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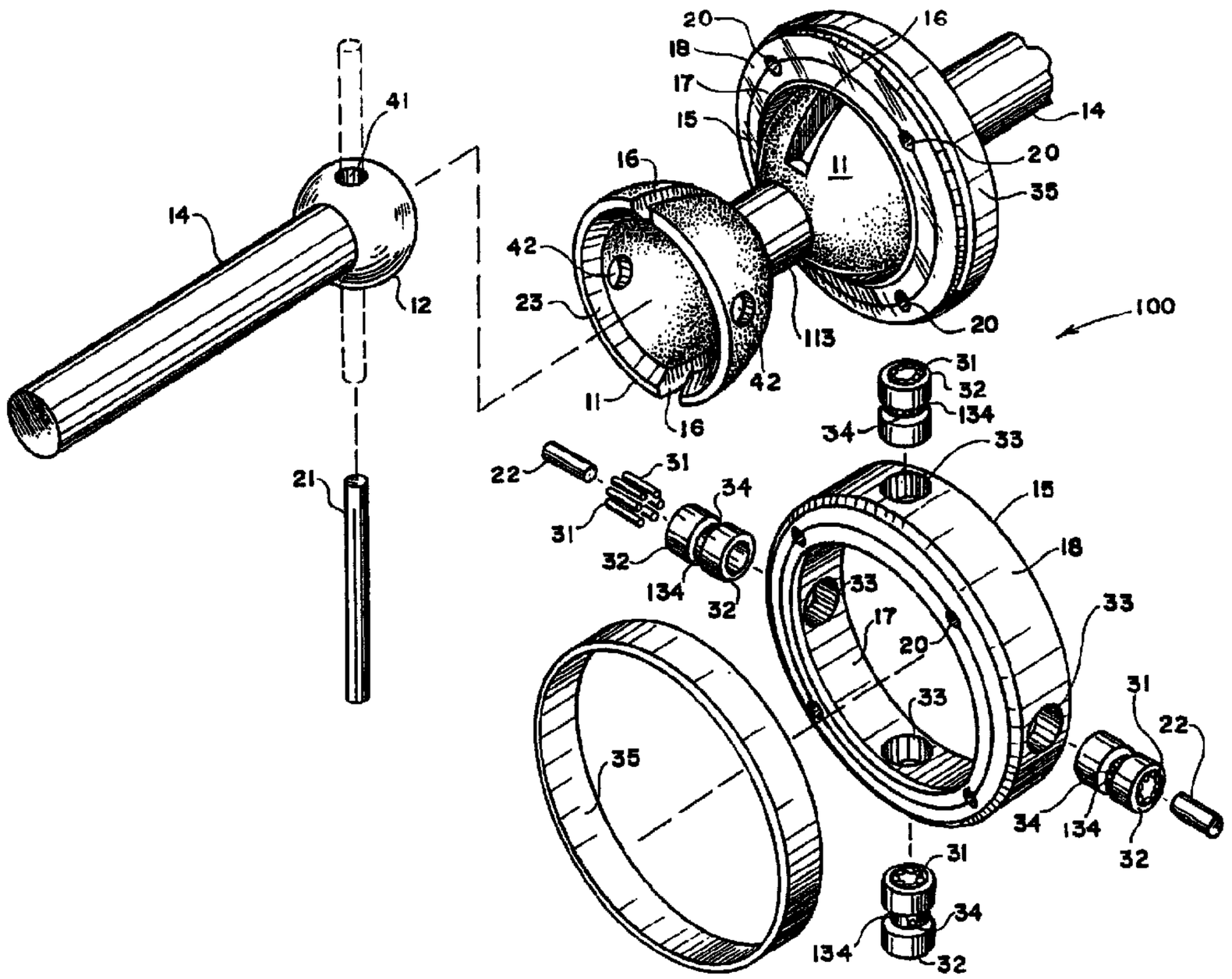
(54) Title: UNIVERSAL JOINT HAVING HEMISPHERICAL CUP-SHAPED YOKE AND EXTERIOR, LUBRICATING RING



(57) Abrégé/Abstract:
A universal joint that includes a ring having a lubricant channel for allowing lubricant flow. A yoke is disposed within the ring. The universal joint further includes a shaft and pins pivotally interconnecting the yoke and the shaft to the ring. A number of bearings are disposed in the ring in fluid contact with the lubricant channel. The lubricant channel is non-continuous, extending less than 360 degrees around the ring such that lubricant entering a first lubricant port must travel through the entire length of the lubricant channel before exiting through a second lubricant port.

Abstract

A universal joint that includes a ring having a lubricant channel for allowing lubricant flow. A yoke is disposed within the ring. The universal joint further includes a shaft and pins pivotally interconnecting the yoke and the shaft to the ring. A number of bearings are disposed in the ring in fluid contact with the lubricant channel. The lubricant channel is non-continuous, extending less than 360 degrees around the ring such that lubricant entering a first lubricant port must travel through the entire length of the lubricant channel before exiting through a second lubricant port.

UNIVERSAL JOINT HAVING HEMISPHERICAL CUP-SHAPED YOKE AND EXTERIOR, LUBRICATING RING

This is a division of co-pending Canadian Patent Application Serial No. 2,062,800 filed on June 28, 1990 as PCT/US90/03695.

Background of the Invention

1. Field of the Invention

The present invention relates to universal joints.

2. General Background of the Invention

Universal joints are used in a multitude of industries, including the aerospace, automotive, and marine industries. The aerospace industry uses universal joints, for example, to transfer power to control surfaces. Universal joints are used in steering columns in automobiles to transfer power. Universal joints are used in boat motors. In addition, universal joints can be found in everything from tractors to robots.

Summary of the Invention

In accordance with one aspect of the present invention there is provided a universal joint comprising: (a) a ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having two ends; (b) a yoke disposed within the ring; (c) a first shaft having an end adjacent the ring; (d) first pin means pivotally interconnecting the yoke and the ring; (e) second pin means pivotally interconnecting the first shaft and the ring; (f) a plurality of bearing means in the ring in fluid contact with the lubricant channel in the ring, the bearing means receiving the first and second pin means; (g) a second shaft connected to the yoke; and (h) first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant channel, wherein: the lubricant channel is non-continuous, extending less than 360 degrees around the ring, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

In accordance with another aspect of the present invention there is provided a universal joint comprising: (a) first and second rings, each ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having first and second ends; (b) first and second yokes disposed within the first and second rings, respectively; (c) first and second shafts; (d) first pin means pivotally interconnecting the first yoke and the first ring; (e) second pin means pivotally interconnecting the first shaft and the first ring; (f) third pin means pivotally interconnecting the second yoke and the second ring; (g) fourth pin means interconnecting the second shaft and the second ring; (h) a third shaft interconnecting the first yoke and the second yoke; and (i) a plurality of bearing means in each ring in fluid contact with the lubricant channel in the ring, the bearing means in the first ring receiving the first and second pin means, and the bearing means in the second ring receiving the third and fourth pin means, wherein: each ring has first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant channel, and the lubricant channel is non-continuous, extending less than 360 degrees around the ring, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

In accordance with yet another aspect of the present invention there is provided a universal joint comprising: (a) a ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having first and second ends; (b) a yoke disposed within the ring; (c) a first shaft having an end adjacent the ring; (d) a first pin pivotally interconnecting the yoke means and the ring; (e) a second pin pivotally interconnecting the first shaft and the ring; (f) a plurality of bearing devices in the ring in fluid contact with the lubricant channel in the ring, the bearing devices receiving the first and second pin; (g) a second shaft connected to the yoke; and (h) first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant

channel, wherein: the lubricant channel is non-continuous, extending less than 360 degrees around the ring, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

More specifically, the yoke is cup-shaped internally to have the closest fit to the ball. The yoke is cup-shaped externally to have the closest fit to the ring. The cup shape of the yoke enables it to withstand centrifugal and torsional loads better than convention Y-shaped yokes.

The ring, the shaft, the ball, and the yoke are each formed from components which are circularly symmetrical about their own longitudinal axes. This shape of the

components allows the joint to be manufactured in computerized lathes and allows the joint to run at higher angles and at higher r.p.m. with less vibration than other universal joints.

Having the ball inside the yoke with the yoke inside the ring causes the bulk of the mass of the universal joint to be closer to the spin axis of the universal joint than would be possible if the ring were between the ball and the yoke. This reduces the effects of centrifugal force, allowing for greater dynamic joint stability. The yoke is beveled to minimize its size and maximize its strength, while maximizing the operating angle of the joint.

Having the ball inside the yoke enables the joint to be misaligned at angles up to and beyond 45° in less lateral distance (that is, distance along the longitudinal axis of the joint) than in conventional Cardan-type joints.

All pivotal motion of the joint takes place in the ring, where the pins connecting the ring to the ball and to the yoke are surrounded by needle bearings. Lubrication of the pins and bearings is achieved by means of an annular lubricant-filled channel in the ring. Lubricant ports are provided to allow the channel to be filled with lubricant.

The preferred embodiment of the present invention is a universal joint comprising a dual trunnion, a hemispherical split-cup shaped yoke, and a ring. The dual trunnion is inside the yoke, which is inside the ring. Pins connect the ring to the yoke and to the dual trunnion.

A first shaft is connected to the dual trunnion and a second shaft is connected to the yoke.

The yoke is shaped internally to have a close fit to the dual trunnion while allowing the dual trunnion to freely move therein at the desired operating angle of the joint without contact of the two parts. The yoke is cup-shaped externally to have the closest fit to the ring while allowing the ring to oscillate therearound without contact of the two parts. The cup shape of the yoke enables it to withstand centrifugal and torsional loads

better than conventional Y-shaped yokes.

The ring and the yoke are each formed from components which are circularly symmetrical about their own longitudinal axes. This shape of the components allows the joint to be manufactured in computerized lathes which facilitates balancing and allows the joint to run at higher angles and at higher r.p.m. with less vibration than other universal joints.

Having the dual trunnion inside the yoke with the yoke inside the ring causes the bulk of the mass of the universal joint to be closer to the spin axis of the universal joint than would be possible if the ring were between the dual trunnion and the yoke. This reduces the effects of centrifugal force, allowing for greater dynamic joint stability. The yoke is beveled internally to minimize its size and maximize its strength, while maximizing the operating angle of the joint.

Having the dual trunnion inside the yoke enables the joint to be misaligned at angles up to and beyond 45° in less lateral distance (that is, distance along the longitudinal axis of the joint) than in conventional Cardan-type joints.

All pivotal motion of the joint takes place in the ring, where the pins connecting the ring to the dual trunnion and to the yoke are surrounded by needle bearings. Lubrication of the pins and bearings is achieved by means of a non-continuous annular lubricant-filled channel in the ring. Lubricant ports are provided to allow the channel to be filled with lubricant. Bearing assemblies having two lubricant ports located in the outer race and 180° apart are in communication with the annular lubricant channel in the ring allowing the lubricant to be pumped through the ring and through all four bearing assemblies. The two adjacent lubricant ports in the ring are only connected by the non-continuous annular channel with there being no communication in the shortest distance between the two ports in the ring. This is advantageous over other ring

designs by omitting the chance of a blockage in the lubricant channel causing the lubricant to follow the path of least resistance thereby not lubricating all four bearing assemblies. In addition, the non-continuous lubricant channel with an entry and exit port allows the system to be purged, replacing old lubricant with new.

The joints are designed to accommodate an operating angle of up to 45° between the drive shaft and the driven shaft.

Two joints, as described above, can be connected with a common shaft between the two yokes, producing a joint capable of accommodating an angle between the drive and driven shafts of up to 90° in less lateral distance than in other joint designs known to the inventor.

There may be some advantages associated with the use of the input, output, and center shafts having their mass concentrated near the axes of rotation and rings having a larger moment of inertia resisting changes in operating speed than the moment of inertia resisting oscillation. This may reduce the transmission of vibration, especially at large shaft angles. Having the mass of the hourglass-shaped yoke located nearest the center of rotation greatly reduces the effect of inertial vibrations caused by the non-uniform motion of this member in a double-joint configuration. Comparative testing against a typical double-Cardan design showed that the present invention can have up to 75% less vibration when run at high angles and speeds. In addition, the hemispherical cups as well as the rings may facilitate balancing the unit and this may contribute to vibration control as well.

<u>Brief Description of the Drawings</u>

For a further understanding of the nature, objects, and advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

Fig. 1 is an exploded view of a universal joint in

accordance with the present invention.

Fig. 2 is a side view of the embodiment of the invention shown in Fig. 1.

Fig. 3 is a sectional view of an alternative embodiment of the present invention.

Fig. 4 is a sectional view of the pivot ring of the first and second embodiments of the present invention.

Fig. 5 is a sectional view taken along the lines 5-5 in Fig. 6.

Fig. 6 is a partially cut-away view of a third embodiment of the universal joint of the present invention.

Fig. 7 is an exploded view of the preferred embodiment of the universal joint of the present invention.

Fig. 8 is a side view of the preferred embodiment of the present invention.

Fig. 9 is a sectional view of the preferred embodiment of the present invention.

Fig. 10 is a sectional view of the pivot ring of the preferred embodiment of the present invention.

Fig. 11 is a sectional view taken along the lines 11-11 in Fig. 12.

Fig. 12 is a partially cut-away view of a fifth embodiment of the universal joint of the present invention.

Parts List:

The following is a list of suitable parts and materials for the various elements of the present invention.

10 Universal joint

11 hemispherical split-cup yoke (AISI 4340 metal alloy)

12 ball (AISI 4340)

13 shaft (AISI 4340)

14 shaft (AISI 4340)

15 ring (AISI 4340)

16 notches in yoke 11

17 inner ring member (AISI 4340)

18 outer ring member (AISI 4340)

19 channel in ring 15

20 lubricant ports in ring 15
21 long pin (AISI 1060 with a hardness of 60-65 Rockwell C)
22 short pin (AISI 1060 with a hardness of 60-65 Rockwell C)
23 bevel in yoke 11
31 needle bearings
32 races
33 holes in ring 15
34 holes in races 32
35 band of material, preferably metal with an inner surface induction hardened to a depth of 0.075 cm to a hardness of Rockwell C 60
41 hole in ball 12
42 hole in yoke 11
100 universal joint
113 shaft (AISI 4340)
134 channel in races 32
200 universal joint
213 shaft (AISI 4340)
300 universal joint
310 universal joint
311 hemispherical split-cup yoke (AISI 4340)
312 dual trunnion (AISI 4340)
313 shaft (AISI 4340)
314 shaft (AISI 4340)
315 ring (AISI 4340)
316 notches in yoke 311
317 inner ring member (AISI 4340)
318 outer ring member (AISI 4340)
319 channel in ring 315
320 lubricant port in ring 315
321 long pin (AISI 1060 with a hardness of 60-65 Rockwell C)
322 short pin (AISI 1060 with a hardness of 60-65 Rockwell C)
323 beveled inner radial surface of yoke 311

324 beveled inner surface of yoke 311
325 beveled flat surface of yoke 311
326 Lubricant port in ring 315
327 flush-fitting NPT allen-head plug
328 flush-fitting NPT allen-head plug
330 closed-end needle bearing assembly (modified Torrington bearing number M-1081-20H)
332 races
333 holes in ring 315
334 holes in races 332
336 internal snap rings
337 snap-ring grooves in holes 333
338 polytetrafluoroethylene (PTFE) spacer rings
339 rubber O-ring (Bruna-N 90 Durometer, such as Parker No. 2-016)
340 shaft (AISI 4340)
341 hole in dual trunnion 312
342 hole in yoke 311
513 shaft (AISI 4340)

Detailed Description of the Preferred Embodiment

Referring now to the drawings, universal joint 10 (Figs. 5 and 6), comprises a hemispherical split-cup yoke 11, a ball 12, a shaft 13, a shaft 14, and a ring 15.

Yoke 11 has a substantially hemispherical outer surface and a concentric, substantially hemispherical inner surface.

A relatively long pin 21 extends through a hole 41 (see Fig. 1) in ball 12 into ring 15. Relatively short pins 22 connect yoke 11 with ring 15. The first and second ends of pin 21 are pivotally received in ring 15 and are surrounded by needle bearings 31. A first end of each pin 22 is received in holes 42 in yoke 11 and a second end of each pin 22 is pivotally received in ring 15. The second end of each pin 22 is surrounded by needle bearings 31. A band 35 of material, preferably metal, encircles ring 15, and prevents needle bearings 31 and pins 21 and 22 from protruding out of ring 15. Band 35 also acts as a seal to

hold in lubricant. Needle bearings 31 are contained in races 32 which press-fit into holes 33 (see Fig. 1) in ring 15. The press fit of races 32 in holes 33 prevents needle bearings 31 from moving inward toward the center of universal joint 10. Races 32 have a channel 134 therein to allow lubricant to pass therearound and two holes 34 therein to allow lubricant to pass therethrough. Holes 34 in races 32 align with a channel 19 in ring 15. The bearing assembly comprising races 32 and needle bearings 31 can advantageously be made by modifying Torrington bearing assembly number BH-108-20H.

When a sealed closed-end needle bearing assembly similar to Torrington Bearing Part No. M-11101-OH is used in place of the open-end bearing assembly comprising race 32 and needle bearings 31, band 35 may be omitted.

Yoke 11 has notches 16 to allow pin 21 to move therein.

Shaft 14 is fixedly attached to ball 12; shaft 14 and ball 12 may be integral. Shaft 13 and yoke 11 are fixedly attached to one another; they may be integral.

Ring 15 comprises an inner ring member 17 and an outer ring member 18 (see Fig. 4). A portion of channel 19 is in each ring member in the form of an annular recess. Ring members 17 and 18 are sized such that inner ring member 17 may be press-fit into outer ring member 18 to form channel 19 as a lubricant-tight channel. Races 32 help to hold ring 15 together by preventing movement of inner ring member 17 with respect to outer ring member 18.

Ring 15 has a number of lubricant ports 20 communicating with channel 19. Lubricant ports 20 may be sealed with, for example, removable screw plugs (not shown). Lubricant ports 20 allow one to add lubricant to channel 19, change the lubricant in channel 19, or purge lubricant from channel 19.

The edge of yoke 11 has a bevel 23 to permit shaft 14 to misalign up to a full angle A (preferably 45° - see Figure 6) with respect to the longitudinal axis of shaft

13. When operational conditions do not require angle A to be so large, bevel 23 may be omitted.

Prior to the forming of holes 33, 41, and 42 and notches 16, ring 15, ball 12, yoke 11, and shafts 13 and 14 are each circularly symmetrical about their longitudinal axes.

Universal joint 100 (Figs. 1 and 2) is similar to universal joint 10. Universal joint 100 has two hemispherical split-cup yokes 11 joined by a shaft 113 which is fixedly attached to the yokes. The two yokes 11 and the shaft 113 may be integral. Shafts 14 of universal joint 100 may be flexed up to an angle B relative to one another. Angle B is preferably 90°. The diameter of shaft 113 limits the size of angle B when the universal joint is in the position shown in Fig. 2. If the desired application does not require that the shafts 14 be offset by an angle as great as angle B in Fig. 2, the diameter of the shaft connecting yokes 11 can be greater than that of shaft 113. Fig. 3 shows a universal joint 200 having such a shaft 213. Shaft 213 is advantageous over shaft 113 because its increased diameter gives it increased strength and greater dynamic stability.

Universal joint 10 is assembled and made ready for use by: press-fitting inner ring member 17 into outer ring member 18; press-fitting races 32 having needle bearings 31 therein into holes 33 in ring 15; placing ring 15 such that two holes 33 align with holes 42 in yoke 11 and inserting pins 22 through races 32 and press-fitting pin 22 into holes 42; inserting ball 12 into yoke 11 and aligning it such that hole 41 aligns with two holes 33 in ring 15, and inserting pin 21 through holes 33 in ring 15 and press-fitting it into hole 41 in ball 12 so that an equal amount of pin 21 protrudes from each side of ball 12; press-fitting band 35 over ring 15; and pumping lubricant into channel 19 through one of lubricant ports 20 and out of another lubricant port 20. The lubricant passes through channels 134 and holes 34 in races 32 to lubricate needle

bearings 31. As can be seen in Figure 5, all needle bearings 31 share the lubricant in channel 19.

Although lubricant ports 20 are shown in the ring 15 in the upper part of Figure 1 as being on the surface facing the second ring 15, it is preferable for the ports 20 to be on the opposite surface of ring 15 (as shown in the lower ring 15 in Figure 1) so that access to ports 20 is easier when joint 100 is installed.

Either shaft 13 or 14 can be connected to a drive shaft; the other is connected to the driven shaft. These connections can be made by any conventional means.

Another embodiment of the present invention, universal joint 310 (Figs. 11 and 12), comprises a hemispherical split-cup yoke 311, a dual trunnion 312, a shaft 513, a shaft 340, and a ring 315.

Yoke 311 has a substantially hemispherical outer surface and a concentric, substantially hemispherical inner surface.

A relatively long pin 321 extends through a hole 341 (see Fig. 7) in dual trunnion 312 into ring 315. Relatively short pins 322 connect yoke 311 with ring 315. The first and second ends of pin 321 are pivotally received in closed-end needle bearing assemblies 330 in ring 315. A first end of each pin 322 is received by a shrink fit or press fit in holes 342 in yoke 311 and a second end of each pin 322 is pivotally received in ring 315. The second end of each pin 322 is received in closed-end needle bearing assemblies 330. Closed-end needle bearing assemblies 330 include needle bearings 31 which are contained in races 332 which press-fit into holes 333 (see Fig. 7) in ring 315. Races 332 have two holes 334 therein, 180° apart, to allow lubricant to pass therethrough. Holes 334 in races 332 align with a channel 319 in ring 315. Closed-end needle bearing assemblies 330 are secured by internal snap rings 336 which fit into snap-ring grooves 337 in holes 333.

Yoke 311 has notches 316 to allow dual trunnion 312 to move therein.

Shaft 340 is fixedly attached to trunnion 312; shaft 340 and trunnion 312 may be integral. Shaft 513 and yoke 311 are fixedly attached to one another; they may be integral.

Ring 315 comprises an inner ring member 317 and an outer ring member 318 (see Fig. 11). Channel 319 is in ring member 317 and is in the form of a non-continuous annular recess whose cross section is semi-circular in shape (see Figure 10). Channel 319 is preferably formed by machining a groove in the outer diameter of ring member 317 before assembling ring 315. Ring members 317 and 318 are sized such that inner ring member 317 may be press-fit into outer ring member 318 to form channel 319 as a lubricant-tight channel. Races 332 help to hold ring 315 together by preventing movement of inner ring member 317 with respect to outer ring member 318.

Ring 315 has two lubricant ports, 320, 326, communicating with non-continuous annular channel 319. Lubricant ports 320, 326, are located on top of ring 315 and are centered over channel 319. Ports 320 and 326 are adjacent one another and each port communicates with one end of channel 319. Channel 319 does not extend completely around ring 315; rather, channel 319 extends around in ring 315 almost 360° from port 320 to port 326. Lubricant ports 320 and 326 may be sealed with, for example, removable flush fitting NPT allen-head plugs 327, 328. Bearing assemblies 330 are lubricated by removing allen-head plugs 327, 328, and threading a lubricant gun (not shown) into either lubricant port 320, 326 and lubricating by conventional means. Lubricant ports 320, 326, allow one to add lubricant to channel 319, change the lubricant in channel 319, or purge lubricant from channel 319 by forcing the lubricant through all four bearing assemblies 330 (via holes 334 in races 332) before exiting ring 315. Lubricant can be pumped into channel 319 form either port 320 or 326, allowing purging of the system from either direction. Because channel 319 does not extend completely around in

ring 315, lubricant pumped into port 320 can travel in only one direction before lubricant exits out of port 326, thus forcing lubricant to contact all bearing assemblies 330 before exiting channel 319. Having two holes 334 spaced 180° apart in each race 332 forces lubricant to travel through all bearing assemblies 330 (via holes 334) before exiting channel 319. This ensures that lubrication will reach all needle bearings 31. Further, one can see in Figure 11 that holes 334 are positioned adjacent the inner end of bearing assemblies 330. This positioning helps to ensure that centrifugal force will aid in causing the lubricant to fill assemblies 330.

The interior of yoke 311 has a conical bevel 324 and a flat bevel 325 to permit shaft 340 to misalign up to a full angle A (preferably 45°) with respect to the longitudinal axis of shaft 513 while maintaining maximum strength of yoke 311.

Prior to the forming of holes 333, 341, and 342 and notches 316, ring 315, and yoke 311 are each circularly symmetrical about their longitudinal axes.

Yoke 311 preferably has a flat outer surface adjacent holes 342 (see Figure 7) for accommodating a spacer ring 338. Spacer rings 338 compress O-ring 339 to ensure that O-ring 339 is compressed on three sides: the inner diameter by pins 321, 322; the front by races 332; and the back by spacer rings 338. O-rings 339 seal bearing assemblies 330 to prevent lubricant from escaping from between pins 321, 322 and races 332. Rings 338 and 339 and the flat exterior surface adjacent holes 342 may be omitted if closed-end bearings with built-in seals are used.

Universal joint 300 (Figs. 7-9) is similar to universal joint 310. Universal joint 300 has two hemispherical split-cup yokes 311 joined by a shaft 313 which is fixedly attached to the yokes. Shaft 313 blends into yokes 311 with a smooth radius forming an hourglass-shaped component. The two yokes 311 and the shaft 313 may be (and preferably are) integral. Shafts 314 and 340 of

universal joint 300 may be flexed up to an angle B relative to one another. Angle B is preferably 90°. Universal joint 300 can operate at 90° in less lateral distance than can other universal joint designs known to the inventor. The size of angle B is limited by the contact of shafts 314 and 340 with yoke 311 when universal joint 300 is in the position shown in Fig. 8. If the desired application does not require that the shafts 314 and 340 be offset by an angle as great as angle B in Fig. 8, the diameter of the shaft connecting yokes 311 can be greater than that of shaft 313. Increasing the diameter of a shaft such as shaft 313 gives it increased strength and greater dynamic stability.

Universal joint 310 is assembled and made ready for use by: inserting yoke 311 into ring 315, with lubricant ports 320 and 326 facing outward, such that two holes 333 align with holes 342 in yoke 311; inserting pins 322 into holes 333 and pressing pins 322 into holes 342 of yoke 311; inserting PTFE spacer rings 338 over pins 322 in holes 333; inserting O-rings 339 over pins 322 in holes 333 and then pressing closed-end bearing assemblies 330 into holes 333 and over pins 322 until the ends of bearing assemblies 330 are flush with snap-ring grooves 337; securing bearing assemblies 330 in holes 333 by inserting snap rings 336 into snap-ring grooves 337; inserting dual trunnion 312 into yoke 311 and aligning it such that hole 341 aligns with holes 333 in ring 315; inserting long pin 321 into holes 333 and pressing long pin 321 into hole 341 until equal amounts of pin 321 extend out both ends of hole 341 in dual trunnion 312; inserting PTFE spacer rings 338 over both ends of pin 321 in holes 333; inserting O-rings 330 over both ends of pin 321 in holes 333 and pressing closed-end bearing assemblies 330 into holes 333 and over both ends of pin 321 until the ends of bearing assemblies 330 are flush with snap-ring grooves 337; securing bearing assemblies 330 in holes 333 by inserting snap rings 336 into snap-ring grooves 337; and pumping lubricant into

channel 319 through one of lubricant ports 320, 326, and out of the other lubricant port. The lubricant passes through holes 334 in races 332 to lubricate needle bearings 31. As can be seen in Figure 11, all needle bearings 31 share the lubricant in channel 319.

Either shaft 513 or 340 can be connected to a drive shaft; the other is connected to the driven shaft. These connections can be made by any conventional means.

Closed-end bearing assemblies 330 and the bearing assemblies comprising races 32 can be interchanged, although assemblies 330 are preferred. Ring 35 is used to carry thrust load and to provide a seal when bearing assemblies comprising races 32 are used.

Pins 21, 22, 321, and 322 preferably have the same surface hardness as needle bearings 31; this is preferably a surface hardness of 60-65 Rockwell C.

Holes 33, 333, 41, 341, 42, and 342 are preferably made by line-boring. Line boring these holes enables very accurate pin alignment to be achieved; accurate pin alignment helps to increase the life of the joint by extending the life of the bearings.

The smooth outer surface of yoke 311 is helpful in that stresses can be evenly distributed thereover, rather than being concentrated at sharp edges.

Whenever "press-fit" has been used herein, "shrink-fit" could also have been used. Press fitting involves forcing together, for example, a pin into a hole of slightly smaller diameter than the pin, simply by mechanical force. Shrink fitting involves heating the part containing the hole and cooling the pin so that the diameter of the hole can be even smaller compared to the diameter of the pin than is possible with press fitting, resulting in a tighter fit of parts.

The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

Claims:

1. A universal joint comprising:

(a) a ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having two ends;

(b) a yoke disposed within the ring;

(c) a first shaft having an end adjacent the ring;

(d) first pin means pivotally interconnecting the yoke and the ring;

(e) second pin means pivotally interconnecting the first shaft and the ring;

(f) a plurality of bearing means in the ring in fluid contact with the lubricant channel in the ring, the bearing means receiving the first and second pin means;

(g) a second shaft connected to the yoke; and

(h) first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant channel, wherein:

the two ends of the lubricant channel are spaced apart, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

2. The universal joint of claim 1, wherein:

the bearing means include holes through which lubricant must flow when traveling from the first port to the second port.

3. The universal joint of claim 1, wherein:

the ring comprises an inner ring member and an outer ring member;

the inner ring member is sized to press-fit into the outer ring member; and

the bearing means include races which contain bearings and which extend through the inner ring member and the outer ring member and help to hold the ring together by preventing movement of the inner ring member with respect to the outer ring member.

4. The universal joint of claim 1, wherein:

the bearing means include a plurality of races, each race having two holes which are in fluid communication with the lubricant channel and through which lubricant must flow when traveling from the first port to the second port.

5. The universal joint of claim 1, wherein:

the ring comprises an inner ring member and an outer ring member.

6. The universal joint of claim 5, wherein:

the inner ring member is sized to press-fit into the outer ring member.

7. The universal joint of claim 1, further comprising means for allowing the first shaft to move up to 45 degrees relative to the second shaft.

8. A universal joint comprising:

(a) first and second rings, each ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having first and second ends;

(b) first and second yokes disposed within the first and second rings, respectively;

(c) first and second shafts;

(d) first pin means pivotally interconnecting the first yoke and the first ring;

(e) second pin means pivotally interconnecting the first shaft and the first ring;

(f) third pin means pivotally interconnecting the second yoke and the second ring;

(g) fourth pin means interconnecting the second shaft and the second ring;

(h) a third shaft interconnecting the first yoke and the second yoke; and

(i) a plurality of bearing means in each ring in fluid contact with the lubricant channel in the ring, the bearing means in the first ring receiving the first and second pin means, and the bearing means in the second ring receiving the third and fourth pin means, wherein:

each ring has first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant channel, and the two ends of the lubricant channel are spaced apart, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

9. The universal joint of claim 8, wherein:

the bearing means include holes through which lubricant must flow when traveling from the first port to the second port.

10. The universal joint of claim 8, wherein:

each ring comprises an inner ring member and an outer ring member;

the inner ring member is sized to press-fit into the outer ring member; and

the bearing means include races which contain bearings and which extend through the inner ring member and the outer ring member and help to hold the ring together by preventing movement of the inner ring member with respect to the outer ring member.

11. The universal joint of claim 8, wherein:

the bearing means include a plurality of races, each race having two holes which are in fluid communication with the lubricant channel and through which lubricant must flow when traveling from the first port to the second port.

12. The universal joint of claim 8, wherein:

each ring comprises an inner ring member and an outer ring member.

13. The universal joint of claim 12, wherein:

the inner ring member is sized to press-fit into the outer ring member.

14. The universal joint of claim 8, further comprising means for allowing the first shaft to move up to 90 degrees relative to the second shaft.

15. A universal joint comprising:

(a) a ring having a lubricant channel for allowing lubricant flow therein, the lubricant channel having first and second ends;

(b) a yoke disposed within the ring;

(c) a first shaft having an end adjacent the ring;

(d) a first pin pivotally interconnecting the yoke and the ring;

(e) a second pin pivotally interconnecting the first shaft and the ring;

(f) a plurality of bearing devices in the ring in fluid contact with the lubricant channel in the ring, the bearing devices receiving the first and second pins;

(g) a second shaft connected to the yoke; and

(h) first and second lubricant ports communicating with the lubricant channel, with one lubricant port being adjacent each end of the lubricant channel, wherein:

the two ends of the lubricant channel are spaced apart, such that lubricant entering the first lubricant port must travel through the entire length of the lubricant channel before exiting through the second lubricant port.

16. The universal joint of claim 15, wherein:

the bearing devices include holes through which lubricant must flow when traveling from the first port to the second port.

17. The universal joint of claim 15, wherein:

the ring comprises an inner ring member and an outer ring member;

the inner ring member is sized to press-fit into the outer ring member; and

the bearing devices include races which contain bearings and which extend through the inner ring member and the outer ring member and help to hold the ring together by preventing movement of the inner ring member with respect to the outer ring member.

18. The universal joint of claim 15, wherein:

the bearing devices include a plurality of races, each race having two holes which are in fluid communication with the lubricant channel and through which lubricant must flow when traveling from the first port to the second port.

19. The universal joint of claim 15, wherein:

the ring comprises an inner ring member and an outer ring member.

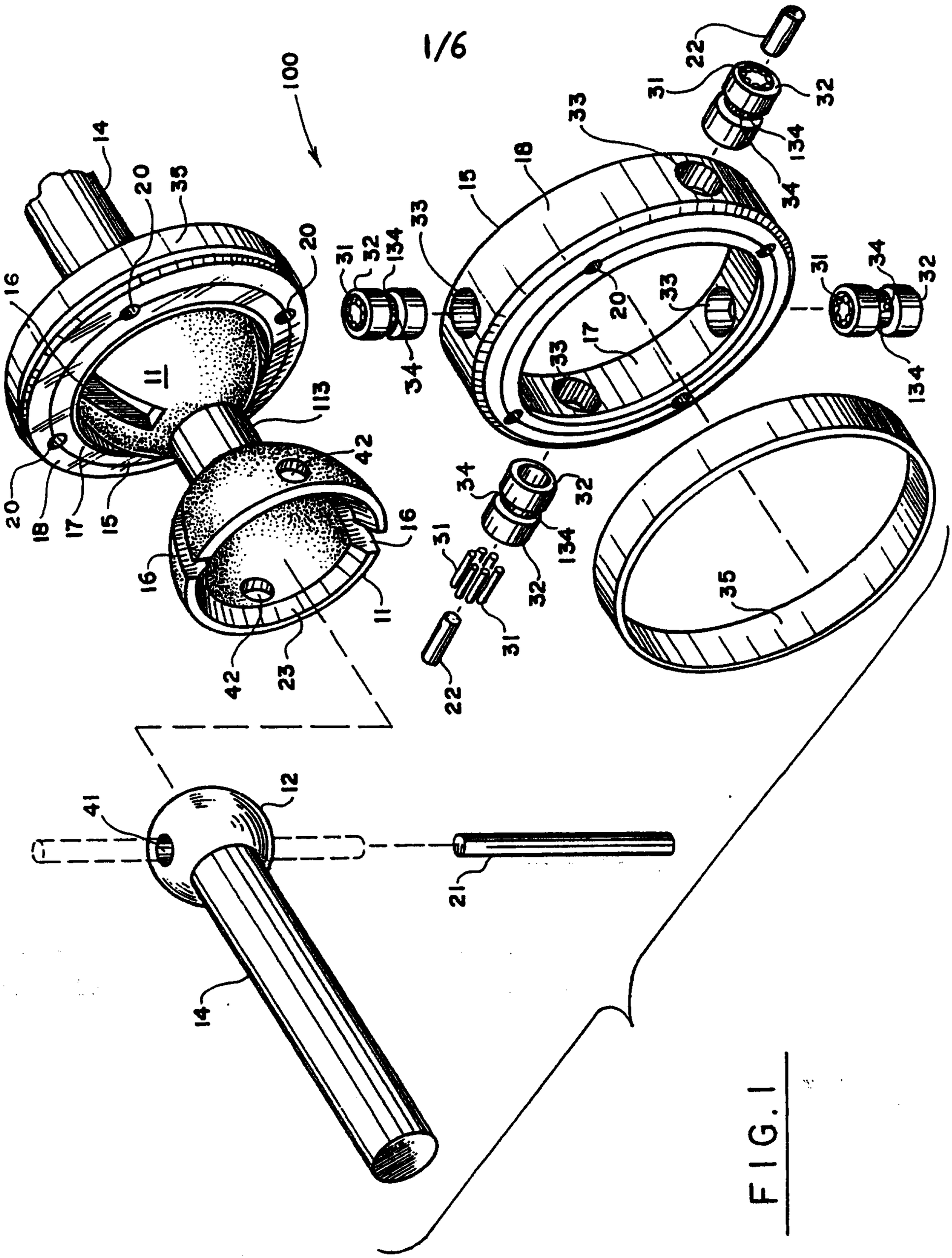


FIG. 1

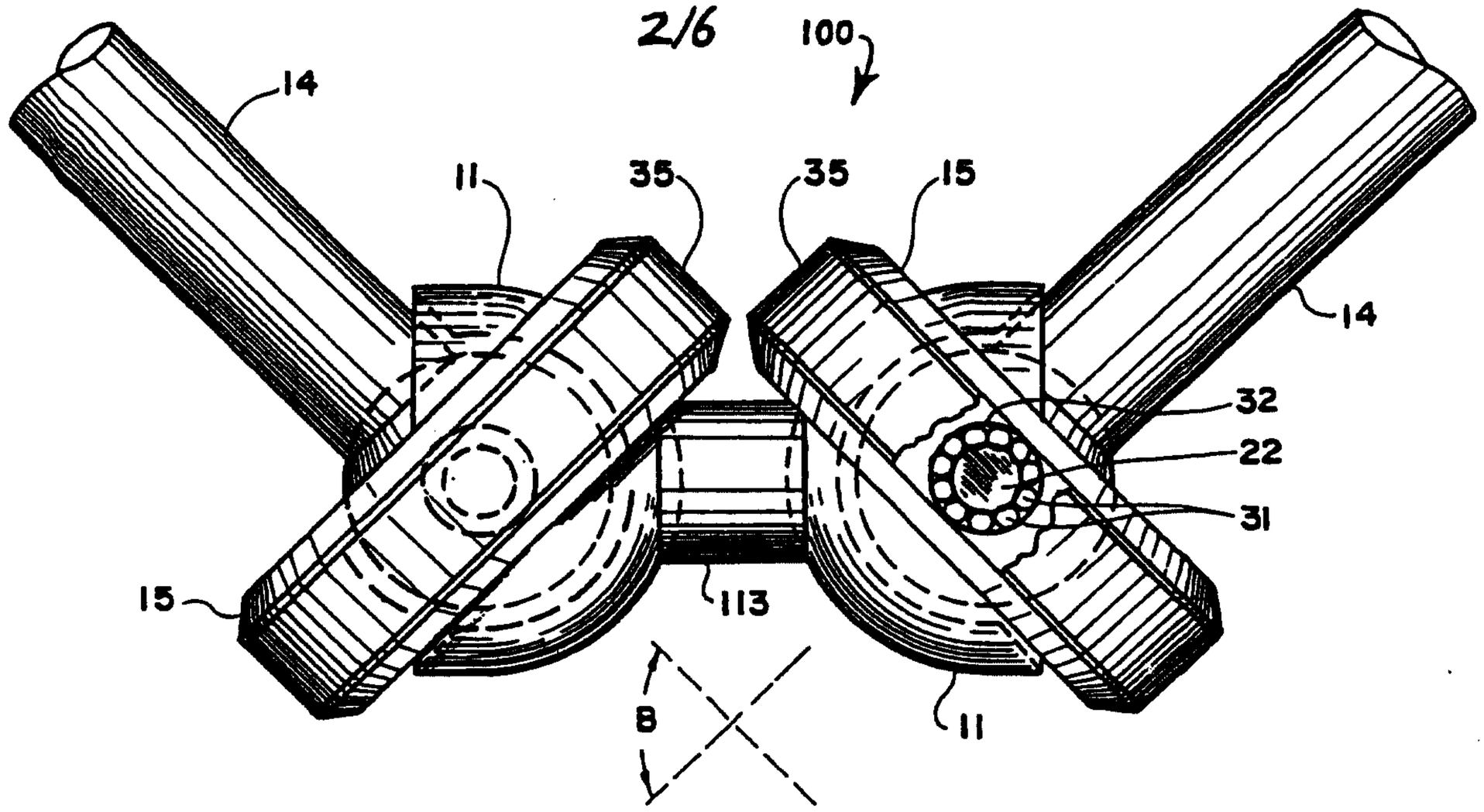


FIG. 2

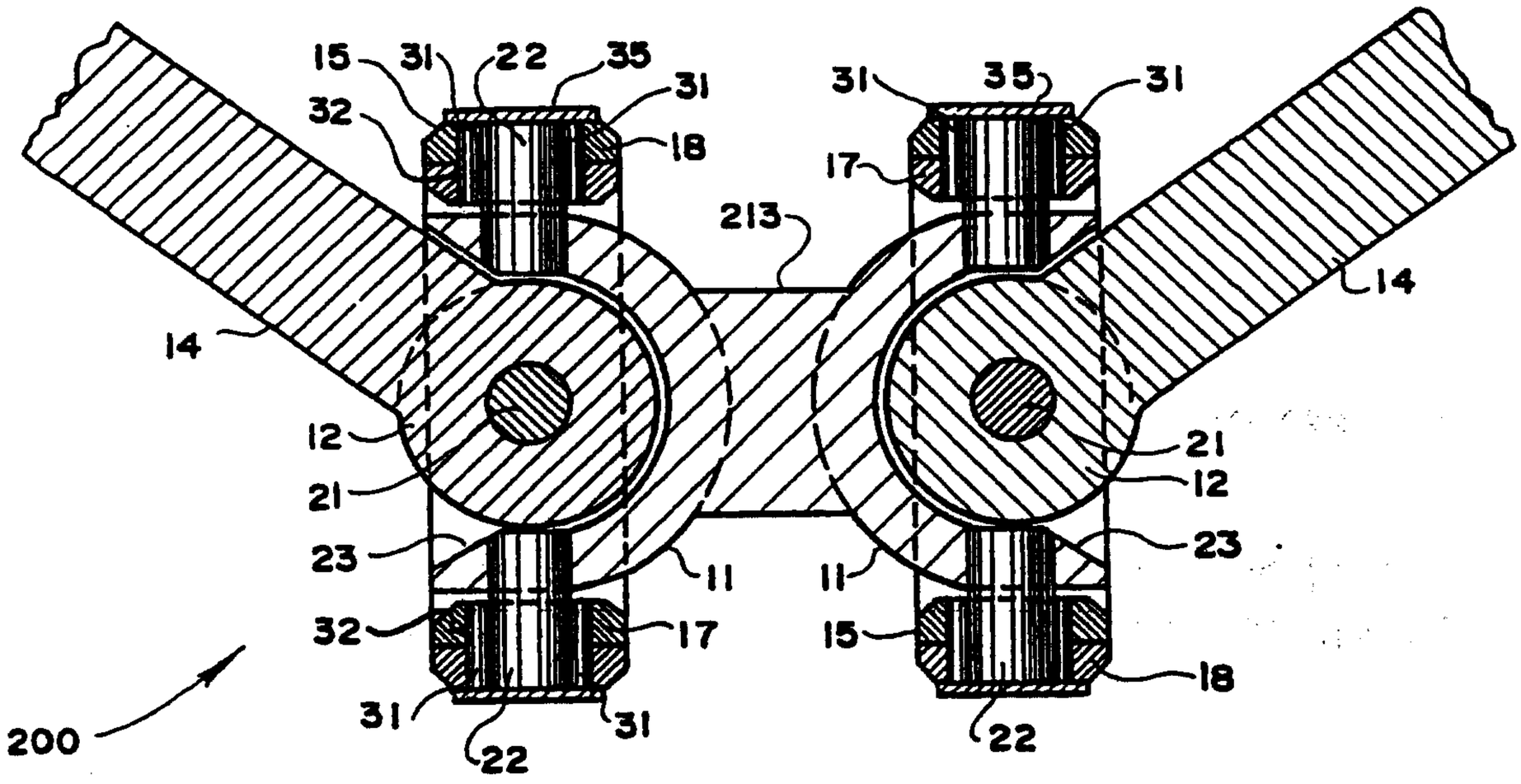


FIG. 3

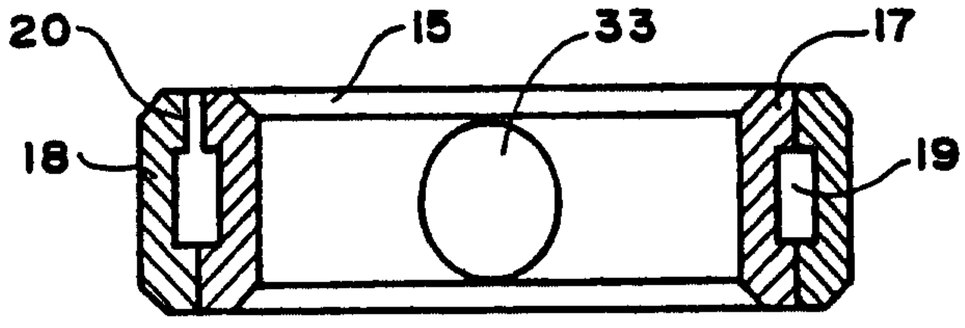


FIG. 4

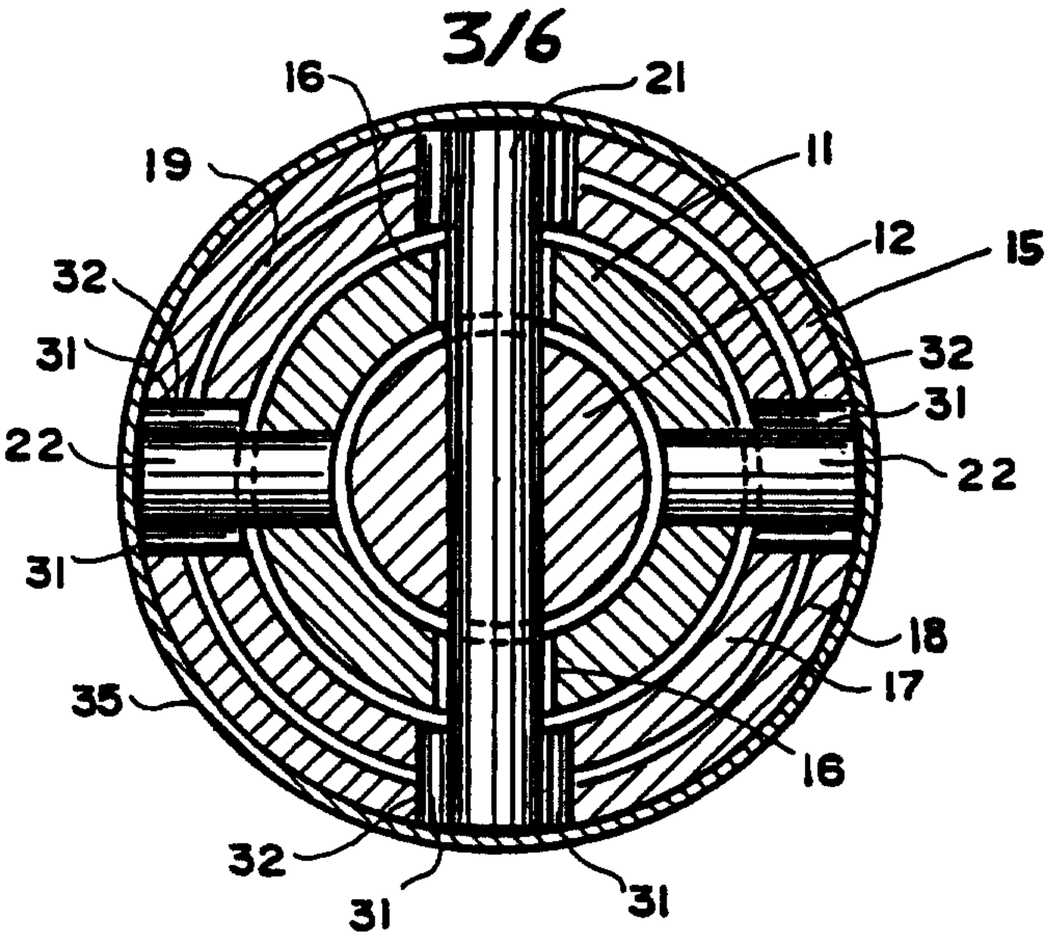

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FIG. 5

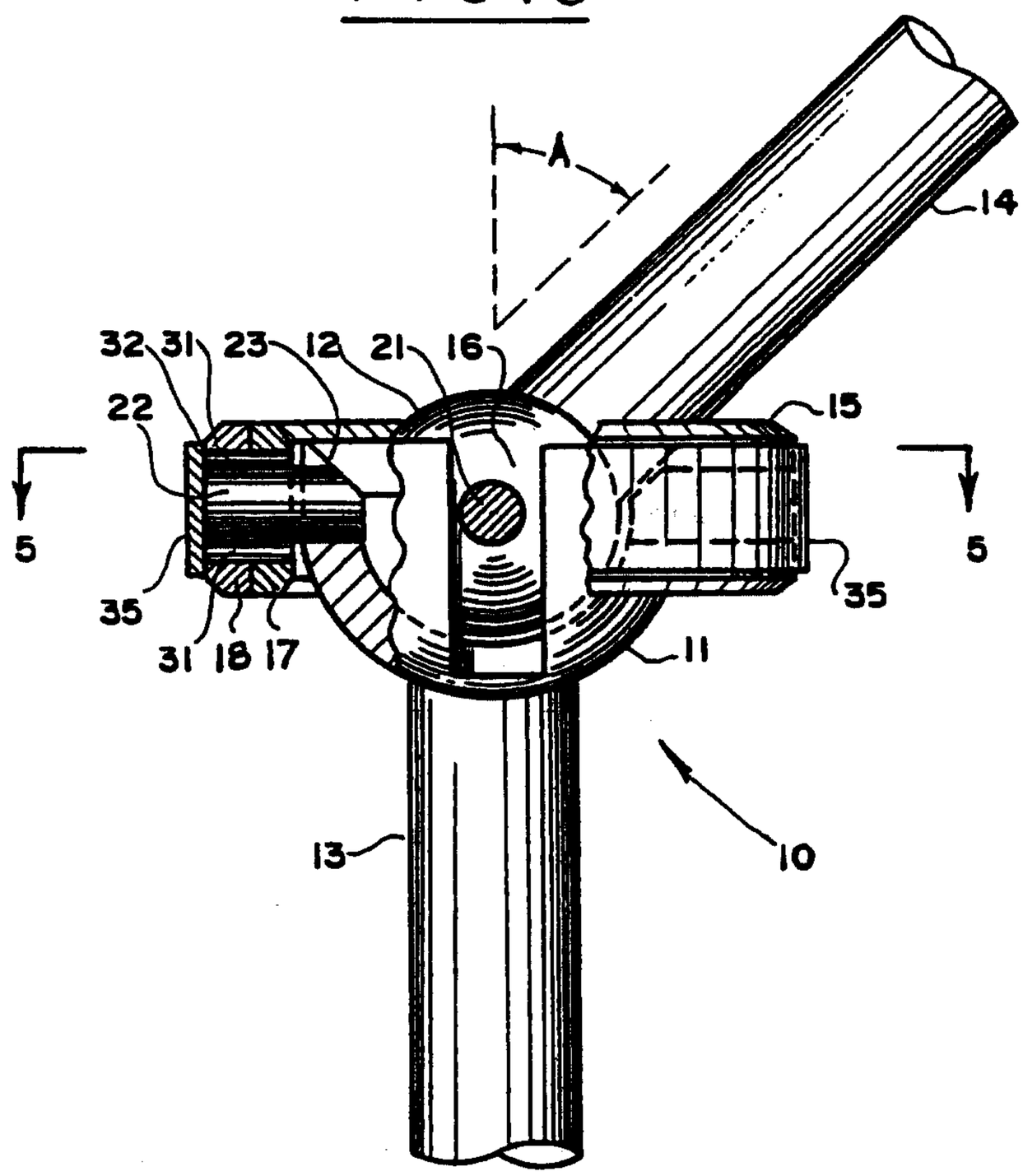
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FIG. 6

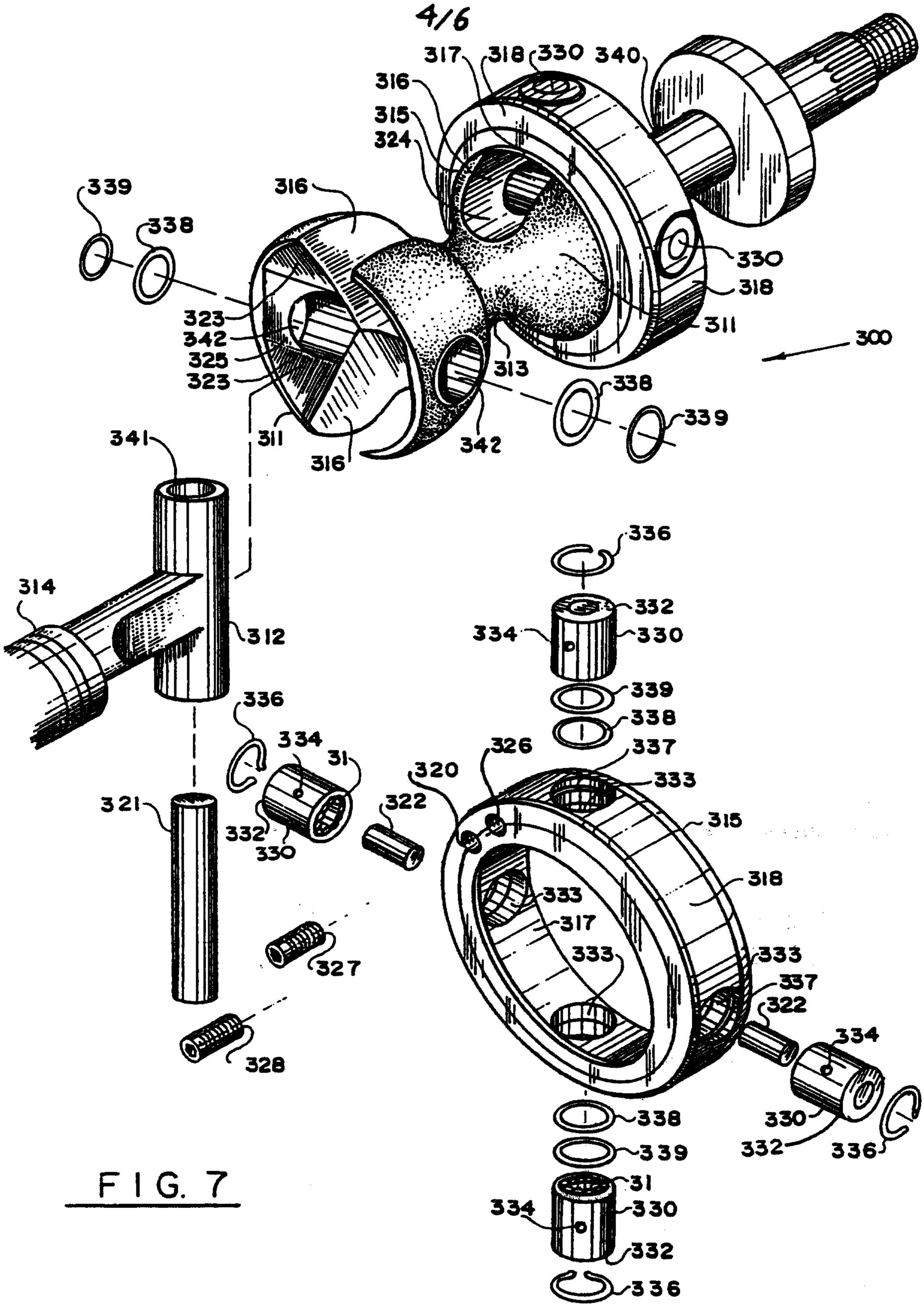
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FIG. 7

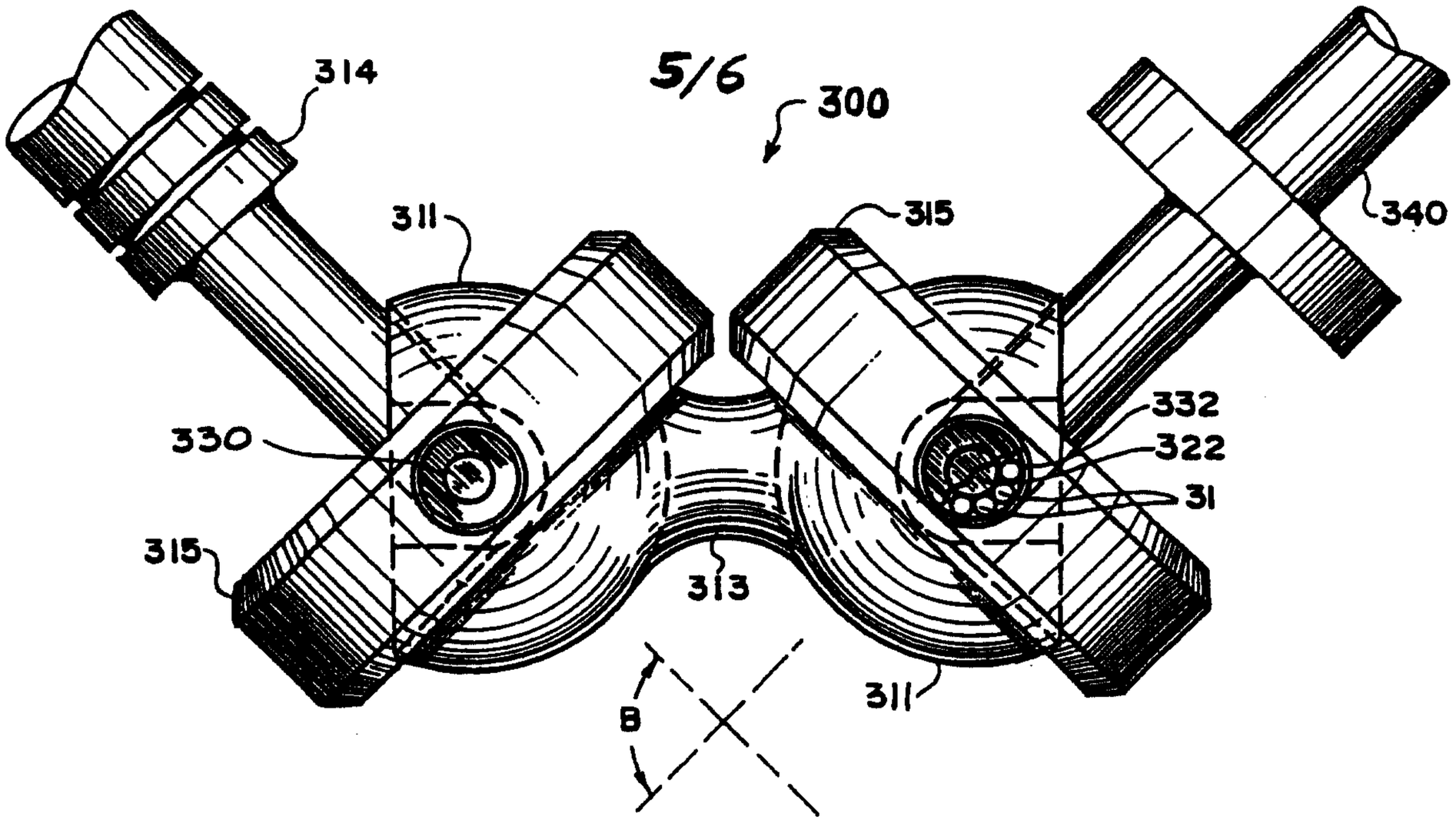

FIG. 8

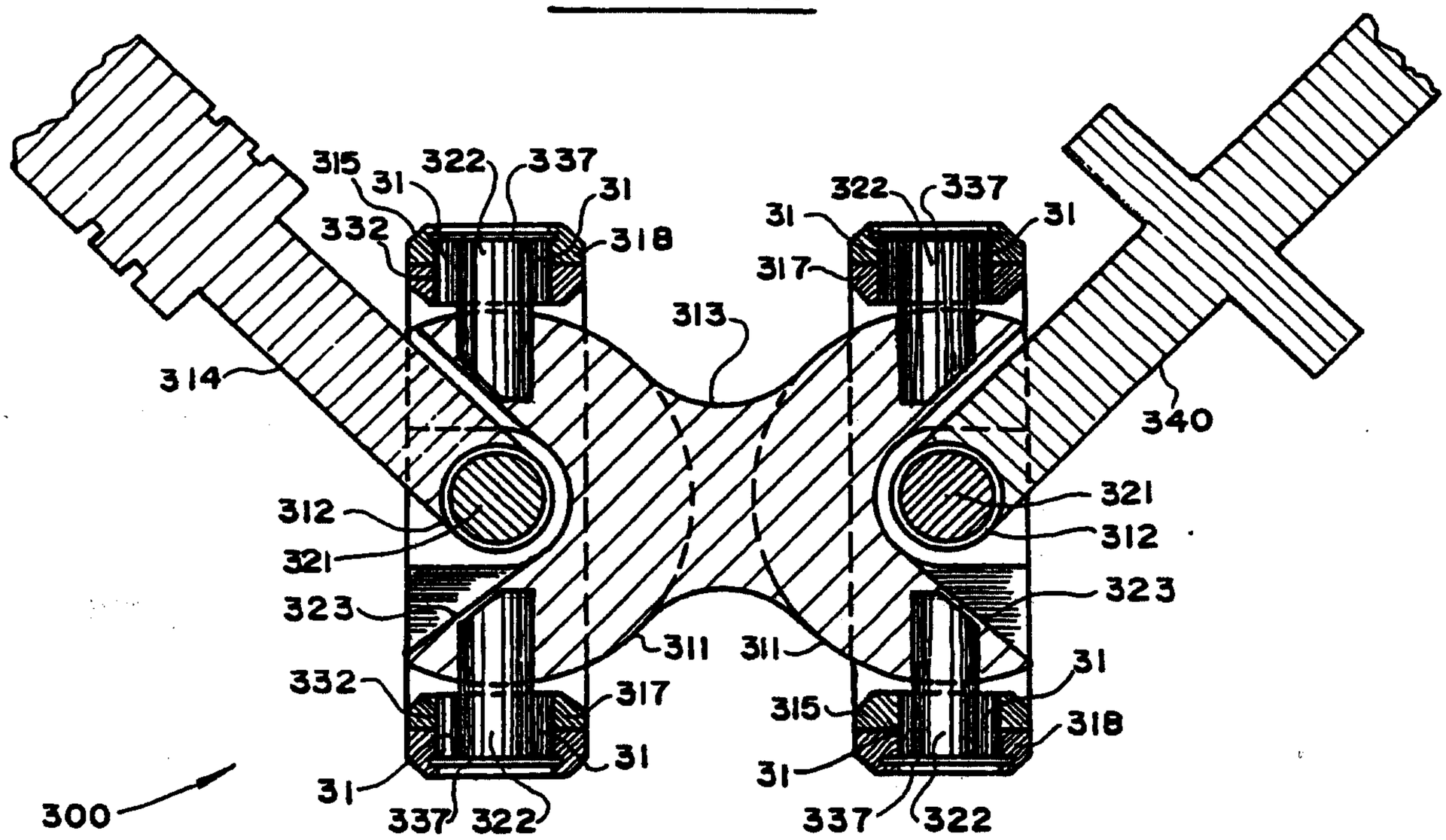

FIG. 9

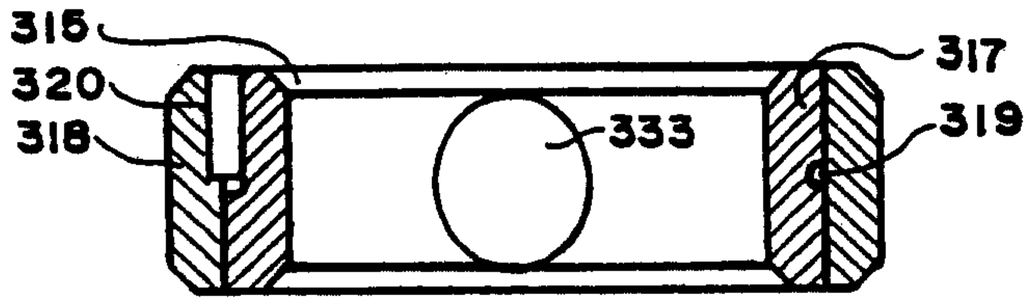

FIG. 10

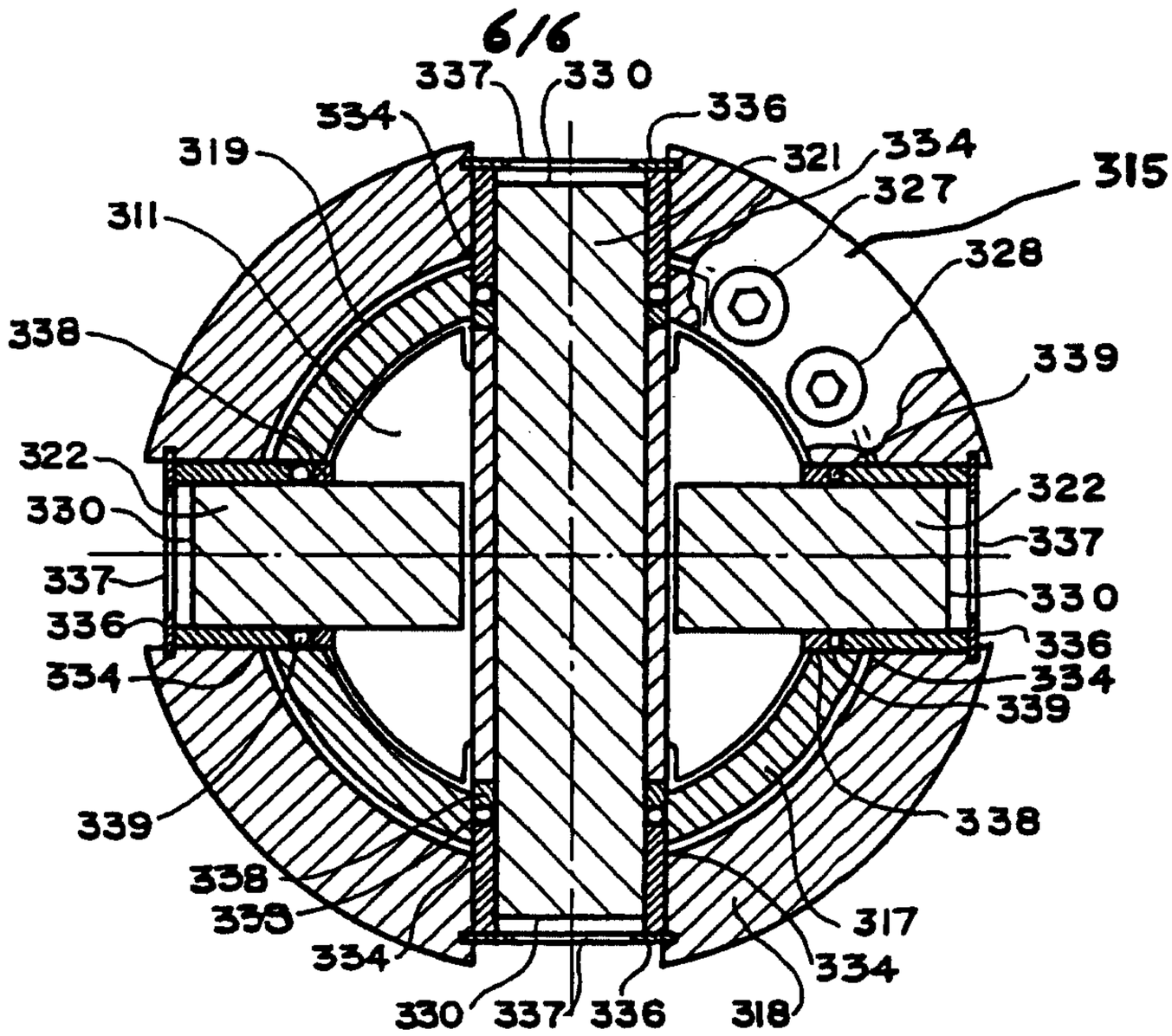
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FIG. 11

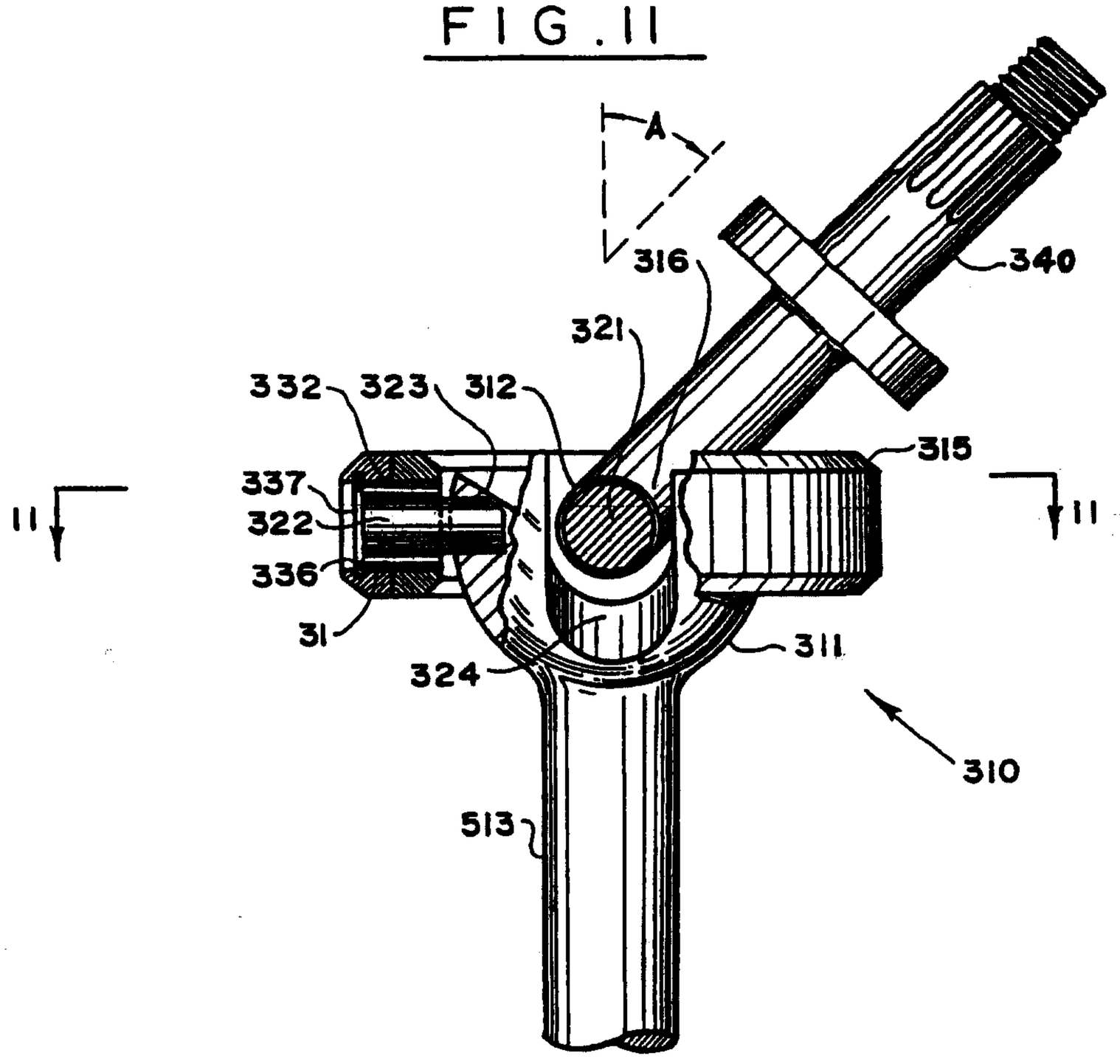
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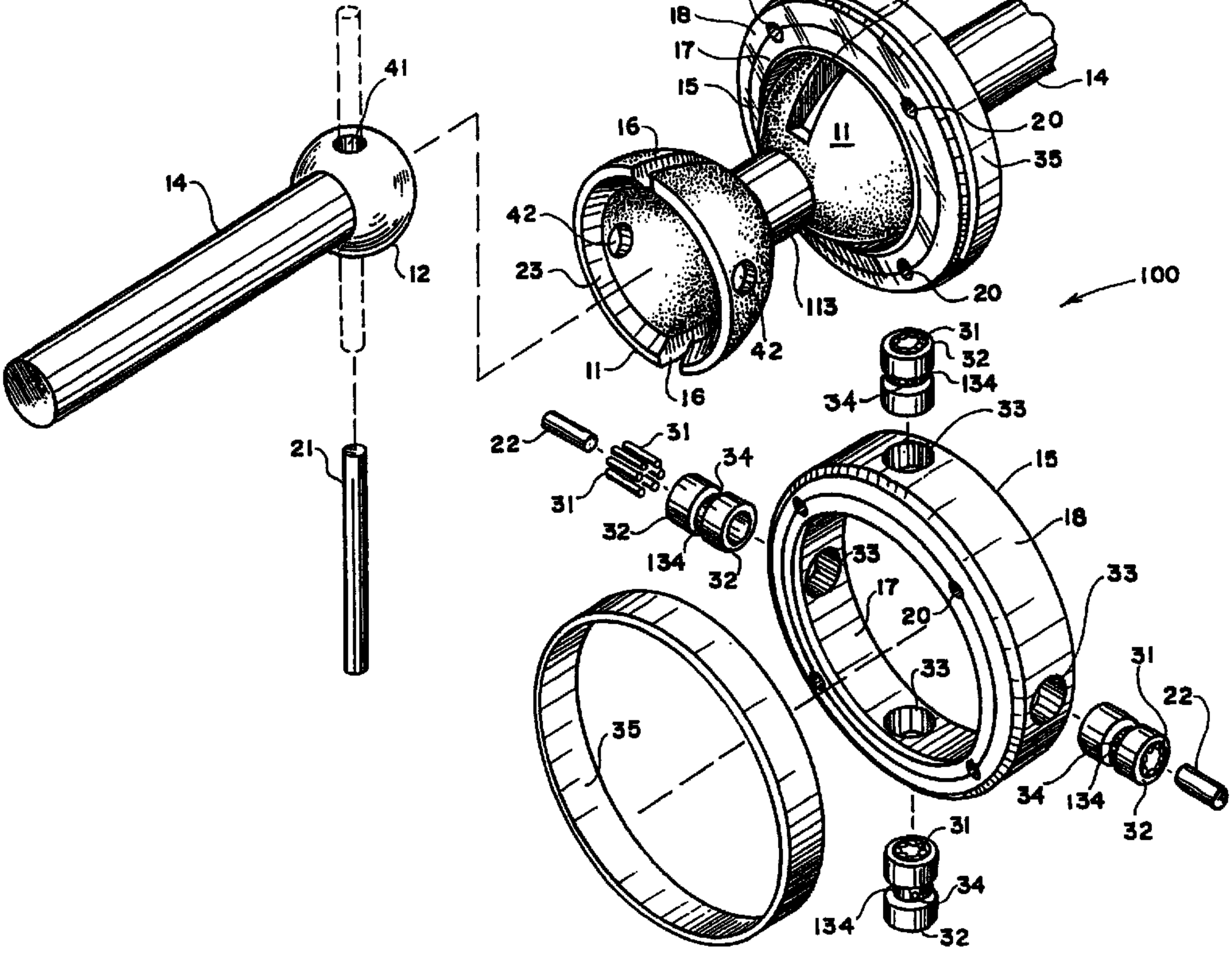
FIG. 12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