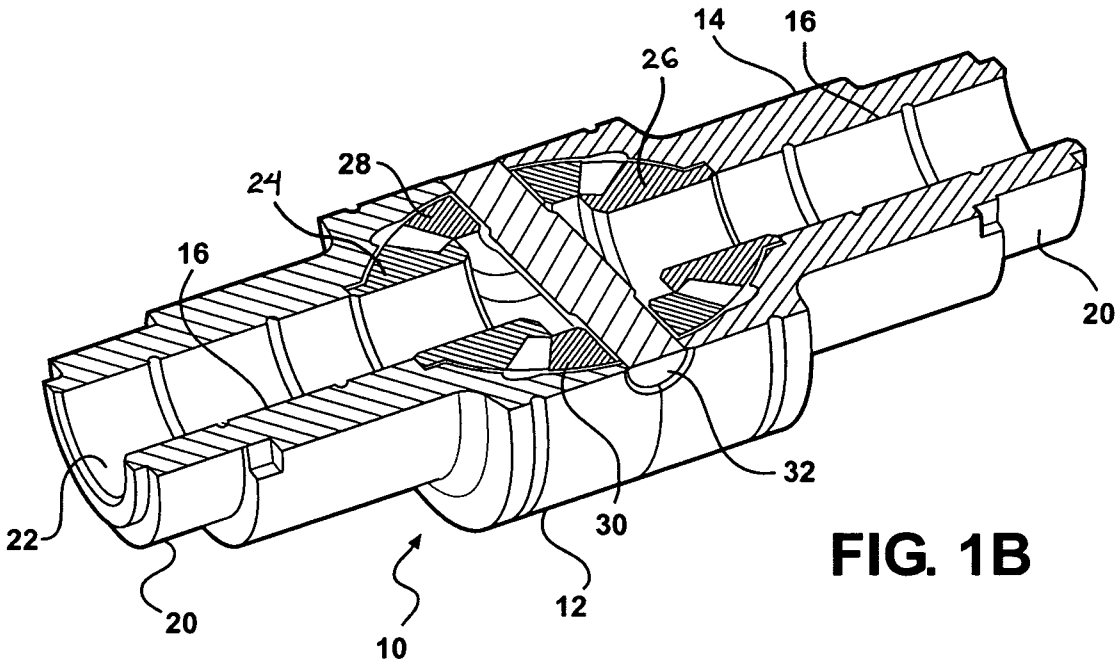


FIG. 1B

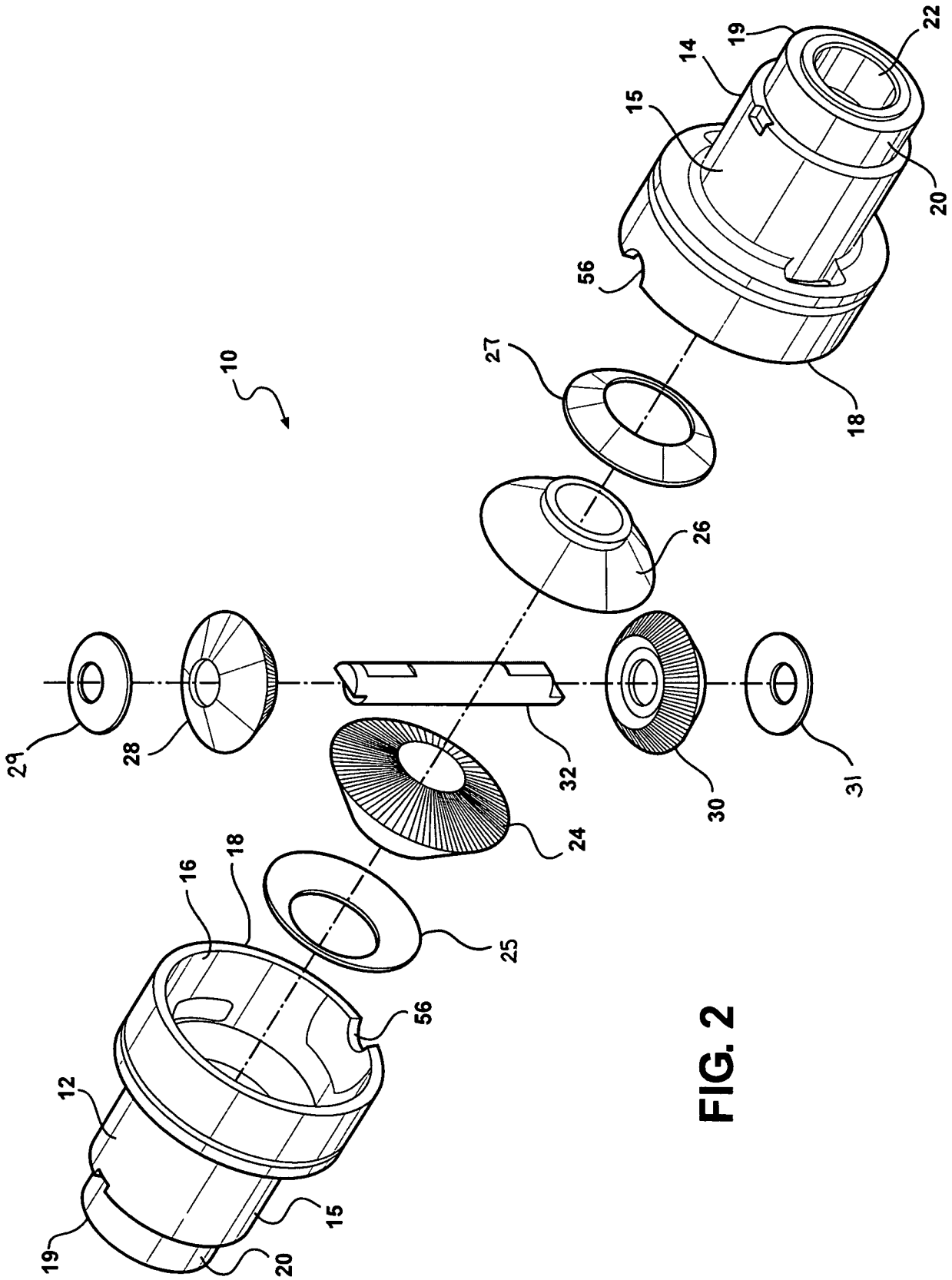


FIG. 2

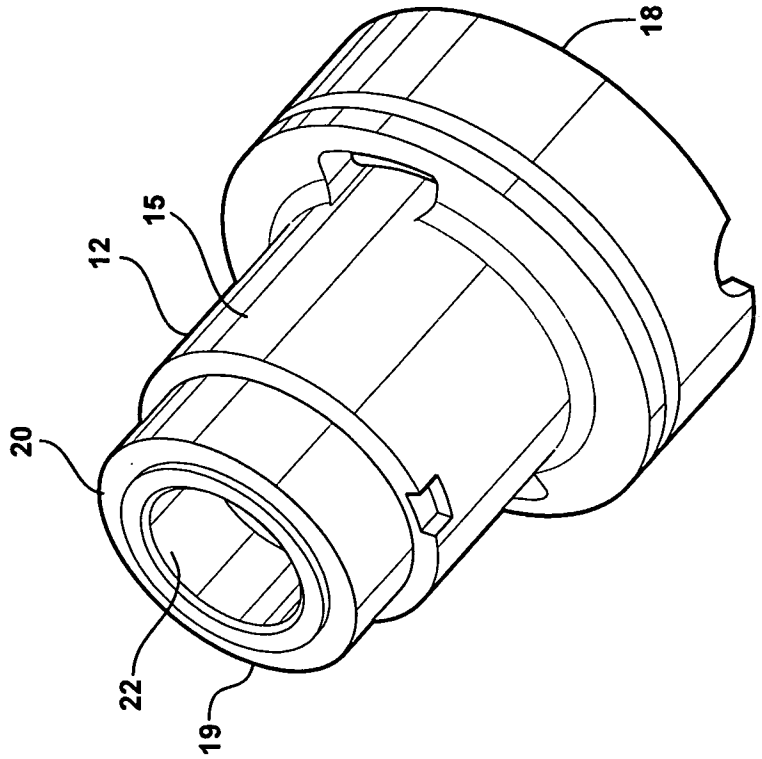


FIG. 3B

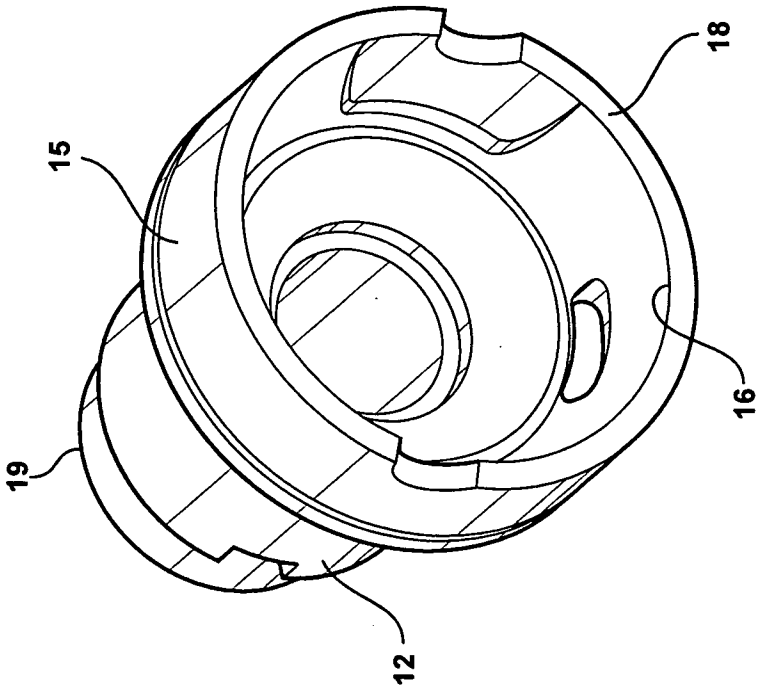


FIG. 3A

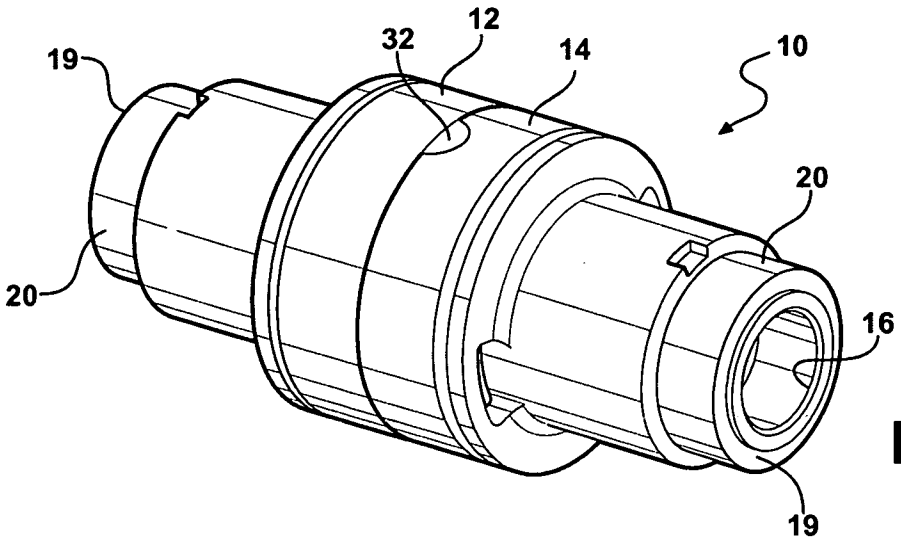


FIG. 4A

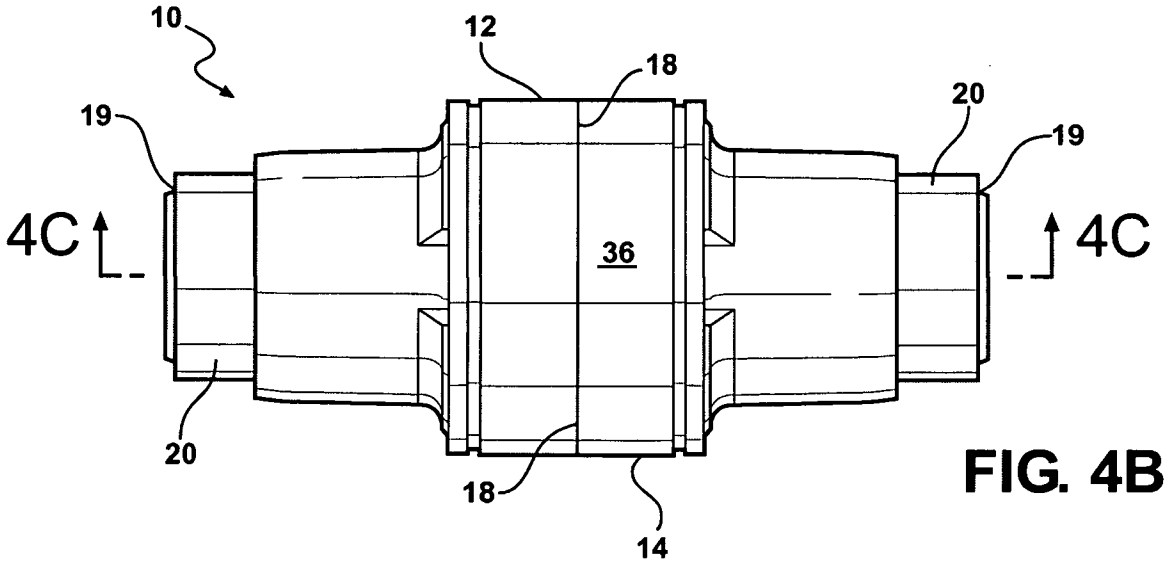


FIG. 4B

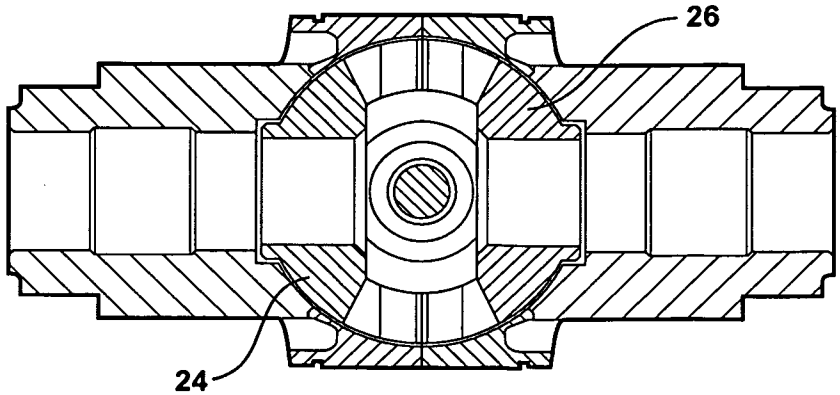


FIG. 4C

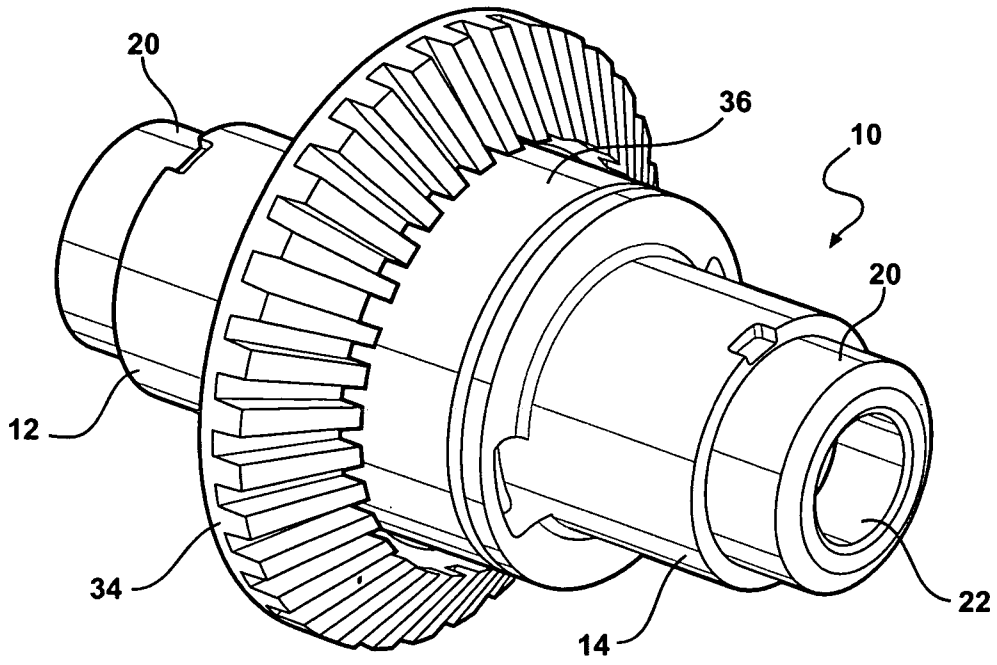


FIG. 5A

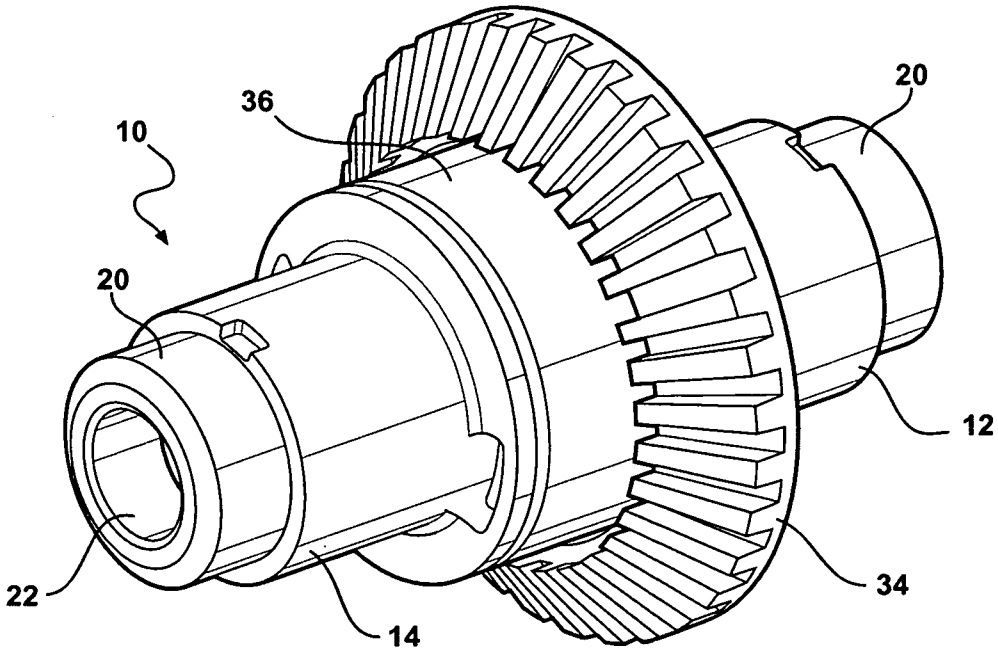


FIG. 5B

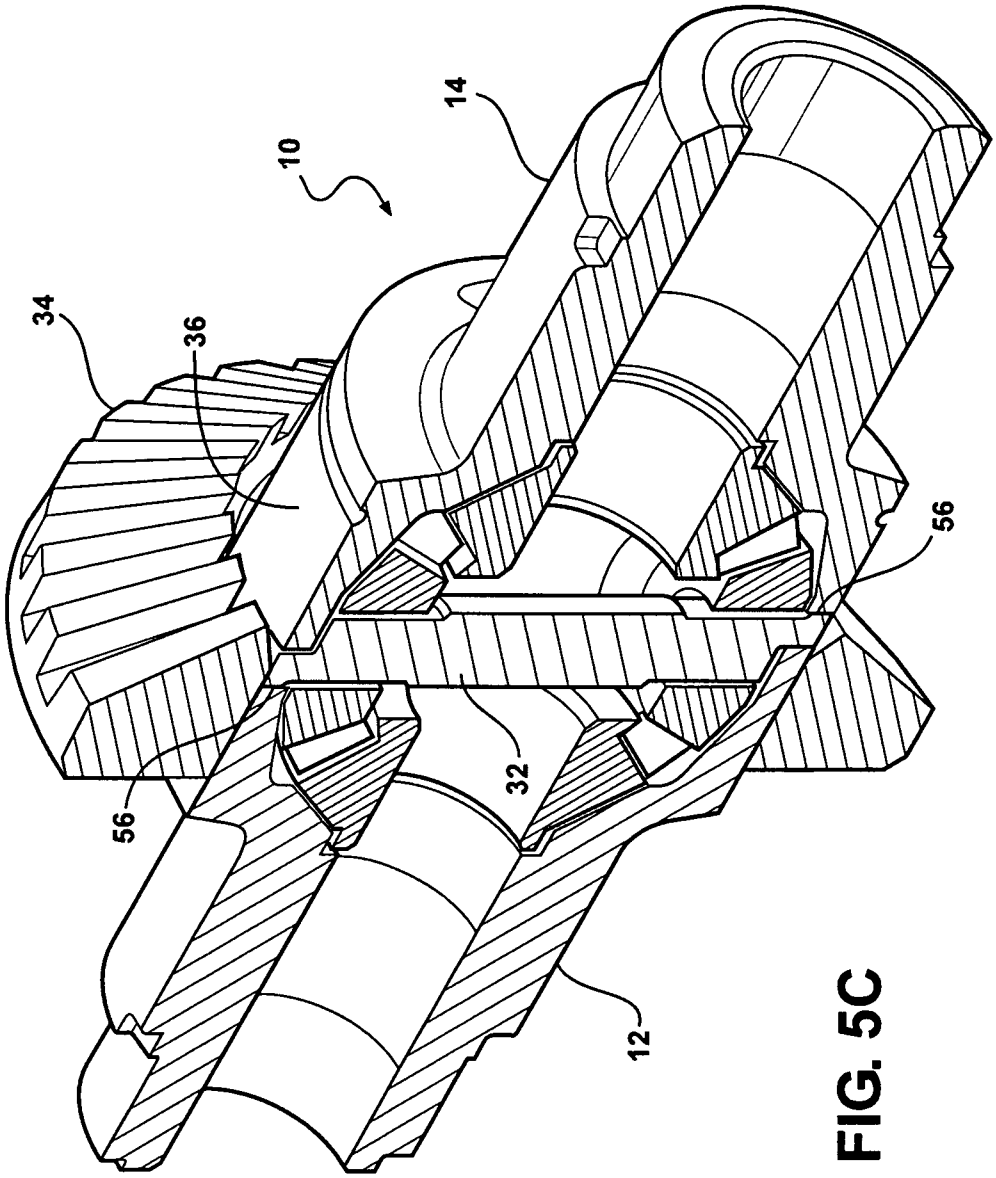


FIG. 5C

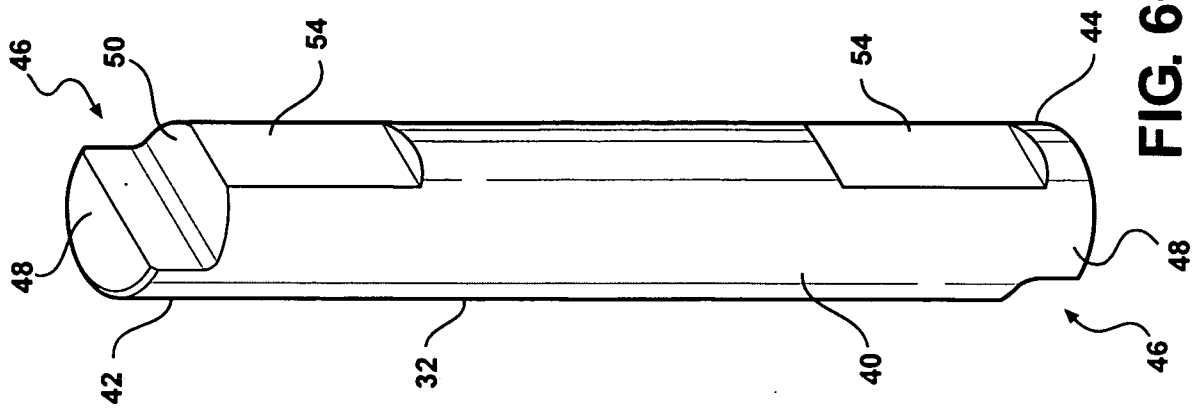


FIG. 6C

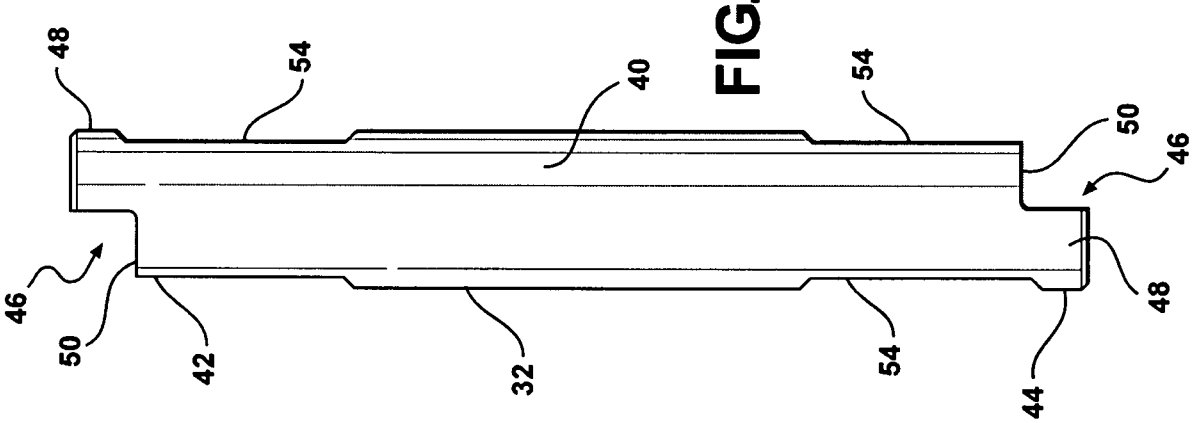


FIG. 6B

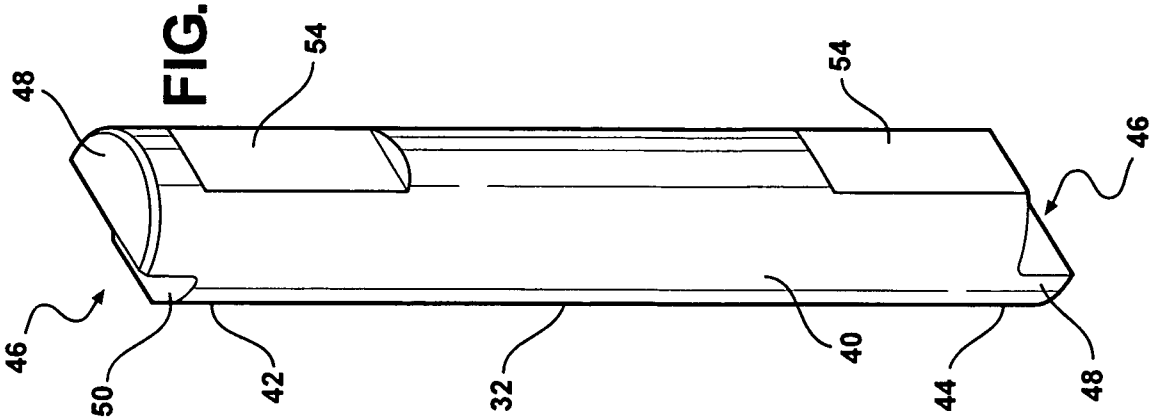


FIG. 6A

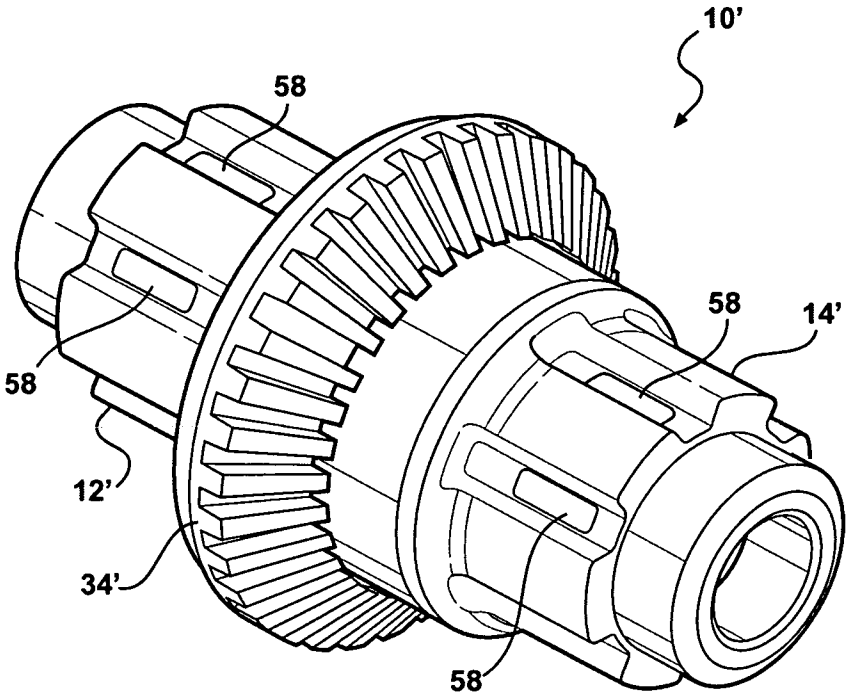


FIG. 7A

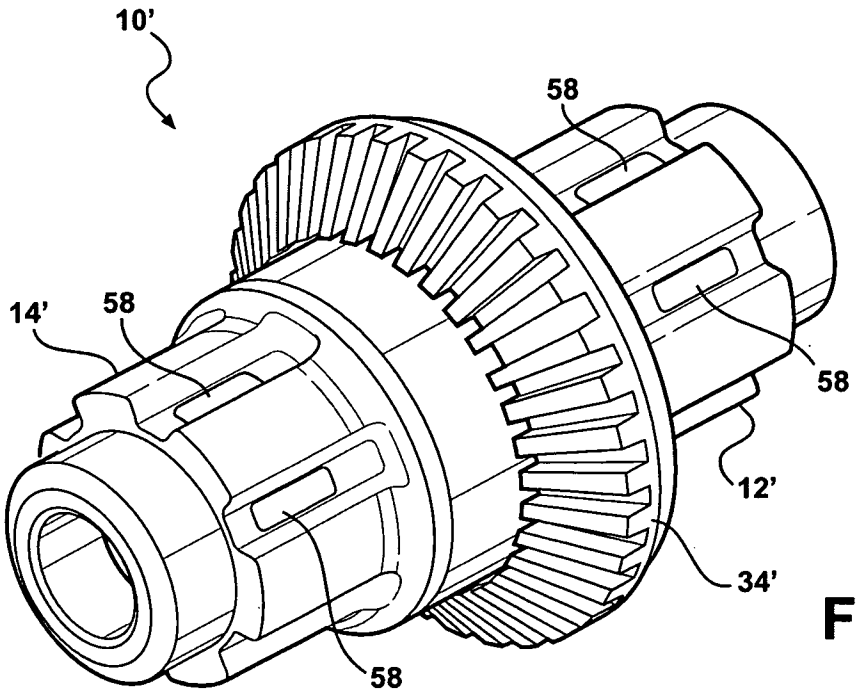


FIG. 7B

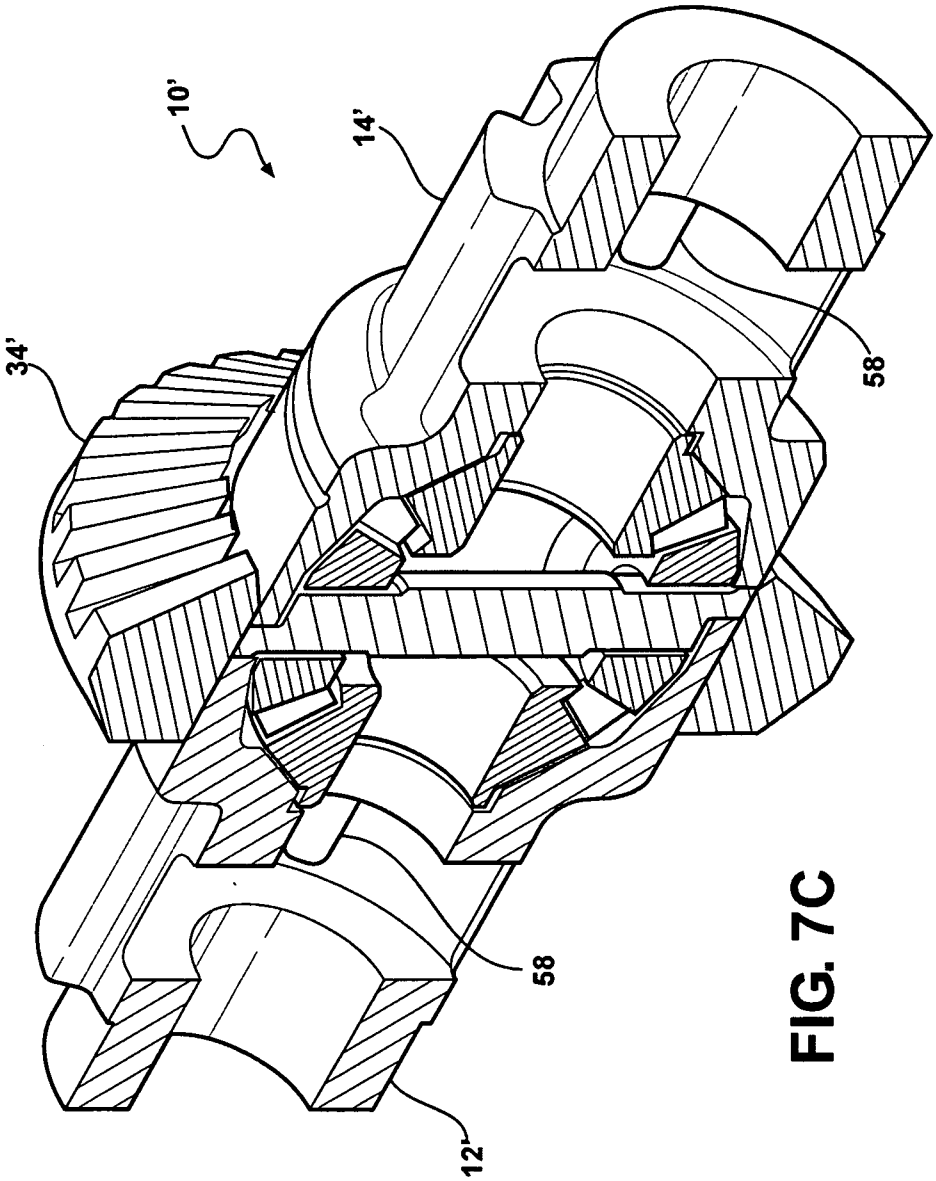


FIG. 7C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/004475

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - F16H 61/00 (2009.01)
USPC - 74/606R
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 61/00 (2009.01)
USPC - 74/606R; 475/230

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)
PatBase; Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,176,152 B1 (VICTORIA et al) 23 January 2001 (23.01.2001) entire document	1-13, 16-20
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Y		14-15
Y	US 4,722,244 A (TSUCHIYA et al) 02 February 1988 (02.02.1988) entire document	14-15
A	US 4,125,026 A (TORII et al) 14 November 1978 (14.11.1978) entire document	1-20
A	US 6,196,942 B1 (PETERSON et al) 06 March 2001 (06.03.2001) entire document	1-20
A	US 7,294,084 B2 (KOEHLER et al) 13 November 2007 (13.11.2007) entire document	1-20

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Date of the actual completion of the international search	Date of mailing of the international search report
03 September 2009	15 SEP 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774