(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 March 2006 (16.03.2006)

PCT

(10) International Publication Number
WO 2006/029416 A2

(51) International Patent Classification:
B60W 10/02 (2006.01)

(21) International Application Number:
PCT/US2005/037424

(22) International Filing Date: 19 October 2005 (19.10.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/622,037	26 October 2004 (26.10.2004)	US
60/642,060	7 January 2005 (07.01.2005)	US
11/223,132	9 September 2005 (09.09.2005)	US

(71) Applicant *(for all designated States except US)*: **MATTEL, INC.** [US/US]; 333 Continental Blvd., El Segundo, CA 90425-5012 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MOLL, Joseph, Thomas** [US/US]; 1200 Esplanade #320, Redondo Beach, CA 90277 (US). **LEONOV, Vladimir**; 1429 Brett Place, Unit 203, San Pedro, CA 90732 (US). **WILLETT, William** [US/US]; 5 Birchwood Street, Irvine, CA 92618 (US). **ONG, Kenlip** [SG/SG]; 132 Tamarind Road, Singapore 806079 (SG).

(74) Agents: **JAMIESON, John** et al.; Akin Gump Strauss Hauer & Feld, LLP, One Commerce Square, Suite 2200, 2005 Market Street, Philadelphia, PA 19103 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *upon request of the applicant, before the expiration of the time limit referred to in Article 21(2)(a)*

— *without international search report and to be republished upon receipt of that report*

— *without classification; title and abstract not checked by the International Searching Authority*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2006/029416 A2

(54) Title: TRANSFORMABLE TOY VEHICLE

(57) Abstract: A toy vehicle (10, 1010, 1110, 1210) includes a central housing (12, 1134, 1234) having first and second oppositely disposed sides (12a, 12b, 1134a, 1134b). A first wheel (30, 1014, 1114, 1214) is rotatably mounted on the first side of the housing, and a second wheel (40, 1016, 1116, 1216) is rotatably mounted on the second side of the housing. Each of the first and second wheels has a central hub (50, 1020, 1120, 1220) and a plurality of individual vanes (20, 1018, 1118, 1218) rotatably attached to the hub. Each hub has a center disposed along a first axis of rotation (50', 1032, 1132) common to the first and second wheels. Each vane is rotatable about a second vane axis (20') extending transversely with respect to the first axis. An end of each van distal to the hub forms a circumferential surface portion of one of the first and second wheels. Motor (83, 85, 87, 1040, 1042, 1044, 1140, 1142, 1144) drive the wheels and rotate the vanes.

TITLE OF THE INVENTION

[0001] Transformable Toy Vehicle

FIELD OF THE INVENTION

[0002] The present invention relates to toy vehicles, particularly those having unusual transforming characteristics.

BACKGROUND OF THE INVENTION

[0003] Some toy vehicles try to simulate real vehicles for entertainment value. More imaginary toy vehicles try to provide features never seen in real vehicles for entertainment value. One form of imaginary toy vehicle is a motorized ball toy.

[0004] One type of motorized ball toy is disclosed in U.S. Patent No. 6,066,026. Here, two generally hemispherical wheels are connected together with their circular ends facing each other. One or each hemispheric wheel contains its own drive motor, which is mounted in a central support structure substantially or essentially surrounded by the two wheels. The central support structure further supports a power supply also surrounded by the two wheels and an antenna which extends outwardly from the support member and between the wheels to form a "tail" extending from the "ball". In one embodiment, paddles are attached around the outer circumference of each of the hemispheric wheels to drive to the ball toy in water.

[0005] Another type of motorized ball toy is shown in U.S. Patent No. 4,671,779. A spherical shell surrounds a drum containing a motor. The shell is formed by a pair of spherical segment support members that are rotatably attached to the axial ends of the drum, and a set of partially spherical segments that are connected to one another around the support members and the drum so as to peel or unwind away from the drum and the support members when the drum is powered to move in a certain direction. The unwound segments form a tail that is dragged around behind the drum hanging from the support members. The drum rides on circumferential sets of teeth at either end of the drum. The motor drives the drum to rotate in either of two opposite directions unwinding the shell segments in one direction and winding up the sections in a ball around the cylinder in the other direction. A pair of "feelers" can be deployed from the support members by the motor module in the cylinder. The direction of rotation of the motor in the cylinder may be reversed in response to engagement of the feelers with an object such as an obstacle positioned in the way of the toy.

[0006] It is believed that a different type of motorized ball toy having a different construction and operation would have significant new and different entertainment value than existing toys.

BRIEF SUMMARY OF THE INVENTION

[0007] Briefly stated, the present invention is a toy vehicle comprising a central housing having first and second oppositely disposed sides. At least first and second wheels are rotatably engaged with the housing. The first wheel is rotatably mounted on the first side of the housing and the second wheel is rotatably mounted on the second side of the housing. Each of the first and second wheels has a central hub and a plurality of individual vanes rotatably attached to the hub. Each hub has a center disposed along a first axis of rotation common to the first and second wheels. Each vane is rotatable about a second vane axis extending transversely with respect to the first axis. Each vane extends outwardly from the hub to an end distal to the hub forming a circumferential surface portion of one of the first and second wheels.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0008] The foregoing summary, as well as the following detailed description of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings an embodiment which is presently preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown.

[0009] In the drawings:

[0010] Fig. 1 is a front left perspective view of a first preferred toy vehicle embodiment of the present invention having vanes in a first position and a tail in a retracted position;

[0011] Fig. 2 is a front left perspective view of the toy vehicle of Fig. 1 having the vanes in a second position and the tail in an extended position;

[0012] Fig. 3 is a front left perspective view of the toy vehicle of Fig. 2 having the vanes in an intermediate rotational position and the tail in the extended position;

[0013] Fig. 4 is a right side elevational view of the toy vehicle of Fig. 2 having a first wheel and a first side of a central housing omitted to expose an on-board control unit, a battery housing, and a gear housing within the central housing;

[0014] Fig. 5 is a partially exploded view of the gear housing of Fig. 4;

[0015] Fig. 6 is a partially exploded view of the gear housing of Fig. 5 having motors and the first portion of the gear housing omitted;

[0016] Fig. 7 is an exploded view of the gear housing of Fig. 4;

[0017] Fig. 8 is an exploded view of a central shaft assembly of the gear housing of Fig. 4;

[0018] Fig. 9 is a front left perspective view of the toy vehicle of Fig. 2 having the first wheel partially exploded;

[0019] Fig. 10 is a front left perspective view of the toy vehicle of Fig. 9 having a portion of the first wheel omitted and the remaining portion of the first wheel exploded;

[0020] Fig. 11 is a perspective view of a second preferred embodiment toy vehicle having some mechanical components different from the first embodiment, the toy vehicle being in the generally spherical configuration with most of its vanes and its central chassis housing removed;

[0021] Fig. 12 is a view similar to Fig. 11 with the vanes rotated 90 degrees from the Fig. 11 position;

[0022] Fig. 13 is a perspective view with chassis housing and most vanes removed similarly to Figs. 11 and 12 with the vanes rotated 90 degrees from those in Fig. 12 and 180 degrees from those in Fig. 11;

[0023] Fig. 14 is a bottom perspective view of a chassis of the toy vehicle of Figs. 11-13 showing the main drive arrangement;

[0024] Fig. 15 is an upper perspective view of the chassis of Fig. 14 with the battery/electronics compartment removed showing the same drive configuration;

[0025] Fig. 16 is a top perspective view of a third preferred embodiment toy vehicle of the present invention approximately midway through a state transformation with the majority of its vanes, one polygonal housing, and its central housing removed and with several components partially broken away along a first axis to reveal another possible set of motor-driven components;

[0026] Fig. 17 is a bottom rear perspective view of the toy vehicle of Fig. 16 having several components broken away along a plane generally taken through centers of motors of the toy vehicle;

[0027] Fig. 18 is a close-up partial side elevational view of an arm or "tail" driving mechanism;

[0028] Fig. 19 is a front right perspective view of the second embodiment toy vehicle with the majority of its vanes, one polygonal housing, and an outer surface of the other polygonal housing removed;

[0029] Fig. 20 is a perspective view of shuttles of the toy vehicle of Fig. 16;

[0030] Fig. 21 is a perspective view of the shuttles of Fig. 20 having a lead screw attached thereto and a lead screw housing surrounding the lead screw;

[0031] Fig. 22 is a perspective view of a portion of the toy vehicle shown in Fig. 16, the portion having some components shown in Fig. 16 removed;

[0032] Fig. 23 is a perspective view of the portion of the toy vehicle shown in Fig. 22 having motors attached thereto;

[0033] Fig. 24 is a perspective view of the portion of the toy vehicle of Fig. 23 having a "wheel" attached thereto;

[0034] Fig. 25 is a perspective view of a fourth preferred embodiment toy vehicle of the present invention approximately midway through a state transformation with the majority of its vanes removed and an articulated tail in a stored position; and

[0035] Fig. 26 is a bottom plan view of the toy vehicle of Fig. 25 with the articulated tail in an extended position.

DETAILED DESCRIPTION OF THE INVENTION

[0036] Certain terminology is used in the following description for convenience only and is not limiting. The words "right," "left," "upper," and "lower" designate directions in the drawings to which reference is made. The terminology includes the words above specifically mentioned, derivatives thereof, and words of similar import.

[0037] Referring to the drawings in detail, wherein like numerals indicate like elements throughout, there is shown in Figs. 1-10 a first preferred embodiment of a transformable toy vehicle, indicated generally at 10, in accordance with the present invention, in a generally spherical configuration for movement on a surface (not shown). Referring initially to Fig. 1, the toy vehicle 10 includes a central housing 12, preferably having first and second oppositely disposed sides 12a, 12b. The central housing 12 preferably also includes a front cover 12c which is engaged with the first and second sides 12a, 12b. While this is preferred, it is within the spirit and scope of the present invention that the front cover 12c be omitted, leaving only the first and second sides 12a, 12b, provided the toy vehicle 10 is still capable of functioning as described herein.

[0038] The toy vehicle 10 preferably includes at least two reconfigurable "wheels" rotatably engaged with the central housing 12. Specifically, a first "wheel" 30 is rotatably mounted on the first side 12a of the housing 12, and a second "wheel" 40 is rotatably mounted on the second side 12b of the housing 12. Rotation of the first and second "wheels" 30, 40 causes the toy vehicle 10 to move on the surface.

[0039] Referring now to Figs. 1-3, each of the first and second "wheels" 30, 40 has a central hub 50 and a plurality of individuals vanes 20 rotatably attached to the hub 50. Preferably, each hub 50 has seven vanes 20 rotatably attached thereto, circumferentially disposed around the hub 50, although there can be more or less than seven vanes 20, provided the toy vehicle 10 is still capable of functioning as described herein. Each vane 20 has a length much greater than its thickness and flares in width as it extends away from the hub 50. Each vane 20 is preferably at least slightly

curved along a longitudinal axis thereof and transversely in the width direction. Each hub 50 has a center generally disposed along a first axis of rotation 50′. As will be described below, the first and second wheels 30, 40, including their respective hubs 50, are rotatable with respect to the central housing 12, such that the first and second wheels 30, 40 rotate about the first axis of rotation 50′. Each vane 20 is further rotatable about a second vane axis 20′ extending transversely and preferably generally radially from the first axis 50′.

[0040] Preferably, the vanes 20 are rotatable about the individual second axes 20′ between a first position 22 (Fig. 1) and a second position 24 (Fig. 2) rotationally different from the first position 22. Because the vanes 20 are curved, in the first position 22, the first and second wheels 30, 40 are generally cupped with open ends directed inwardly toward one another and the central housing 12, such that the central housing 12 is at least partially received in the first and second wheels 30, 40, partially covered by the vanes 20, and the toy vehicle 10 is generally spherical in shape. In the second position 24, the first and second wheels 30, 40 are generally cupped with the open ends directed outwardly away from one another and the central housing 12, thereby exposing at least a majority of the central housing 12. It is preferable that the first and second wheels 30, 40 are generally hemispherical in the first and second positions 22, 24, although it is within the spirit and scope of the present invention that the first and second wheels 30, 40 have shapes other than generally hemispherical, such as semi-ovoid or conical, provided the toy vehicle is capable of functioning as described herein. Moreover, the vanes do not have to be cupped but may, instead, be essentially straight or curved in only one direction. Furthermore, the vanes can be configured and sized to fully surround the central housing 12, if desired.

[0041] It is preferred that the first and second wheels 30, 40, and specifically the vanes 20 thereof, are rotatable about 180 degrees between the first and second positions 22, 24, and further can be oriented in at least one intermediate rotational position 26 between the first and second positions 22, 24. Preferably, the vanes 20 can be oriented at least to an intermediate position 26 rotationally halfway between the first and second positions 22, 24, such that the first and second wheels 30, 40 generally resemble paddle wheels, as shown in Fig. 3, to facilitate travel of the toy vehicle 10 on water or soft surfaces such as snow, sand, etc. While this is the preferred intermediate position 26, it is preferred that the vanes 20 be capable of being maintained in any desired rotational position between the first and second positions 22, 24, such that the first and second wheels 30, 40 essentially have an unlimited number of intermediate positions. It is part of the invention that the vanes 20 be rotatable only 90 degrees (*i.e.*, between positions 22 and 26 or 26 and 24) or more than

180 degrees. Preferably, the vanes 20 are linked together in each wheel 30, 40 so as to rotate in unison, as will be described in more detail below.

[0042] Referring to Figs. 2 and 4, the toy vehicle 10 further includes a tail 70 preferably movably engaged with the central housing 12. Preferably, the tail 70 has at least a first end 70d secured to the remainder of the toy vehicle 10 and an oppositely disposed, free second end 70e. It is preferred that the first end 70d of the tail 70 is pivotably attached to the central housing 12 by suitable means, such as a pin 71. The tail 70 preferably has a retracted position 72 (shown in phantom in Fig. 4) and an extended position 74. The tail 70 is preferably flexible, such that the tail 70, in the retracted position 72, is generally wrapped around the central housing 12 and, in the extended position 74, the tail 70 extends outwardly from the central housing 12 so that at least the second end 70e is spaced from the central housing 12 and beyond an imaginary cylinder having a cross-section defined by circumferential perimeters, indicated in phantom in Figs. 3 and 4, of the two wheels 30, 40, preferably in all possible configurations of the vanes 20. Preferably, the tail 70 is formed by at least two articulated segments 70a, 70b, such that a first segment 70a is rotatably coupled to the central housing 12 and at least a second segment 70b is rotatably coupled to the first segment 70a. More specifically, the tail 70 is preferably formed by at least three segments with the first segment 70a rotatably coupled to the central housing 12, the second segment 70b rotatably coupled to the first segment 70a, and a third segment 70c rotatably coupled to the second segment 70b. Although it is preferred to have an articulated tail, it is within the spirit and scope of the present invention that the tail 70 be made flexible in other ways. For example, the tail could be provided by a spring member that is partially coiled around the central housing and that resiliently reacts to uncoiling. Also, the tail need not be flexible. It may be relatively rigid and coupled with the central housing to be always extended or movably mounted to be controllably extended and retracted.

[0043] Preferably, when in the retracted position 72, the tail 70 is disposed between open ends of the first and second wheels 30, 40 with the vanes 20 in the first position 22, such that the toy vehicle 10 is generally spherical or, alternatively, generally ovular in shape. Preferably, the tail 70 includes at least one tail wheel 76 proximate the second end 70e for contacting a surface (not shown) in at least the extended position 74 of the tail 70. The tail wheel 76 is preferably rotatably coupled to the second end 70e of the tail 70 so as to roll along the surface during movement of the toy vehicle 10. Although only one tail wheel 76 is shown, there may be more than one wheel or, alternatively, no wheels on the tail 70, such that the second end 70e of the tail 70 merely slides along the surface during movement of the toy vehicle 10.

[0044] If desired, the tail 70 and the vanes 20 of the first and second wheels 30, 40 can be made buoyant in water. Buoyancy of the tail 70 and vanes 20 can be accomplished in any number of ways, including, but not limited to, forming the tail 70 and vanes 20 of generally hollow, sealed, shell-like forms and/or making the tail 70 and the vanes 20 at least partially from a sealed (*e.g.*, closed cell or solid skin) plastic foam material. Although these methods of making the tail 70 and the vanes 20 buoyant are preferred, they are not meant to be limiting, as it is within the spirit and scope of the present invention for the tail 70 and the vanes 20 to be made buoyant in another manner that is generally known to one skilled in the art or to be made non-buoyant for use of the toy vehicle only on solid surfaces. By constructing the vanes 20 and the tail 70 in a manner so that the vanes 20 and tail 70 are buoyant, and appropriately sealing the electronics, the toy vehicle 10 can be made capable of traveling along the surface of the water, if so desired.

[0045] Referring to Fig. 4, preferably, a gear housing 80 is disposed within the central housing 12 and includes first and second portions 80a, 80b. Preferably, the central housing 12 is also an outer housing and is decorated in some manner so as to be visually interesting to a user. For instance, the outer housing 12 can be decorated to resemble an animal, a monster, or an insect, although this is not intended to be limiting. As such, it is within the spirit and scope of the present invention that the outer housing 12 be decorated in any manner. Optionally, the outer housing 12 could be omitted and the gear housing 80 could be used as the central housing of the toy vehicle, with or without decoration.

[0046] Referring now to Figs. 5-8, preferably, housed within the gear housing 80 are first and second drive gear trains 82, 84 and a transformation gear train 86. The first and second drive gear trains 82, 84 and the transformation gear train 86 are preferably reduction gear trains. Preferably, the first drive gear train 82 is operatively coupled to the first wheel 30. The second drive gear train 84 is operatively coupled to the second wheel 40. The transformation gear train 86 is operatively coupled with a central shaft assembly 90 that is at least partially housed within the gear housing 80. Preferably, at least a first preferably reversible motor 83 is operatively coupled to at least the first wheel 30 through the first drive gear train 82 to drive at least the first wheel 30, and at least a second preferably reversible motor 85 is operatively coupled to at least the second wheel 40 through the second drive gear train 84 to drive at least the second wheel 40. More specifically, it is preferred that pinions 83a, 85a of the first and second motors 83, 85 mesh with the first and second drive gear trains 82, 84, respectively, such that the first and second motors 83, 85 separately and independently drive the first and second wheels 30, 40. In this way, the first and second wheels 30, 40 can be driven in the same direction to move the toy vehicle 10 in either a forward or backward direction.

The first and second wheels 30, 40 can also be driven in opposite directions to quickly turn the toy vehicle 10 in place about its center to either the left or the right. Alternatively, only one of the first and second wheels 30, 40 can be driven (the other of the first and second wheels 30, 40 being un-driven) so as to turn the toy vehicle 10 generally about the undriven wheel more slowly than if the first and second wheels 30, 40 are driven in opposite directions.

[0047] Referring specifically to Figs. 5 and 7, the first and second drive gear trains 82, 84 are essentially similar. As such, only the first drive gear train 82 will be described in detail. The first motor 83 is preferably secured to the second portion 80b of the gear housing 80 such that the pinion 83a of the first motor 83 extends through the second portion 80b and through an opening 102a in an innermost first cover 102 and meshes with a first spur portion 822a of a first compound gear 822 of the first drive gear train 82. A smaller, second spur portion 822b of the first compound gear 822 meshes with a first spur portion 824a of a second compound gear 824. A second smaller spur portion 824b of the second compound gear 824 then meshes with a drive gear 96, which, as will be described in more detail below, is part of the central shaft assembly 90 and is coupled with the first wheel 30. In this way, the first motor 83 is able to power the first wheel 30 through the first drive gear train 82. In a like manner, the second motor 85 is able to power the second wheel 40 through the second drive gear train 84, in order to separately and independently drive the first and second wheels 30, 40.

[0048] It is preferred that at least one of the first and second compound gears 822, 824 of the first drive gear train include a clutch (not shown) therein in order to limit damage of the first drive gear train 82 and/or the first motor 83 should the first wheel 30 be stopped or otherwise held up during driving thereof. Preferably, the second compound gear 824 includes the clutch. While the clutch is not shown in detail, such clutches are well known in the art. Preferably, the clutch included with the second compound gear 824 is a generally circular leaf spring disposed between the separate first and second spur portions 824a, 824b, which allows rotation of the first spur portion 824a with respect to the second spur portion 824b when a certain threshold torque is reached, the threshold torque generally being the amount of torque experienced by the second compound gear 824 when the first wheel 30 is powered but unable to move.

[0049] Referring again to Figs. 5-8, the transformation gear train 86 is preferably disposed partially within the second portion 80b of the gear housing 80 and is driven by a third, preferably reversible, transformation motor 87, which is preferably engaged with the first portion of the gear housing 80. As will be described below, the transformation gear train 86 is operatively coupled to the vanes 20 of the first and second wheels 30, 40. In turn, the transformation motor 87 is

operatively coupled to the vanes 20 in order to rotate the vanes 20 to transform the toy vehicle 10 by rotating the vanes 20 about the vane axes 20′ between at least the first and second positions 22, 24.

[0050] Referring specifically to Figs. 5-7, a pinion 87a of the transformation motor 87 meshes with a first spur portion 862a of a first compound gear 862. A second, smaller spur portion 862b of the first compound gear 862 meshes with a first spur portion 864a of a second compound gear 864. A second, smaller spur portion 864b of the second compound gear 864 then meshes with a first spur portion 866a of a third compound gear 866. A second, smaller spur portion 866b of the third compound gear 866 then engages with a threaded spur gear 98 rotatably mounted on the central shaft assembly 90. The structure and operation of the threaded gear 98 will be described below.

[0051] Preferably, the transformation gear train 86 includes a slip clutch (unnumbered) on the third compound gear 866 in order to limit damage to the transformation gear train 86 and/or the transformation motor 87 if, during driving of the transformation gear train 86, the vanes 20 are stuck or otherwise prevented from rotating or manually forced to rotate about the second axes 20′. It is preferred that the third compound gear 866 have separate first and second spur portions 866a, 866b with engagement surfaces (*e.g.*, serrated surfaces, not shown) therebetween. The second spur portion 866b is preferably biased toward the first spur portion 866a by a spring (unnumbered), so that, under normal conditions, the engagement surfaces prevent slippage between the first and second spur portions 866a, 866b to enable the transformation motor 87 to cause rotation of the threaded gear 98. However, if the vanes 20 become bound and prevent rotation of the threaded gear 98 during driving of the transformation gear train 86 by the transformation motor 87, the engagement surfaces between the first and second spur portion 866a, 866b slip with the second spur portion 866b being forced against the spring and away from the first spur portion 866a, thereby allowing the first spur portion 866a to continue rotating while also allowing the second spur portion 866b to not rotate. Although it is preferred that the slip clutch be included within the third compound gear 866, it is within the spirit and scope of the present invention for the slip clutch to be disposed in a different portion of the transformation gear train 86 or to be a different form of clutch. Such alternate clutches are generally well known in the art and need not be specifically described herein.

[0052] Referring now to Fig. 8, the central shaft assembly 90 preferably includes a rod 91 having caps in the form of drive gear supports 97 rotatably disposed on either end of the rod 91. The rod 91 and drive gear supports 97 are disposed partially within a screw member or threaded tube 92, such that at least ends of the drive gear supports 97 extend outwardly from either end of the threaded tube 92. The rod 91 keeps flange portions 97a abutted against annular end walls (not

depicted) of the threaded tube 92. The threaded gear 98, briefly discussed above, has internal threads 98a (partially shown in phantom) within a bore thereof for threadably engaging threads 92b on the outer surface of the threaded tube 92. A collar 92a engages an end of the threaded tube 92 to retain the threaded gear 98 on the threaded tube 92 and the drive gear supports 97 and rod 91 in the threaded tube 92.

[0053] The threaded gear 98 is essentially sandwiched between innermost first and second covers 102, 104 through which the threaded tube 92 is disposed when the gear housing 80 is assembled. The innermost first and second covers 102, 104 are engaged with the first and second portions 80a, 80b, respectively, of the gear housing 80. At least the ends of the drive gear supports 97 extend through the innermost first and second covers 102, 104 so that the drive gears 96 can be slidably disposed thereon in assembly so as to abut outer surfaces of the innermost first and second covers 102, 104.

[0054] Preferably, the drive gears 96 rotate with the drive gear supports 97, while at the same time being axially slidable with respect thereto. Preferably, this is accomplished by slidably keying the drive gears 96 with the drive gear supports 97, for example, by forming the ends of the drive gear supports 97 with a hexagonal cross-section and forming the drive gears 96 with a mating hexagonal bore, thereby allowing axial sliding movement of the drive gear supports 97 with respect to the drive gears 96 while rotationally fixing the drive gears 96 with the drive gear supports 97.

[0055] Engaged with the ends of the drive gear supports 97 and extending axially outwardly therefrom are rack gears 100. The central shaft assembly 90 further includes limit switches 94, preferably engaged with each of the innermost first and second covers 102, 104, which function to cut power to the transformation motor 87 when sliding limits of the central shaft assembly 90 are reached. The drive gear supports 97 and rack gears 100 together constitute first and second vane transformation members extending from the first and second sides 12a, 12b of the central housing 12. These vane transformation members are movable in a manner (axially along the first axis 50') to rotate the vanes 20 of each wheel 30, 40.

[0056] Generally speaking, the central shaft assembly 90 allows the rack gears 100, the drive gear supports 97, the rod 91, and the threaded tube 92 and collar 92a to move axially with respect to the drive gears 96, the threaded gear 98, and the innermost first and second covers 102, 104, as well as the gear housing 80 and the central housing 12. At the same time, the central shaft assembly 90 allows the drive gears 96 and the drive gear supports 97 to rotate separately and independently of each other without affecting the above-described axial motion. This is accomplished by retaining one drive gear 96 between the first portion 80a of the gear housing 80 and the innermost first cover

102, the other drive gear 96 between the second portion 80b of the gear housing 80 and the innermost second cover 104, and, as described above, the threaded gear 98 between the innermost first and second covers 102, 104, such that each can be rotated but cannot be moved axially with respect to the gear housing 80. The threaded tube 92, however, is able to move axially along the first axis 50′ during rotation of the threaded gear 98, which causes the threads 98a of the threaded gear 98 to travel along the threads 92b of the threaded tube 92 during rotation of the threaded gear 98 by the transformation gear train 86. Because the threaded gear 98 is unable to move axially, it forces the threaded tube 92 to move axially along the first axis 50′. Doing so further causes the drive gear supports 97, the rod 91, and the rack gears 100 to move axially along the first axis 50′. However, regardless of the axial position of the above-listed components, the drive gears 96 are still capable of being rotated by the respective first and second drive gear trains 82, 84 in order to drive the first and second wheels 30, 40. In this way, the first and second wheels 30, 40 can be independently driven with the vanes 20 fixed in any vane position, *e.g.*, any of the first, second, and intermediate positions 22, 24, 26 (as well as any other intermediate position), as well as during rotation of the vanes 20 between positions.

[0057] Referring now to Figs. 9 and 10, a generally cylindrical collar 54 is preferably fixed to a distal end portion 96a of the drive gear 96 that extends outwardly from the first side 12a of the central housing 12 and the first portion 80a of the gear housing 80. Because the collar 54 is fixed to the drive gear 96, the collar 54 rotates with the drive gear 96. An inner portion 50b of the central hub 50 is fixed to the collar 54 and thus with the drive gear 96 so as to rotate therewith. The vanes 20 are preferably rotatably retained between the inner portion 50b and an outer portion or cover portion 50a of the central hub 50 so that the first wheel 30 and its vanes 20 rotate about the first axis 50′ along with the central hub 50. In this way, driving of the first wheel 30 is accomplished. The second wheel 40 is driven in a similar manner.

[0058] Referring still to Figs. 9 and 10, disposed within the collar 54 is a series of gears including a pinion 56 engaged with and rotatable by axial sliding motion of the rack gear 100. A driving spur gear 58 is engaged with the pinion 56 so as to rotate in the same direction therewith. A driven spur gear 59 is disposed on the other side of the pinion 56. The driven spur gear 59 is not rotatably engaged with the pinion 56. Disposed within the inner portion 50b of the central hub 50 is a compound crown gear 52. The compound crown gear 52 includes a first crown portion 52a and a second crown portion 52b engaged for rotation therewith by suitable means, such as a hexagonal boss 53a on the first crown portion 52a mating with a hexagonal recess 53b in the second crown portion 52b. The first crown portion 52a is driven by the driving spur gear 58 so as to rotate about

the first axis 50' while permitting axial motion of the rack gear 100. This, in turn, causes the second crown portion 52b to also rotate about the first axis 50'. The second crown portion 52b engages with each of a plurality of vane gears 21, which are fixed to each vane 20 and also disposed within the central hub 50, captured between the outer and inner portions 50a, 50b of the central hub 50.

[0059] Preferably, each vane 20 is rotatably mounted on a post 28a (disposed along the second axis 20') of a wheel floret 28, also captured within the hub 50, such that rotation of the second crown portion 52b causes rotation of each of the vane gears 21 and, in turn, rotation of each vane 20 about its respective post 28a. In this way, when the rack gear 100 is moved axially along the first axis 50', each of the vanes 20 of the first wheel 30 is rotated in unison. Because the rack gear 100 associated with the second wheel 40 is also operatively coupled with the transformation gear train 86, it also slides axially along the first axis 50' to cause the vanes 20 of the second wheel 40 to rotate in unison with each other and with the vanes 20 of the first wheel 30. In this way, the toy vehicle 10 is capable of being transformed between a generally spherical shape with the vanes 20 in the first position 22 (Fig. 1) and a transformed shape with the vanes 20 in the second position 24 (Fig. 2).

[0060] Referring to Fig. 4, the toy vehicle 10 further includes an on-board control unit 16 operatively coupled with the first, second, and transformation motors 83, 85, 87 and configured to receive and process control signals transmitted from a remote, preferably wireless transmission source (*e.g.*, a conventional, manually operated controller, not shown) spaced from the toy vehicle 10 to selectively remotely control operation of the first, second, and transformation motors 83, 85, 87, and, consequently, selectively control rotation and reconfiguration of the first and second wheels 30, 40. The on-board control unit 16 is preferably electrically powered, as are the first, second, and transformation motors 83, 85, 87. Preferably, a battery power source (not shown) disposed within a battery housing 14 supplies the electrical power needed to power the toy vehicle 10. Although it is preferred that the toy vehicle 10 be remotely controlled, it is within the spirit and scope of the present invention that the toy vehicle 10 be controlled in other ways, such as, but not limited to, programming of the toy vehicle 10 to move in a predefined manner. While first and second motors are preferred for independent wheel drive, in smaller variations of the invention, a single motor might be provided to drive both wheels simultaneously in a forward direction or in opposite directions when such motor is reversed. Similarly, while a transformation motor is used to axially move the central shaft assembly, the central shaft assembly might be moved in other ways, particularly in smaller versions of the invention. For example, a central shaft assembly might be moved electromagnetically between two extreme axial positions or spring biased toward one extreme axial position and driven against the bias toward an opposing extreme axial position or

moved pneumatically or hydraulically (with or without spring bias). Moreover, the vanes can be configured to be turned manually by rotating gear linked vanes directly by hand or by means of a suitable implement, such as a key.

[0061] In use, the toy vehicle 10 is driven on a surface by rotation of the first and/or second wheels 30, 40. The toy vehicle 10 can be transformed by causing the vanes 20 of the first and second wheels 30, 40 to rotate about the second axes 20′ between the first position 22 in which the toy vehicle 10 is generally spherical in shape and the second position 24 in which the entire central housing 12 is exposed. Further, the tail 70 is able to be positioned in the extended position 74 or wrapped partially around the central housing 12 in the retracted position 72 with rotation of the central housing 12 caused by driving of the first and second wheels 30, 40. Although this is preferred, it is within the spirit and scope of the present invention that the tail 70 be powered so that it can be caused to move to the extended position 74 and back to the retracted position 72 independently from the driving of the first and second wheels 30, 40. The vanes 20 of the toy vehicle 10 can also be configured in the intermediate position 26 (Fig. 3), so that the first and second wheels 30, 40 resemble paddle wheels, or any other rotational position between the first and second positions 22, 24. If provided with buoyant vanes 20 and tail 70, the toy vehicle 10, otherwise sealed, can then be driven on the surface of water. Although intended to be driven on water when in the intermediate position 26, the toy vehicle 10 can also be driven on dry land with the vanes 20 in any intermediate position. Moreover, it is contemplated that the toy vehicle 10 can be driven on water with the vanes 20 in either of the first and second positions 22, 24, though not as effectively.

[0062] Although the manner described above for driving and transforming the toy vehicle 10 is preferred, it is not intended to be limiting. As such, it is within the spirit and scope of the present invention that alternate methods of driving and transforming the toy vehicle 10 are also contemplated, such as, but not limited to, the methods discussed below.

[0063] Referring now to Figs. 11-15, there is shown a transformable toy vehicle 1010 in accordance with a second preferred embodiment. Transformation of wheels 1014, 1016 and operation of the vehicle 1010 are best understood with respect to Figs. 13-15 showing the various drive components of the vehicle 1010. A central chassis 1012 normally supports an outer housing (not shown, but generally similar to the central housing 12 of the preferred first embodiment), which has been removed in Figs. 11-15. The central chassis 1012 is formed in part by parallel plates 1036, 1037, 1038 adjoining pairs of which are held together by various shafts (unnumbered), spacers 1039 and motors 1040, 1042 and 1044. The three motors 1040, 1042 and 1044 are best seen in Figs. 14

and 15, which are views from an opposite side of the vehicle 1010 from that depicted in Fig. 13 and from which plate 1038 of Fig. 13 has been removed.

[0064] Motor 1040 controls the rotation of the first wheel 1014 while motor 1042 controls the rotation of the second wheel 1016 independently of first wheel 1014. Pinion 1041 of motor 1040 drives a reduction gear train, indicated generally at 1050, which drives a final spur gear 1051. The final gear 1051 of the reduction drive 1050 is engaged with and drives a spur gear 1052 fixedly mounted at an inner end of a drive shaft 1054 driving the first wheel 1014. While the drive shaft 1054 may be solid, preferably it is hollow so that it can receive a stronger support shaft, *e.g.*, a metal shaft (hidden), to support drive shaft 1054. Similarly, a pinion (not depicted) on motor 1042 drives a second reduction gear train 1060, partially seen in Fig. 13, substantially if not exactly identical to the first reduction gear drive train 1050. The last gear of the second reduction drive train (not depicted) similarly drives a spur gear (also not depicted) fixedly mounted at the inner end of the second drive shaft 1064 driving the second wheel 1016. In this way, each wheel 1014, 1016 is separately and independently driven by its own motor 1040, 1042, respectively. Again, the support shaft (not depicted) preferably extends through the second drive shaft 1064. A polygonal housing 1020 (Figs. 11-13) is fixedly mounted to the outer/distal end of each of the drive shafts 1054, 1064 to rotate with that shaft. Similar to the first preferred embodiment, the housings 1020 receive and support a plurality of vanes 1018 forming each wheel 1014, 1016.

[0065] Referring now particularly to Figs. 14 and 15, the pinion 1045 of the transformation motor 1044 drives a third reduction gear train, indicated generally at 1070, the final spur gear 1071 of which drives a spur gear 1065 at an inner end of a "second" screw member 1066, which is responsible for the transformability of the second wheel 1016. Second screw member 1066 is formed by a sleeve 1067 which is fixedly connected to the spur gear 1065, is supported on second drive shaft 1064 and bears a helical screw thread 1068 on its cylindrical outer surface. Rotation of the second screw member 1066 is further passed through its spur gear 1065 and through a pair of idler spur gears 1072, 1074 fixedly mounted together on a shaft 1073 for common rotation. The first idler gear 1072 meshes with the spur gear 1055 on an inner/proximal end of a "first" screw member 1056, which is responsible for the transformability of the first wheel 1014. First screw member 1056 is substantially if not exactly identical to second screw member 1066 and is also formed by a sleeve 1057 bearing a helical screw thread 1058 on its outer cylindrical surface. Referring to Fig. 13, a multi-piece "nut" 1080 is mounted on each screw member 1056, 1066 to move axially along the screw member via the helical threads 1058, 1068. An inner component 1082 of the nut 1080 is non-rotationally coupled with the chassis through suitable means such as a pin (not depicted)

extending from an inner side of the inner component 1082 to the chassis 1012, *e.g.*, the outer housing 1034 and/or one or more of the parallel plates 1036-1038, etc. An outer component 1084 of nut 1080 is mounted for free rotation on the inner component 1082 and is coupled indirectly with the facing polygonal housing 1020 for rotation with that housing. More particularly, the outer component 1084 is coupled with an inner member 1021 (shown separated from nut 1080 in Fig. 13 for clarity), which is polygonal in this embodiment and which moves telescopically with respect to the polygonal housing 1020. Although not depicted in any figure, supported on the inner polygonal member 1021 extending axially, generally parallel with a first axis 1032, are a plurality of racks preferably equal in number to the number of vanes 1018 supported by the outer housing 1020. The racks are telescoped in and out of the outer housing 1020 by virtue of movement of the multi-piece nut 1080 along either drive shaft 1054, 1064. Each rack (not depicted) is drivingly engaged with a spur gear mounted on an inner end of each vane shaft (neither depicted) within the polygonal housing 1020 to rotate that spur gear and its connected vane as the inner polygonal member 1021 moves in and out of the of the polygonal housing 1020 on the multi-piece nut 1080. In this way, each of the two wheels 1014 and 1016 is identically transformed and each of the individual vanes 1018 rotated in unison between the generally spherical (*i.e.*, inward opening) and outward opening configurations 1024, 1026 of each wheel 1014, 1016.

[0066] At the same time, an extendable arm 1028 forming a "tail" is slidingly supported on an inner frame member 1086, mounted on one side of the parallel plates 1036-1038 and the motor drive assemblies in the chassis 1012. A pinion 1076 is provided on the shaft 1073 between the idler spur gears 1072, 1074 and engages a rack 1078 (Fig. 13) provided along a side of the arm 1028 facing the pinion 1076. Thus, when the third, transformation motor 1044 is activated, not only are the vanes 1018 of the wheels 1014 and 1016 rotated, but the arm 1028 is moved inwardly as the vehicle 1010 transforms into the ball-like, generally spherical configuration 1024 and outwardly as the wheels 1014, 1016 invert to expose their inner sides outwardly in the second configuration 1026 of the vehicle 1010. Referring to Fig. 14, an electronic waterproof housing 1088 may be fixedly supported on the inner frame member 1086 as well, receiving and protecting a battery power supply and control circuitry.

[0067] Referring to Figs. 16-24, there is shown various portions of a third preferred embodiment of a generally spherical transforming toy vehicle, indicated generally at 1110, in accordance with the present invention. The toy vehicle 1110 is generally similar in overall appearance to that of the toy vehicles 10, 1010 of the first and second preferred embodiments. That is, the toy vehicle 1110 includes a central housing 1134 and first and second generally hemispheric "wheels" 1114, 1116

(although the second "wheel" is not shown in the figures, it is generally similar and preferably a mirror image of the first "wheel" 1114). Each of the first and second "wheels" 1114, 1116 is preferably formed by a plurality of individual vanes 1118 mounted around the sides of a polygonal housing 1120. Preferably, the central housing 1134 has an ornamented outer shell 1135 engaged thereto, as shown in Fig. 19. The ornamental outer shell 1135 preferably at least partially covers the central housing 1134. While it is preferred that the toy vehicle 1110 include the outer shell 1135, it is within the spirit and scope of the present invention that the outer shell 1135 can be omitted. If the outer shell 1135 is omitted, it is further contemplated that the central housing 1134 be ornamented.

[0068] Referring first to Figs. 16, 17, and 22, drive mechanisms for each of the first and second wheels 1114, 1116 can be seen. Initially, it is noted that the mechanism for driving the first wheel 1114 is essentially similar and is generally a mirror image of the mechanism for driving the second wheel 1116. The drive mechanism for the first wheel 1114 (hereinafter referred to as the "first drive mechanism") includes a first motor 1140, which is preferably attached to a first portion 1134a (Fig. 23) of the central housing 1134. The first motor 1140 has an output shaft on which a first pinion 1141 is fixed. The pinion 1141 engages with and drives a first reduction gear train 1150, including a first compound gear 1152, a second compound gear 1154, and a drive gear 1156. Specifically, the pinion 1141 engages with and rotates a large spur portion of the first compound gear 1152. A small spur portion of the first compound gear 1152 engages with and rotates a large spur portion of a second compound gear 1154. A small spur portion of the second compound gear 1154 engages with and rotates the drive gear 1156.

[0069] The drive gear 1156 is preferably rotatable about a first axis 1132 defined as the line passing through centers of each of the first and second wheels 1114, 1116. As will be described in greater detail below, preferably, the drive gear 1156 is rotatably fixed to a first shuttle 1138, which is essentially an elongate tubular member also disposed along the first axis 1132. The drive gear 1156 is also preferably rotatably fixed to an inner portion 1120a of the polygonal housing 1120, such that rotation of the drive gear 1156 causes rotation of the polygonal housing 1120. Preferably, each of the polygonal housings 1120 includes an inner portion 1120a proximate the central housing 1134 and an outer portion 1120b that is engaged with an end of the inner portion 1120a and that faces outwardly from the central housing 1134. Rotation of the polygonal housing 1120 then causes rotation of the vanes 1118 about the first axis 1132, thereby rotating the first wheel 1114.

[0070] The drive mechanism for the second wheel 1116 is essentially similar to the drive mechanism for the first wheel 1114. That is, the second drive mechanism includes a second motor 1142 preferably attached to a second portion 1134b (Fig. 23) of the central housing 1134, a second

pinion 1143, a first compound gear 1162, a second compound gear 1164, and a drive gear 1166 (Fig. 22), which is fixed to a second shuttle 1139 (Fig. 20) and an inner portion 1120a of a second polygonal housing 1120. The first and second compound gears 1162, 1164 and the drive gear 1166 make up a second reduction gear train 1160, which allows the motor 1142 to drive the second wheel 1116 in the same way as was described above with respect to the first drive mechanism. With each wheel 1114, 1116 separately and independently driven by the first and second drive mechanisms, the toy vehicle 1110 can be operated in the same ways as the toy vehicles 10, 1010.

[0071] Referring now to Figs. 16, 17, 20, 21, and 24, the mechanism for transforming the toy vehicle 1110 functions to simultaneously rotate all of the vanes 1118 of the toy vehicle 1110. The transformation mechanism includes a transformation motor 1144 having a third pinion 1145 fixed to an output shaft thereof. The transformation motor 1144 is preferably attached to the second portion 1134b of the central housing 1134. The third pinion 1145 drives a third reduction gear train 1170, which includes a first compound gear 1172, a second compound gear 1174, and a third compound gear 1176. A small spur portion of the third compound gear 1176 engages with and rotates a screw gear 1178 generally rotatable about the first axis 1132. Essentially, the screw gear 1178 has an outer circumferential spur gear portion to engage with the small spur portion of the third compound gear 1176 and internal circumferential threads within a central bore. The screw gear 1178 is engaged with a rotationally fixed screw member 1136 (Figs. 16 and 21), which is centered and generally slideable along the first axis 1132.

[0072] Referring to Fig. 16, the screw member 1136 is a generally tubular member having external threads around an outer surface thereof. These external threads engage with the internal threads of the screw gear 1178. Because the screw member 1136 is rotationally fixed by protrusions 1136a but slideable side-to-side, rotation of the screw gear 1178, which is rotatable but slideably fixed, causes the screw member 1136 to translate side-to-side along the first axis 1132, depending on the direction of rotation of the screw gear 1178. Translation of the screw member 1136 causes translation of the first and second shuttles 1138, 1139, inner ends of which are disposed within the screw member 1136.

[0073] Referring to Fig. 20, a modified screw member 1136′ preferably is maintained within an inner housing 1133 that is fixed within the central housing 1134. The inner housing 1133 is preferably formed in two portions 1133a, 1133b and functions to restrain the screw member 1136′ from rotating and the screw gear 1178 from translating. Preferably, this is accomplished by forming the screw member 1136′ with non-circular (*e.g.*, generally hex-shaped) ends 1136a′ that fit within corresponding non-circular (*e.g.*, hex-shaped) tubular portions 1133c, 1133d of the inner housing

1133. In this way, the hex-shaped ends 1136a allow the screw member 1136′ to slide along the first axis 1132 within the hex-shaped portions 1133c, 1133d of the inner housing 1133 but restrain the screw member 1136′ from rotating. Also, portions 1133a, 1133b of the inner housing 1133 abut each side of the screw gear 1178 to allow it to rotate about the first axis 1132 but restrain it from translating along the first axis 1132.

[0074] Referring to Fig. 16, preferably, the first (inner) ends of the first and second shuttles 1138, 1139 preferably are kept in abutting relation by springs 1137 disposed within the screw member 1136 between the ends of the screw member 1136 and flanges disposed at the first, inner ends of the first and second shuttles 1138, 1139. That is, the first ends of the first and second shuttles 1138, 1139 are biased toward each other by the springs 1137 to abut. The same arrangement is used in the Fig. 20-23 configuration. This arrangement permits each shuttle 1138, 1138′, 1139, 1139′ to rotate within its respective screw member 1136, 1136′, yet move only axially with the screw member 1136, 1136′.

[0075] Referring still to Fig. 16, second (outer) ends of the first and second shuttles 1138, 1139 extend outwardly from the ends of screw member 1136, along the first axis 1132, through the respective drive gears 1156, 1166, and into the respective inner portions 1120a of the polygonal housings 1120. The shuttles 1138, 1139 are rotationally fixed in their respective drive gears 1156, 1166 to rotate with those gears 1156, 1166, preferably by mating keyed (*e.g.*, hexagonal or other non-circular cross sectional) surfaces on the shuttles 1138, 1139 and in the gears 1156, 1166. Crown gears 1121 are disposed within the inner portions 1120a of the polygonal housings 1120. Each has a sleeve 1121a extending inwardly from a gear disk 1121b and engaged with the second (outer) ends of the first and second shuttles 1138, 1139. The second ends of the first and second shuttles 1138, 1139 are preferably axially slideable with respect to crown gears 1121 in sleeves 1121a.

[0076] It is preferable that the sliding of the first and second shuttles 1138, 1139 impart rotation to the crown gears 1121. This can be accomplished by furnishing a pin that is fixed to an inner surface of the crown gear sleeve 1121a and slideable along a generally spiral-shaped slot provided in the outer surface of each of the first and second shuttles 1138, 1139, as shown in Fig. 16. The locations of the pin and slot can be reversed. In this way, sliding of the first and second shuttles 1138, 1139 along first axis 1132 imparts rotation to the corresponding crown gear 1121 as each pin rides within its corresponding spiral slot.

[0077] Referring to Figs. 20-23, first and second shuttles 1138′, 1139′ can be keyed with the crown gears 1121 for axial movement, and gear rotation in other ways the shuttles 1138′, 1139′

might be given non-circular cross sections, for example, generally spiral-shaped hex pattern 1138a, 1139a formed proximate the second (outer) ends thereof. The sleeves 1121a of crown gears 1121 would also have a corresponding, generally non-circular (*e.g.*, spiral-shaped hex) pattern formed therein (not depicted). Similar to the pin-in-slot configuration described above for Fig. 16, sliding of the first and second shuttles 1138′, 1139′ with respect to such configured crown gears 1121 would cause the crown gears 1121 to rotate with respect to the first and second shuttles 1138′, 1139′.

[0078] Referring to Fig. 19, each vane 1118 preferably includes a vane gear 1119 (*e.g.*, a spur or bevel gear) fixed thereto and disposed within the polygonal housing 1120. Each of the crown gears 1121 engages with all of the vane gears 1119 within the corresponding polygonal housing 1120, such that rotation of the crown gear 1121 causes rotation of all of vane gears 1119. Because the vane gears 1119 are fixed to the vanes 1118, rotation of the vane gears 1119 causes rotation of the vanes 1118.

[0079] Preferably, the shafts on which the vanes 1118 are mounted are engaged with a hub 1122, which is disposed with each of the polygonal housings 1120 and has a center located generally along the first axis 1132. Preferably, a support shaft 1146 is disposed between the hubs 1122 along the first axis 1132 to add structural rigidity to the above-described components disposed along the first axis 1132 of the toy vehicle 1110. Although it is preferable that the support shaft 1146 be made of metal, it is within the spirit and scope of the present invention that the support shaft 1146 be made of a different material, provided it can perform to increase the structural rigidity of the toy vehicle 1110.

[0080] Referring to Figs. 16-18, 22, and 23, the toy vehicle 1110 preferably includes an elongate arm 1128 again forming a "tail" of the toy vehicle 1110 and having first and second opposed ends and a central longitudinal plane (preferably a plane of symmetry) that extends generally perpendicular to the first axis 1132. The arm 1128 is preferably bent slightly in order to conform to the shape of the central housing 1134 and generally wrap around the central housing 1134 in the retracted position (like that of Fig. 1). The arm 1128 preferably is extended from the toy vehicle 1110 at least when the vanes 1118 are positioned between the first and second configurations in the paddlewheel configuration, as described above.

[0081] The arm 1128 is movably engaged with preferably rotatably attached to the central housing 1134 at the first end, with the second end of the arm 1128 being free and optionally having a freely rotatable wheel 1130 attached at or proximate to the second end (see Figs. 22 and 23). The arm 1128 is preferably rotatable from a compact storage position in which the entire arm 1128 can be stored proximate the central housing 1134 within the confines of the vanes 1118 when the toy

vehicle 1110 is in the first, generally spherical configuration. The arm 1128 is rotated to an extended position, at least when the vanes 1118 are rotated to about the 90 degree paddle-wheel configuration intermediate position 26, and remains extended in all positions of the vanes 1118 between the 90° position 26 and the second, outward position 24. In the extended position, the arm 1128 trails behind the toy vehicle 1110 to counteract torque created during operation of the toy vehicle 1110, particularly when the toy vehicle 1110 is operated in water with the vanes 1118 in the paddlewheel configuration. The arm 1128 is necessary in such conditions because, without it, the central housing 1134 of the toy vehicle 1110 would tend to spin between the wheels 1114, 1116 at least when the wheels 1114, 1116 were simultaneously driven in the same direction.

[0082] The arm 1128 is caused to rotate by operation of the transformation motor 1144. Referring to Fig. 18, a fourth compound gear 1180 is engaged with and rotated by the small spur portion of the third compound gear 1176 of the third reduction gear train 1170, which is also responsible for rotating the screw gear 1178, as described above. Rotation of the fourth compound gear 1180 causes rotation of a Geneva arrangement including a Geneva drive gear 1182, which is engaged with a small driving spur portion of the fourth compound gear 1180.

[0083] Referring specifically to Fig. 18, the Geneva drive gear 1182 has a protrusion 1182a and a post 1182b extending outwardly from a side thereof. The protrusion 1182a is preferably generally circular with a cut-out section 1182c therein, such that it appears as though an outer circumferential section has been removed from the otherwise circular protrusion 1182a. Preferably, the post 1182b is disposed proximate an outer edge of the Geneva drive gear 1182 and centered proximate the cut-out section 1182c of the protrusion 1182a.

[0084] The protrusion 1182a and post 1182b of the Geneva drive gear 1182 interact with a Geneva driven gear 1184 in order to intermittently rotate the Geneva driven gear 1184. Intermittent rotation of the Geneva driven gear 1184 is accomplished by the post 1182b of the Geneva drive gear 1182 engaging within a slot 1184b in a protrusion 1184a extending outwardly from a side of the Geneva driven gear 1184 that generally faces the Geneva drive gear 1182. When the post 1182b is within the slot 1184b of the Geneva driven gear 1184, rotation of the Geneva drive gear 1182 causes the post 1182b to bear against a side of the slot 1184b to impart rotation to the Geneva driven gear 1184. In this way, the Geneva driven gear 1184 only rotates when the post 1182b is disposed within the slot 1184b, the Geneva driven gear 1184 being inhibited from rotating at all other times by the interaction of the protrusion 1182a of the Geneva drive gear 1182 with the protrusion 1184a of the Geneva driven gear 1184. A spur portion of the Geneva driven gear 1184 then engages with and rotates a spur gear 1186, which is fixed to the end of the arm 1128 that is connected with the central

housing 1134. In this way, although the Geneva drive gear 1182 is constantly rotated during operation of the transformation motor 1144, the Geneva driven gear 1184 ensures that the arm 1128 will only be rotated into or out of the extended position at a certain time, which is determined by the configurations of the Geneva drive gear 1182 and the Geneva driven gear 1184. Preferably, the Geneva drive gear 1182 and the Geneva driven gear 1184 are configured to allow rotation of the arm 1128 once the vanes 1118 have rotated out of the first, generally spherical configuration sufficiently to allow the arm 1128 to pass by the vanes 1118 without coming into contact with the vanes 1118.

[0085] Referring to Figs. 22 and 23, the arm 1128 has optional fins 1129 located proximate the free second end of the arm 1128 for use in water. Preferably, the arm fins 1129 are pivotable with respect to the arm 1128 in order to allow for more compact storage in the ball-like configuration of the vehicle 1110.

[0086] Referring to Figs. 25 and 26, there is shown a toy vehicle of a fourth preferred embodiment, indicated generally at 1210, in accordance with the present invention. The toy vehicle 1210 is generally similar to the third embodiment, except that the rigid arm 1128 of the third embodiment is replaced with an articulated arm or "tail" 1228 comprised of a plurality of individual segments 1228a linked in series for partial rotation with respect to one another. The articulated tail 1228 has a first end attached to a central housing 1234 and a second, free end. The articulated tail 1228 has a stored position (Fig. 25) in which the articulated tail 1228 is generally wrapped around the central housing 1234, and an extended position (Fig. 26) in which the articulated tail 1228 extends rearwardly from the central housing 1234. The articulated tail 1228 has an optional freely rotatably wheel 1230 attached to or proximate to the second (outer) end.

[0087] When in the extended position, the articulated tail 1228 functions in the same way as described above with respect to the arm 1128 of the third embodiment in that it counteracts torque created during operation of the toy vehicle 1210. The articulated tail 1228 can be moved between the extended and stored positions using any appropriate mechanism, such as, but not limited to, a wire and winch or reel assembly in which a wire (not shown) is fed through the plurality of segments 1228a and anchored at one end to the segment 1228a at the second (outer) end of the articulated tail 1228. Another end of the wire is attached to a winch (not shown), such that rotation of the winch lets out or takes up wire, depending on the direction of rotation of the winch. Taking up the wire causes the articulated tail 1228 to move into the stored position, and letting out the wire results in the articulated tail 1228 moving into the extended position. Alternatively, a gear train (not shown) along the articulated tail 1228 could be used to move the articulated tail 1228 between the

stored and extended positions. Finally, the tail 1228 can be free rotating so as to deploy and retract in response to centrifugal and/or contact forces on the tail 1228 like tail 70 of the first embodiment.

[0088] It will be appreciated by those skilled in the art that changes could be made to the embodiment described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiment disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as defined by the appended claims.

CLAIMS

I/we claim:

1. A toy vehicle (10, 1010, 1110, 1210), including a central housing (12, 1134, 1234) having first and second oppositely disposed sides (12a, 12b, 1134a, 1134b) and at least first and second wheels (30, 1014, 1114, 1214, 40, 1016, 1116, 1216) rotatably engaged with the housing, the first wheel rotatably mounted on the first side of the housing and the second wheel rotatably mounted on the second side of the housing, characterized by each of the at least first and second wheels having a central hub (50, 1020, 1120, 1220) and a plurality of individual vanes (20, 1018, 1118, 1218) rotatably attached to the hub, each hub having a center disposed along a first axis of rotation (50′, 1032, 1132) common to the at least first and second wheels, each vane being rotatable about a second vane axis (20′) extending transversely with respect to the first axis, and each vane extending outwardly from the hub to an end distal to the hub forming a circumferential surface portion of one of the at least first and second wheels.

2. The toy vehicle of claim 1, further comprising at least a first motor (83, 1040, 1140) operatively coupled to at least the first wheel to drive at least the first wheel.

3. The toy vehicle of claim 2, further comprising a transformation motor (87, 1044, 1144) operatively coupled to the vanes to rotate the vanes.

4. The toy vehicle of claim 3, further comprising an on-board control unit (16) operatively coupled with the first and transformation motors and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the first and transformation motors.

5. The toy vehicle of claim 2, further comprising at least a second motor (85, 1042, 1142) operatively coupled to at least the second wheel to drive at least the second wheel.

6. The toy vehicle of claim 5, wherein the first motor is separately and independently operable from the second motor to separately and independently drive the first and second wheels.

7. The toy vehicle of claim 6, further comprising an on-board control unit (16) operatively coupled with the first and second motors and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the first and second motors.

8. The toy vehicle of claim 6, further comprising a transformation motor (87, 1044, 1144) operatively coupled to the vanes to rotate the vanes.

9. The toy vehicle of claim 8, further comprising an on-board control unit (16) operatively coupled with the first, second, and transformation motors and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the first, second, and transformation motors.

10. The toy vehicle of claim 1, wherein the vanes of each wheel are rotatable simultaneously between a first position (22, 1024) and a second position (24, 1026) rotationally different from the first position.

11 The toy vehicle of claim 1, wherein the vanes are curved, such that, in a first rotational position (22, 1024) of the vanes, the first and second wheels are generally cupped with open ends directed inwardly toward one another and, in a second rotational position (24, 1026) of the vanes, the first and second wheels are generally cupped with the open ends directed outwardly away from one another.

12. The toy vehicle of claim 11, wherein the first and second wheels are generally hemispherical in the first and second rotational positions.

13. The toy vehicle of claim 11, wherein the vanes are selectively rotatable to provide at least one intermediate rotational position (26) between the first and second positions.

14. The toy vehicle of claim 1, wherein the vanes of each of the first and second wheels are linked together so as to rotate in unison.

15. The toy vehicle of claim 14, further comprising a transformation motor (87, 1044, 1144) operatively coupled to the vanes to rotate the vanes.

16. The toy vehicle of claim 15, further comprising an on-board control unit (16) operatively coupled with the transformation motor and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the transformation motor.

17. The toy vehicle of claim 1, further comprising an on-board control unit (16) operatively coupled with the at least first and second wheels and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the at least first and second wheels.

18. The toy vehicle of claim 1, further comprising a tail (70, 1028, 1128, 1228), the tail being generally coupled with the central housing at a first end (70d) and having an oppositely disposed, free second end (70e).

19. The toy vehicle of claim 18, wherein the first end of the tail is rotatably attached to the housing for movement between a retracted position (72) and an extended position (74).

20. The toy vehicle of claim 19, wherein the tail is flexible, such that the tail, in the retracted position, is generally wrapped at least partially around the housing and, in the extended position, extends outwardly from the housing so that at least the second end is spaced further away from the housing than in the retracted position.

21. The toy vehicle of claim 20, wherein the tail is formed by at least two articulated segments, such that a first segment (70a, 1228a) is rotatably coupled to the housing and at least a second segment (70b, 1228a) is rotatably coupled to the first segment.

22. The toy vehicle of claim 20, wherein the tail, in the retracted position, is disposed between open ends of the first and second wheels with the vanes in the first position.

23. The toy vehicle of claim 18, wherein in an extended position (74), at least the free end of the tail extends beyond an imaginary cylinder having a cross-section defined by circumferential perimeters of the two wheels in all possible configurations of the two wheels and wherein, in a retracted position (72), the free end is closer to the central housing than the free end is in the extended position.

24. The toy vehicle of claim 23, wherein, in the second configuration, each of the first and second wheels is generally cupped and has an open end generally extending outwardly from the housing.

25. The toy vehicle of claim 24, wherein the first and second wheels are generally hemispherical in at least one of the first and second configurations.

26. The toy vehicle of claim 25, wherein the first and second wheels have at least an intermediate third configuration (26) in which the wheels are converted into paddle wheels.

27. The toy vehicle of claim 26, wherein the first and second wheels and the tail are buoyant in water.

28. The toy vehicle of claim 26, wherein the first and second wheels and the tail are made at least partially from a sealed plastic foam material.

29. The toy vehicle of claim 18, wherein, with the tail in a retracted position (72) and the first and second wheels in the first configuration, the tail is disposed between the first and second wheels, such that the toy vehicle is generally ovular in shape.

30. The toy vehicle of claim 18, wherein the tail is buoyant in water.

31. The toy vehicle of claim 18, wherein the tail is made at least partially from a sealed plastic foam material.

32. The toy vehicle of claim 18, wherein the tail includes at least one tail wheel (76, 1030, 1130, 1230) proximate the second end for contacting a surface in at least an extended position (74) of the tail.

33. The toy vehicle of claim 18, further comprising at least a first motor (83, 1040, 1140) operatively coupled to at least the first wheel to drive at least the first wheel.

34. The toy vehicle of claim 33, further comprising at least a second motor (85, 1042, 1142) operatively coupled to at least the second wheel to drive at least the second wheel.

35. The toy vehicle of claim 34, wherein the first motor is separately and independently operable from the second motor to separately and independently drive the first and second wheels.

36. The toy vehicle of claim 34, further comprising a transformation motor (87, 1044, 1144) operatively coupled to the vanes to rotate the vanes.

37. The toy vehicle of claim 36, further comprising an on-board control unit (16) operatively coupled with the first, second, and transformation motors and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the first, second, and transformation motors.

38. The toy vehicle of claim 36, wherein at least one of the first, second, and transformation motors is operatively engaged with the tail to move the tail between retracted and extended positions (72, 74).

39. The toy vehicle of claim 38, further comprising an on-board control unit (16) operatively coupled with the first, second, and transformation motors and configured to receive and process control signals transmitted from a remote source spaced from the toy vehicle to remotely control operation of the first, second, and transformation motors.

40. The toy vehicle of claim 1, further comprising first and second vane transformation members (97, 100, 156, 166, 1138, 1139, 1138′, 1139′) extending from the first and second sides of the central housing, the first and second vane transformation members being operably coupled with the vanes of the first and second wheels, respectively, and movable with respect to the vanes in a manner to rotate the vanes.

41. The toy vehicle of claim 40, wherein the first and second vane transformation members (97, 100, 156, 166, 1138, 1139, 1138′, 1139′) rotate about the first axis of rotation.

42. The toy vehicle of claim 41, wherein the first and second vane transformation members (97, 100, 1138, 1139, 1138′, 1139′) also translate along the first axis of rotation.

43. The toy vehicle of claim 40, wherein the first and second vane transformation members (97, 100, 1138, 1139, 1138′, 1139′) translate along the first axis of rotation.

44. The toy vehicle of claim 40, further comprising a transformation motor (87, 1144) operably coupled with the first and second vane transformation members to move the first and second vane transformation members with respect to the vanes in a manner to rotate the vanes.

45. The toy vehicle of claim 44, further comprising a screw member (92, 1136, 1136') supporting the first and second vane transformation members for translation along the first axis of rotation.

46. The toy vehicle of claim 45, wherein the screw member is supported for only translational movement with respect to the first axis.

47. The toy vehicle of claim 45, wherein the first and second vane transformation members are supported in the screw member for rotation along the first axis of rotation relative to the screw member.

48. The toy vehicle of claim 47, further comprising a first motor (83, 1040, 1140) operably coupled with the first wheel and the first vane transformation member for simultaneous rotation of the first wheel and the first vane transformation member about the first axis.

49. The toy vehicle of claim 48, further comprising a wheel drive gear (96, 1156, 1166) driven by the first motor and rotationally fixed with the first wheel to rotate the first wheel.

50. The toy vehicle of claim 49, wherein the first vane transformation member is slidingly keyed to the wheel drive gear for rotation with the wheel driving gear and axial movement with respect to the wheel drive gear.

51. The toy vehicle of claim 50, further comprising a gear (20, 1119) on an inner end of each vane of the first wheel and means (52, 1121) within the hub coupled with the vane transformation member and engaged with each of the vane gears for selective rotation of the vane gears within the hub during rotation of the first wheel with the hub by the first motor.

52. The toy vehicle of claim 40, further comprising a gear (20, 1119) on an inner end of each vane of the first wheel and means (52, 1121) within the hub of the first wheel coupled with the first vane transformation member and engaged with each of the vane gears for selective rotation of the vane gears within the hub of the first wheel during rotation of the first wheel with the hub.

53. The toy vehicle of claim 44, wherein the transformation motor is coupled with the first and second transformation members to selectively rotate the vane transformation members about the first axis.

54. The toy vehicle of claim 53, further comprising a first motor (83, 1040, 1140) drivingly coupled to the first wheel for rotation of the first wheel independent of any rotation of the first vane transformation member by the transformation motor.

55. The toy vehicle of claim 44, further comprising a tail (1028, 1128) coupled with the central housing and extending longitudinally away from the central housing to a free end and wherein the transformation motor is drivingly coupled with the tail to move the tail with respect to the central housing.

56. The toy vehicle of claim 55, further comprising a gear train (1070, 1170) coupling the transformation motor with the tail.

57. The toy vehicle of claim 56, wherein the gear train comprises a Geneva mechanism (1182, 1184).

58. The toy vehicle of claim 56, wherein the tail is supported from the central housing for linear movement by the gear train.

59. The toy vehicle of claim 56, wherein the tail is supported for rotational movement on the central housing.

60. The toy vehicle of claim 1, wherein the vanes of each of the first and second wheels are linked together in the wheel so as to rotate in unison.

61. The toy vehicle of claim 60, further comprising a support member (1122) within the hub rotatably receiving and supporting an innermost end of each vane extending from the hub.

62. The toy vehicle of claim 61, further comprising a plurality of posts in the hub, the innermost end of each separate vane being rotatably supported on a separate one of the posts.

63. The toy vehicle of claim 61, further comprising a plurality of individual vane gears (20, 1119) in the hub, each individual vane gear fixedly coupled with the innermost end of a separate vane of the plurality of individual vanes to rotate with the separate vane.

64. The toy vehicle of claim 63, further comprising a drive gear (52, 1121) engaged with each of the plurality of individual vane gears to simultaneously rotate the plurality of vane gears in the hub.

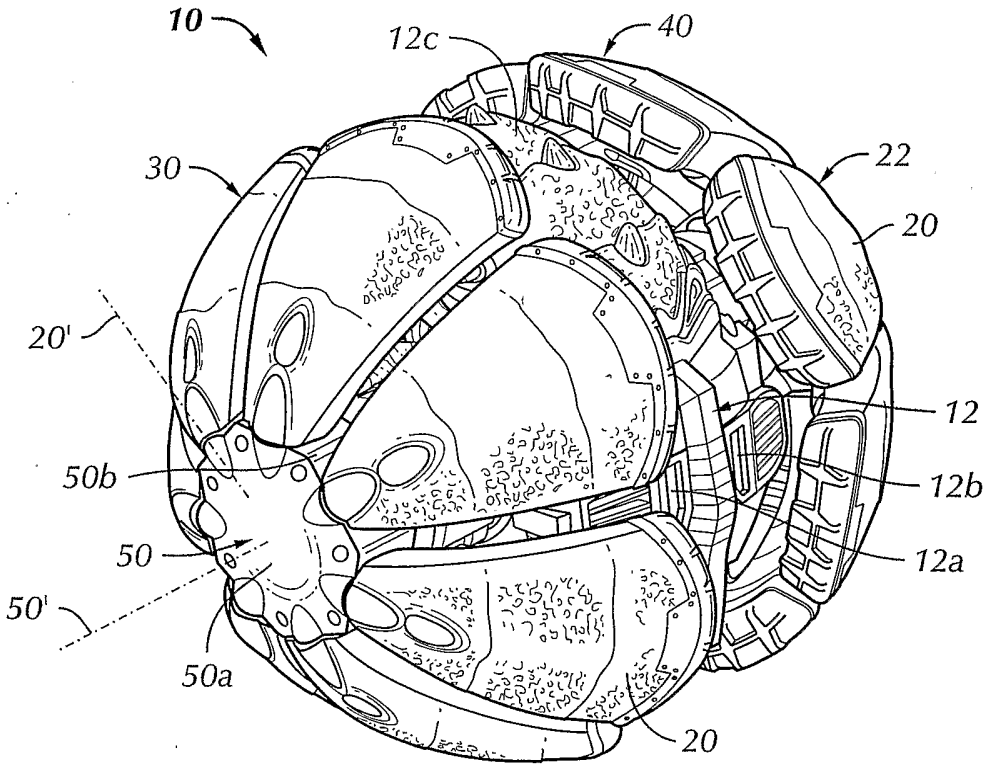

FIG. 1

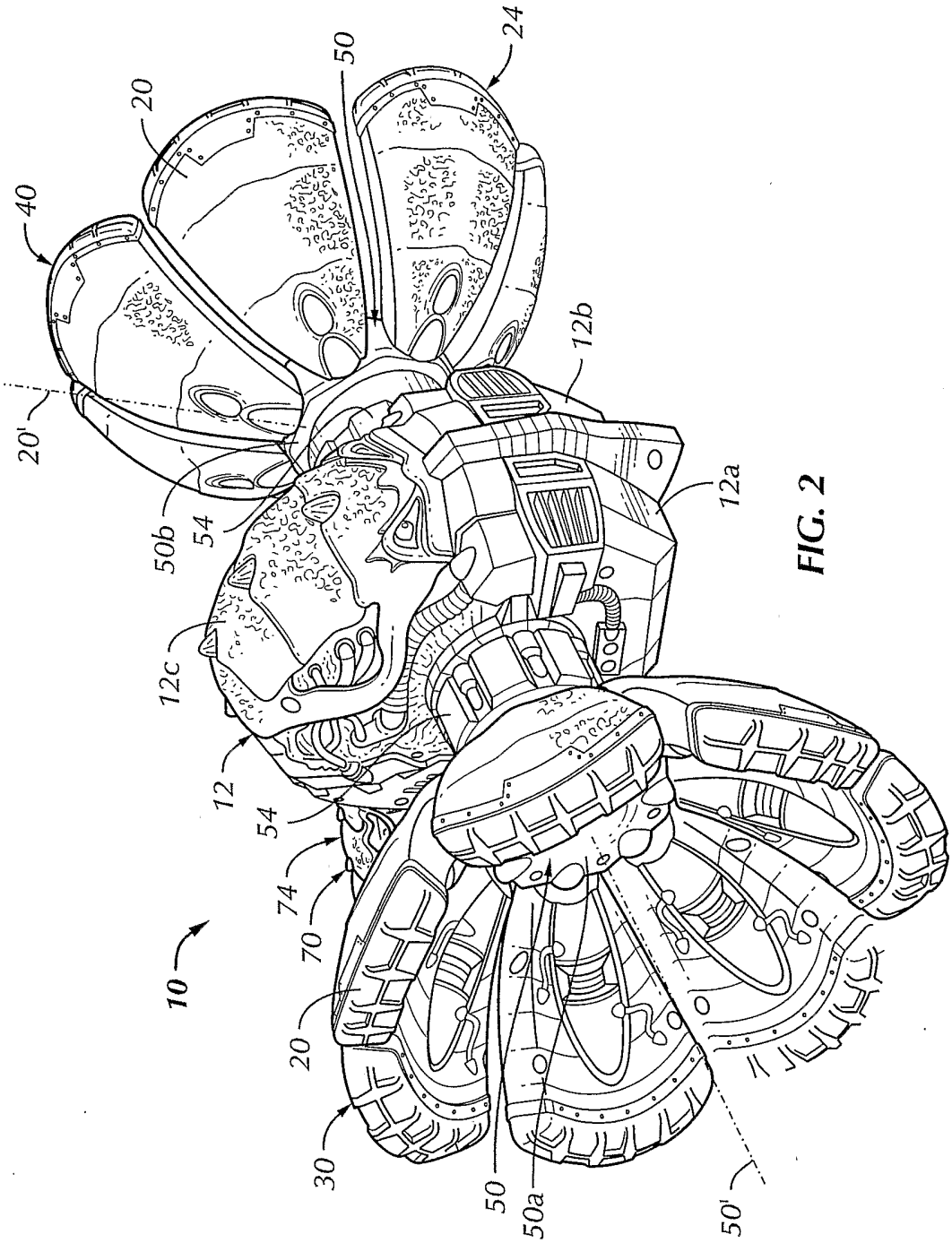

FIG. 2

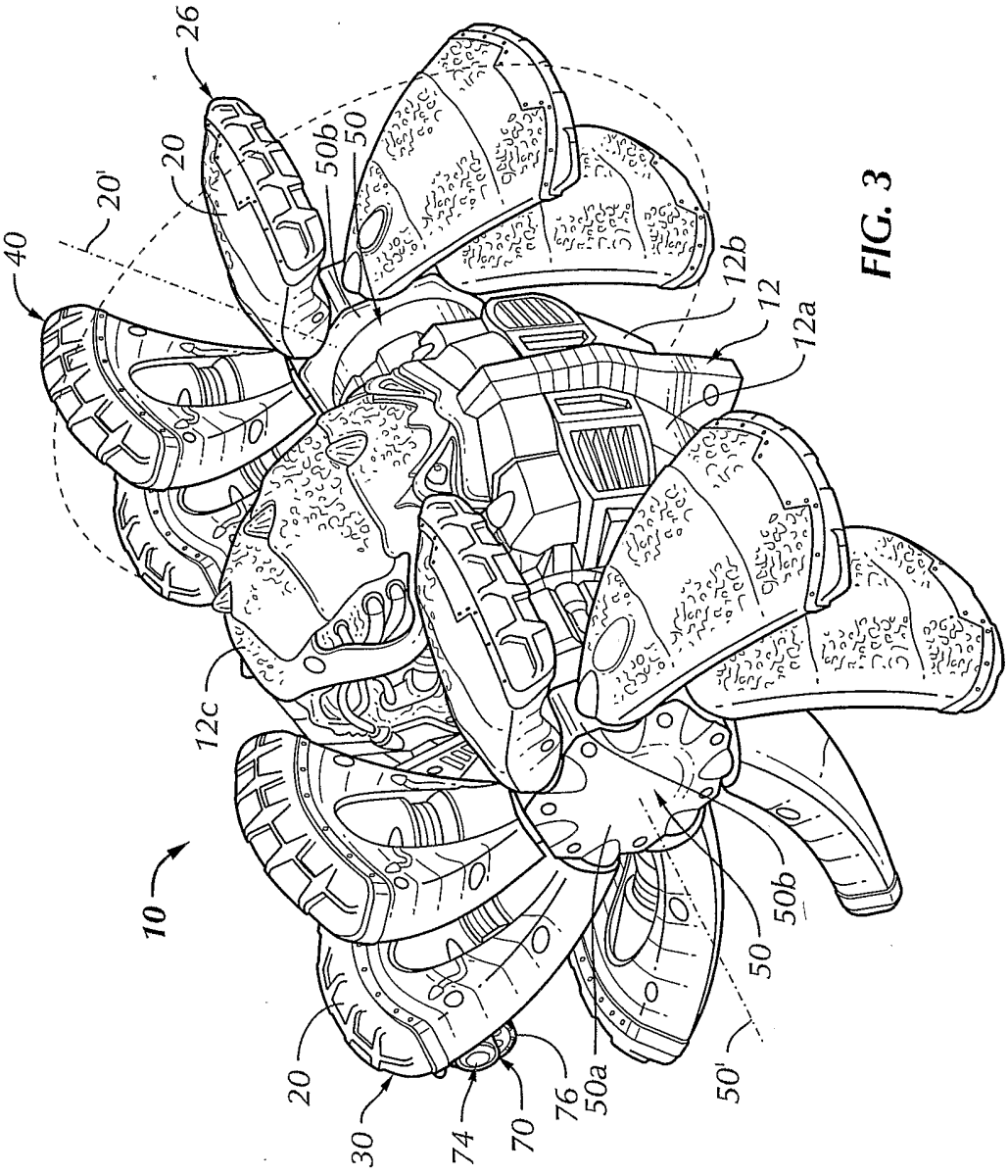

FIG. 3

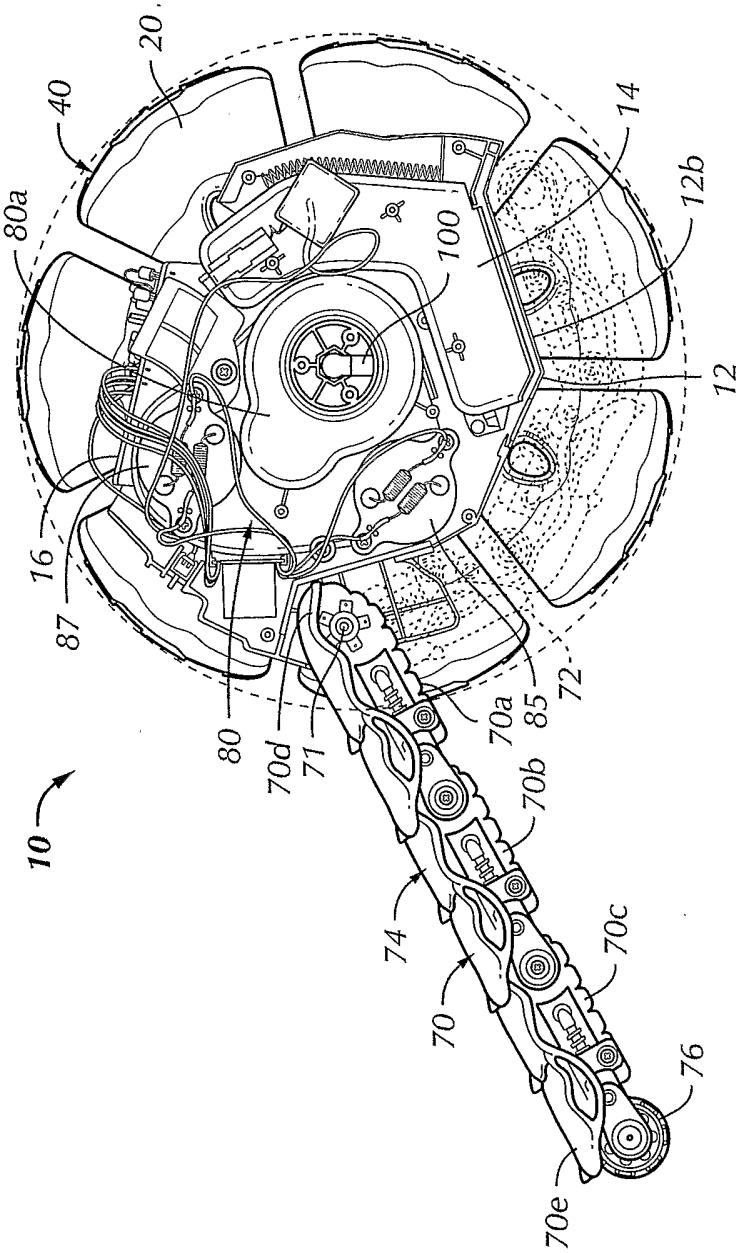
20
40
14
80a
12b
100
12
16
87
72
85
70a
80
70d
71
70b
10
74
70c
70
76
70e

FIG. 4

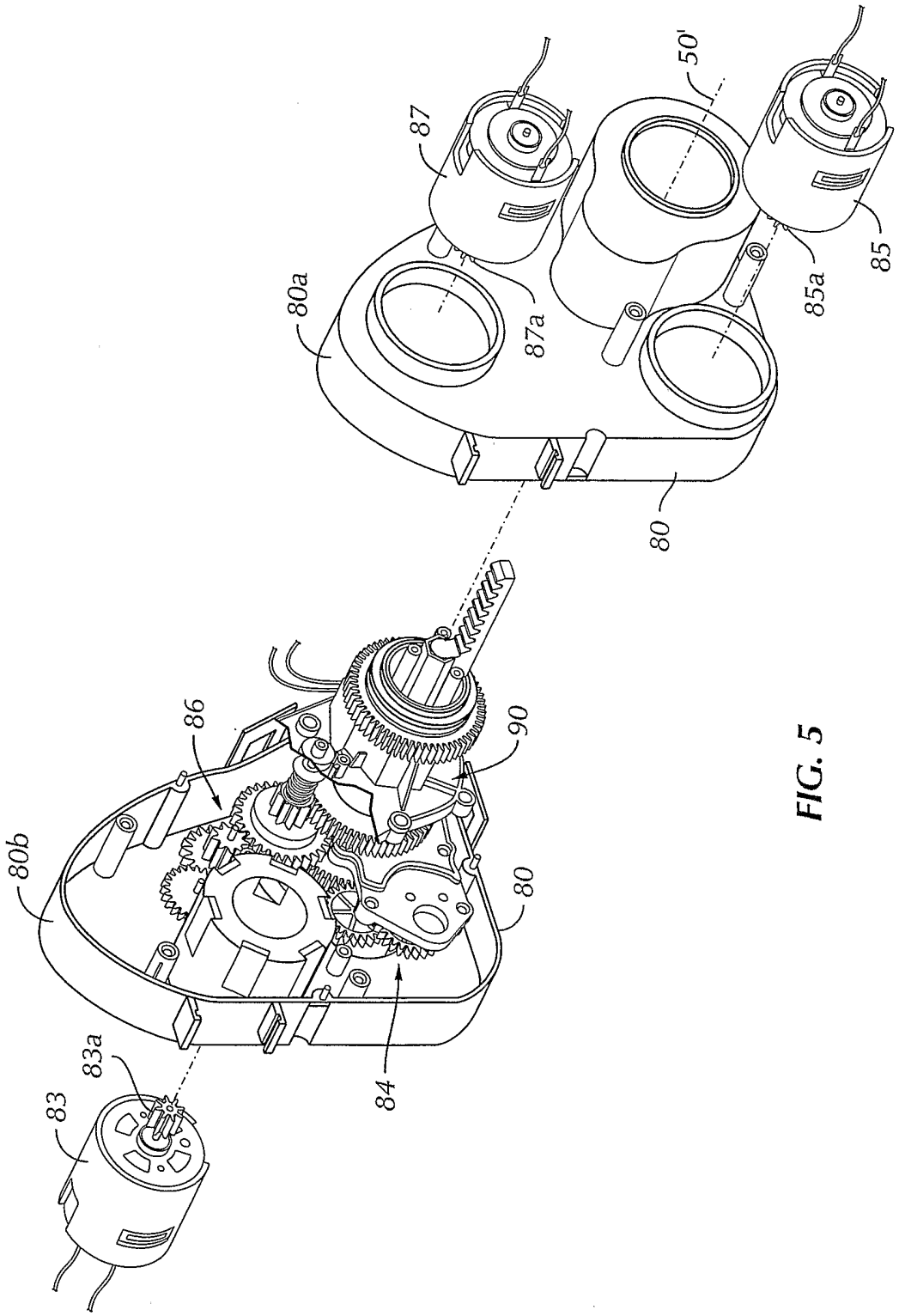

FIG. 5

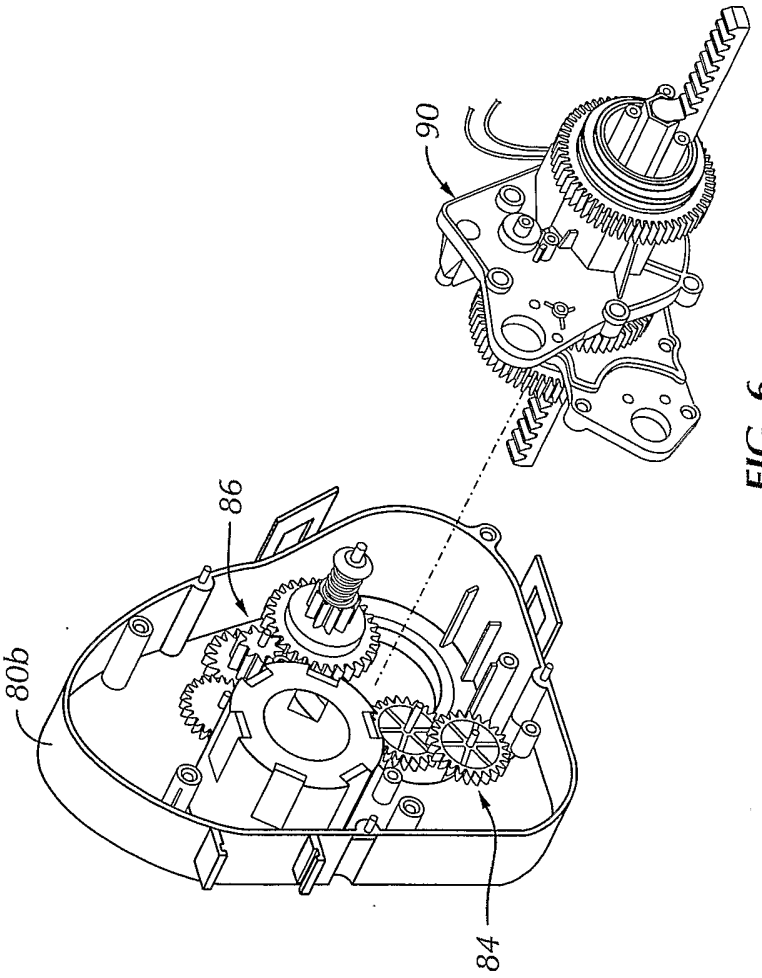

FIG. 6

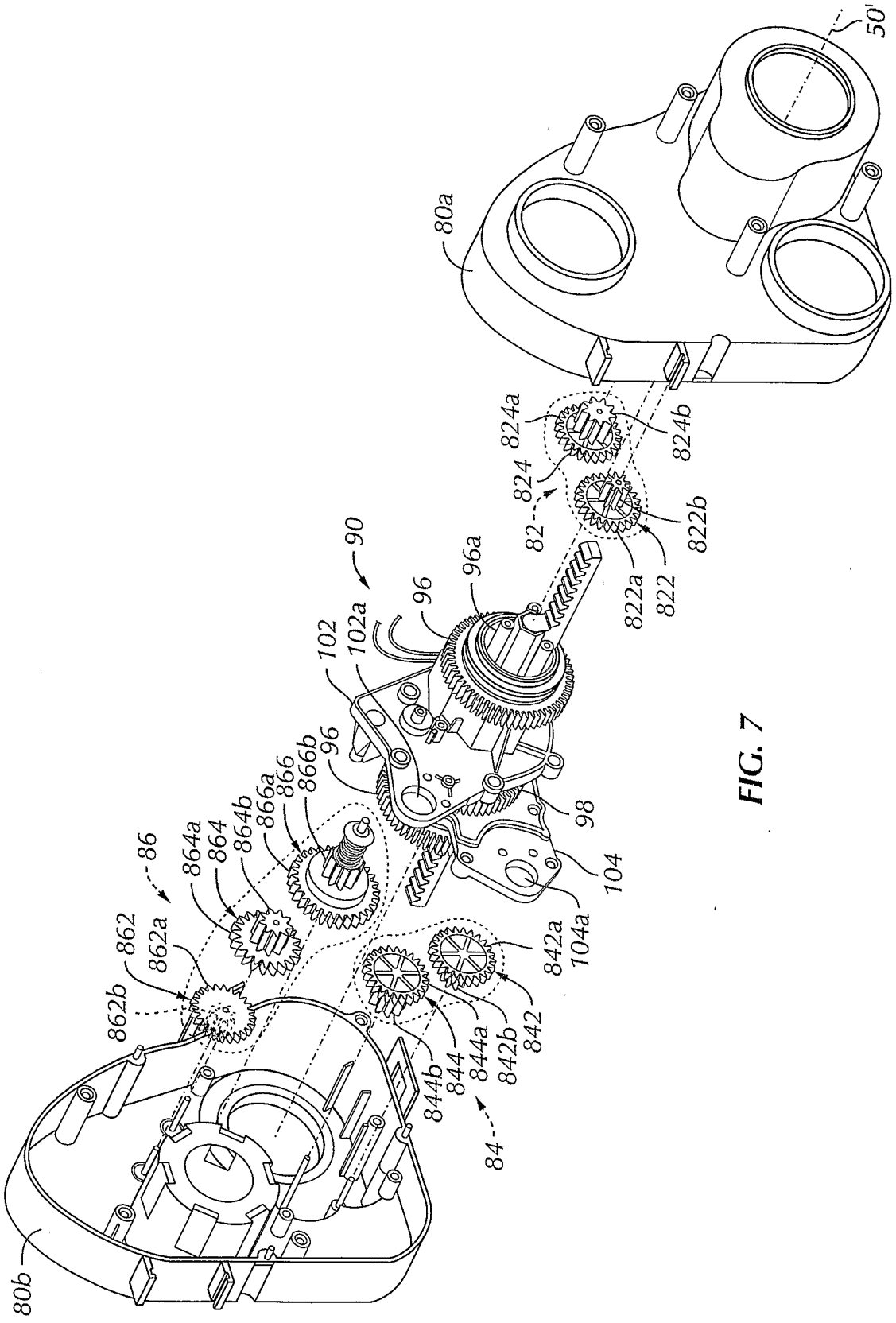
50'
80a
824a
824b
824
82
822b
822a
822
90
96a
96
102a
102
96
866b
866a
866
864b
864a
864
86
862
862a
862b
98
104
104a
842a
842
842b
844a
844
844b
84
80b

FIG. 7

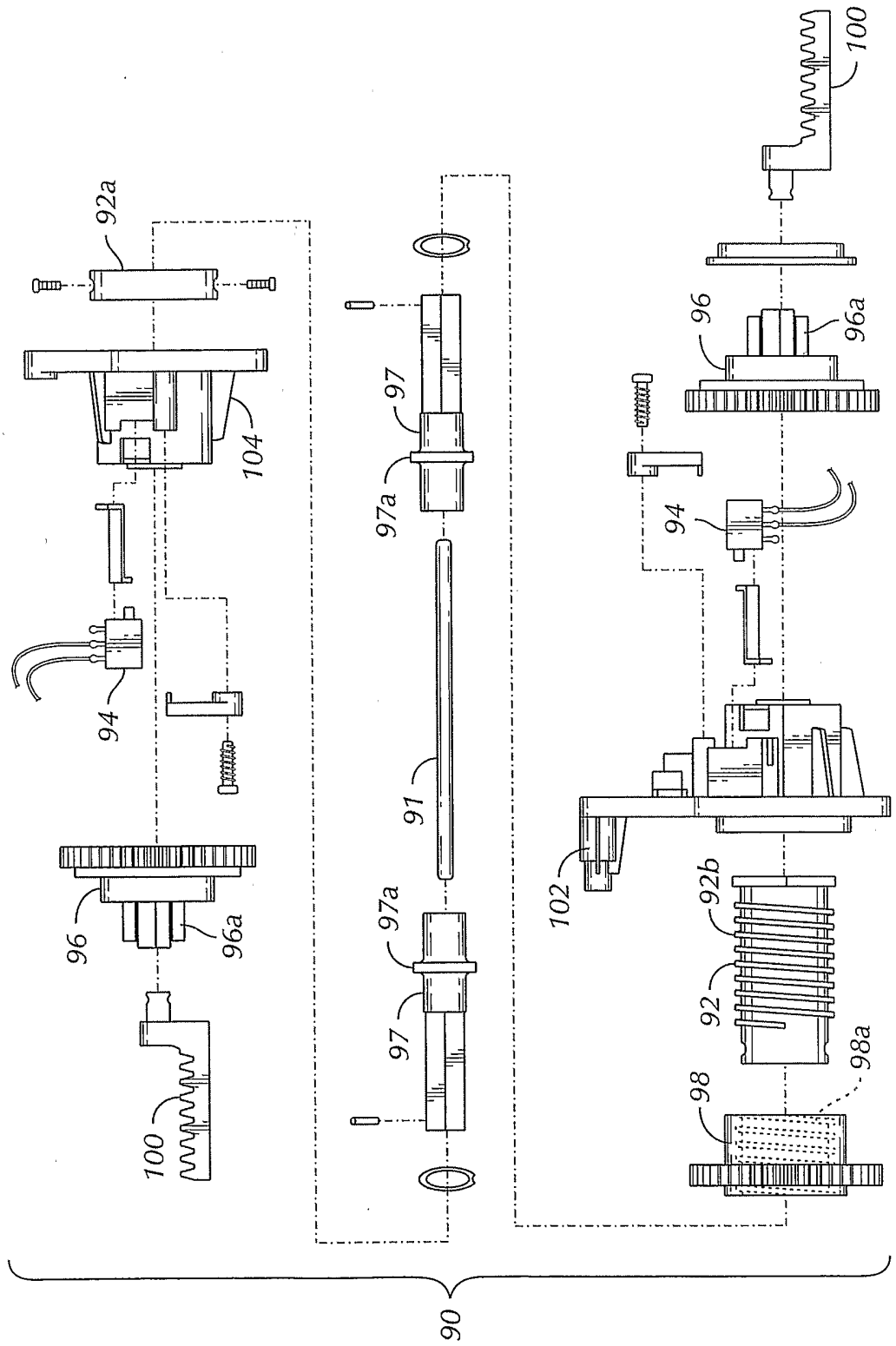
92a
104
94
96
96a
100
97
97a
91
97a
97
100
96
96a
94
102
92b
92
98a
98
90

FIG. 8

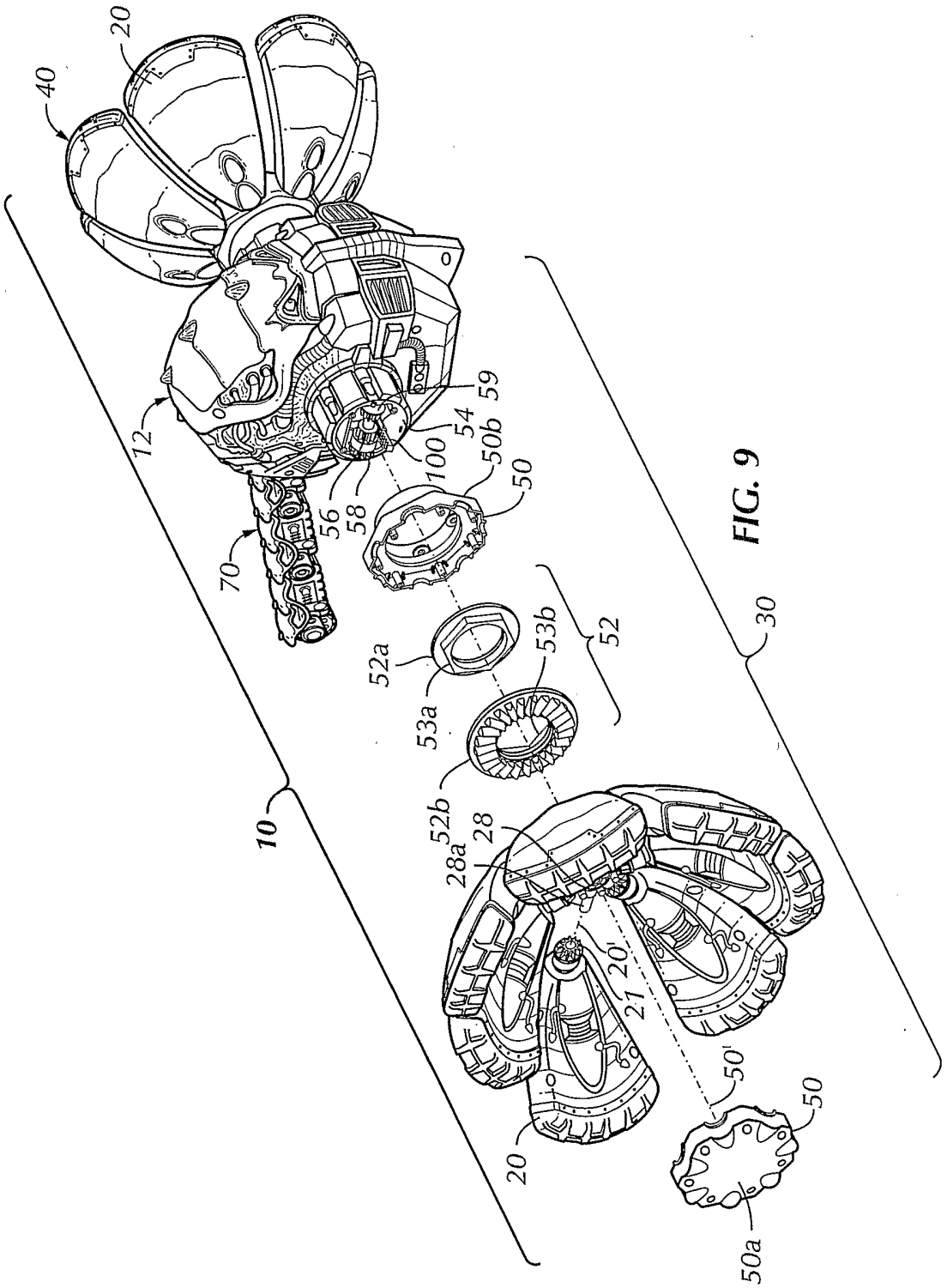
40
20
72
59
54
50b
50
100
56
58
70
52a
53b
52
53a
52b
28
28a
10
30
20'
21
50'
50
20
50a

FIG. 9

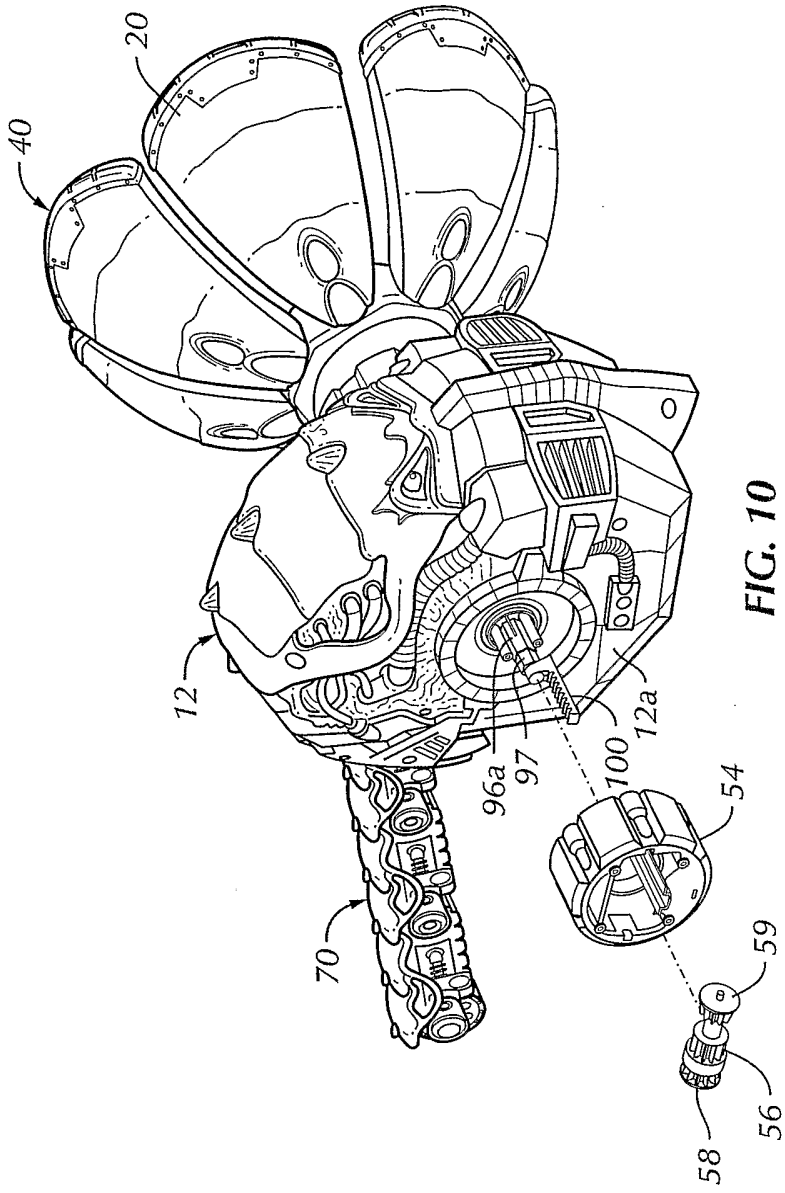

FIG. 10

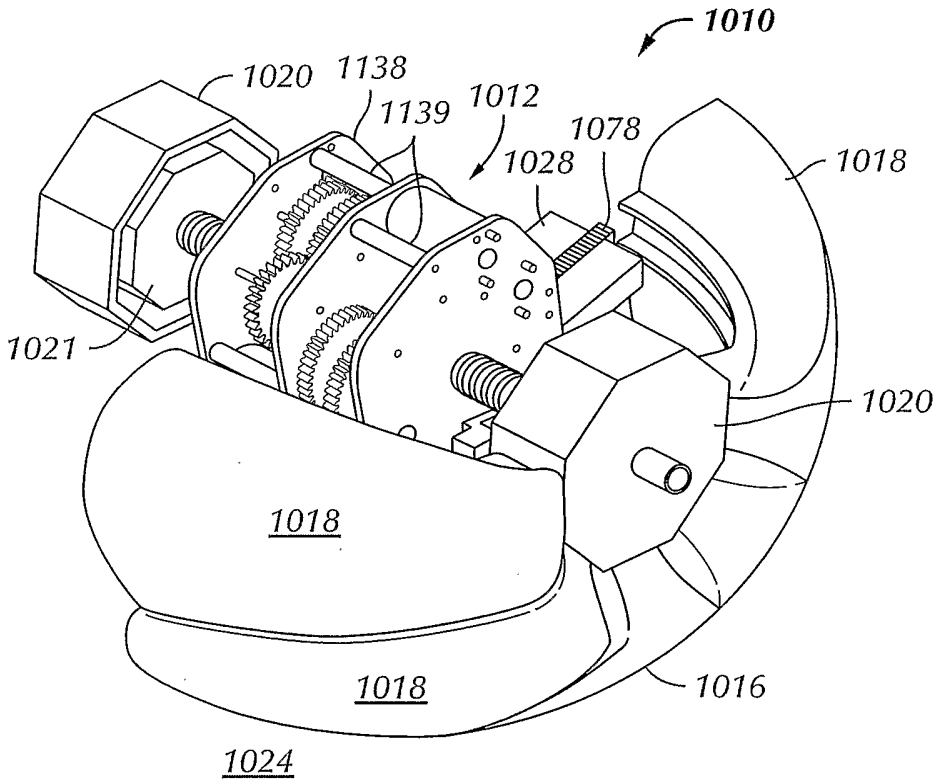
1010
1020
1138
1139
1012
1078
1028
1018
1021
1020
1018
1018
1016
1024

FIG. 11

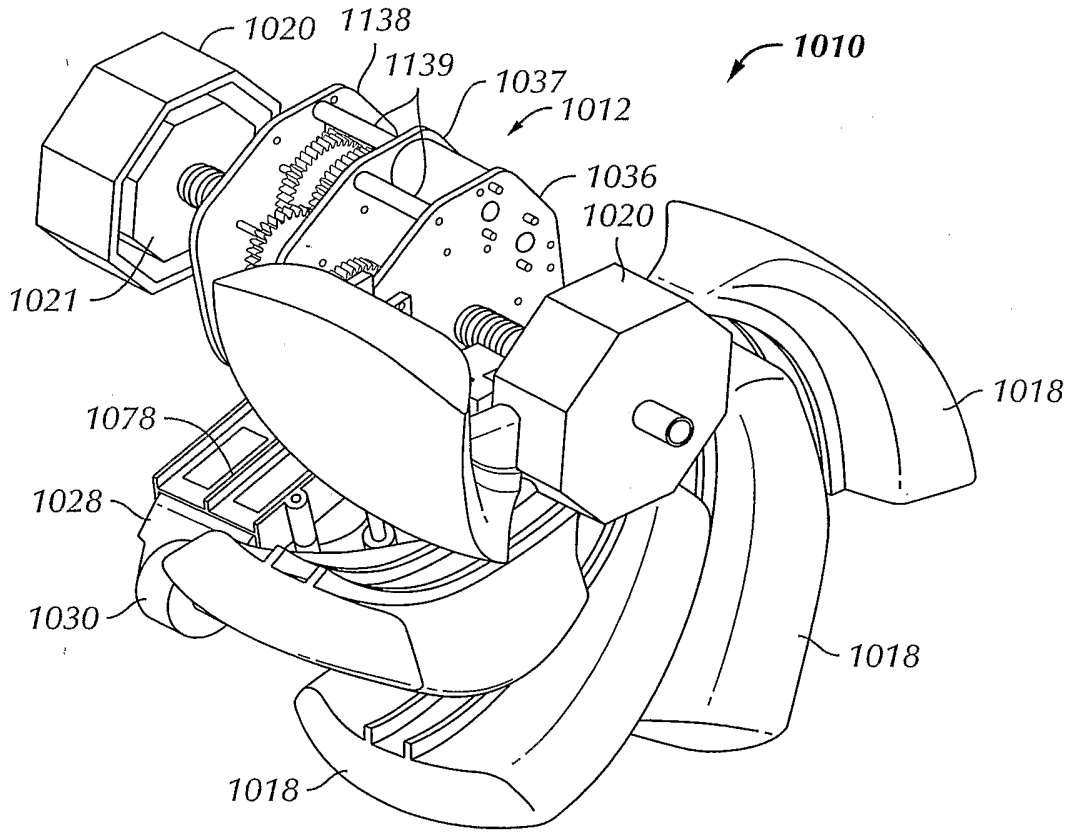
1020
1138
1139
1037
1012
1010
1036
1020
1021
1018
1078
1028
1030
1018
1018

FIG. 12

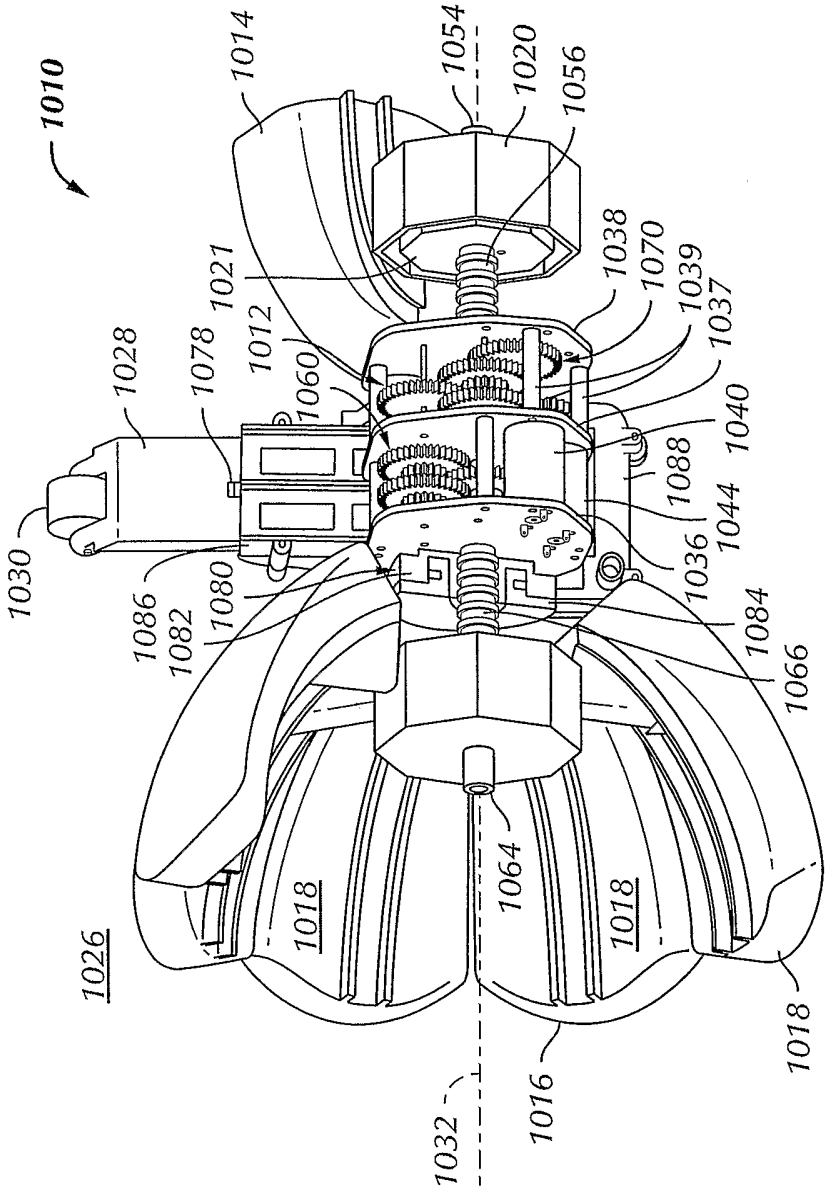
1010
1014
1054
1020
1056
1021
1012
1038
1070
1039
1037
1028
1078
1060
1040
1088
1044
1030
1086
1082
1080
1036
1084
1066
1064
1018
1026
1032
1016

FIG. 13

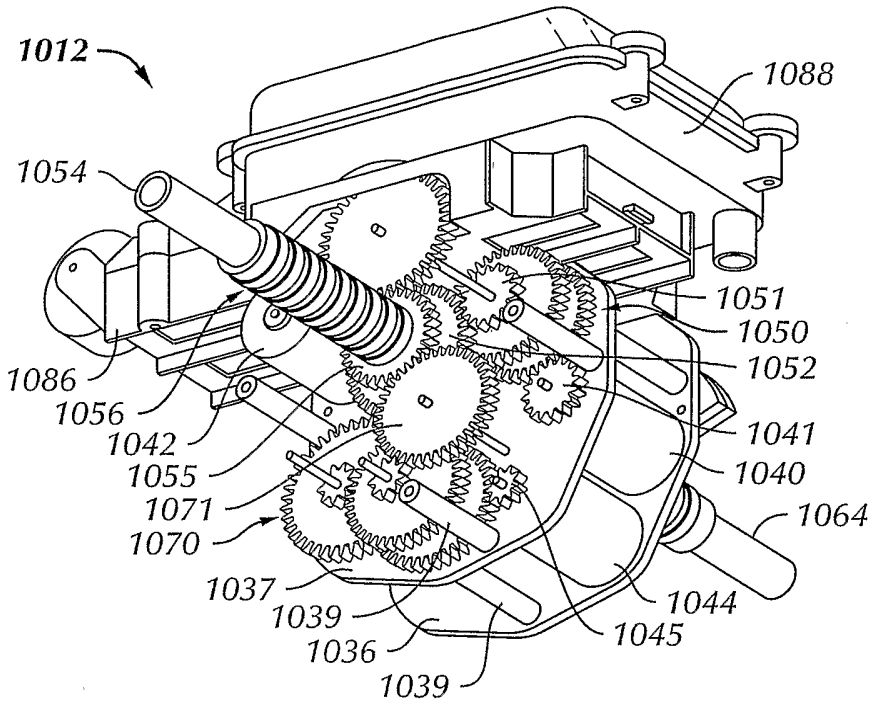
1012
1088
1054
1051
1050
1052
1086
1056
1042
1041
1055
1040
1071
1064
1070
1037
1044
1039
1045
1036
1039

FIG. 14

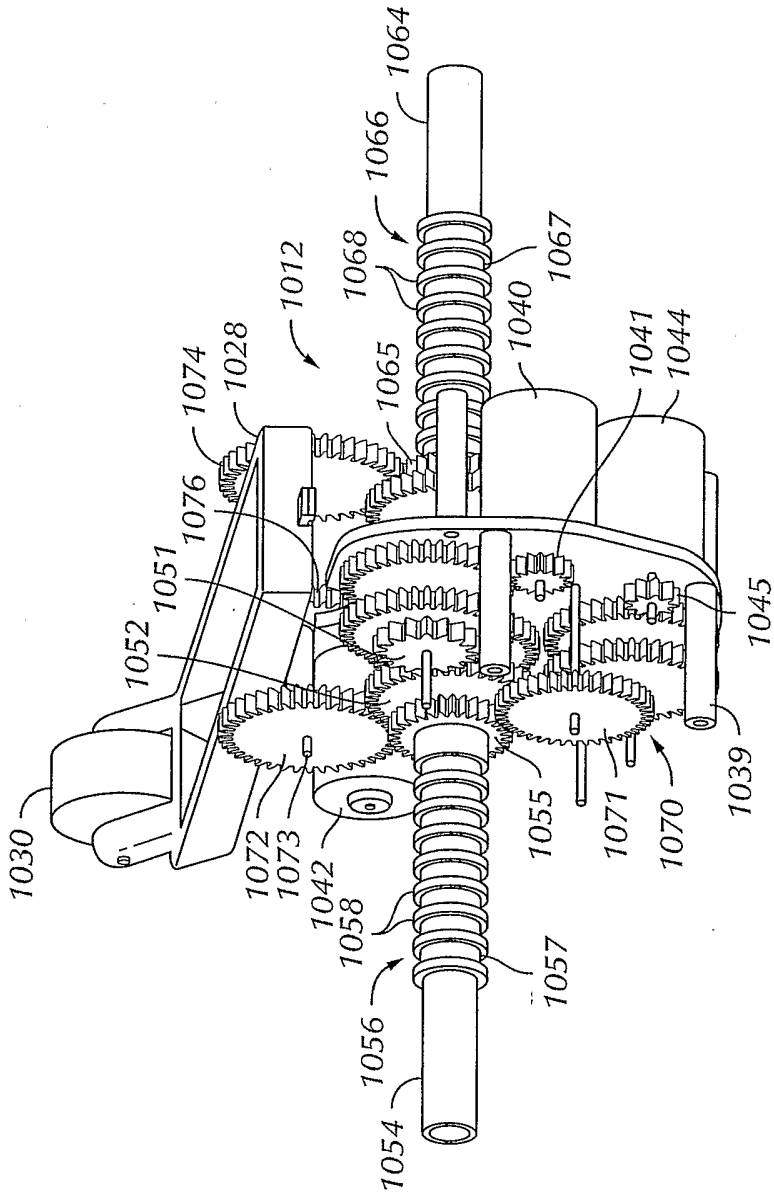
1064
1066
1068
1067
1012
1040
1041
1044
1028
1074
1065
1076
1051
1052
1045
1030
1072
1073
1042
1058
1055
1071
1070
1039
1057
1056
1054

FIG. 15

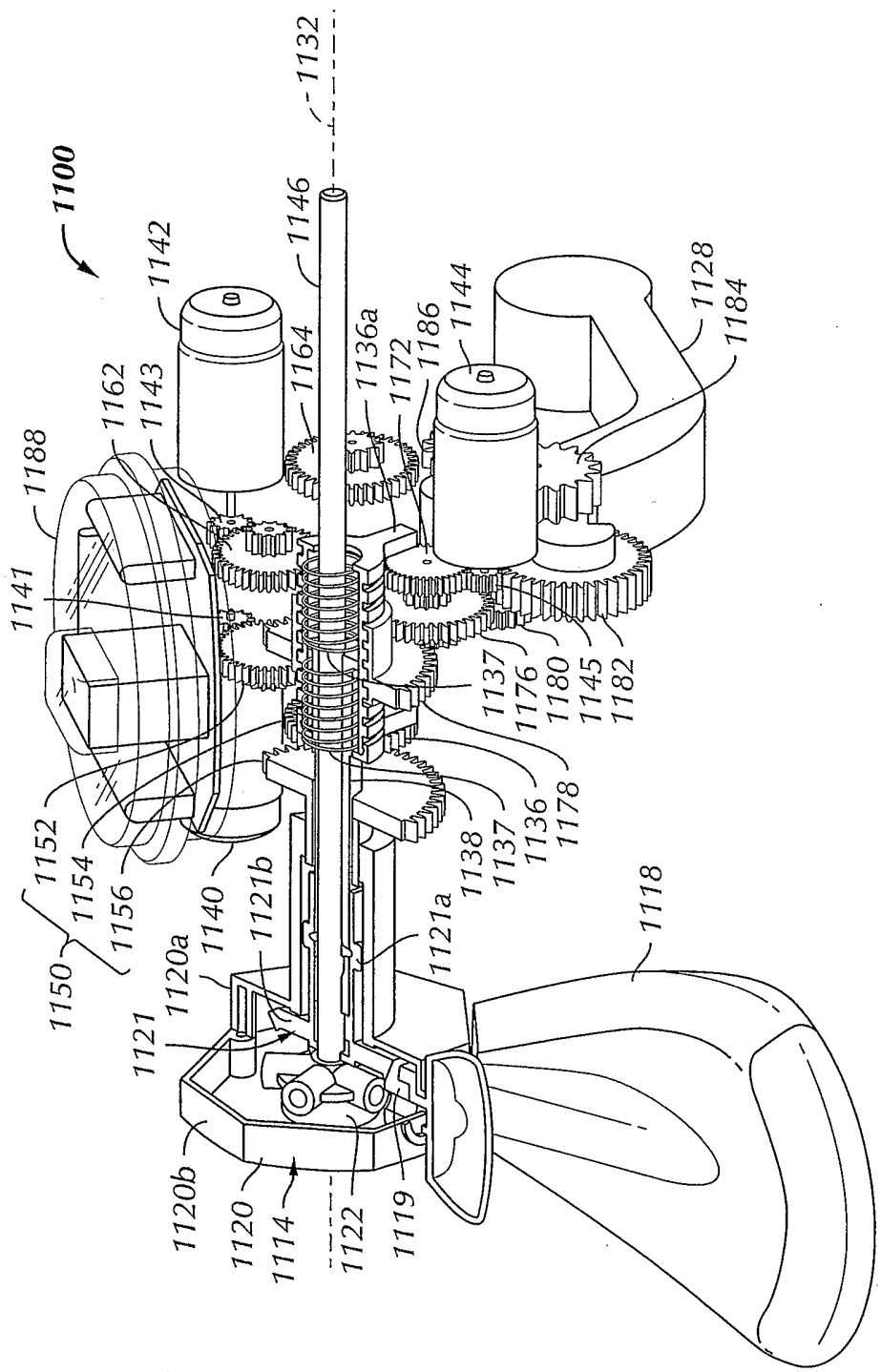
1100
1132
1146
1142
1164
1136a
1172
1186
1144
1128
1184
1162
1143
1188
1141
1137
1176
1180
1145
1182
1152
1154
1156
1150
1140
1121b
1120a
1121
1138
1137
1136
1178
1121a
1118
1120b
1120
1114
1122
1119

FIG. 16

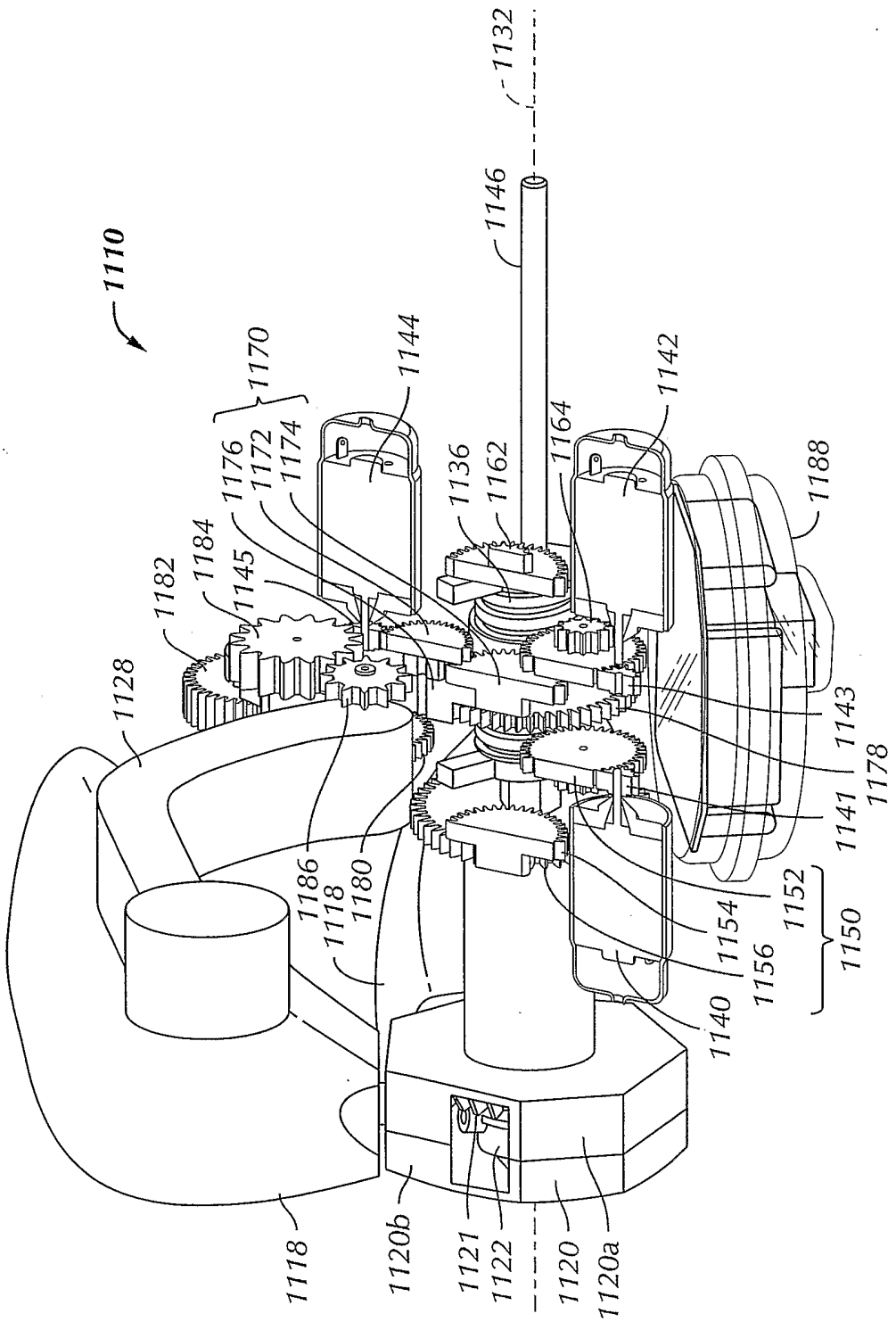
1110
1132
1146
1144
1170
1142
1164
1176
1172
1174
1136
1162
1188
1184
1145
1182
1128
1143
1178
1141
1186
1118
1180
1152
1154
1156
1150
1140
1118
1120b
1121
1122
1120
1120a

FIG. 17

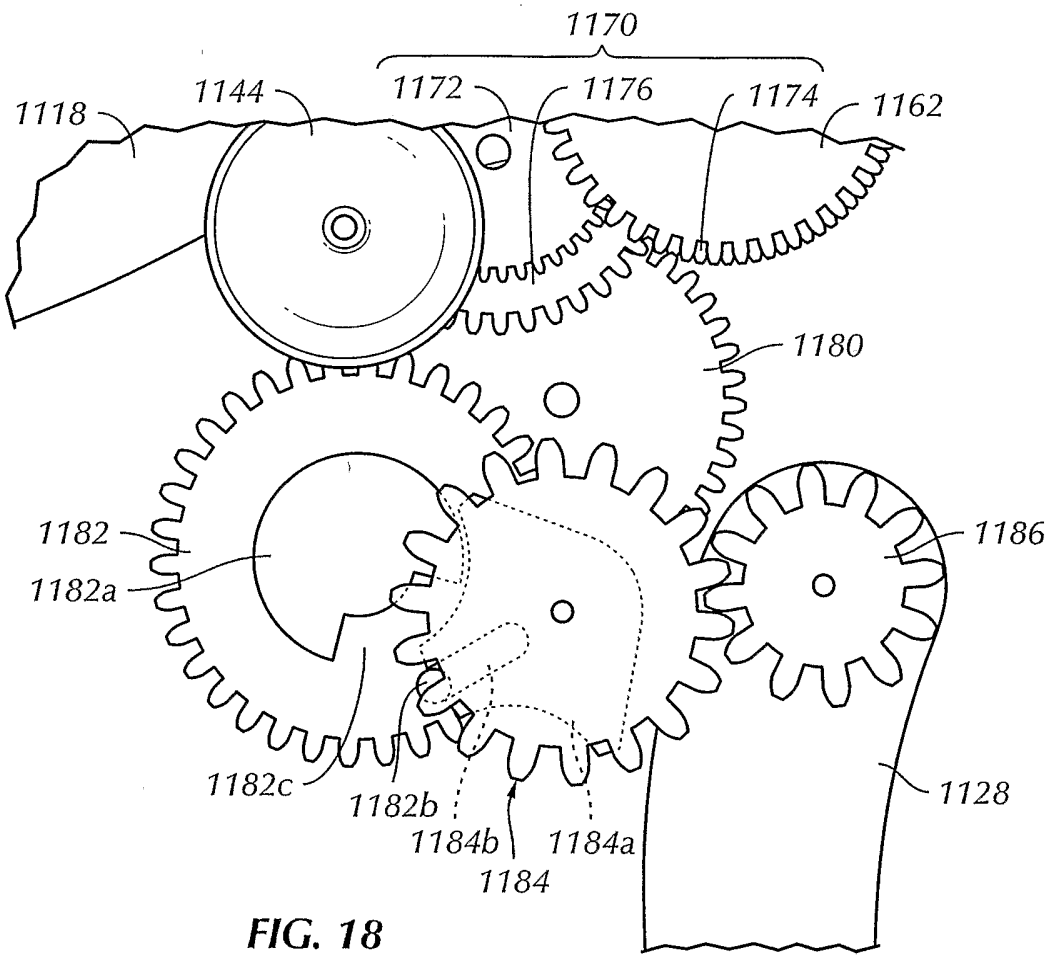
1170
1144
1172
1176
1174
1162
1118
1180
1182
1182a
1186
1182c
1182b
1184b
1184a
1184
1128

FIG. 18

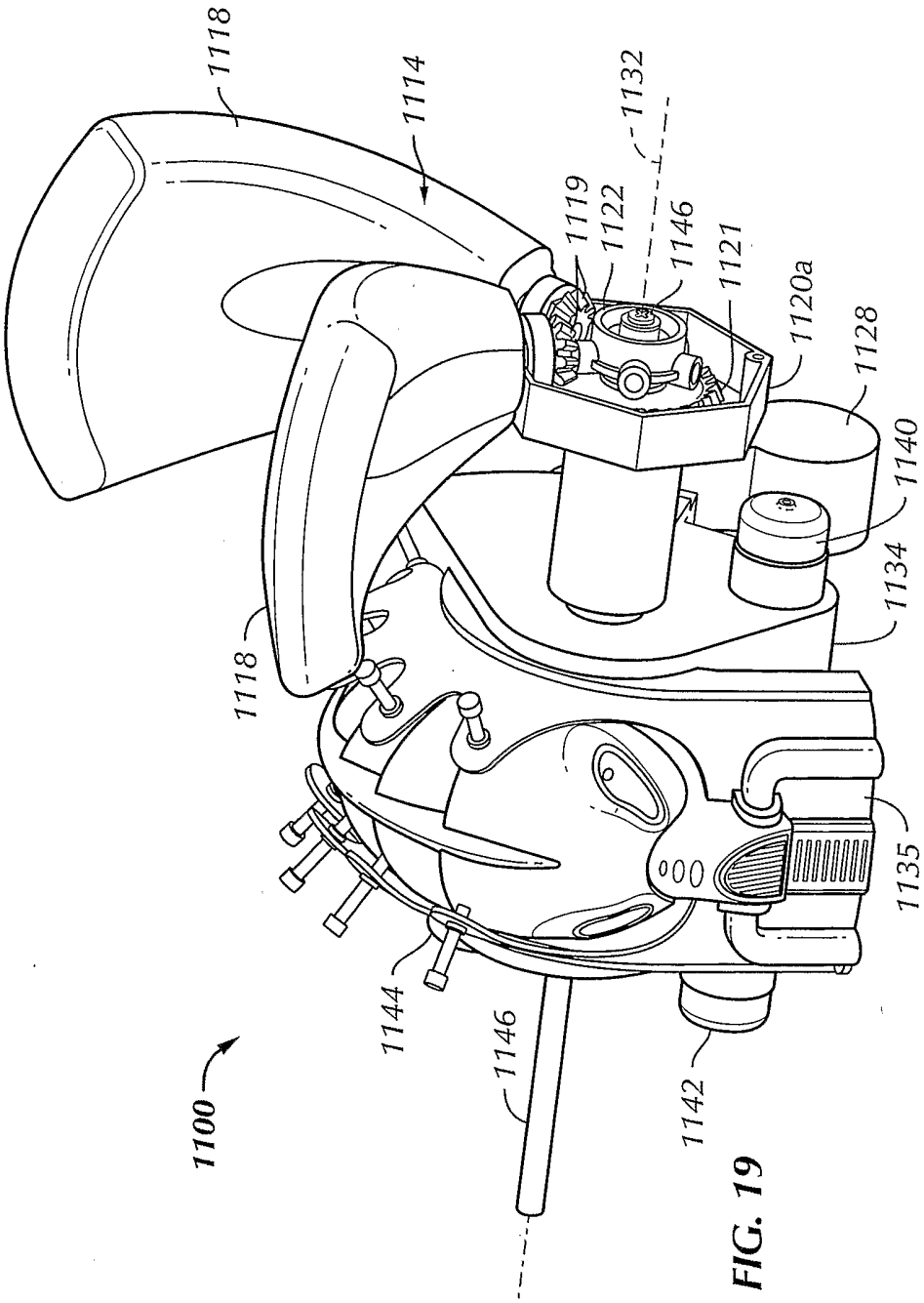
1118
1114
1132
1119
1122
1146
1121
1120a
1128
1140
1134
1118
1135
1144
1146
1142
1100

FIG. 19

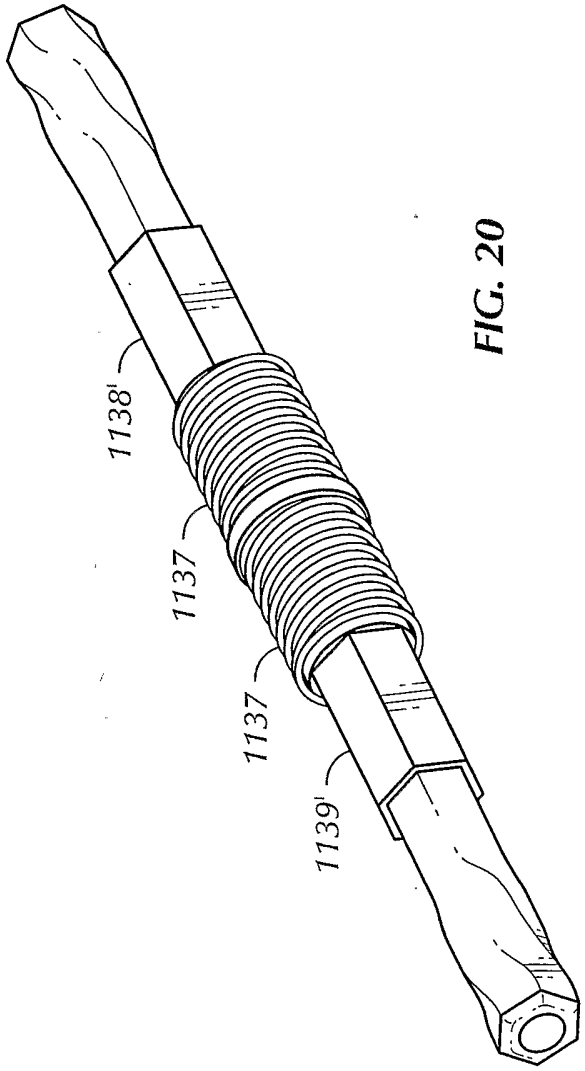

FIG. 20

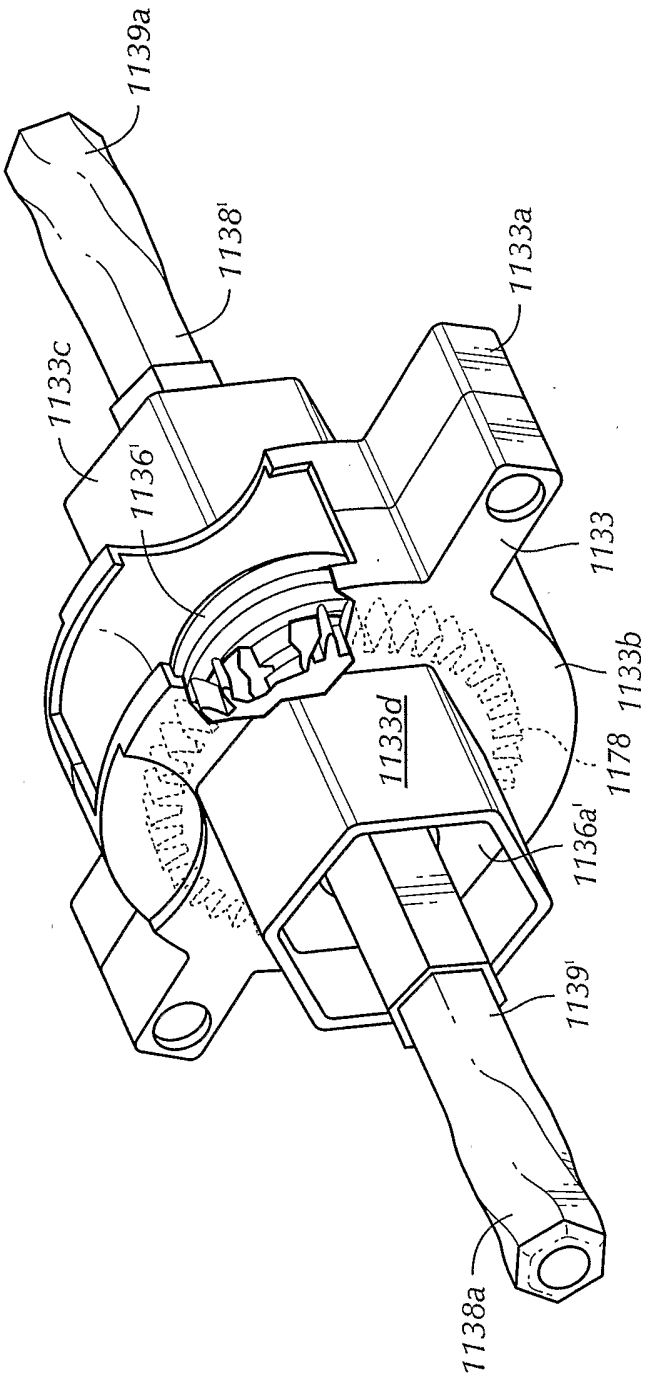
1139a
1138'
1133a
1133c
1136'
1133
1133b
1133d
1178
1136a'
1139'
1138a

FIG. 21

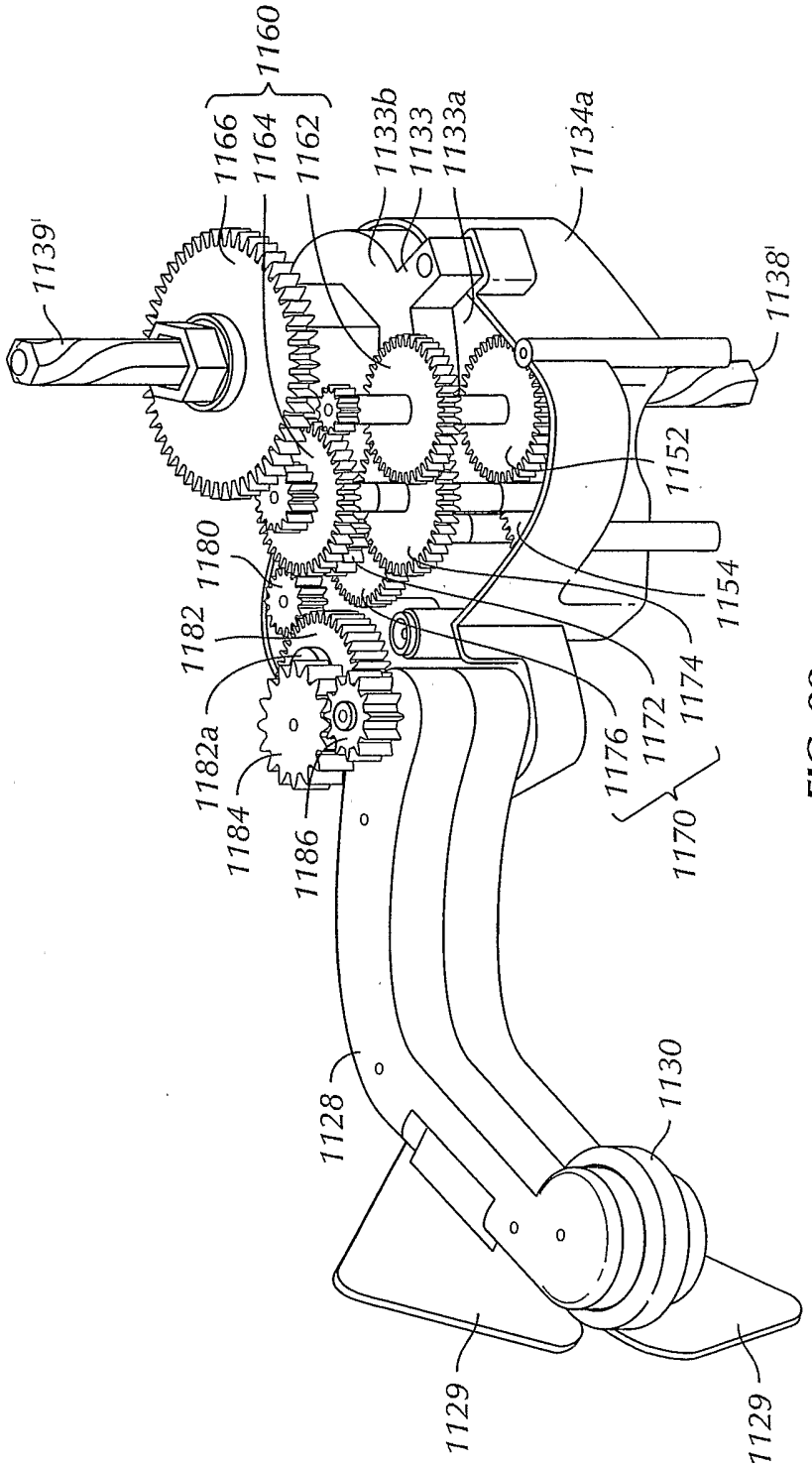
1160
1166
1164
1162
1133b
1133
1133a
1134a
1139'
1138'
1152
1180
1182
1154
1182a
1174
1176
1172
1184
1186
1170
1128
1130
1129
1129

FIG. 22

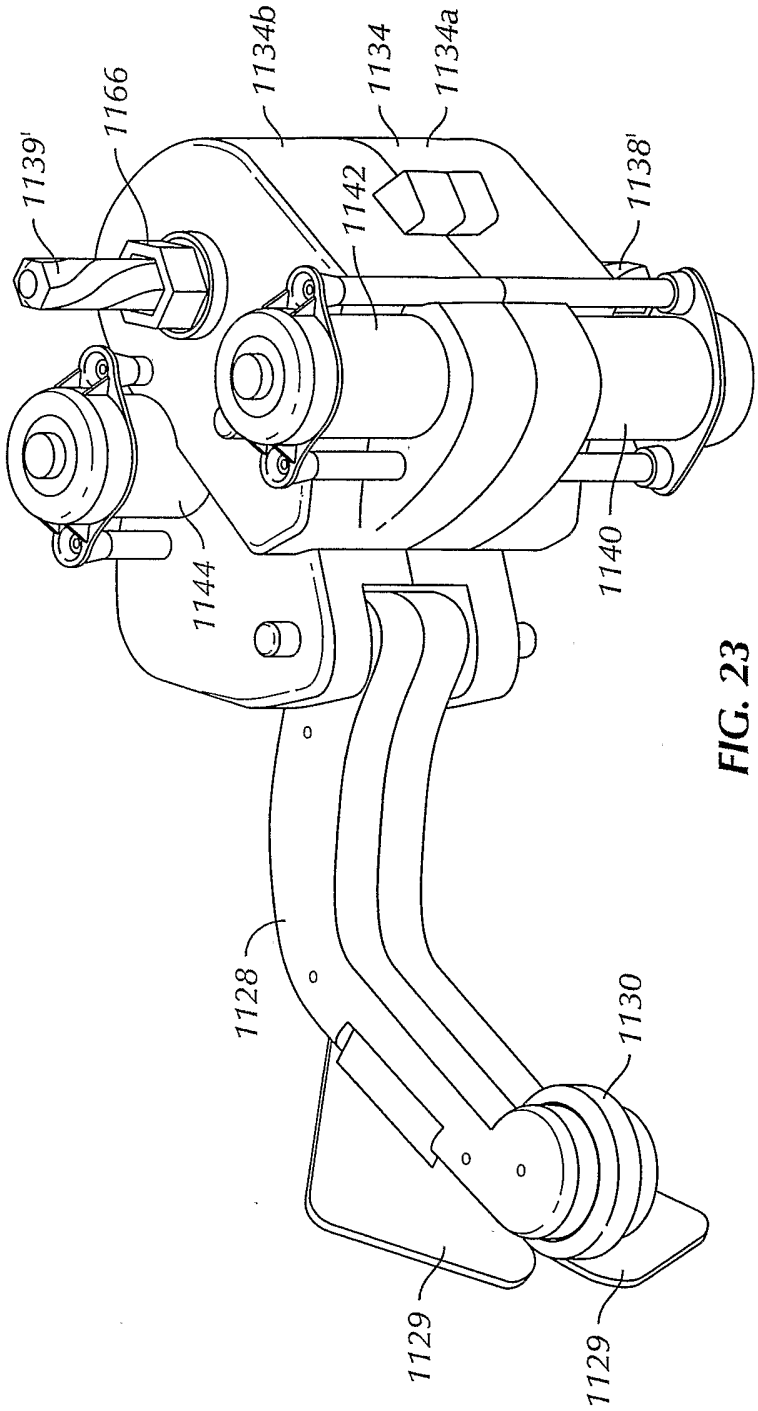
1134b
1134
1134a
1166
1139'
1142
1138'
1144
1140
1128
1130
1129
1129

FIG. 23

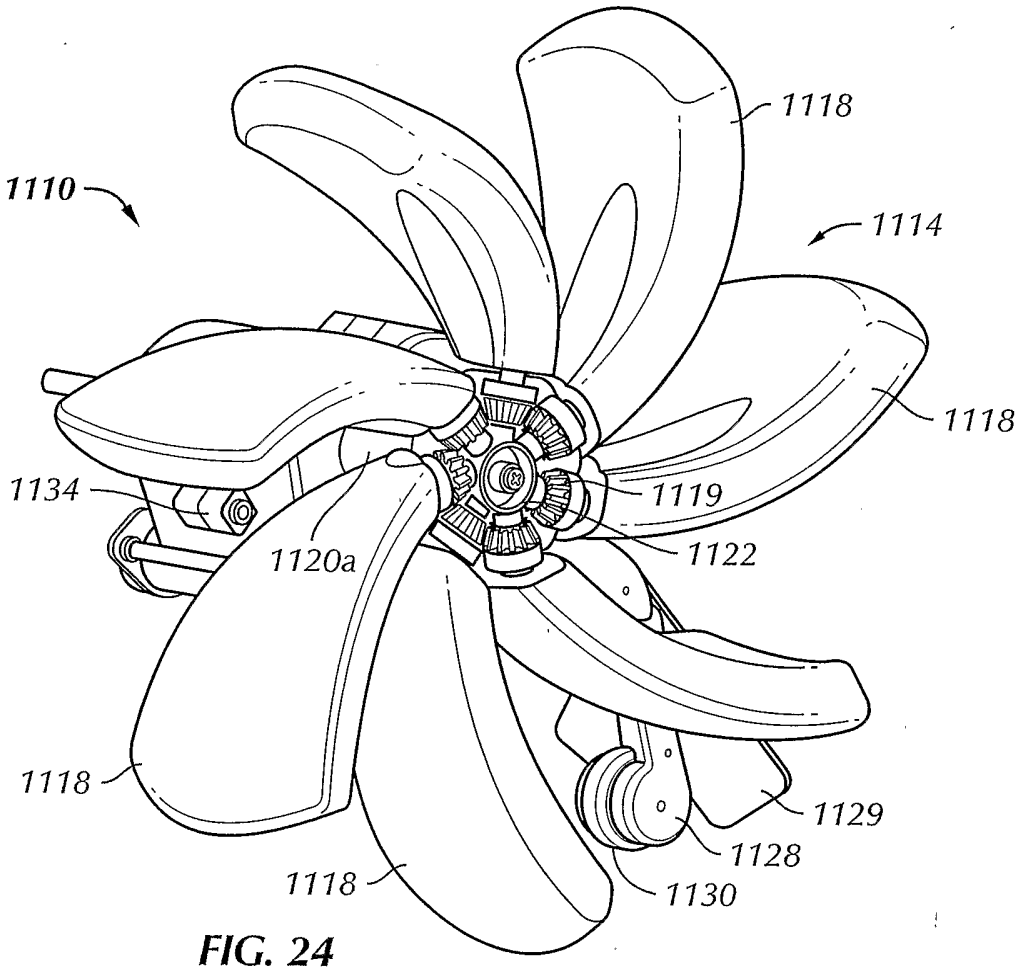
1110
1118
1114
1118
1134
1119
1120a
1122
1118
1129
1128
1118
1130

FIG. 24

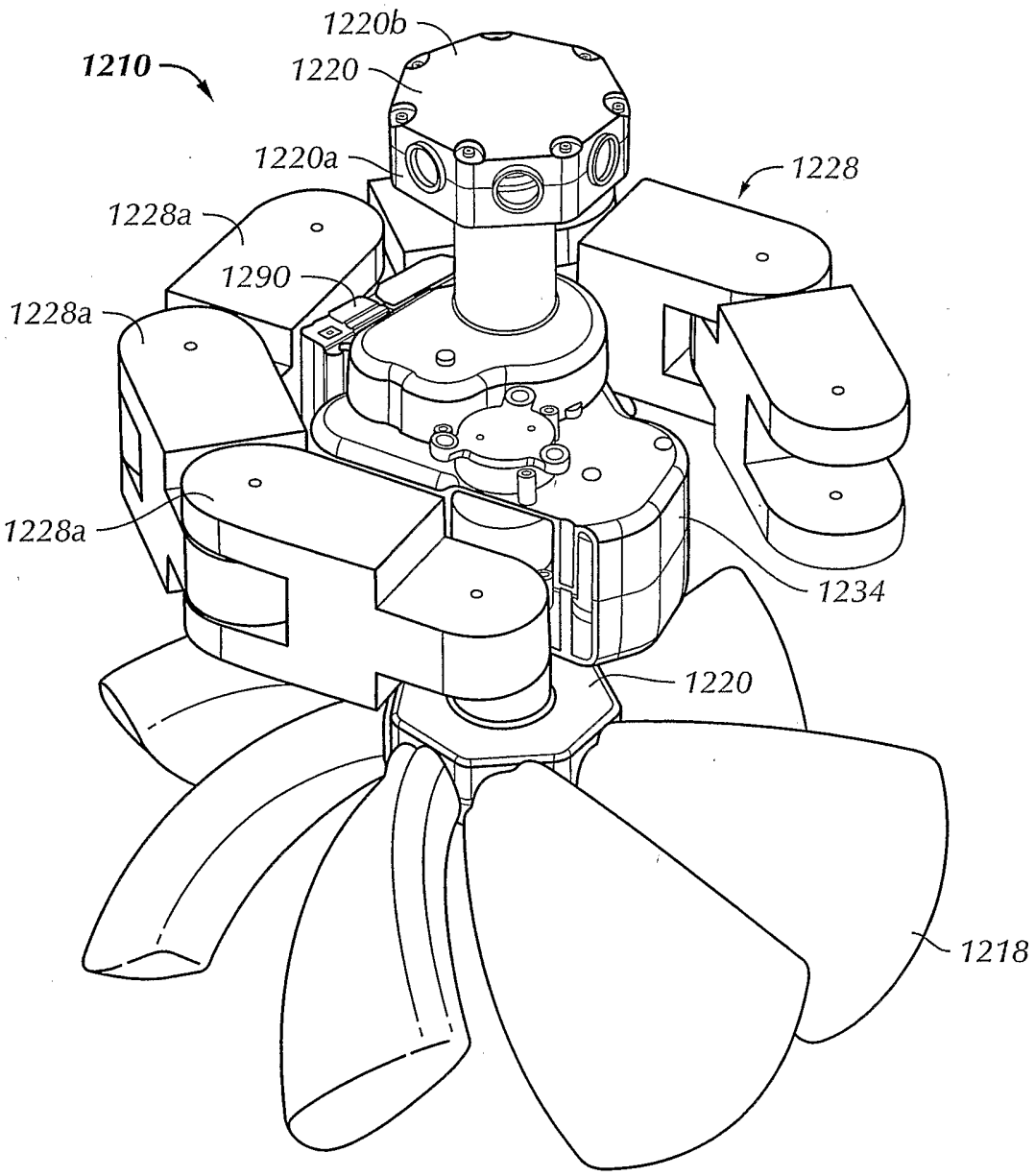
1220b
1210
1220
1220a
1228
1228a
1290
1228a
1228a
1234
1220
1218

FIG. 25

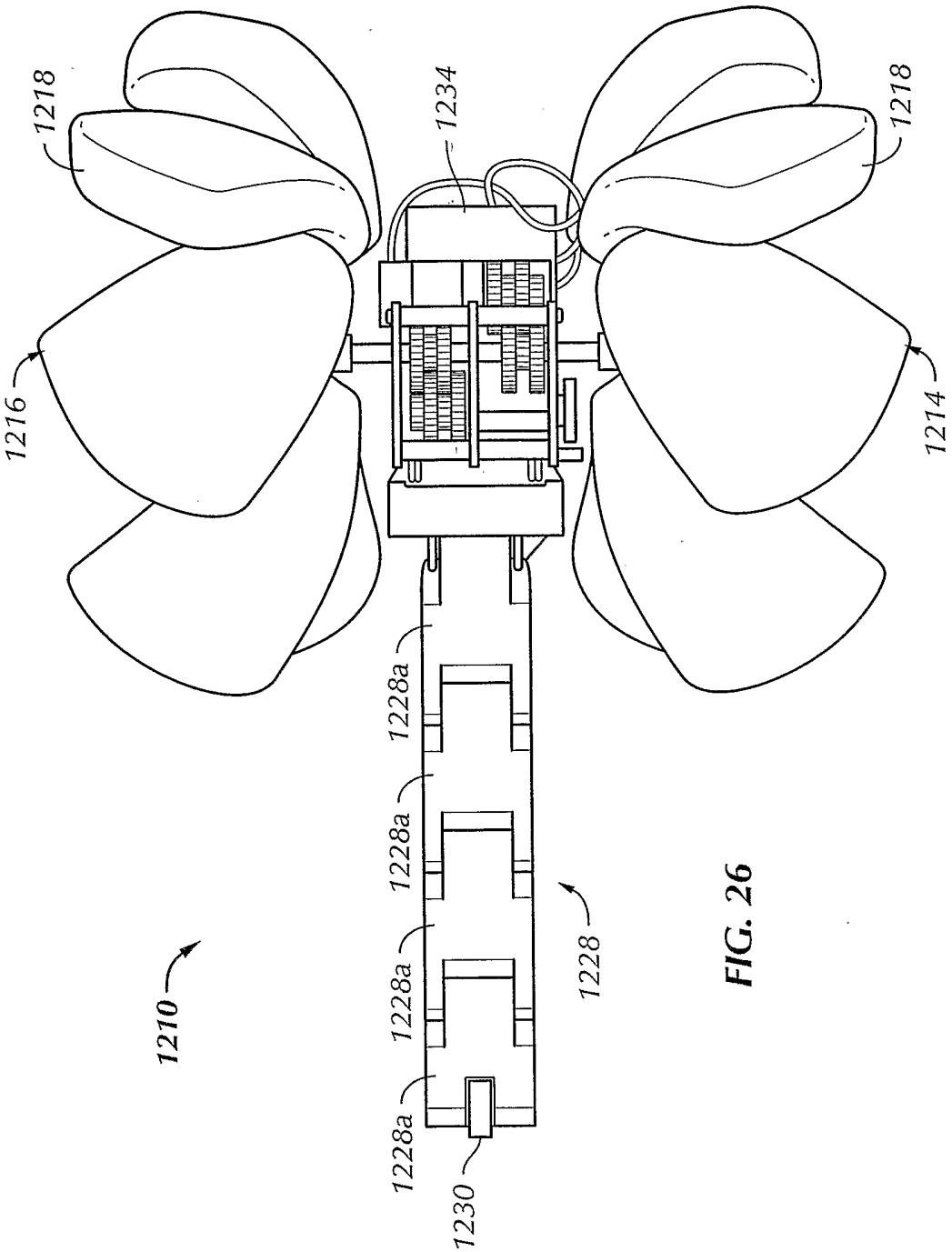
1218
1234
1218
1216
1214
1228a
1228a
1228a
1228a
1228
1210
1230

FIG. 26