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(54) **CONTINUOUSLY VARIABLE TRANSMISSION**

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(73) Assignee: **Fallbrook Technologies Inc.**, San Diego, CA (US)

(*) Notice: This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/330,425**

(22) Filed: **Jan. 11, 2006**

Related U.S. Patent Documents

Reissue of:
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Issued: **Jan. 13, 2004**
Appl. No.: **10/016,116**
Filed: **Oct. 30, 2001**

U.S. Applications:

(63) Continuation of application No. 09/823,620, filed on Mar. 30, 2001, now Pat. No. 6,322,475, which is a continuation of application No. 09/133,284, filed on Aug. 12, 1998, now Pat. No. 6,241,636.

(60) Provisional application No. 60/062,860, filed on Oct. 16, 1997, provisional application No. 60/056,045, filed on Sep. 2, 1997, provisional application No. 60/062,620, filed on Oct. 22, 1997, and provisional application No. 60/070,044, filed on Dec. 30, 1997.

(51) **Int. Cl.**
F16H 15/00 (2006.01)

(52) **U.S. Cl.** **476/38**; 476/36; 476/62

(58) **Field of Classification Search** 476/36, 476/38, 62
See application file for complete search history.

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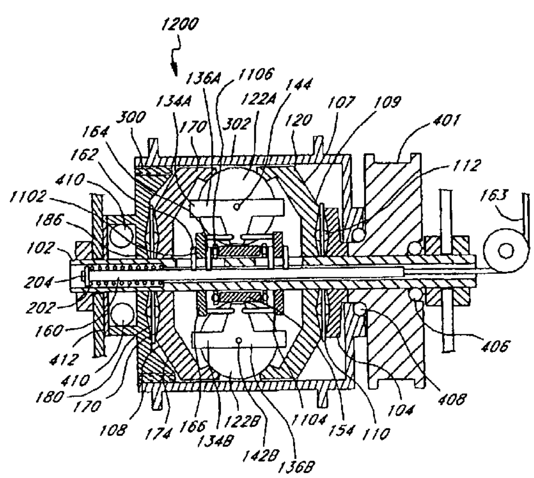
(74) *Attorney, Agent, or Firm*—Knobbe Martens Olson & Bear LLP

(57) **ABSTRACT**

A continuously variable transmission. The transmission includes a plurality of power adjusters, such as spherical balls, frictionally interposed between a driving and a driven member. The driving and the driven member are each rotatably disposed over a main shaft. The spherical balls are configured to rotate about a modifiable axis and thereby provide a continuously variable shifting capability by adjusting the ratio between the angular velocity of the driving member in relation to the driven member. The system includes automatic and manual shifting gearing for adjusting the speed of the transmission. The system also includes a support a support member which is rotatably disposed over the main shaft and frictionally engaged to each of the spherical balls.

33 Claims, 10 Drawing Sheets



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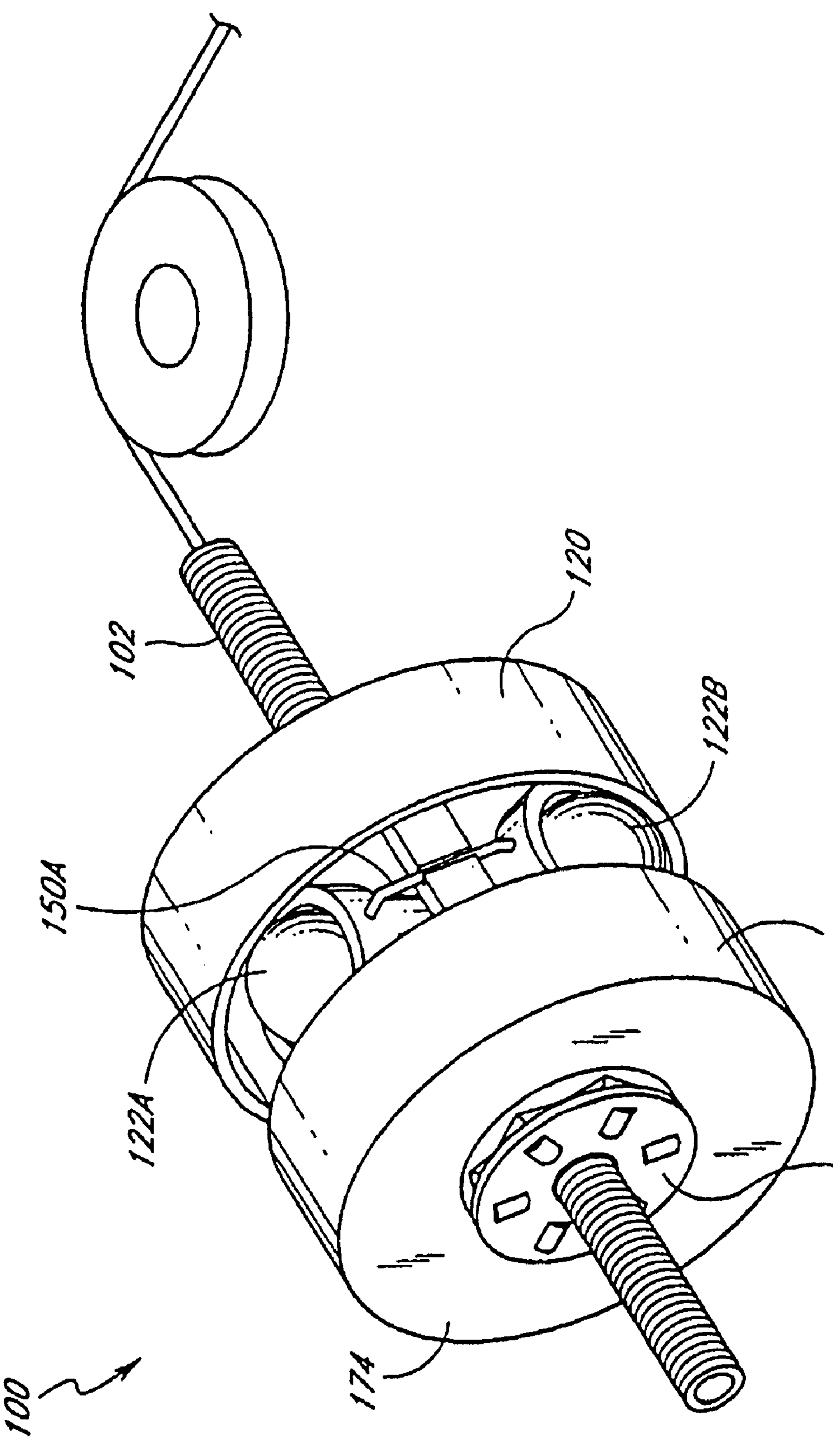

FIG. 1

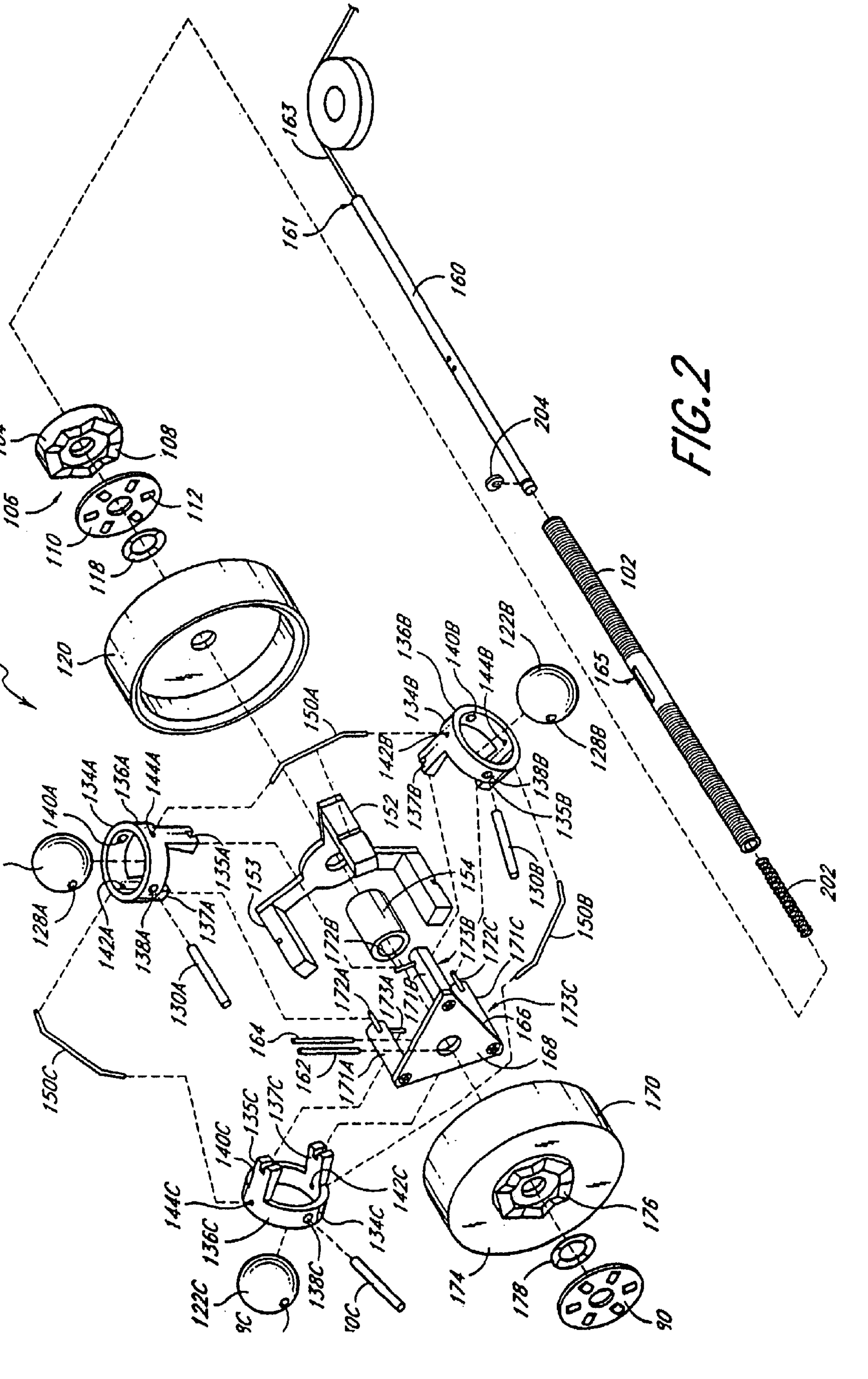

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FIG. 2

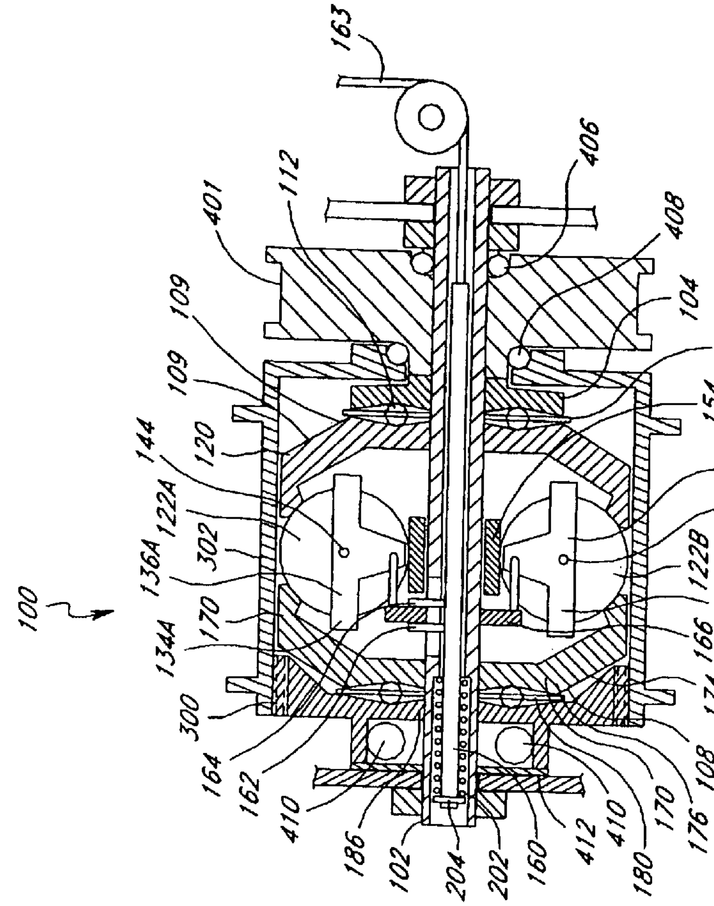
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FIG. 4

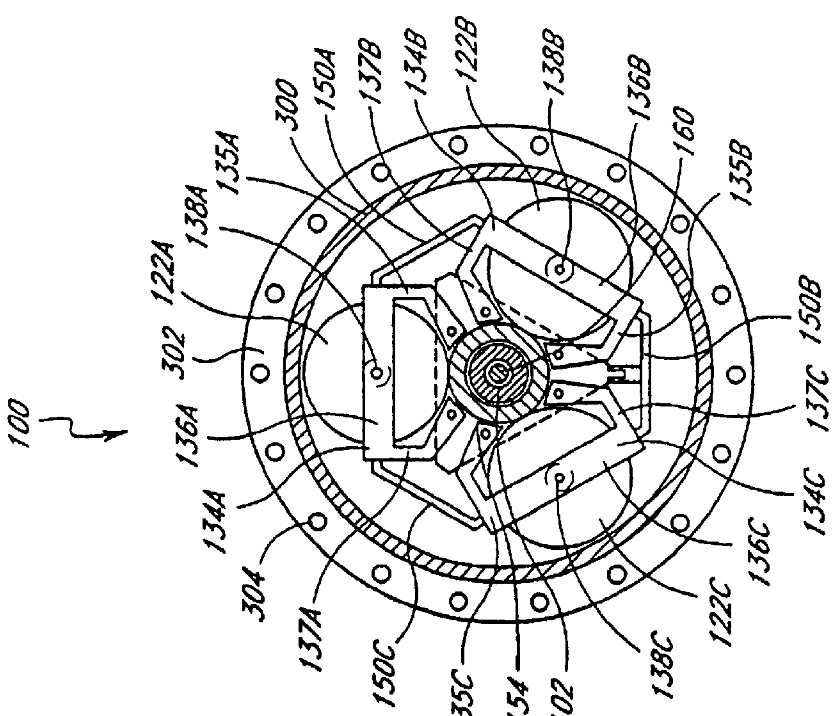
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FIG. 3

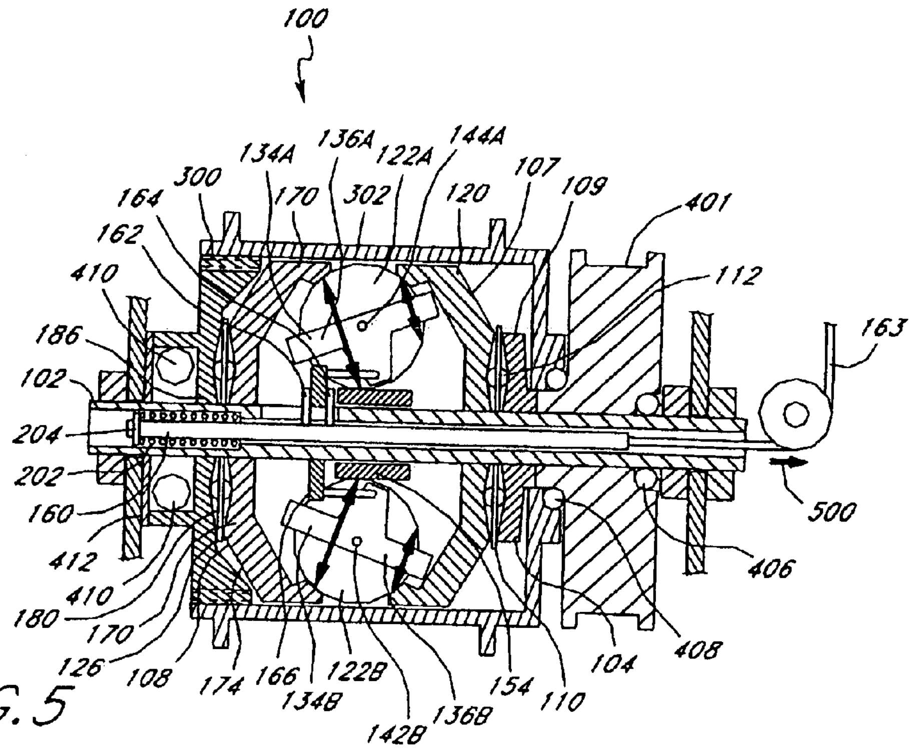
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FIG. 5

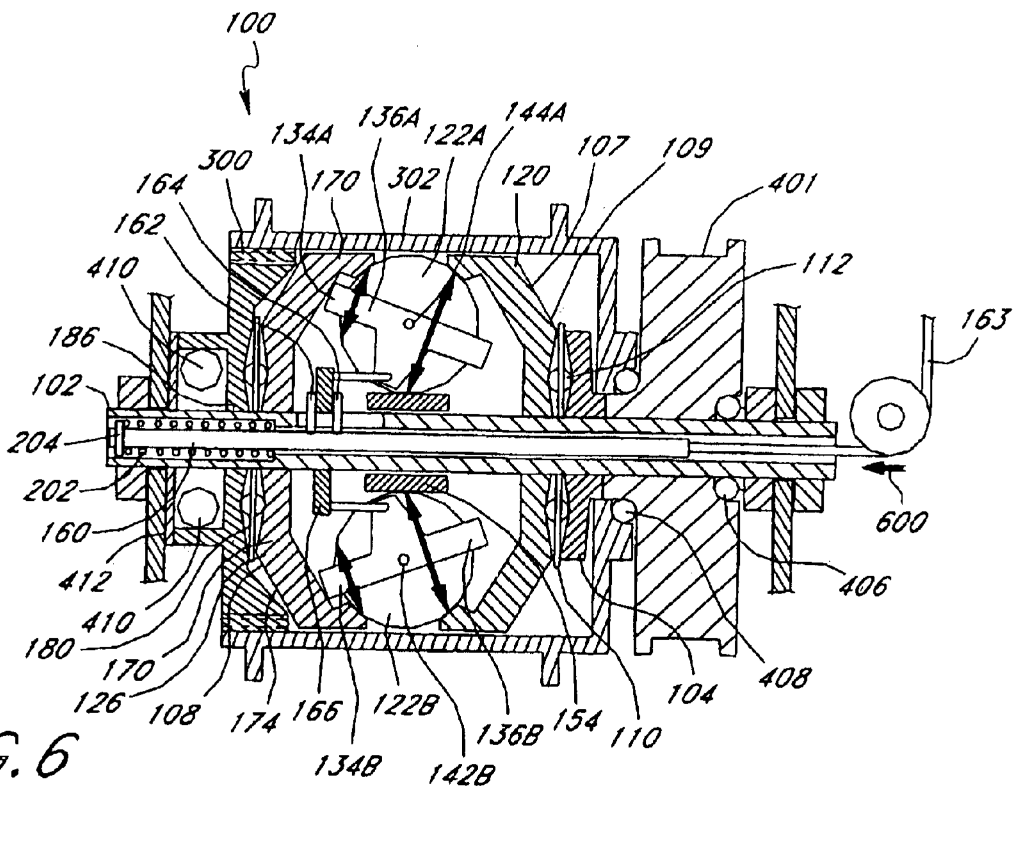
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FIG. 6

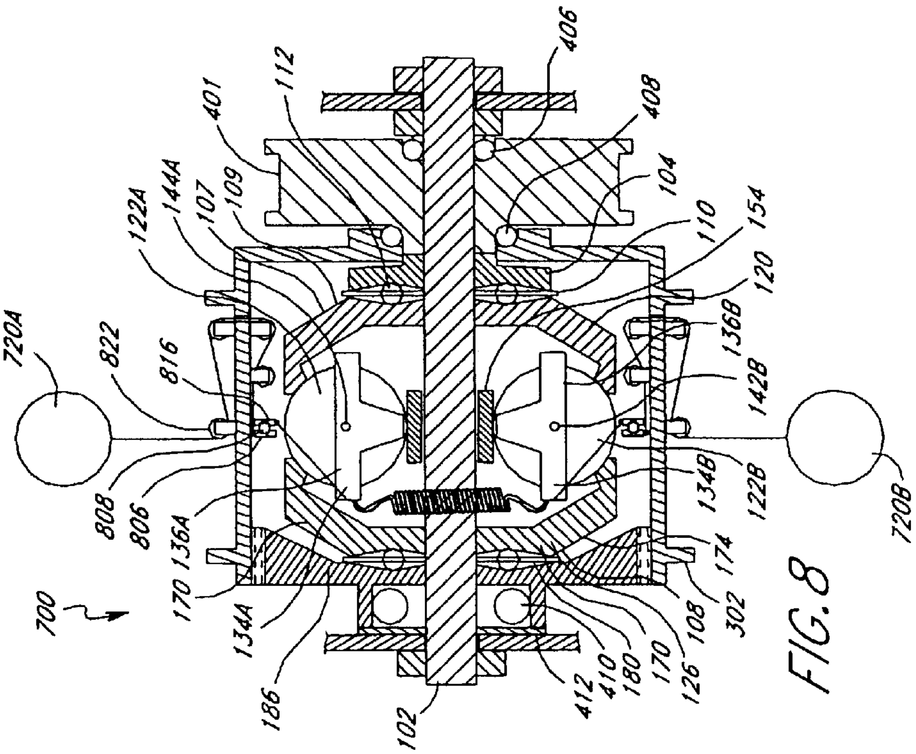
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FIG. 8

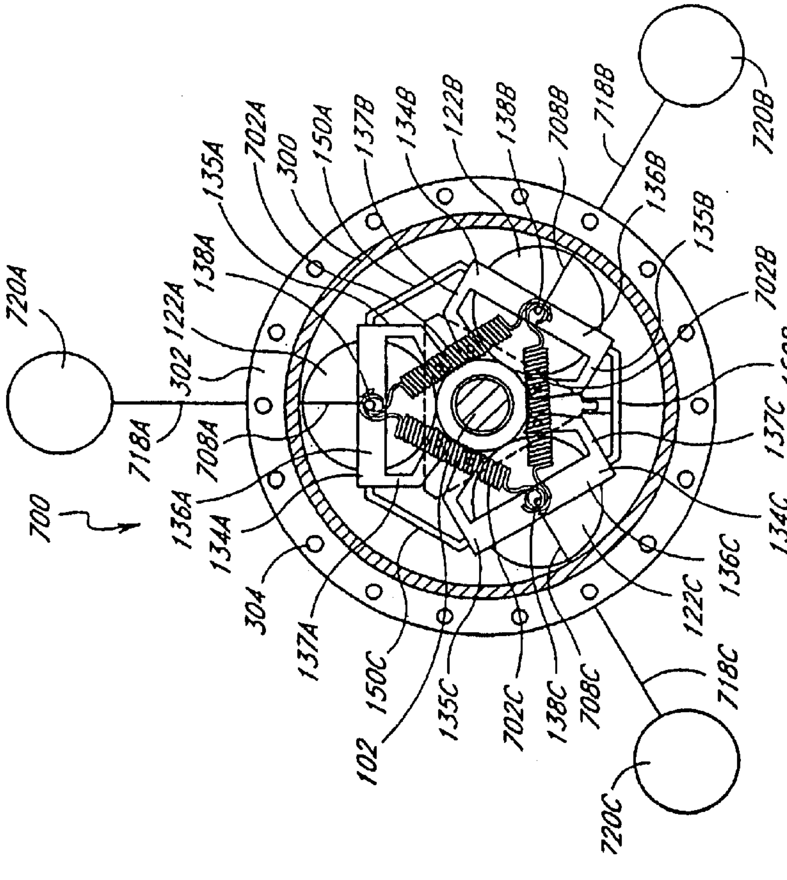
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FIG. 7

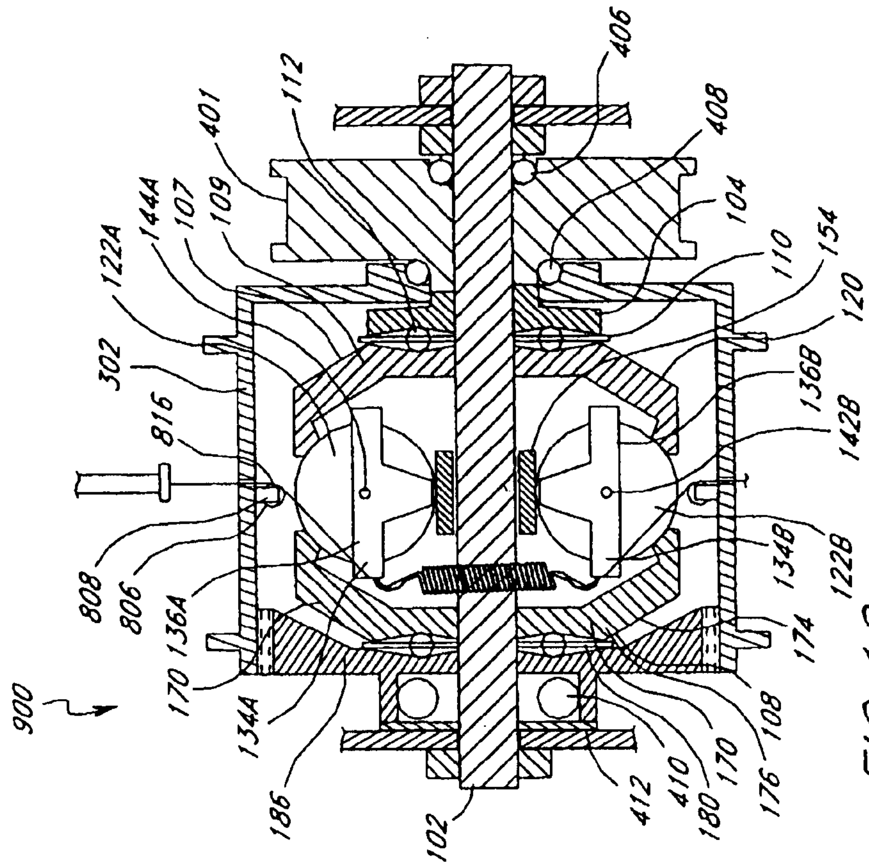
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FIG. 10

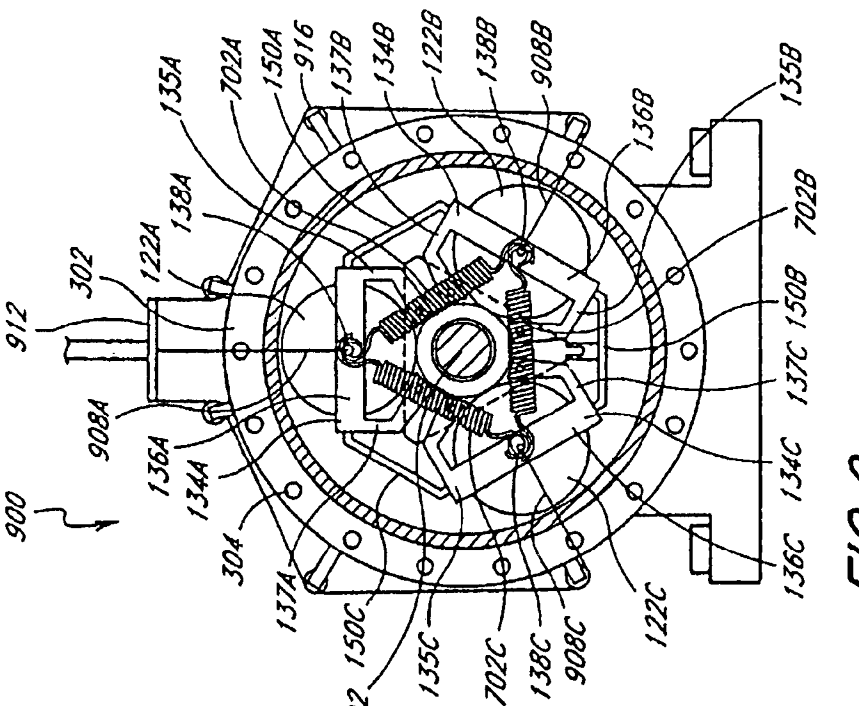
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FIG.9

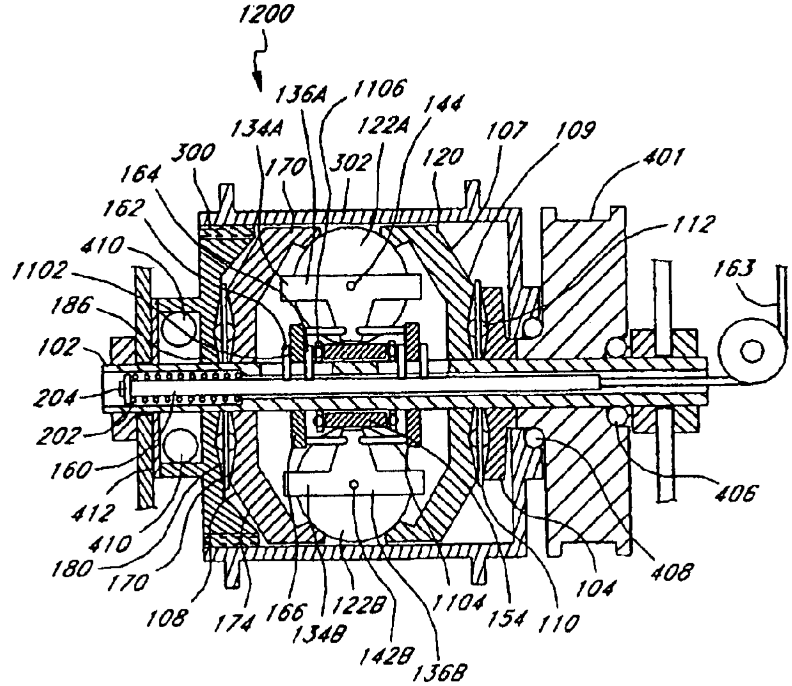
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FIG. 11

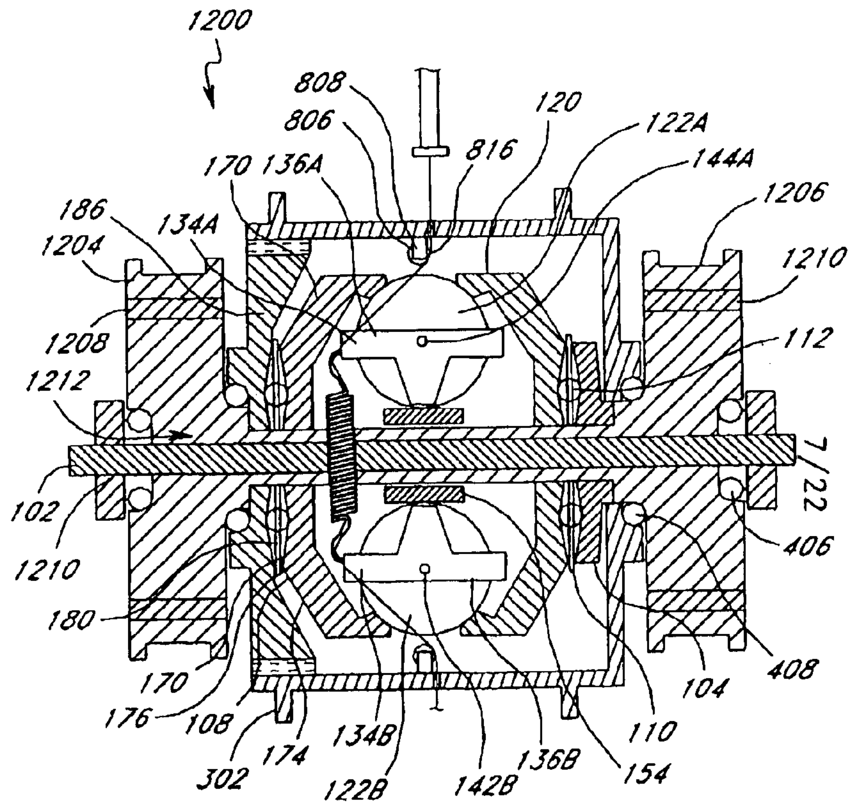
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FIG. 12

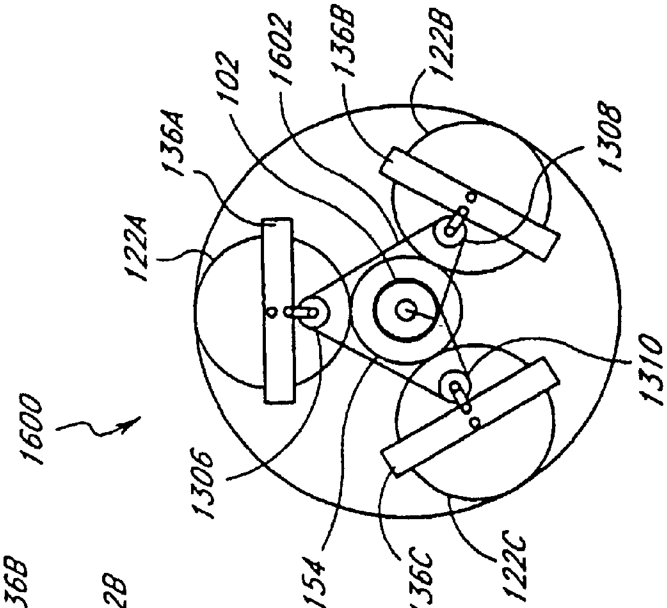

FIG. 16

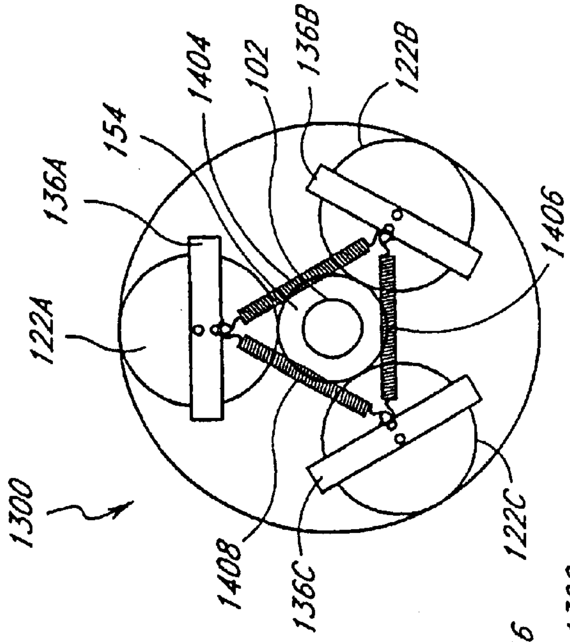

FIG. 14

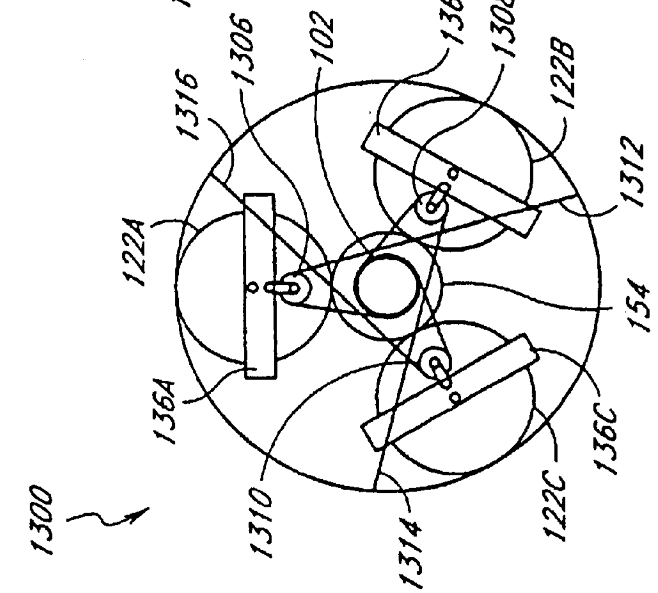

FIG. 13

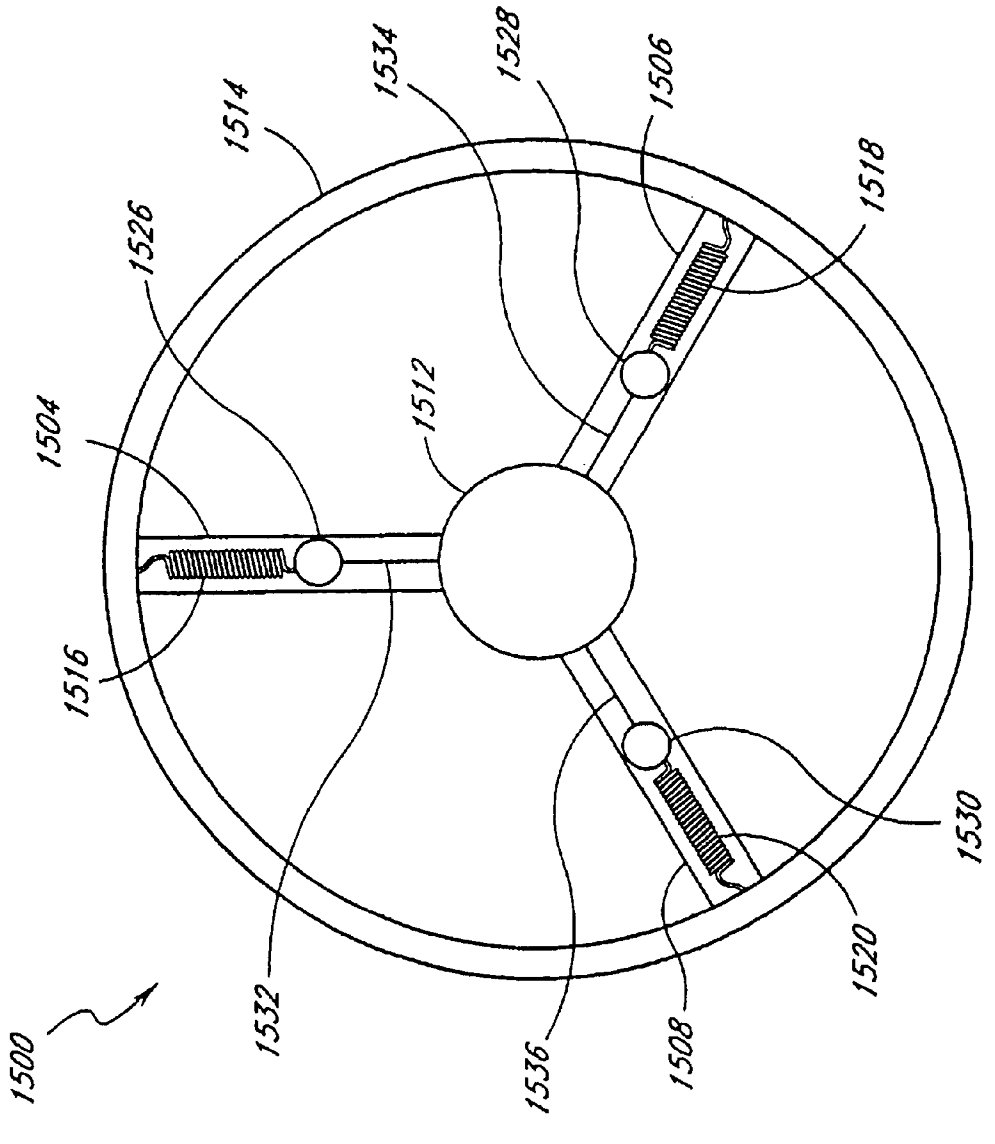
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FIG. 15

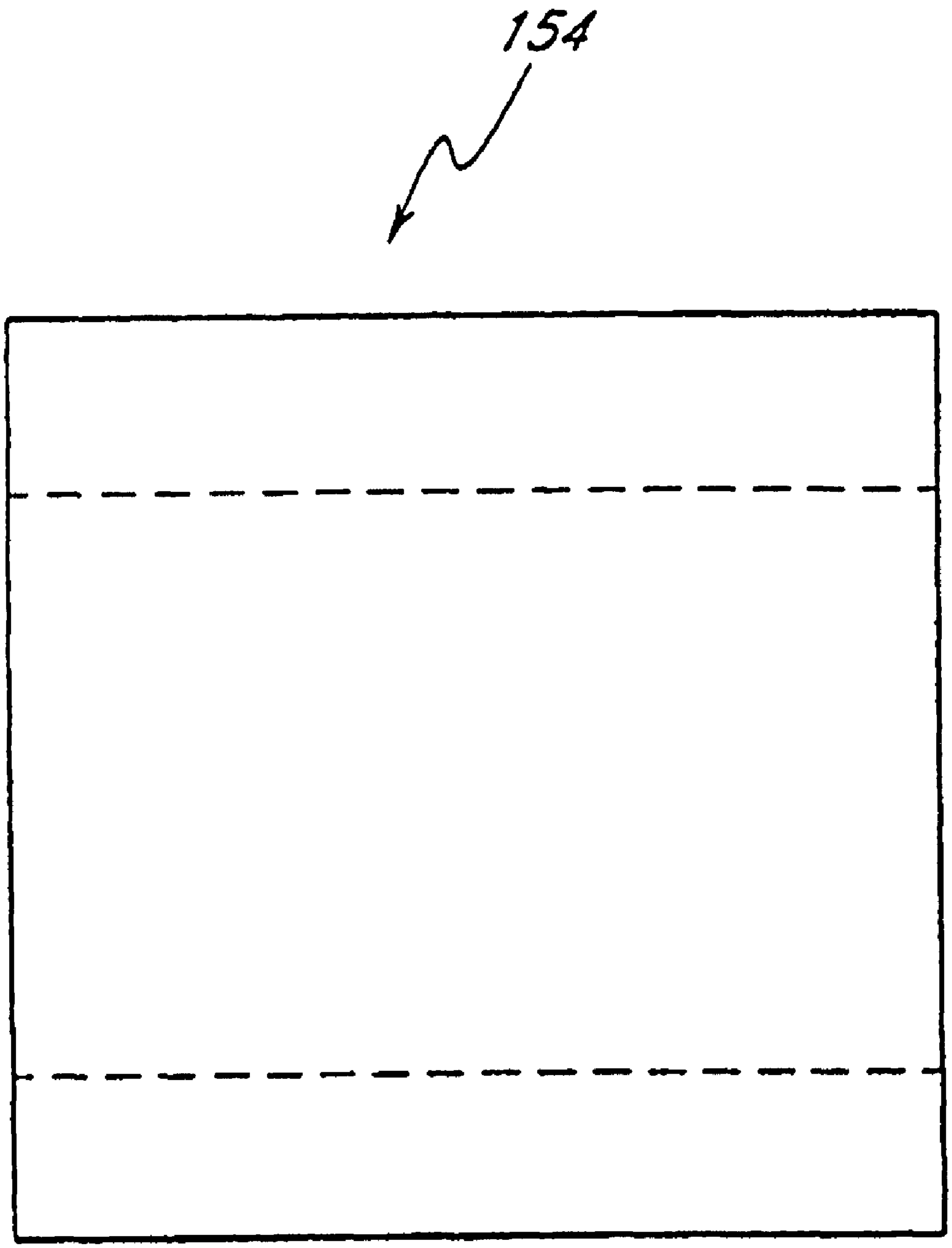

FIG. 17

CONTINUOUSLY VARIABLE TRANSMISSION

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 09/823,620, filed Mar. 30, 2001 now U.S. Pat. No. 6,322,475, which is a continuation of U.S. application Ser. No. 09/133,284, filed Aug. 12, 1998 now U.S. Pat. No. 6,241,636, which in turn claims priority to U.S. Provisional Application No. 60/062,860, filed on Oct. 16, 1997; U.S. Provisional Application No. 60/056,045, filed on Sep. 2, 1997; U.S. Provisional Application No. 60/062,620, filed on Oct. 22, 1997 and U.S. Provisional Application No. 60/070,044 filed on Dec. 30, 1997, all of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the invention relates to transmissions. More particularly the invention relates to continuously variable transmissions.

2. Description of the Related Art

In order to provide an infinitely variable transmission, various traction roller transmissions in which power is transmitted through traction rollers supported in a housing between torque input and output disks have been developed. In such transmissions, the traction rollers are mounted on support structures which, when pivoted, cause the engagement of traction rollers with the torque disks in circles of varying diameters depending on the desired transmission ratio.

However, the success of these traditional solutions have been limited. For example, in U.S. Pat. No. 5,236,403 to Schievelbusch, a driving hub for a vehicle with a variable adjustable transmission ratio is disclosed. Schievelbusch teaches the use of two iris plates, one on each side of the traction rollers, to tilt the axis of rotation of each of the rollers. However, the use of iris plates can be very complicated due to the large number of parts which are required to adjust the iris plates during shifting the transmission. Another difficulty with this transmission is that it has a guide ring which is configured to be predominantly stationary in relation to each of the rollers. Since the guide ring is stationary, shifting the axis of rotation of each of the traction rollers is difficult. Yet another limitation of this design is that it requires the use of two half axles, one on each side of the rollers, to provide a gap in the middle of the two half axles. The gap is necessary because the rollers are shifted with rotating motion instead of sliding linear motion. The use of two axles is not desirable and requires a complex fastening system to prevent the axles from bending when the transmission is accidentally bumped, is as often the case when a transmission is employed in a vehicle. Yet another limitation of this design is that it does not provide for an automatic transmission.

Therefore, there is a need for a continuously variable transmission with a simpler shifting method, a single axle, and a support ring having a substantially uniform outer surface. Additionally, there is a need for an automatic traction roller transmission which is configured to shift automatically. Further, the practical commercialization of traction roller transmissions requires improvements in the reliability, ease of shifting, function and simplicity of the transmission.

SUMMARY OF THE INVENTION

The present invention includes a transmission, comprising three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center and three or more cylindrical spindles with each spindle positioned in the hole of one power adjuster. There may be at least one stationary support with an aperture at its center and a rotatable support member having first and second sides. The rotatable support member can be located between the power adjusters and frictionally engaged with the plurality of power adjusters. The rotatable support member can have a substantially uniform outer diameter, and is capable of axial movement. The rotatable support member may have at least two areas that are bearing surfaces to control axial movement of the rotatable support member. Interacting with the rotatable support member is a first annular bearing, capable of axial movement, is positioned on the first side of the support member and a second annular bearing capable of axial movement, positioned on the second side of the support member. A first planar platform capable of axial movement, is positioned so that the first annular bearing is between the rotatable support member and the first planar platform. A second planar platform, capable of axial movement, is positioned so that the second annular bearing is between the rotatable support and the second planar platform. A ratio changer operably connected to the cylindrical spindles causes the cylindrical spindles to change their axes of rotation.

One embodiment includes a transmission, comprising a drive sleeve with three or more ramped surfaces on the drive sleeve that face the rotatable driving member. Three or more rollers are positioned to roll on the three or more ramped surfaces of the drive sleeve and also roll on the rotatable driving member. A roller cage positions the three or more rollers. The three or more ramped surfaces of the drive sleeve are configured so that when the three or more rollers rotate they compress the rotatable driving member against the three or more spherical power adjusters upon an increase in torque and decompress the rotatable driving member upon a decrease in torque. The embodiment may have at least one stationary support with an aperture at its center.

Yet another embodiment includes a plurality of legs rigidly attached to the at least one stationary support. The plurality of legs extend in a direction from the at least one stationary support towards the spherical power adjusters. The plurality of legs are designed to assist in holding the spherical power adjusters in a stationary position.

Another embodiment includes a shifting member having an end that extends outside of the transmission. The shifting member is positioned along the axis of the rotatable support member and is operably engaged with the rotatable support member. An adjustment in the position of the shifting member causes the rotatable support member, the first annular bearing, the second annular bearing, the first planar platform, and the second planar platform to all move simultaneously and a substantially equal distance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial perspective view of the transmission of the present invention.

FIG. **2** is a partial exploded view of the transmission of FIG. **1**.

FIG. **3** is an end cutaway elevational view of the transmission of FIG. **1**.

FIG. **4** is a cutaway side elevational view of the transmission of FIG. **1**.

FIGS. **5** and **6** are cutaway side elevational views of the transmission of FIG. **1** illustrating the transmission of FIG. **1** shifted into different positions.

FIG. **7** is an end cutaway view of an alternative embodiment of the transmission of the invention wherein the transmission shifts automatically.

FIG. **8** is a side elevational view of the transmission of FIG. **7**.

FIG. **9** is an end cutaway view of an alternative embodiment of the transmission of the invention wherein the transmission includes a stationary hub shell.

FIG. **10** is a cutaway side elevational view of the transmission of FIG. **9**.

FIG. **11** is a cutaway side elevational view of an alternative embodiment of the transmission of FIG. **1** wherein the transmission has two thrust bearings.

FIG. **12** is a cutaway side elevational view of an alternative embodiment of the invention wherein a first and second one way rotatable driver provides an input torque to the transmission.

FIG. **13** is a schematic cutaway end elevational view of another alternative embodiment of the transmission of the invention.

FIG. **14** is a schematic cutaway front elevational view of the transmission of FIG. **13**.

FIG. **15** is a schematic end view of a housing for the transmission of FIGS. **13** and **14**.

FIG. **16** is a schematic cutaway front elevational view of another alternative embodiment of the transmission of the invention.

FIG. **17** is a side elevational view of an alternative embodiment of a support member.

DETAILED DESCRIPTION OF THE INVENTION

The following detailed description is directed to certain specific embodiments of the invention. However, the invention can be embodied in a multitude of different ways as defined and covered by the claims. In this description, reference is made to the drawings wherein like parts are designated with like numerals throughout.

The present invention includes a continuously variable transmission that may be employed in connection with any type of machine that is in need of a transmission. For example, the transmission may be used in (i) a motorized vehicle such as an automobile, motorcycle, or watercraft, (ii) a non-motorized vehicle such as a bicycle, tricycle, scooter, exercise equipment or (iii) industrial power equipment, such as a drill press.

FIGS. **1** through **4** disclose one embodiment of the present invention. FIG. **1** is a partial perspective view of a transmission **100**. FIG. **2** is an exploded view of the transmission **100** of FIG. **1**. FIG. **3** shows a partial cross sectional end view of the transmission **100**. FIG. **4** shows a cutaway side elevational view of the transmission **100**.

Referring generally to FIGS. **1** through **4**, a hollow main shaft **102** is affixed to a frame of a machine (not shown). The shaft **102** may be threaded at each end to allow a fastener (not shown) to be used to secure the transmission **100** on the main shaft **102** and/or to attach the main shaft **102** to a machine. A rotatable driver **401** (FIG. **4**) comprising a sprocket or a pulley is rotatably affixed to the main shaft **102**, so as to provide an input torque to the transmission **100**. A drive sleeve **104** is coaxially coupled to the rotatable driver **401** (FIG. **4**) and rotatably disposed over the main shaft **102**. A surface **106** (FIG. **2**) of the drive sleeve **104** opposite the rotatable driver **401** (FIG. **4**), can include a plurality of shallow grooves **108**.

A first roller cage assembly **110** is coaxially coupled to the drive sleeve **106** opposite the rotatable driver **401** and also rotatably disposed over the main shaft **102**. The first roller cage assembly **110** has a plurality of cylindrical rollers **112** radially arranged about a midpoint of the roller cage assembly **110**. Each of the cylindrical rollers **112** are rotatably mounted on the first roller cage assembly **110** such that each of the rollers may rotate about its lengthwise axis. Preferably, a one-to-one correlation exists between each of the shallow grooves **108** and each of the cylindrical rollers **112**. Optionally, the cylindrical rollers **112** may be replaced with rollers of an alternative geometric shape, such as with spherical rollers.

A tension inducer **118** (FIG. **2**), such as a spring, is rotatably disposed over the main shaft **102** and frictionally coaxially coupled to the first roller cage assembly **110** opposite to the drive sleeve **104**. Further, a rotatable driving member **120** is rotatably affixed to the main shaft **102** and coaxially coupled to a side of the first roller cage assembly **110** opposite the drive sleeve **104**. A surface **107** (FIG. **4**) of the rotatable driving member **120** opposed to the drive sleeve **104** includes a plurality of shallow grooves **109** (FIG. **4**). Relative rotation of the roller cage **110** with respect to the drive sleeve **104** causes the cylindrical rollers **112** to roll on the shallow grooves **108**, **109** and move the shallow grooves **108**, **109** toward or away from each other along the axis of the main shaft **102**.

A plurality of spherical power adjusters **122**A, **122**B, **122**C are in frictional contact with a side of the rotatable driving member **120** opposite the roller cage assembly **110**. In one embodiment of the invention, the power adjusters **122**A, **122**B, **122**C are spheres made of hardened steel; however, the power adjusters **122**A, **122**B, **122**C may alternatively include other shapes and be manufactured from other materials. A plurality of spindles **130**A, **130**B, **130**C (FIG. **2**) respectively extend through multiple passages **128**A, **128**B, **128**C (FIG. **2**) in the power adjusters **122**A, **122**B, **122**C. Radial bearings (not shown) may be disposed over each of the spindles **130**A, **130**B, **130**C (FIG. **2**) to facilitate the rotation of the power adjusters **122**A, **122**B, **122**C.

A plurality of pivot supports **134**A, **134**B, **134**C respectively hold the spindles **130**A, **130**B, **130**C (FIG. **2**). The support **134**A includes two legs **135**A and **137**A for connection to a ratio changer **166** which is discussed in further detail below. Similarly, the support **134**B includes two legs **135**B and **137**B, and the pivot support **134**C includes two legs **135**C and **137**C.

The pivot supports **134**A, **134**B, **134**C respectively include pivot rings **136**A, **136**B, **136**C. The pivot ring **136**A has four apertures **138**A, **140**A, **142**A, **144**A (FIG. **2**). Similarly, the pivot support **134**B has four apertures **138**B, **140**B, **142**B, and **144**B, and the pivot support **134**C has four apertures **138**C, **140**C, **142**C, and **144**C (FIG. **2**). The apertures **138**A, **138**B, **138**C are respectively located opposite to the apertures **140**A, **140**B, **140**C on the pivot rings **136**A, **136**B, and **136**C. Together, the apertures **138**A, **138**B, **138**C, and the apertures **140**A, **140**B, **140**C are respectively configured to receive the spindles **130**A, **130**B, **130**C (FIG. **2**).

The apertures **142**A, **142**B, **142**C (FIG. **2**) are respectively located opposite to the apertures **144**A, **144**B, **144**C (FIG. **2**) on the pivot rings **136**A, **136**B, **136**C. Together, the apertures **142**A, **142**B, **142**C and the apertures **144**A, **144**B, **144**C are configured to receive multiple immobilizers **150**A, **150**B, **150**C (FIG. **2**). In one embodiment of the invention, the immobilizers **150**A, **150**B, **150**C are each cylindrical rigid rods, slightly angled at each end. A central portion of each of the immobilizers **150**A, **150**B, **150**C are affixed to one of multiple legs **153** (FIG. **2**) of a stationary support **152** (FIG. **2**). The stationary support **152** is fixedly attached to the main shaft **102**.

A support member **154** is slidingly and rotatably disposed over the main shaft **102** proximate to a side of the stationary support **152** (FIG. **2**) which is opposite to the rotatable driving member **120**. The support member **154** is in frictional contact with each of the power adjusters **122**A, **122**B, **122**C. In one embodiment of the invention, the support member **154** is a cylindrical ring having a substantially uniform outer circumference from an end cross-sectional view. In another embodiment of the invention, the support member **154** is a cylindrical ring having a first and second flange (not shown) which respectively extend radially outwardly from a first and second end of the support member **154** so as to prevent the power adjusters **122**A, **122**B, **122**C from disengaging from the support member **154**. In yet another embodiment of the invention, the support member **154** is a cylindrical ring having a nominally concavical outer surface (FIG. **17**).

The support member **154** may contact and rotate upon the main shaft **102**, or may be suspended over the main shaft **102** without substantially contacting it due to the centering pressures applied by the power adjusters **122**A, **122**B, **122**C.

Referring in particular to FIG. **2**, a shifting member **160**, such as an inflexible rod, is slidingly engaged to an inner passage of the main shaft **102**. Two extensions **162**, **164** perpendicularly extend from the shifting member **160** through an opening **165** in the main shaft **102**. A first end **161** of the shifting member **160** proximate to the drive side of the transmission **100** is connected to a linkage **163**, such as a cable. The linkage **163** is connected at an end opposite to the main shaft **102** to a shifting actuator (not shown). A tension member **202**, such as a spring, is connected to a second end of the shifting member **160** by a fastener **204**.

Still referring in particular to FIG. **2**, the extensions **162**, **164** connect to the ratio changer **166**. The ratio changer **166** includes a planar platform **168** and a plurality of legs **171**A, **171**B, **171**C which perpendicularly extend from a surface of the platform **168** proximate to the support member **154**. The leg **171**A includes two linkage pins **172**A, **173**A. Similarly, the leg **171**B includes two linkage pins **172**B and **173**B, and the leg **171**C includes two linkage pins **172**C and **173**C. The linkage pins **172**A, **172**B, **172**C, and the linkage pins **173**A, **173**B, **173**C are used to couple the ratio changer **166** to each of the pivot supports **134**A, **134**B, and **134**C.

In regard to the coupling of the support **134**A and the ratio changer **166**, the linkage pin **172**A engages an end of the leg **137**A of the support **134**A opposite the pivot ring **136**A, and the linkage pin **172**B engages an end of the leg **135**A opposite the pivot ring **136**A. Further, in regard to the coupling between the pivot support **134**B and the ratio changer **166**, the linkage pin **173**B engages an end of the leg **137**B opposite the pivot ring **136**B, and the linkage pin **172**C engages an end of the leg **135**B opposite the pivot ring **136**B. Finally, in regard to the coupling between the pivot support **134**C and the ratio changer **166**, the linkage pin **173**C engages an end of the leg **137**C opposite the pivot ring **136**C, and the linkage pin **173**A engages an end of the leg **137**B opposite the pivot ring **136**C.

Although only three power adjusters **122**A, **122**B, **122**C are disclosed, the transmission **100** of the invention may be configured with fewer (e.g., 2) or more (e.g., 4, 5, 6 or more) power adjusters. Further, the number of legs on the ratio changer **166**, the number of legs on the stationary support **152**, the number of immobilizers, the number of pivot supports in the transmission may all be correspondingly adjusted according to the number of power adjusters that are employed.

Referring again in general to FIGS. **1**–**4**, a rotatable driven member **170** is rotatably engaged to the main shaft **102** proximate to the ratio changer **166** (FIG. **2**). The rotatable driven member **170** is in frictional contact with each of the power adjusters **122**A, **122**B, **122**C. A surface **174** of the rotatable driven member **170** opposite the power adjusters **122**A, **122**B, **122**C, includes a plurality of shallow grooves **176**. The rotatable driven member **170** is in frictional coaxial contact with a second tension inducer **178** (FIG. **2**), such as a spring, and a second roller cage assembly **180** that is similar in design to the roller cage assembly **110**. The second tension inducer **178** (FIG. **2**) and the second roller cage assembly **180** are rotatably disposed over the main shaft **102**. A hub driver **186** (FIG. **4**) is rotatably disposed over the main shaft **102** and coaxially engaged to a side of the second roller cage assembly **180** opposite the rotatable driven member **170**. The hub driver **186** (FIG. **4**) may be affixed to a hub shell **302** (FIGS. **3** and **4**) using any traditional gearing mechanism. In one embodiment of the invention, the hub driver **186** extends proximate to the hub shell **302** and is connected to a one way rotatable driver **300**, such as a one way roller clutch. The one way rotatable driver **300** (FIGS. **3** and **4**) is rotatably coupled to the hub shell **302** (FIGS. **3** and **4**).

Note that the power adjusters **122**A, **122**B, **122**C are suspended in tight three-point frictional contact with the drive member **120**, the support member **154**, and the driven member **170**.

The hub shell **302** (FIGS. **3** and **4**) has a plurality of holes **304** (FIG. **3**) which provide a means for attaching the hub shell **302** to a wheel, propeller or other propulsion means. The hub shell **302** is supported and is free to rotate on the main shaft **102** by means of hub bearings **410** (FIG. **4**) which fit into slots in the hub driver **186**. A washer **412** (FIG. **4**) is affixed to the main shaft **102** proximate to a side of the hub driver **186** opposite the second roller cage assembly **180** to facilitate the rotation of the hub bearings **410** (FIG. **4**).

FIGS. **5** and **6** are a cutaway side elevational views of the transmission of FIG. **1** illustrating the transmission of FIG. **1** in two different shifted positions. With reference to FIGS. **5** and **6**, a method of shifting the transmission **100** is disclosed below.

Upon an input force, the drive sleeve **104** begins to rotate in a clockwise direction. (It should be noted that the transmission **100** is also designed to be driven in a counterclockwise direction.) At the beginning of the rotation of the drive sleeve **104**, nominal axial pressure is supplied by the tension inducers **118**, **178** (FIG. **2**) to ensure that the rotatable driving member **120**, the rotatable driven member **170**, and the support member **154** are in tractive contact with the power adjusters **122**A, **122**B, **122**C.

The rotation of the drive sleeve **104** in a clockwise direction engages the first roller cage assembly **110** to rotate in a similar direction. At a low torque, the rollers **112** remain centered between the shallow grooves **108**, **109** of the rotatable driving member **120** and the drive sleeve **104**. As additional torque is applied, the rollers **112** ride up the sloping sides of the grooves **108** and force the drive sleeve **104** and the rotatable driving member **120** farther apart. The same action occurs on the opposite end of the transmission **100** wherein the rotatable driven member **170** engages the hub driver **186** though the second roller cage assembly **180**. Thus, the first roller cage assembly **110** and second roller cage assembly **180** compress the rotatable driving member **120** and the rotatable driven member **170** together against the power adjusters **122**A, **122**B, **122**C, which increases the frictional contact of the power adjusters **122**A, **122**B, **122**C against the support member **154**, the drive member **120**, and the driven member **170**.

As the first rotatable driving member **120** is rotated in a clockwise direction by the roller cage assembly **110**, the roller cage assembly **110** frictionally rotates the power adjusters **122**A, **122**B, **122**C. The clockwise rotation of the power adjusters **122**A, **122**B, **122**C causes a clockwise rotation of the rotatable driven member **170**. The clockwise rotation of the rotatable driven member **170** engages the second roller cage assembly **180** to rotate in a clockwise direction. In turn, the clockwise rotation of the second roller cage assembly **180** engages the hub driver **186** (FIG. **4**) to drive in a clockwise direction. The clockwise rotation of the hub driver **186** causes the one way rotatable driver **300** to rotate clockwise. The one way rotatable driver **300** then drives the hub shell **302** (FIGS. **3** and **4**) to rotate in a clockwise direction.

The shifting member **160** is used to modify the axis of a rotation for the power adjusters **122**A, **122**B, **122**C. To shift the transmission **100**, the shifting actuator (not shown) slides the shifting member **160** in a first direction **500** (FIG. **5**). A release in tension of the linkage **163** by the shifting actuator (not shown) causes the shifting member **160** to slide in a second and opposite direction **600** (FIG. **6**) by the tension member **202**. The particular construction of the present transmission **100** provides for much easier shifting than prior art traction roller designs.

When the shifting member **160** is moved in either direction by a user, the extensions **162**, **164** engage the ratio changer **166** to axially move across the main shaft **102**. Referring to FIG. **5**, when the shifting member **160** is moved, the ratio changer **166** pivots the supports **134**A, **134**B, **134**C. The pivoting of the supports **134**A, **134**B, **134**C tilts the ball spindles **130**A, **130**B, **130**C and changes the axis of rotation of each of the power adjusters **122**A, **122**B, and **122**C. When the shifting member **160** is moved in the direction **500**, the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C is modified such that the rotatable driving member **120** contacts a surface of power adjuster, **120**A, **120**B, **120**C closer to the axis of rotation of the power adjusters **120**A, **120**B, **120**C. Further, the rotatable driven member **170** contacts the power adjuster at a point on a surface of the each of the power adjusters **120**A, **120**B, **120**C further away from the axis of rotation of the power adjusters **120**A, **120**B, **120**C. The adjustment of the axis of rotation for the power adjusters **122**A, **122**B, **122**C increases an output angular velocity for the transmission **100** because for every revolution of the rotatable driving member **120**, the rotatable driven member **170** rotates more than once.

Referring to FIG. **6**, the transmission **100** of the invention is shown in a position which causes a decrease in the output angular velocity for the transmission **100**. As the shifting member **160** is directed in the direction **600**, opposite the first direction **500**, the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C is modified such that the rotatable driven member **170** contacts a surface of each of the power adjusters **122**A, **122**B, **122**C closer to the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. Further, the rotatable driving member **120** contacts each of the power adjusters **122**A, **122**B, **122**C at a point on a surface of each of the power adjusters **122**A, **122**B, **122**C further away from the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. The adjustment of the axis of rotation for the power adjusters **122**A, **122**B, **122**C decreases an output angular velocity for the transmission **100** because for every revolution of the rotatable driving member **120**, the rotatable driven member **170** rotates less than once.

FIGS. **7** and **8** illustrate an automatic transmission **700** of the present invention. For purposes of simplicity of description, only the differences between the transmission **100** of FIGS. **1**–**6** and the automatic transmission **700** are described. FIG. **7** is a partial end elevational view of the transmission **700**, and FIG. **8** is partial side elevational view of the transmission **700**.

A plurality of tension members **702**A, **702**B, **702**C, which may each be a spring, interconnect each of the pivot rings **136**A, **136**B, **136**C. The tension member **702**A is connected at a first end to the pivot ring **136**A and at a second end opposite the first end to the pivot ring **136**B. Further, the tension member **702**B is connected at a first end to the pivot ring **136**B proximate to the aperture **138**B and at a second end opposite the first end to the pivot ring **136**C proximate to the aperture **138**C. Further, the tension member **702**C is connected at a first end to the pivot ring **136**C proximate to the aperture **138**C and at a second end opposite the first end to the pivot ring **136**A proximate to the aperture **138**A.

The transmission **700** also includes flexible extension members **708**A, **708**B, **708**C respectively connected at a first end to the pivot rings **136**A, **136**B, **136**C. The transmission **700** also includes a first annular bearing **806** and a second annular bearing **816** to assist in the shifting of the transmission **700**. The first annular bearing **806** is slidingly attached to the hub shell **302** such that first the annular bearing **806** can further be directed toward the rotatable driving member **120** or the rotatable driven member **170**. The second annular bearing **816** also is configured to be slid toward either the rotatable driving member **120** or the rotatable driven member **170**; however, the second annular bearing **816** is not rotatable about the main shaft **102**, unlike the first annular bearing **806**. The first annular bearing **806** and the second annular bearing **816** supports multiple bearing balls **808**. A second end of each the extension members **708**A, **708**B, **708**C connects to the second annular bearing **816** (FIG. **8**).

Multiple extension members **718**A, **718**B, **718**C respectively connect the first annular bearing **806** to multiple weights **720**A, **720**B, **720**C. Optionally, a plurality of pulleys **822** may be used to route the extension members **718**A, **718**B, **718**C from the second annular bearing **816** to the weights **720**A, **720**B, **720**C, and route the extension members **708**A, **708**B, **708**C to the first annular bearing **806**.

Still referring to FIGS. **7** and **8**, a method of operation for the transmission **700** is disclosed. Similar to the embodiment of the invention disclosed in FIG. **1**, a clockwise input torque causes clockwise rotation of the drive sleeve **104**, the first roller cage assembly **110**, and the rotatable driving member **120**. The rotatable driving member **120** engages the power adjusters **122**A, **122**B, **122**C to rotate, and thereby drives the rotatable driven member **170**. The rotation of the rotatable driven member **170** drives the second roller cage assembly **180** and produces an output torque.

However, to be distinguished from the transmission **100** illustrated in FIG. **1**, the ratio of rotation between the rotatable driving member **120** and the rotatable driven member **170** is adjusted automatically by a centrifugal outward movement of the weights **720**A, **720**B, **720**C. As the weights **720**A, **720**B, **720**C extend outwardly, the extensions **718**A, **718**B, **718**C pull the first annular bearing **806** toward the rotatable driving member **120**. The movement of the first annular bearing **806** toward the rotatable driving member **120** similarly causes the movement of the bearings **808** and the second annular bearing **816** toward the rotatable driving member **120**.

The movement of the first annular bearing **806** toward the rotatable driving member **120** causes the extension members **708**A, **708**B, **708**C to respectively pivot the pivot rings **306**A, **306**B, **306**C and adjust the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. After the adjustment, the rotatable driven member **170** contacts a surface of power adjusters **120**A, **120**B, **120**C closer to the axis of rotation of each of the power adjuster **122**A, **122**B, **122**C. Conversely, the rotatable driving member **120** contacts the power adjusters **122**A, **122**B, **122**C at a point on a surface of the each of the power adjusters **122**A, **122**B, **122**C further away from the axis of rotation of the power adjusters **122**A, **122**B, **122**C. The adjustment of the axis of rotation for the power adjusters **122**A, **122**B, **122**C decreases an output angular velocity for the transmission **100** because for every revolution of the rotatable driving member **120**, the rotatable driven member **170** rotates less than once. When the hub shell **302** rotates more slowly, the compression members **702**A, **702**B, **702**C adjust the axis of rotation of the power adjusters **122**A, **122**B, **122**C to provide to a lower output angular velocity in comparison to the input angular velocity.

FIGS. **9** and **10** illustrate an alternative embodiment of the invention. For purposes of simplicity of description, only the differences between the transmission **100** of FIG. **1** and a transmission **900** of FIGS. **9** and **10** are described. FIG. **9** is a partial end elevational view of the transmission **900**, and FIG. **10** is partial side elevational view of the transmission **900**.

The transmission **900** includes flexible extension members **908**A, **908**B, **908**C respectively connected at a first end to the pivot rings **136**A, **136**B, **136**C. A second end of the extension members **908**A, **908**B, **908**C connects to a synchronization member **912**. Further each of the extension members **908**A, **908**B, **908**C are slidingly engaged to a plurality of pulleys **916** (FIG. **9**) which are affixed to the hub shell **302**. It is noted that the number and location of the each of the pulleys **916** (FIG. **9**) may be varied. For example, a different pulley configuration may be used to route the extension members **908**A, **908**B, **908**C depending on the selected frame of the machine or vehicle that employs the transmission **900**. Additionally, the pulleys **916** and extension members **908**A, **908**B, **908**C may be located inside the hub shell **302**.

The hub shell **302** of the transmission **900** is non-rotational. Further, the hub shell **302** includes a plurality of apertures (not shown) which are used to guide the extension members **908**A, **908**B, **908**C to the synchronization member **912**.

To be noted, according to the embodiment of the invention illustrated in FIGS. **9** and **10**, the shifting assembly of the transmission **100** of FIG. **2** may be eliminated, including the main shaft **102** (FIG. **2**), the tension member **202** (FIG. **2**), the extensions **162**, **164** (FIG. **2**) and the shifting actuator (not shown).

Still referring to FIGS. **9** and **10**, a method of operation for the transmission **900** is disclosed. Similar to the embodiment of the invention disclosed in FIG. **1**, an input torque causes a clockwise rotation of the drive sleeve **104**, the first roller cage assembly **110**, and the rotatable driving member **120**. The rotatable driving member **120** engages the power adjusters **122**A, **122**B, **122** to rotate, and thereby drive the rotatable driven member **170**. The rotation of the rotatable driven member **170** drives the second roller cage assembly **180** and produces an output torque.

In the transmission **900**, the ratio of rotation between the rotatable driving member **120** and the rotatable driven member **170** is adjusted by the manipulation of the synchronization member **912**. As the synchronization member **912** is outwardly directed from the hub shell **302**, the extension members **908**A, **908**B, **908**C respectively pivot the pivot rings **136**A, **136**B, **136**C such that the axis of rotation of each of the power adjusters **122**A, **122**B, and **122**C is similarly pivoted. The axis of rotation of each of the power adjusters **122**A, **122**B, **122**C is modified such that the rotatable driving member **120** contacts a surface of power adjusters **122**A, **122**B, **122**C further away from the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. Conversely, the rotatable driven member **170** contacts the power adjusters **122**A, **122**B, **122**C at a point on a surface of the each of the power adjusters **122**A, **122**B, **122**C closer to the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. The adjustment of the axis of rotation for the power adjusters **122**A, **122**B, **122**C decreases an output angular velocity for the transmission **100** because for every revolution of the rotatable driving member **120**, the rotatable driven member **170** rotates less than once.

When the synchronization member **912** is directed toward the hub shell **302**, the tension members **702**A, **702**B, **702**C compress. This compression causes an end of the pivot rings **136**A, **136**B, **136**C proximate to the rotatable driven member **170** to pivot toward the main shaft **102**. The pivoting of the pivot rings **136**A, **136**B, **136**C causes the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C to be modified such that the rotatable driven member **170** rotates slower than the rotatable driving member **120**.

FIG. **11** illustrates another alternative embodiment of the invention including a transmission **1100** having a first thrust bearing **1106** and a second thrust bearing **1108**. The first thrust bearing **1106** is rotatably disposed over the main shaft **102** and is positioned between the support member **154** and the extensions **162**, **164**. The second thrust bearing **1108** is disposed over the main shaft **102** on a side of the support member **154** opposite the first thrust bearing **1106**. The transmission **1100** may optionally also include a second ratio changer, such as ratio changer **1110**, which is disposed over the main shaft **102** and is axially slidable.

When the ratio changers **166**, **1110** slide axially to cause a shift in the transmission **1100**, the ratio changers **166**, **1110** also slide the thrust bearings **1106**, **1108**. The sliding of the thrust bearings **1106**, **1108** forces the support member **154** to slide in unison with the ratio changers **166**, **1110**. A small amount of play is provided between the support member **154** and the thrust bearings **1106**, **1008** so that the thrust bearings **1106**, **1108** do not contact the support member **154** except when the transmission **1100** is in the process of shifting.

FIG. **12** illustrates an alternative embodiment of the invention. FIG. **12** illustrates a transmission **1200** that operates similarly to the embodiment of the invention disclosed in FIG. **10**; however, the transmission **1200** of FIG. **12** includes two rotatable drivers **1204**, **1206** and a rotatable driving shaft **1212**. The rotatable driving shaft **1212** is fixedly attached to the drive sleeve **104**.

Still referring to FIG. **12**, the first rotatable driver **1204** includes a one way clutch **1208** that is configured to rotate the rotatable driving shaft **1212** upon the rotation of the rotatable driver in a first direction. The second rotatable driver **1206** includes a one way clutch **1210**. The second rotatable driver **1206** is configured to engage the drive sleeve **104** upon the rotation of the second rotatable driver **1206** in a second direction, which is opposite to the activation direction of the first rotatable driver **1204**. The second rotatable driver **1206** is fixedly attached to the drive sleeve **104**.

FIG. **13** schematically illustrates another alternative embodiment of the invention having a transmission **1300** that is configured to shift automatically. Three pulleys **1306**, **1308**, **1310** are respectively connected to the pivot rings **136**A, **136**B, and **136**C. A cable **1312** is guided around the pulley **1306** and connects at a first end to the main shaft **102** and connects at a second end to an annular ring (not shown), similar to the annular ring **816** of FIG. **8**. Similarly, a cable **1314** is guided around the pulley **1308** and connects to the main shaft **102** at a first end and connects at a second end to the annular ring (not shown) Lastly, a cable **1316** is guided around the pulley **1310** and connects at a first end to the main shaft **102** and connects at a second end to the annular ring (not shown).

FIG. **14** schematically illustrates the transmission **1300** of FIG. **13** from a front end. A plurality of tension members **1404**, **1406**, **1408** interconnect each of the pivot rings **136**A, **136**B, and **136**C. The tension member **1404** connects at a first end to the pivot ring **136**A and connects at a second end opposite the first end to the pivot ring **136**B. The tension member **1406** connects at a first end to the pivot ring **136**B and connects at a second end opposite the first end at the pivot ring **136**C. The tension member **1408** connects at a first end to the pivot ring **136**A and connects at a second end opposite the first end at the pivot ring **136**C.

FIG. **15** schematically illustrates a housing **1500** for the transmission **1300** of FIGS. **13** and **14**. The housing **1500** includes three hollow guide tubes **1504**, **1506**, and **1508**. Each of the hollow guide tubes **1504**, **1506**, **1508** connect at a first end to a hub shell **1512** that holds the transmission **1300** and at a second end opposite the first end to a transmission wheel **1514**. Three tension members **1516**, **1518**, **1520** are respectively disposed within the guide tubes **1504**, **1506**, **1508** and are connected at a first end to the transmission wheel **1514**. A second end of the tension members **1516**, **1518**, **1520** opposite the transmission wheel **1514** are respectively connected with spherical weights **1526**, **1528**, **1530**. In alternative embodiments of the invention, the weights **1526**, **1528**, **1530** may be adapted to other geometric shapes.

Multiple linkage members **1532**, **1534**, **1536**, respectively extend from the weights **1526**, **1528**, **1530** to an annular member (not shown), such as the annular member **806** of FIG. **8**.

Turning to the method of operation of the housing **1500** of FIG. **15**, the rotation of the hub shell **1512** causes the rotation of the hollow guide tubes **1504**, **1506**, **1508**. As the guide tubes **1504**, **1506**, **1058** rotate, the weights **1526**, **1528**, **1530** extend outwardly toward the transmission wheel **1514**. The outward movement of the weights **1526**, **1528**, **1530** causes a shifting of the axis of rotation of the power adjusters **122**A, **122**B, **122**C of FIGS. **13** and **14**.

FIG. **16** is another alternative embodiment of the invention. FIG. **16** is a schematic illustration of a manual version of the transmission **1300** shown in FIGS. **13** and **14**. For purposes of simplicity of description, only the differences between the transmission **1600** of FIG. **16** and the transmission **1300** of FIGS. **13** and **14** are described. The transmission **1600** includes a flexible cable **1602** that connects at a first end to a shifting actuator (not shown). The cable **1602** extends from the shifting actuator (not shown), through the central passageway of the main shaft **102** and then extends through an aperture (not shown) on the main shaft **102**. From the aperture (not shown) the cable **1602** extends around the pulley **1308**. From the pulley **1308**, the cable is guided around the pulley **1306**. From the pulley **1306**, the cable extends to the pulley **1308**. Finally, from the pulley **1308**, the cable **1602** connects to the main shaft **102**.

Still referring to FIG. **16**, as the cable **1602** is directed toward the shifting actuator (not shown), the cable **1602** pulls on the pulleys **1304**, **1306**, **1308** thereby causing a shift in the axis of rotation of each of the power adjusters **122**A, **122**B, **122**C. Conversely, when the shifting actuator (not shown) releases the cable **1602**, the tension members **1404**, **1406**, **1408** cause each of the axis of rotation of the power adjusters **122**A, **122**B, **122**C to shift in a second and opposite direction.

The present invention provides a novel transmission which provides a continuously variable input/output angular velocity ratio offering up to a 900% range of input/output angular velocity. Further, the transmission can be actuated either manually or automatically.

Further, the transmission of the invention provides a simple design which requires a minimal number of parts to implement, and is therefore simple to manufacture, compact, light and produces very little friction. The transmission eliminates duplicate, overlapping, or unusable gears which are found in geared transmissions. The transmission eliminates the need for clutches which are traditionally used for changing gears. Lastly, the transmission can save energy or gasoline by providing an ideal input to output angular speed ratio.

While the above detailed description has shown, described, and pointed out novel features of the invention as applied to various embodiments, it will be understood that various omissions, substitutions, and changes in the form and details of the device or process illustrated may be made by those skilled in the art without departing from the spirit of the invention. The scope of the invention is indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A continuously variable transmission, comprising:

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

at least one stationary support with an aperture at its center;

a rotatable support member having first and second sides, the rotatable support member located between the power adjusters and frictionally engaged with the plurality of power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the support member;

a second annular bearing capable of axial movement, positioned on the second side of the support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearing is between the rotatable support and the second planar platform; and

a ratio changer operably connected to the cylindrical spindles, wherein an adjustment in the ratio changer causes the cylindrical spindles to change their axes of rotation.

2. A continuously variable transmission, comprising:

a rotatable driving member;

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

a drive sleeve;

three or more ramped surfaces on the drive sleeve that face the rotatable driving member;

three or more rollers positioned to roll on the three or more ramped surfaces of the drive sleeve and also roll on the rotatable driving member;

a roller cage positioning the three or more rollers;

the three or more ramped surfaces of the drive sleeve configured so that when the three or more rollers rotate they compress the rotatable driving member against the three or more spherical power adjusters upon an increase in torque and decompress the rotatable driving member upon a decrease in torque;

a rotatable support member located between the power adjusters that has first and second sides, and is frictionally engaged with the three or more power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the support member;

a second annular bearing capable of axial movement, positioned on the second side of the support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearings is between the rotatable support and the second planar platform;

at least one stationary support with an aperture at its center; and

wherein the rotatable support member, the first annular bearing, the second annular bearing, the first planar platform, and the second planar platform are all capable of simultaneous axial movement.

3. The transmission of claim **2** wherein the ramped surfaces of the drive sleeve are linear.

4. The transmission of claim **2** wherein the rollers are cylindrical.

5. The transmission of claim **2**, further comprising a hollow shaft and a shifting member positioned in the shaft, wherein the shifting member is configured to actuate an adjustment in an axis of rotation of each of the power adjusters.

6. A continuously variable transmission, comprising:

a shaft;

a rotatable driving member rotatably mounted over the shaft;

a rotatable driven member rotatably mounted over the shaft;

a plurality of spherical power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member and adapted to transmit power from the rotatable driving member to the rotatable driven member, each power adjuster having a cylindrical hole extending through its center;

a plurality of cylindrical spindles, each spindle positioned in the hole of one power adjuster;

a rotatable support member located between the power adjusters and frictionally engaged with the plurality of power adjusters so that the power adjusters each are in frictional contact with each of the driving member, the driven member, and the rotatable support member;

a first annular bearing positioned on a first side of the support member;

a second annular bearing positioned on a second side of the support member;

at least one stationary support with an aperture at its center; and

a plurality of legs attached to the at least one stationary support.

7. The transmission of claim **6**, wherein the legs are rigidly attached to the at least one stationary support and assist holding the power adjusters in a stationary position to prevent them from orbiting around the axis of the rotatable support member.

8. The transmission of claim **7**, wherein the plurality of legs extend substantially perpendicular from the at least one stationary support.

9. The transmission of claim **6**, wherein the shaft is hollow, and the transmission further includes a shifting member in the shaft, the shifting member configured to actuate an adjustment in an axis of rotation in each of the plurality of power adjusters.

10. A continuously variable transmission, comprising:

a rotatable driving member;

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

at least one stationary support with an aperture at its center;

a rotatable support member located between the power adjusters having first and second sides, and frictionally engaged with the plurality of power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the support member;

a second annular bearing capable of axial movement, positioned on the second side of the support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearing is between the rotatable support and the second planar platform;

a shifting member, having an end that extends outside of the transmission, that is positioned along the axis of the rotatable support member and is operably engaged with the rotatable support member; and

wherein an adjustment in the position of the shifting member causes the rotatable support member, the first annular bearing, the second annular bearing, the first planar platform, and the second planar platform to all move simultaneously and a substantially equal distance.

11. The transmission of claim **10**, further comprising a linkage having first and second ends attached at the first end to the shifting member and at the second end to a shifting actuator.

12. The transmission of claim **10**, further comprising a tension member biasing the shifting member towards a first position.

13. The transmission of claim **10**, further comprising a ratio changer, the ratio changer operably engaged with the cylindrical spindles.

14. The transmission of claim **10**, wherein at least one point on the surface of each of the power adjusters undergoes an arcuate travel in the axis of rotation of the spindle that is longer than the axial movement of the rotatable support member when the transmission is shifted.

15. A continuously variable transmission, comprising:

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

at least one stationary support;

a rotatable support member having first and second sides, the rotatable support member located between the power adjusters and frictionally engaged with the plurality of power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the rotatable support member;

a second annular bearing capable of axial movement, positioned on the second side of the rotatable support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearing is between the rotatable support and the second planar platform; and

a ratio changer operably connected to the cylindrical spindles, wherein an adjustment in the ratio changer causes the cylindrical spindles to change their axes of rotation.

16. A continuously variable transmission, comprising:

a rotatable driving member;

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

a drive sleeve;

three or more ramped surfaces on the drive sleeve that face the rotatable driving member;

three or more rollers positioned to roll on the three or more ramped surfaces of the drive sleeve and also roll on the rotatable driving member;

a roller cage positioning the three or more rollers;

the three or more ramped surfaces of the drive sleeve configured so that when the three or more rollers rotate they compress the rotatable driving member against the three or more spherical power adjusters upon an increase in torque and decompress the rotatable driving member upon a decrease in torque;

a rotatable support member located between the power adjusters that has first and second sides, and is frictionally engaged with the three or more power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the rotatable support member;

a second annular bearing capable of axial movement, positioned on the second side of the rotatable support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearings is between the rotatable support and the second planar platform;

at least one stationary support; and

wherein the rotatable support member, the first annular bearing, the second annular bearing, the first planar platform, and the second planar platform are all capable of simultaneous axial movement.

17. The transmission of claim 16 wherein the ramped surfaces of the drive sleeve are linear.

18. The transmission of claim 16, wherein the rollers are cylindrical.

19. The transmission of claim 16, further comprising a hollow shaft and a shifting member positioned in the shaft, wherein the shifting member is configured to actuate an adjustment in an axis of rotation of each of the power adjusters.

20. A continuously variable transmission, comprising:

a shaft;

a rotatable driving member rotatably mounted over the shaft;

a rotatable driven member rotatably mounted over the shaft;

a plurality of spherical power adjusters frictionally interposed between the rotatable driving member and the rotatable driven member and adapted to transmit power from the rotatable driving member to the rotatable driven member, each power adjuster having a cylindrical hole extending through its center;

a plurality of cylindrical spindles, each spindle positioned in the hole of one power adjuster;

a rotatable support member located between the power adjusters and frictionally engaged with the plurality of power adjusters so that the power adjusters each are in frictional contact with each of the driving member, the driven member, and the rotatable support member;

a first annular bearing positioned on a first side of the rotatable support member;

a second annular bearing positioned on a second side of the rotatable support member;

at least one stationary support; and

a plurality of legs attached to the at least one stationary support.

21. The transmission of claim 20, wherein the legs are rigidly attached to the at least one stationary support and assist holding the power adjusters in a stationary position to prevent them from orbiting around the axis of the rotatable support member.

22. The transmission of claim 21, wherein the plurality of legs extend substantially perpendicular from the at least one stationary support.

23. The transmission of claim 20, wherein the shaft is hollow, and the transmission further includes a shifting member in the shaft, the shifting member configured to actuate an adjustment in an axis of rotation in each of the plurality of power adjusters.

24. A continuously variable transmission, comprising:

a rotatable driving member;

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

at least one stationary support;

a rotatable support member located between the power adjusters having first and second sides, and frictionally engaged with the plurality of power adjusters, wherein the rotatable support member has a substantially uniform outer diameter, wherein the rotatable support member is capable of axial movement, and wherein the rotatable support member has at least two areas that are bearing surfaces to control axial movement of the rotatable support member;

a first annular bearing capable of axial movement, positioned on the first side of the rotatable support member;

a second annular bearing capable of axial movement, positioned on the second side of the rotatable support member;

a first planar platform capable of axial movement, positioned so that the first annular bearing is between the rotatable support member and the first planar platform;

a second planar platform capable of axial movement, positioned so that the second annular bearing is between the rotatable support and the second planar platform;

a shifting member, having an end that extends outside of the transmission, that is positioned along the axis of the rotatable support member and is operably engaged with the rotatable support member; and

wherein an adjustment in the position of the shifting member causes the rotatable support member, the first annular bearing, the second annular bearing, the first planar platform, and the second planar platform to all move simultaneously and a substantially equal distance.

25. The transmission of claim 24, further comprising a linkage having first and second ends attached at the first end to the shifting member and at the second end to a shifting actuator.

26. The transmission of claim 24, further comprising a tension member biasing the shifting member towards a first position.

27. The transmission of claim 24, further comprising a ratio changer, the ratio changer operably engaged with the cylindrical spindles.

28. The transmission of claim 24, wherein at least one point on the surface of each of the power adjusters undergoes an arcuate travel in the axis of rotation of the spindle that is longer than the axial movement of the rotatable support member when the transmission is shifted.

29. A continuously variable transmission, comprising:

three or more spherical power adjusters, each power adjuster having a cylindrical hole extending through its center;

three or more cylindrical spindles, each spindle positioned in the hole of one power adjuster;

a rotatable driving member adjacent to and in contact with each of the power adjusters;

a rotatable driven member adjacent to and in contact with each of the power adjusters;

a cylindrical rotatable support member having first and second sides and a substantially uniform outer diameter, the rotatable support member located radially between and in contact with the plurality of power adjusters, wherein the rotatable support member is capable of axial movement; and

a shift rod operably connected to the support member and adapted move axially and control axial movement of the support member in order to control the ratio of the transmission.

30. A continuously variable transmission comprising:

a drive sleeve;

a driving member;

a first roller cage, the first roller cage assembly interposed between the drive sleeve and the driving member, whereby a torque applied to the drive sleeve is transferred via the roller cage assembly to the driving member;

a driven member;

a plurality of power adjusters in contact with each of the driving member and the driven member, whereby torque is transferred from the driving member to the driven member via, at least in part, the power adjusters;

a hub driver;

a second roller cage assembly, the second roller cage assembly interposed between the driven member and the hub driver, whereby torque is transferred from the driven member to the hub driver through the second roller cage assembly;

a hub shell coupled to the hub driver;

a support member interposed between the driving member and the driven member, wherein each power *adjuster contacts the support member at a point that is radially inward relative to the points where the power adjusters contact the driving member and the driven member; and*

a hollow shaft adapted to support the driving member, the driven member, and the support member.

31. The transmission of claim 30, further comprising a shifting member positioned in the hollow shaft, wherein the shifting member and the support member are operationally coupled so that an axial movement of the shifting member results in an axial movement of the support member.

32. The transmission of claim 31, wherein the driving member and the driven member each comprises grooves.

33. The transmission of claim 32, wherein the drive sleeve and the hub driver each comprises grooves.

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