(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 312 460 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Description Paragraph(s) 3

(48) Corrigendum issued on:
17.11.2021 Bulletin 2021/46

(45) Date of publication and mention of the grant of the patent:
15.09.2021 Bulletin 2021/37

(21) Application number: **17191904.6**

(22) Date of filing: **19.09.2017**

(51) Int Cl.:
F16H 3/66 *(2006.01)*

(54) MULTI-SPEED PLANETARY TRANSMISSION

PLANETENGETRIEBE MIT MEHREREN DREHZAHLEN

TRANSMISSION PLANÉTAIRE À PLUSIEURS VITESSES

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **28.09.2016 US 201615278694**

(43) Date of publication of application:
25.04.2018 Bulletin 2018/17

(60) Divisional application:
21192972.4

(73) Proprietor: **Allison Transmission, Inc.**
Indianapolis, IN 46222-3271 (US)

(72) Inventors:
- **SCHOOLCRAFT, Brian**
Cedar Park, TX 78613-6721 (US)
- **RASZKOWSKI, James**
Indianapolis, Indiana 46234 (US)

(74) Representative: **Banzer, Hans-Jörg**
Kraus & Weisert
Patentanwälte PartGmbB
Thomas-Wimmer-Ring 15
80539 München (DE)

(56) References cited:
EP-A1- 2 817 536 US-A1- 2015 080 168

- **Thomas Belz: "Varianten von Mehrgang-Planetengetrieben", , 8 March 2016 (2016-03-08), XP055257458, Retrieved from the Internet: URL:https://register.epo.org/application?documentId=EYPWMGE67270DSU&appnumber=EP1375 6488&showPdfPage=all [retrieved on 2016-03-11]**

EP 3 312 460 B9

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a multi-speed transmission and in particular to a multi-speed transmission including a plurality of planetary gearsets and a plurality of selective couplers to achieve at least nine forward speed ratios and at least one reverse speed ratio.

BACKGROUND OF THE INVENTION

[0002] Multi-speed transmissions use a plurality of planetary gearsets, selective couplers, interconnectors, and additional elements to achieve a plurality of forward and reverse speed ratios. Exemplary multi-speed transmissions are disclosed in US Published Patent Application No. 2016/0047440, serial no. 14/457,592, titled MULTI-SPEED TRANSMISSION, filed August 12, 2014. EP 2 817 536 A1 discloses, in the opinion of the examining division of the European Patent Office, a transmission falling within the wording of the precharacterizing portion of claim 1.

SUMMARY

[0003] According to the present invention, a transmission as defined in claim 1 is provided. The dependent claims define preferred and/or advantageous embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and will be better understood by reference to the following description of exemplary embodiments taken in conjunction with the accompanying drawings, wherein Fig.3 does not show a transmission falling within the wording of claim 1 and wherein:

FIG. 1 is a diagrammatic view of a first exemplary multi-speed transmission including four planetary gearsets and six selective couplers;
FIG. 2 is a truth table illustrating the selective engagement of the six selective couplers of FIG. 1 to provide ten forward gear or speed ratios and a reverse gear or speed ratio of the multi-speed transmission of FIG. 1;
FIG. 3 is a diagrammatic view of a second exemplary multi-speed transmission including four planetary gearsets and six selective couplers; and
FIG. 4 is a truth table illustrating the selective engagement of the six selective couplers of FIG. 3 to provide ten forward gear or speed ratios and a reverse gear or speed ratio of the multi-speed transmission of FIG. 3;
FIG. 5 is a diagrammatic view of a third exemplary multi-speed transmission including four planetary gearsets and six selective couplers; and
FIG. 6 is a truth table illustrating the selective engagement of the six selective couplers of FIG. 5 to provide ten forward gear or speed ratios and a reverse gear or speed ratio of the multi-speed transmission of FIG. 5.

[0005] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate exemplary embodiments of the invention and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0006] For the purposes of promoting an understanding of the principles of the present invention, reference is now made to the embodiments illustrated in the drawings, which are described below. The embodiments disclosed below are not intended to be exhaustive or limit the present invention to the precise form disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. Therefore, no limitation of the scope of the present invention is thereby intended. Corresponding reference characters indicate corresponding parts throughout the several views.

[0007] In the illustrated transmission embodiments, selective couplers are disclosed. A selective coupler is a device which may be actuated to fixedly couple two or more components together. A selective coupler fixedly couples two or more components to rotate together as a unit when the selective coupler is in an engaged configuration. Further, the two or more components may be rotatable relative to each other when the selective coupler is in a disengaged configuration. The terms "couples", "coupled", "coupler" and variations thereof are used to include both arrangements wherein the two or more components are in direct physical contact and arrangements wherein the two or more components are not in direct contact with each other (e.g., the components are "coupled" via at least a third component), but yet still cooperate or interact with each other.

[0008] A first exemplary selective coupler is a clutch. A clutch couples two or more rotating components to one another so that the two or more rotating components rotate together as a unit in an engaged configuration and permits relative rotation between the two or more rotating components in the disengaged position. Exemplary clutches may be shiftable friction-locked multi-disk clutches, shiftable form-locking claw or conical clutches, wet clutches, or any other known form of a clutch.

[0009] A second exemplary selective coupler is a brake. A brake couples one or more rotatable components to a stationary component to hold the one or more

rotatable components stationary relative to the stationary component in the engaged configuration and permits rotation of the one or more components relative to the stationary component in the disengaged configuration. Exemplary brakes may be configured as shiftable-friction-locked disk brakes, shiftable friction-locked band brakes, shiftable form-locking claw or conical brakes, or any other known form of a brake.

[0010] Selective couplers may be actively controlled devices or passive devices. Exemplary actively controlled devices include hydraulically actuated clutch or brake elements and electrically actuated clutch or brake elements. Additional details regarding systems and methods for controlling selective couplers are disclosed in US Published Patent Application No. 2016/0047440.

[0011] In addition to coupling through selective couplers, various components of the disclosed transmission embodiments may be fixedly coupled together continuously throughout the operation of the disclosed transmissions. Components may be fixedly coupled together either permanently or removably. Components may be fixedly coupled together through spline connections, press fitting, fasteners, welding, machined or formed functional portions of a unitary piece, or other suitable methods of connecting components.

[0012] The disclosed transmission embodiments include a plurality of planetary gearsets. Each planetary gearset includes at least four components: a sun gear; a ring gear; a plurality of planet gears; and a carrier that is rotatably coupled to and carries the planet gears. In the case of a simple planetary gearset, the teeth of the sun gear are intermeshed with the teeth of the planet gears which are in turn engaged with the teeth of the ring gear. Each of these components may also be referred to as a gearset component. It will be apparent to one of skill in the art that some planetary gearsets may include further components than those explicitly identified. For example, one or more of the planetary gearsets may include two sets of planet gears. A first set of planet gears may intermesh with the sun gear while the second set of planet gears intermesh with the first set of planet gears and the ring gear. Both sets of planet gears are carried by the planet carrier.

[0013] One or more rotating components, such as shafts, drums, and other components, may be collectively referred to as an interconnector when the one or more components are fixedly coupled together. Interconnectors may further be fixedly coupled to one or more gearset components and/or one or more selective couplers.

[0014] An input member of the disclosed transmission embodiments is rotated by a prime mover. Exemplary prime movers include internal combustion engines, electric motors, hybrid power systems, and other suitable power systems. In one embodiment, the prime mover indirectly rotates the input member through a clutch and/or a torque converter. An output member of the disclosed transmission embodiments provides rotational power to one or more working components. Exemplary working components include one or more drive wheels of a motor vehicle, a power take-off shaft, and other suitable devices. The output member is rotated based on the interconnections of the gearset components and the selective couplers of the transmission. By changing the interconnections of the gearset components and the selective couplers, a rotation speed of the output member may be varied from a rotation speed of the input member.

[0015] The disclosed transmission embodiments are capable of transferring torque from the input member to the output member and rotating the output member in at least nine forward gear or speed ratios relative to the input member, illustratively ten forward gear or speed ratios for some embodiments, and one reverse gear or speed ratio wherein the rotation direction of the output member is reversed relative to its rotation direction for the at least nine forward ratios. Exemplary gear ratios that may be obtained using the embodiments of the present invention are disclosed herein. Of course, other gear ratios are achievable depending on the characteristics of the gearsets utilized. Exemplary characteristics include respective gear diameters, the number of gear teeth, and the configurations of the various gears.

[0016] FIG. 1 is a diagrammatic representation of a multi-speed transmission 100. Multi-speed transmission 100 includes an input member 102 and an output member 104. Each of input member 102 and output member 104 is rotatable relative to at least one stationary member 106. An exemplary input member 102 is an input shaft or other suitable rotatable component. An exemplary output member 104 is an output shaft or other suitable rotatable component. An exemplary stationary member 106 is a housing of multi-speed transmission 100. The housing may include several components coupled together.

[0017] Multi-speed transmission 100 includes a plurality of planetary gearsets, illustratively a first planetary gearset 108, a second planetary gearset 110, a third planetary gearset 112, and a fourth planetary gearset 114. In one embodiment, additional planetary gearsets may be included. Further, although first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 are illustrated as simple planetary gearsets, it is contemplated that compound planetary gearsets may be included in some embodiments.

[0018] In one embodiment, multi-speed transmission 100 is arranged as illustrated in FIG. 1, with first planetary gearset 108 positioned between a first location or end 116 at which input member 102 enters stationary member 106 and second planetary gearset 110, second planetary gearset 110 is positioned between first planetary gearset 108 and third planetary gearset 112, third planetary gearset 112 is positioned between second planetary gearset 110 and fourth planetary gearset 114, and fourth planetary gearset 114 is positioned between third planetary gearset 112 and a second location or end 118 at which output member 104 exits stationary member

106. In alternative embodiments, first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 are arranged in any order relative to location 116 and location 118. In the illustrated embodiment of FIG. 1, each of first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 are axially aligned. In one example, input member 102 and output member 104 are also axially aligned with first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114. In alternative embodiments, one or more of input member 102, output member 104, first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 are offset and not axially aligned with the remainder.

[0019] First planetary gearset 108 includes a sun gear 120, a planet carrier 122 supporting a plurality of planet gears 124, and a ring gear 126. Second planetary gearset 110 includes a sun gear 130, a planet carrier 132 supporting a plurality of planet gears 134, and a ring gear 136. Third planetary gearset 112 includes a sun gear 140, a planet carrier 142 supporting a plurality of planet gears 144, and a ring gear 146. Fourth planetary gearset 114 includes a sun gear 150, a planet carrier 152 supporting a plurality of planet gears 154, and a ring gear 156.

[0020] Multi-speed transmission 100 further includes a plurality of selective couplers, illustratively a first selective coupler 162, a second selective coupler 164, a third selective coupler 166, a fourth selective coupler 168, a fifth selective coupler 170, and a sixth selective coupler 172. In the illustrated embodiment, first selective coupler 162 and second selective coupler 164 are brakes and third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172 are clutches. The axial locations of the clutches and brakes relative to the plurality of planetary gearsets may be altered from the illustrated axial locations. In alternative embodiments, any number of clutches and brakes may be used.

[0021] Multi-speed transmission 100 includes several components that are illustratively shown as being fixedly coupled together. Input member 102 is fixedly coupled to third selective coupler 166, fourth selective coupler 168, and fifth selective coupler 170. Output member 104 is fixedly coupled to planet carrier 152 of fourth planetary gearset 114. Sun gear 130 of second planetary gearset 110, sun gear 140 of third planetary gearset 112, sun gear 150 of fourth planetary gearset 114, and first selective coupler 162 are fixedly coupled together. Planet carrier 132 of second planetary gearset 110, ring gear 156 of fourth planetary gearset 114, and third selective coupler 166 are fixedly coupled together. Ring gear 126 of first planetary gearset 108 and ring gear 136 of second planetary gearset 110 are fixedly coupled together. Planet carrier 122 of first planetary gearset 108, planet carrier 142 of third planetary gearset 112, and fourth selective coupler 168 are fixedly coupled together. Ring gear 146 of third planetary gearset 112, second selective coupler 164, and sixth selective coupler 172 are fixedly coupled together. Sun gear 120 of first planetary gearset 108, fifth selective coupler 170, and sixth selective coupler 172 are fixedly coupled together. In alternative embodiments, one or more of the components fixedly coupled together are selectively coupled together through one or more selective couplers.

[0022] Multi-speed transmission 100 may be described as having eight interconnectors. Input member 102 is a first interconnector that both provides input torque to multi-speed transmission 100 and fixedly couples third selective coupler 166, fourth selective coupler 168, and fifth selective coupler 170 together. Output member 104 is a second interconnector that both provides output torque from multi-speed transmission 100 and is fixedly coupled to planet carrier 152 of fourth planetary gearset 114. A third interconnector 180 fixedly couples sun gear 130 of second planetary gearset 110, sun gear 140 of third planetary gearset 112, sun gear 150 of fourth planetary gearset 114, and first selective coupler 162 together. A fourth interconnector 182 fixedly couples ring gear 156 of fourth planetary gearset 114, planet carrier 132 of second planetary gearset 110, and third selective coupler 166 together. A fifth interconnector 184 fixedly couples ring gear 126 of first planetary gearset 108 to ring gear 136 of second planetary gearset 110. A sixth interconnector 186 fixedly couples planet carrier 122 of first planetary gearset 108, planet carrier 142 of third planetary gearset 112, and fourth selective coupler 168 together. A seventh interconnector 188 fixedly couples ring gear 146 of third planetary gearset 112 to second selective coupler 164 and to sixth selective coupler 172. An eighth interconnector 190 fixedly couples sun gear 120 of first planetary gearset 108, fifth selective coupler 170, and sixth selective coupler 172 together.

[0023] Multi-speed transmission 100 further includes several components that are illustratively shown as being selectively coupled together through selective couplers. First selective coupler 162, when engaged, fixedly couples sun gear 130 of second planetary gearset 110, sun gear 140 of third planetary gearset 112, and sun gear 150 of fourth planetary gearset 114 to stationary member 106. When first selective coupler 162 is disengaged, sun gear 130 of second planetary gearset 110, sun gear 140 of third planetary gearset 112, and sun gear 150 of fourth planetary gearset 114 may rotate relative to stationary member 106.

[0024] Second selective coupler 164, when engaged, fixedly couples ring gear 146 of third planetary gearset 112 to stationary member 106. When second selective coupler 164 is disengaged, ring gear 146 of third planetary gearset 112 may rotate relative to stationary member 106.

[0025] Third selective coupler 166, when engaged, fixedly couples input member 102 to planet carrier 132 of second planetary gearset 110 and ring gear 156 of fourth planetary gearset 114. When third selective coupler 166

is disengaged, input member 102 may rotate relative to planet carrier 132 of second planetary gearset 110 and ring gear 156 of fourth planetary gearset 114.

[0026] Fourth selective coupler 168, when engaged, fixedly couples input member 102 to planet carrier 122 of first planetary gearset 108 and planet carrier 142 of third planetary gearset 112. When fourth selective coupler 168 is disengaged, input member 102 may rotate relative to planet carrier 122 of first planetary gearset 108 and planet carrier 142 of third planetary gearset 112.

[0027] Fifth selective coupler 170, when engaged, fixedly couples input member 102 to sun gear 120 of first planetary gearset 108. When fifth selective coupler 170 is disengaged, input member 102 may rotate relative to sun gear 120 of first planetary gearset 108.

[0028] Sixth selective coupler 172, when engaged, fixedly couples sun gear 120 of first planetary gearset 108 to ring gear 146 of third planetary gearset 112. When sixth selective coupler 172 is disengaged, sun gear 120 of first planetary gearset 108 may rotate relative to ring gear 146 of third planetary gearset 112.

[0029] By engaging various combinations of first selective coupler 162, second selective coupler 164, third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172, additional components of multi-speed transmission 100 may be fixedly coupled together.

[0030] In the illustrated embodiment of transmission 100, input member 102 is coupled to first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 only through third selective coupler 166, fourth selective coupler 168, and fifth selective coupler 170. Third selective coupler 166, when engaged, fixedly couples input member 102 to a first group of the plurality of planetary gearsets, illustratively second planetary gearset 110 and fourth planetary gearset 114. Fourth selective coupler 168, when engaged, fixedly couples input member 102 to a second group of the plurality of planetary gearsets, illustratively first planetary gearset 108 and third planetary gearset 112. Fifth selective coupler 170, when engaged, fixedly couples input member 102 to a third group of the plurality of planetary gearsets, illustratively first planetary gearset 108. Each of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets, may include a single planetary gearset or a plurality of planetary gearsets. Further, each of first planetary gearset 108, second planetary gearset 110, third planetary gearset 112, and fourth planetary gearset 114 may be included in more than one of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets.

[0031] The plurality of planetary gearsets and the plurality of selective couplers of multi-speed transmission 100 may be interconnected in various arrangements to provide torque from input member 102 to output member 104 in at least nine forward gear or speed ratios and one reverse gear or speed ratio. Referring to FIG. 2, an exemplary truth table 200 is shown that provides the state of each of first selective coupler 162, second selective coupler 164, third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172 for ten different forward gear or speed ratios and one reverse gear or speed ratio. Each row corresponds to a given interconnection arrangement for transmission 100. The first column provides the gear range (reverse and 1^{st}-10^{th} forward gears). The second column provides the gear ratio between the input member 102 and the output member 104. The third column provides the gear step. The six rightmost columns illustrate which ones of the selective couplers 162-172 are engaged ("1" indicates engaged) and which ones of selective couplers 162-172 are disengaged ("(blank)" indicates disengaged). FIG. 2 is only one example of any number of truth tables possible for achieving at least nine forward ratios and one reverse ratio.

[0032] In the example of FIG. 2, the illustrated reverse ratio (Rev) is achieved by having first selective coupler 162, second selective coupler 164, and fifth selective coupler 170 in an engaged configuration and third selective coupler 166, fourth selective coupler 168, and sixth selective coupler 172 in a disengaged configuration.

[0033] In one embodiment, to place multi-speed transmission 100 in neutral (Neu), all of first selective coupler 162, second selective coupler 164, third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172 are in the disengaged configuration. One or more of first selective coupler 162, second selective coupler 164, third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172 may remain engaged in neutral (Neu) as long as the combination of first selective coupler 162, second selective coupler 164, third selective coupler 166, fourth selective coupler 168, fifth selective coupler 170, and sixth selective coupler 172 does not transmit torque from input member 102 to output member 104.

[0034] A first forward ratio (shown as 1st) in truth table 200 of FIG. 2 is achieved by having first selective coupler 162, fifth selective coupler 170, and sixth selective coupler 172 in an engaged configuration and second selective coupler 164, third selective coupler 166, and fourth selective coupler 168 in a disengaged configuration.

[0035] A second or subsequent forward ratio (shown as 2nd) in truth table 200 of FIG. 2 is achieved by having first selective coupler 162, fourth selective coupler 168, and sixth selective coupler 172 in an engaged configuration and second selective coupler 164, third selective coupler 166, and fifth selective coupler 170 in a disengaged configuration. Therefore, when transitioning between the first forward ratio and the second forward ratio, fifth selective coupler 170 is placed in the disengaged configuration and fourth selective coupler 168 is placed in the engaged configuration.

[0036] A third or subsequent forward ratio (shown as 3rd) in truth table 200 of FIG. 2 is achieved by having first selective coupler 162, fourth selective coupler 168, and fifth selective coupler 170 in an engaged configuration and second selective coupler 164, third selective coupler 166, and sixth selective coupler 172 in a disengaged configuration. Therefore, when transitioning between the second forward ratio and the third forward ratio, sixth selective coupler 172 is placed in the disengaged configuration and fifth selective coupler 170 is placed in the engaged configuration.

[0037] A fourth or subsequent forward ratio (shown as 4th) in truth table 200 of FIG. 2 is achieved by having first selective coupler 162, third selective coupler 166, and fourth selective coupler 168 in an engaged configuration and second selective coupler 164, fifth selective coupler 170, and sixth selective coupler 172 in a disengaged configuration. Therefore, when transitioning between the third forward ratio and the fourth forward ratio, fifth selective coupler 170 is placed in the disengaged configuration and third selective coupler 166 is placed in the engaged configuration.

[0038] A fifth or subsequent forward ratio (shown as 5th) in truth table 200 of FIG. 2 is achieved by having third selective coupler 166, fourth selective coupler 168, and sixth selective coupler 172 in an engaged configuration and first selective coupler 162, second selective coupler 164, and fifth selective coupler 170 in a disengaged configuration. Therefore, when transitioning between the fourth forward ratio and the fifth forward ratio, first selective coupler 162 is placed in the disengaged configuration and sixth selective coupler 172 is placed in the engaged configuration.

[0039] A sixth or subsequent forward ratio (shown as 6th) in truth table 200 of FIG. 2 is achieved by having second selective coupler 164, third selective coupler 166, and sixth selective coupler 172 in an engaged configuration and first selective coupler 162, fourth selective coupler 168, and fifth selective coupler 170 in a disengaged configuration. Therefore, when transitioning between the fifth forward ratio and the sixth forward ratio, fourth selective coupler 168 is placed in the disengaged configuration and second selective coupler 164 is placed in the engaged configuration.

[0040] A seventh or subsequent forward ratio (shown as 7th) in truth table 200 of FIG. 2 is achieved by having second selective coupler 164, third selective coupler 166, and fifth selective coupler 170 in an engaged configuration and first selective coupler 162, fourth selective coupler 168, and sixth selective coupler 172 in a disengaged configuration. Therefore, when transitioning between the sixth forward ratio and the seventh forward ratio, sixth selective coupler 172 is placed in the disengaged configuration and fifth selective coupler 170 is placed in the engaged configuration.

[0041] An eighth or subsequent forward ratio (shown as 8th) in truth table 200 of FIG. 2 is achieved by having second selective coupler 164, third selective coupler 166, and fourth selective coupler 168 in an engaged configuration and first selective coupler 162, fifth selective coupler 170, and sixth selective coupler 172 in a disengaged configuration. Therefore, when transitioning between the seventh forward ratio and the eighth forward ratio, fifth selective coupler 170 is placed in the disengaged configuration and fourth selective coupler 168 is placed in the engaged configuration.

[0042] A ninth or subsequent forward ratio (shown as 9th) in truth table 200 of FIG. 2 is achieved by having second selective coupler 164, fourth selective coupler 168, and fifth selective coupler 170 in an engaged configuration and first selective coupler 162, third selective coupler 166, and sixth selective coupler 172 in a disengaged configuration. Therefore, when transitioning between the eighth forward ratio and the ninth forward ratio, third selective coupler 166 is placed in the disengaged configuration and fifth selective coupler 170 is placed in the engaged configuration.

[0043] A tenth or subsequent forward ratio (shown as 10th) in truth table 200 of FIG. 2 is achieved by having second selective coupler 164, fourth selective coupler 168, and sixth selective coupler 172 in an engaged configuration and first selective coupler 162, third selective coupler 166, and fifth selective coupler 170 in a disengaged configuration. Therefore, when transitioning between the ninth forward ratio and the tenth forward ratio, fifth selective coupler 170 is placed in the disengaged configuration and sixth selective coupler 172 is placed in the engaged configuration.

[0044] FIG. 3 is a diagrammatic representation of a multi-speed transmission 300. Multi-speed transmission 300 includes an input member 302 and an output member 304. Each of input member 302 and output member 304 is rotatable relative to at least one stationary member 306. An exemplary input member 302 is an input shaft or other suitable rotatable component. An exemplary output member 304 is an output shaft or other suitable rotatable component. An exemplary stationary member 306 is a housing of multi-speed transmission 300. The housing may include several components coupled together.

[0045] Multi-speed transmission 300 includes a plurality of planetary gearsets, illustratively a first planetary gearset 308, a second planetary gearset 310, a third planetary gearset 312, and a fourth planetary gearset 314. In one embodiment, additional planetary gearsets may be included. Further, although first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 are illustrated as simple planetary gearsets, it is contemplated that compound planetary gearsets may be included in some embodiments.

[0046] In one embodiment, multi-speed transmission 300 is arranged as illustrated in FIG. 3, with first planetary gearset 308 positioned between a first location or end 316 at which input member 302 enters stationary member 306 and second planetary gearset 310, second plan-

etary gearset 310 is positioned between first planetary gearset 308 and third planetary gearset 312, third planetary gearset 312 is positioned between second planetary gearset 310 and fourth planetary gearset 314, and fourth planetary gearset 314 is positioned between third planetary gearset 312 and a second location or end 318 at which output member 304 exits stationary member 306. In alternative embodiments, first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 are arranged in any order relative to location 316 and location 318. In the illustrated embodiment of FIG. 3, each of first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 are axially aligned. In one example, input member 302 and output member 304 are also axially aligned with first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314. In alternative embodiments, one or more of input member 302, output member 304, first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 are offset and not axially aligned with the remainder.

[0047] First planetary gearset 308 includes a sun gear 320, a planet carrier 322 supporting a plurality of planet gears 324, and a ring gear 326. Second planetary gearset 310 includes a sun gear 330, a planet carrier 332 supporting a plurality of planet gears 334, and a ring gear 336. Third planetary gearset 312 includes a sun gear 340, a planet carrier 342 supporting a plurality of planet gears 344, and a ring gear 346. Fourth planetary gearset 314 includes a sun gear 350, a planet carrier 352 supporting a plurality of planet gears 354, and a ring gear 356.

[0048] Multi-speed transmission 300 further includes a plurality of selective couplers, illustratively a first selective coupler 362, a second selective coupler 364, a third selective coupler 366, a fourth selective coupler 368, a fifth selective coupler 370, and a sixth selective coupler 372. In the illustrated embodiment, first selective coupler 362 and second selective coupler 364 are brakes and third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372 are clutches. The axial locations of the clutches and brakes relative to the plurality of planetary gearsets may be altered from the illustrated axial locations. In alternative embodiments, any number of clutches and brakes may be used.

[0049] Multi-speed transmission 300 includes several components that are illustratively shown as being fixedly coupled together. Input member 302 is fixedly coupled to third selective coupler 366, fourth selective coupler 368, and fifth selective coupler 370. Output member 304 is fixedly coupled to ring gear 356 of fourth planetary gearset 314. Ring gear 336 of second planetary gearset 310, ring gear 346 of third planetary gearset 312, and sun gear 350 of fourth planetary gearset 314 are fixedly coupled together. Planet carrier 332 of second planetary gearset 310, planet carrier 352 of fourth planetary gearset 314, and third selective coupler 366 are fixedly coupled together. Sun gear 320 of first planetary gearset 308, sun gear 330 of second planetary gearset 310, and first selective coupler 362 are fixedly coupled together. Planet carrier 322 of first planetary gearset 308, planet carrier 342 of third planetary gearset 312, and fourth selective coupler 368 are fixedly coupled together. Sun gear 340 of third planetary gearset 312, fifth selective coupler 370, and sixth selective coupler 372 are fixedly coupled together. Ring gear 326 of first planetary gearset 308, second selective coupler 364, and sixth selective coupler 372 are fixedly coupled together. In alternative embodiments, one or more of the components fixedly coupled together are selectively coupled together through one or more selective couplers.

[0050] Multi-speed transmission 300 may be described as having eight interconnectors. Input member 302 is a first interconnector that both provides input torque to multi-speed transmission 300 and is fixedly coupled to third selective coupler 366, fourth selective coupler 368, and fifth selective coupler 370. Output member 304 is a second interconnector that provides output torque from multi-speed transmission 300 and is fixedly coupled to ring gear 356 of fourth planetary gearset 314. A third interconnector 380 fixedly couples ring gear 336 of second planetary gearset 310, ring gear 346 of third planetary gearset 312, and sun gear 350 of fourth planetary gearset 314 together. A fourth interconnector 382 fixedly couples planet carrier 332 of second planetary gearset 310, planet carrier 352 of fourth planetary gearset 314, and third selective coupler 366 together. A fifth interconnector 384 fixedly couples sun gear 320 of first planetary gearset 308, sun gear 330 of second planetary gearset 310, and first selective coupler 362 together. A sixth interconnector 386 fixedly couples planet carrier 322 of first planetary gearset 308, planet carrier 342 of third planetary gearset 312, and fourth selective coupler 368 together. A seventh interconnector 388 fixedly couples sun gear 340 of third planetary gearset 312, fifth selective coupler 370, and sixth selective coupler 372 together. An eighth interconnector 390 fixedly couples ring gear 326 of first planetary gearset 308, second selective coupler 364, and sixth selective coupler 372 together.

[0051] Multi-speed transmission 300 further includes several components that are illustratively shown as being selectively coupled together through selective couplers. First selective coupler 362, when engaged, fixedly couples sun gear 320 of first planetary gearset 308 and sun gear 330 of second planetary gearset 310 to stationary member 306. When first selective coupler 362 is disengaged, sun gear 320 of first planetary gearset 308 and sun gear 330 of second planetary gearset 310 may rotate relative to stationary member 306.

[0052] Second selective coupler 364, when engaged, fixedly couples ring gear 326 of first planetary gearset 308 to stationary member 306. When second selective coupler 364 is disengaged, ring gear 326 of first planetary

gearset 308 may rotate relative to stationary member 306.

[0053] Third selective coupler 366, when engaged, fixedly couples input member 302 to planet carrier 332 of second planetary gearset 310 and planet carrier 352 of fourth planetary gearset 314. When third selective coupler 366 is disengaged, input member 302 may rotate relative to planet carrier 332 of second planetary gearset 310 and planet carrier 352 of fourth planetary gearset 314.

[0054] Fourth selective coupler 368, when engaged, fixedly couples input member 302 to planet carrier 322 of first planetary gearset 308 and planet carrier 342 of third planetary gearset 312. When fourth selective coupler 368 is disengaged, input member 302 may rotate relative to planet carrier 322 of first planetary gearset 308 and planet carrier 342 of third planetary gearset 312.

[0055] Fifth selective coupler 370, when engaged, fixedly couples input member 302 to sun gear 340 of third planetary gearset 312. When fifth selective coupler 370 is disengaged, input member 302 may rotate relative to sun gear 340 of third planetary gearset 312.

[0056] Sixth selective coupler 372, when engaged, fixedly couples ring gear 326 of first planetary gearset 308 to sun gear 340 of third planetary gearset 312. When sixth selective coupler 372 is disengaged, ring gear 326 of first planetary gearset 308 may rotate relative to sun gear 340 of third planetary gearset 312.

[0057] By engaging various combinations of first selective coupler 362, second selective coupler 364, third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372, additional components of multi-speed transmission 300 may be fixedly coupled together.

[0058] In the illustrated embodiment of transmission 300, input member 302 is coupled to first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 only through third selective coupler 366, fourth selective coupler 368, and fifth selective coupler 370. Third selective coupler 366, when engaged, fixedly couples input member 302 to a first group of the plurality of planetary gearsets, illustratively second planetary gearset 310 and fourth planetary gearset 314. Fourth selective coupler 368, when engaged, fixedly couples input member 302 to a second group of the plurality of planetary gearsets, illustratively first planetary gearset 308 and third planetary gearset 312. Fifth selective coupler 170, when engaged, fixedly couples input member 102 to a third group of the plurality of planetary gearsets, illustratively third planetary gearset 312. Each of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets, may include a single planetary gearset or a plurality of planetary gearsets. Further, each of first planetary gearset 308, second planetary gearset 310, third planetary gearset 312, and fourth planetary gearset 314 may be included in more than one of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets.

[0059] The plurality of planetary gearsets and the plurality of selective couplers of multi-speed transmission 300 may be interconnected in various arrangements to provide torque from input member 302 to output member 304 in at least nine forward gear or speed ratios and one reverse gear or speed ratio. Referring to FIG. 4, an exemplary truth table 400 is shown that provides the state of each of first selective coupler 362, second selective coupler 364, third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372 for ten different forward gear or speed ratios and one reverse gear or speed ratio. Each row corresponds to a given interconnection arrangement for transmission 300. The first column provides the gear range (reverse and 1^{st}-10^{th} forward gears). The second column provides the gear ratio between the input member 302 and the output member 304. The third column provides the gear step. The six rightmost columns illustrate which ones of the selective couplers 362-372 are engaged ("1" indicates engaged) and which ones of selective couplers 362-372 are disengaged ("(blank)" indicates disengaged). FIG. 4 is only one example of any number of truth tables possible for achieving at least nine forward ratios and one reverse ratio.

[0060] In the example of FIG. 4, the illustrated reverse ratio (Rev) is achieved by having first selective coupler 362, second selective coupler 364, and fifth selective coupler 370 in an engaged configuration and third selective coupler 366, fourth selective coupler 368, and sixth selective coupler 372 in a disengaged configuration.

[0061] In one embodiment, to place multi-speed transmission 300 in neutral (Neu), all of first selective coupler 362, second selective coupler 364, third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372 are in the disengaged configuration. One or more of first selective coupler 362, second selective coupler 364, third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372 may remain engaged in neutral (Neu) as long as the combination of first selective coupler 362, second selective coupler 364, third selective coupler 366, fourth selective coupler 368, fifth selective coupler 370, and sixth selective coupler 372 does not transmit torque from input member 302 to output member 304.

[0062] A first forward ratio (shown as 1 st) in truth table 400 of FIG. 4 is achieved by having first selective coupler 362, fifth selective coupler 370, and sixth selective coupler 372 in an engaged configuration and second selective coupler 364, third selective coupler 366, and fourth selective coupler 368 in a disengaged configuration.

[0063] A second or subsequent forward ratio (shown as 2nd) in truth table 400 of FIG. 4 is achieved by having first selective coupler 362, fourth selective coupler 368, and sixth selective coupler 372 in an engaged configu-

ration and second selective coupler 364, third selective coupler 366, and fifth selective coupler 370 in a disengaged configuration. Therefore, when transitioning between the first forward ratio and the second forward ratio, fifth selective coupler 370 is placed in the disengaged configuration and fourth selective coupler 368 is placed in the engaged configuration.

[0064] A third or subsequent forward ratio (shown as 3rd) in truth table 400 of FIG. 4 is achieved by having first selective coupler 362, fourth selective coupler 368, and fifth selective coupler 370 in an engaged configuration and second selective coupler 364, third selective coupler 366, and sixth selective coupler 372 in a disengaged configuration. Therefore, when transitioning between the second forward ratio and the third forward ratio, sixth selective coupler 372 is placed in the disengaged configuration and fifth selective coupler 370 is placed in the engaged configuration.

[0065] A fourth or subsequent forward ratio (shown as 4th) in truth table 400 of FIG. 4 is achieved by having first selective coupler 362, third selective coupler 366, and fourth selective coupler 368 in an engaged configuration and second selective coupler 364, fifth selective coupler 370, and sixth selective coupler 372 in a disengaged configuration. Therefore, when transitioning between the third forward ratio and the fourth forward ratio, fifth selective coupler 370 is placed in the disengaged configuration and third selective coupler 366 is placed in the engaged configuration.

[0066] A fifth or subsequent forward ratio (shown as 5th) in truth table 400 of FIG. 4 is achieved by having third selective coupler 366, fourth selective coupler 368, and sixth selective coupler 372 in an engaged configuration and first selective coupler 362, second selective coupler 364, and fifth selective coupler 370 in a disengaged configuration. Therefore, when transitioning between the fourth forward ratio and the fifth forward ratio, first selective coupler 362 is placed in the disengaged configuration and sixth selective coupler 372 is placed in the engaged configuration.

[0067] A sixth or subsequent forward ratio (shown as 6th) in truth table 400 of FIG. 4 is achieved by having second selective coupler 364, third selective coupler 366, and sixth selective coupler 372 in an engaged configuration and first selective coupler 362, fourth selective coupler 368, and fifth selective coupler 370 in a disengaged configuration. Therefore, when transitioning between the fifth forward ratio and the sixth forward ratio, fourth selective coupler 368 is placed in the disengaged configuration and second selective coupler 364 is placed in the engaged configuration.

[0068] A seventh or subsequent forward ratio (shown as 7th) in truth table 400 of FIG. 4 is achieved by having second selective coupler 364, third selective coupler 366, and fifth selective coupler 370 in an engaged configuration and first selective coupler 362, fourth selective coupler 368, and sixth selective coupler 372 in a disengaged configuration. Therefore, when transitioning between the sixth forward ratio and the seventh forward ratio, sixth selective coupler 372 is placed in the disengaged configuration and fifth selective coupler 370 is placed in the engaged configuration.

[0069] An eighth or subsequent forward ratio (shown as 8th) in truth table 400 of FIG. 4 is achieved by having second selective coupler 364, third selective coupler 366, fourth selective coupler 368 in an engaged configuration and first selective coupler 362, fifth selective coupler 370, and sixth selective coupler 372 in a disengaged configuration. Therefore, when transitioning between the seventh forward ratio and the eighth forward ratio, fifth selective coupler 370 is placed in the disengaged configuration and fourth selective coupler 368 is placed in the engaged configuration.

[0070] A ninth or subsequent forward ratio (shown as 9th) in truth table 400 of FIG. 4 is achieved by having second selective coupler 364, fourth selective coupler 368, and fifth selective coupler 370 in an engaged configuration and first selective coupler 362, third selective coupler 366, and sixth selective coupler 372 in a disengaged configuration. Therefore, when transitioning between the eighth forward ratio and the ninth forward ratio, third selective coupler 366 is placed in the disengaged configuration and fifth selective coupler 370 is placed in the engaged configuration.

[0071] A tenth or subsequent forward ratio (shown as 10th) in truth table 400 of FIG. 4 is achieved by having second selective coupler 364, fourth selective coupler 368, and sixth selective coupler 372 in an engaged configuration and first selective coupler 362, third selective coupler 366, and fifth selective coupler 370 in a disengaged configuration. Therefore, when transitioning between the ninth forward ratio and the tenth forward ratio, fifth selective coupler 370 is placed in the disengaged configuration and sixth selective coupler 372 is placed in the engaged configuration.

[0072] FIG. 5 is a diagrammatic representation of a multi-speed transmission 500. Multi-speed transmission 500 includes an input member 502 and an output member 504. Each of input member 502 and output member 504 is rotatable relative to at least one stationary member 506. An exemplary input member 502 is an input shaft or other suitable rotatable component. An exemplary output member 504 is an output shaft or other suitable rotatable component. An exemplary stationary member 506 is a housing of multi-speed transmission 500. The housing may include several components coupled together.

[0073] Multi-speed transmission 500 includes a plurality of planetary gearsets, illustratively a first planetary gearset 508, a second planetary gearset 510, a third planetary gearset 512, and a fourth planetary gearset 514. In one embodiment, additional planetary gearsets may be included. Further, although first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 are illustrated as simple planetary gearsets, it is contemplated that com-

pound planetary gearsets may be included in some embodiments.

[0074] In one embodiment, multi-speed transmission 500 is arranged as illustrated in FIG. 5, with first planetary gearset 508 positioned between a first location or end 516 at which input member 502 enters stationary member 506 and second planetary gearset 510, second planetary gearset 510 is positioned between first planetary gearset 508 and third planetary gearset 512, third planetary gearset 512 is positioned between second planetary gearset 510 and fourth planetary gearset 514, and fourth planetary gearset 514 is positioned between third planetary gearset 512 and a second location or end 518 at which output member 504 exits stationary member 506. In alternative embodiments, first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 are arranged in any order relative to location 516 and location 518. In the illustrated embodiment of FIG. 5, each of first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 are axially aligned. In one example, input member 502 and output member 504 are also axially aligned with first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514. In alternative embodiments, one or more of input member 502, output member 504, first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 are offset and not axially aligned with the remainder.

[0075] First planetary gearset 508 includes a sun gear 520, a planet carrier 522 supporting a plurality of planet gears 524, and a ring gear 526. Second planetary gearset 510 includes a sun gear 530, a planet carrier 532 supporting a plurality of planet gears 534, and a ring gear 536. Third planetary gearset 512 includes a sun gear 540, a planet carrier 542 supporting a plurality of planet gears 544, and a ring gear 546. Fourth planetary gearset 514 includes a sun gear 550, a planet carrier 552 supporting a plurality of planet gears 554, and a ring gear 556.

[0076] Multi-speed transmission 500 further includes a plurality of selective couplers, illustratively a first selective coupler 562, a second selective coupler 564, a third selective coupler 566, a fourth selective coupler 568, a fifth selective coupler 570, and a sixth selective coupler 572. In the illustrated embodiment, first selective coupler 562 and second selective coupler 564 are brakes and third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572 are clutches. The axial locations of the clutches and brakes relative to the plurality of planetary gearsets may be altered from the illustrated axial locations. In alternative embodiments, any number of clutches and brakes may be used.

[0077] Multi-speed transmission 500 includes several components that are illustratively shown as being fixedly coupled together. Input member 502 is fixedly coupled to third selective coupler 566, fourth selective coupler 568, and fifth selective coupler 570. Output member 504 is fixedly coupled to planet carrier 542 of third planetary gearset 512 and ring gear 556 of fourth planetary gearset 514. Planet carrier 522 of first planetary gearset 508, planet carrier 532 of second planetary gearset 510, and fourth selective coupler 568 are fixedly coupled together. Sun gear 530 of second planetary gearset 510, sun gear 540 of third planetary gearset 512, and first selective coupler 562 are fixedly coupled together. Ring gear 546 of third planetary gearset 512, planet carrier 552 of fourth planetary gearset 514, and third selective coupler 566 are fixedly coupled together. Ring gear 526 of first planetary gearset 508 and sun gear 550 of fourth planetary gearset 514 are fixedly coupled together. Ring gear 536 of second planetary gearset 510, second selective coupler 564, and sixth selective coupler 572 are fixedly coupled together. Sun gear 520 of first planetary gearset 508, fifth selective coupler 570, and sixth selective coupler 572 are fixedly coupled together. In alternative embodiments, one or more of the components fixedly coupled together are selectively coupled together through one or more selective couplers.

[0078] Multi-speed transmission 500 may be described as having eight interconnectors. Input member 502 is a first interconnector that both provides input torque to multi-speed transmission 500 and fixedly couples third selective coupler 566, fourth selective coupler 568, and fifth selective coupler 570 together. Output member 504 is a second interconnector that provides output torque from multi-speed transmission 500 and fixedly couples ring gear 556 of fourth planetary gearset 514 to planet carrier 542 of third planetary gearset 512. A third interconnector 580 fixedly couples ring gear 546 of third planetary gearset 512, planet carrier 552 of fourth planetary gearset 514, third selective coupler 566 together. A fourth interconnector 582 fixedly couples ring gear 526 of first planetary gearset 508 to sun gear 550 of fourth planetary gearset 514. A fifth interconnector 584 fixedly couples sun gear 530 of second planetary gearset 510, sun gear 540 of third planetary gearset 512, and first selective coupler 562 together. A sixth interconnector 586 fixedly couples planet carrier 532 of second planetary gearset 510, planet carrier 522 of first planetary gearset 508, and fourth selective coupler 568 together. A seventh interconnector 588 fixedly couples sun gear 520 of first planetary gearset 508, fifth selective coupler 570, and sixth selective coupler 572 together. An eighth interconnector 590 fixedly couples ring gear 536 of second planetary gearset 510, second selective coupler 564, and sixth selective coupler 572 together.

[0079] Multi-speed transmission 500 further includes several components that are illustratively shown as being selectively coupled together through selective couplers. First selective coupler 562, when engaged, fixedly couples sun gear 530 of second planetary gearset 510 and sun gear 540 of third planetary gearset 512 to stationary member 506. When first selective coupler 562 is disengaged, sun gear 530 of second planetary gearset 510

and sun gear 540 of third planetary gearset 512 may rotate relative to stationary member 506.

[0080] Second selective coupler 564, when engaged, fixedly couples ring gear 536 of second planetary gearset 510 to stationary member 506. When second selective coupler 564 is disengaged, ring gear 536 of second planetary gearset 510 may rotate relative to stationary member 506.

[0081] Third selective coupler 566, when engaged, fixedly couples input member 502 to planet carrier 552 of fourth planetary gearset 514 and ring gear 546 of third planetary gearset 512. When third selective coupler 566 is disengaged, planet carrier 552 of fourth planetary gearset 514 and ring gear 546 of third planetary gearset 512 may rotate relative to input member 502.

[0082] Fourth selective coupler 568, when engaged, fixedly couples input member 502 to planet carrier 522 of first planetary gearset 508 and planet carrier 532 of second planetary gearset 510. When fourth selective coupler 568 is disengaged, planet carrier 522 of first planetary gearset 508 and planet carrier 532 of second planetary gearset 510 may rotate relative to input member 502.

[0083] Fifth selective coupler 570, when engaged, fixedly couples input member 502 to sun gear 520 of first planetary gearset 508. When fifth selective coupler 570 is disengaged, sun gear 520 of first planetary gearset 508 may rotate relative to input member 502.

[0084] Sixth selective coupler 572, when engaged, fixedly couples ring gear 536 of second planetary gearset 510 to sun gear 520 of first planetary gearset 508. When sixth selective coupler 572 is disengaged, ring gear 536 of second planetary gearset 510 may rotate relative to sun gear 520 of first planetary gearset 508.

[0085] By engaging various combinations of first selective coupler 562, second selective coupler 564, third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572, additional components of multi-speed transmission 500 may be fixedly coupled together.

[0086] In the illustrated embodiment of transmission 500, input member 502 is coupled to first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 only through third selective coupler 566, fourth selective coupler 568, and fifth selective coupler 570. Third selective coupler 566, when engaged, fixedly couples input member 502 to a first group of the plurality of planetary gearsets, illustratively third planetary gearset 512 and fourth planetary gearset 514. Fourth selective coupler 568, when engaged, fixedly couples input member 502 to a second group of the plurality of planetary gearsets, illustratively first planetary gearset 508 and second planetary gearset 510. Fifth selective coupler 570, when engaged, fixedly couples input member 502 to a third group of the plurality of planetary gearsets, illustratively first planetary gearset 508. Each of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets, may include a single planetary gearset or a plurality of planetary gearsets. Further, each of first planetary gearset 508, second planetary gearset 510, third planetary gearset 512, and fourth planetary gearset 514 may be included in more than one of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets.

[0087] The plurality of planetary gearsets and the plurality of selective couplers of multi-speed transmission 500 may be interconnected in various arrangements to provide torque from input member 502 to output member 504 in at least nine forward gear or speed ratios, illustratively ten, and one reverse gear or speed ratio. Referring to FIG. 6, an exemplary truth table 600 is shown that provides the state of each of first selective coupler 562, second selective coupler 564, third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572 for ten different forward gear or speed ratios and one reverse gear or speed ratio. Each row corresponds to a given interconnection arrangement for transmission 500. The first column provides the gear range (reverse and 1^{st}-10^{th} forward gears). The second column provides the gear ratio between the input member 502 and the output member 504. The third column provides the gear step. The six rightmost columns illustrate which ones of the selective couplers 562-572 are engaged ("1" indicates engaged) and which ones of selective couplers 562-572 are disengaged ("(blank)" indicates disengaged). FIG. 6 is only one example of any number of truth tables possible for achieving at least nine forward ratios and one reverse ratio.

[0088] In the example of FIG. 6, the illustrated reverse ratio (Rev) is achieved by having first selective coupler 562, second selective coupler 564, and fifth selective coupler 570 in an engaged configuration and third selective coupler 566, fourth selective coupler 568, and sixth selective coupler 572 in a disengaged configuration.

[0089] In one embodiment, to place multi-speed transmission 500 in neutral (Neu), all of first selective coupler 562, second selective coupler 564, third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572 are in the disengaged configuration. One or more of first selective coupler 562, second selective coupler 564, third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572 may remain engaged in neutral (Neu) as long as the combination of first selective coupler 562, second selective coupler 564, third selective coupler 566, fourth selective coupler 568, fifth selective coupler 570, and sixth selective coupler 572 does not transmit torque from input member 502 to output member 504.

[0090] A first forward ratio (shown as 1 st) in truth table 600 of FIG. 6 is achieved by having first selective coupler 562, fifth selective coupler 570, and sixth selective coupler 572 in an engaged configuration and second selec-

tive coupler 564, third selective coupler 566, fourth selective coupler 568 in a disengaged configuration.

[0091] A second or subsequent forward ratio (shown as 2nd) in truth table 600 of FIG. 6 is achieved by having first selective coupler 562, fourth selective coupler 568, and sixth selective coupler 572 in an engaged configuration and second selective coupler 564, third selective coupler 566, and fifth selective coupler 570 in a disengaged configuration. Therefore, when transitioning between the first forward ratio and the second forward ratio, fifth selective coupler 570 is placed in the disengaged configuration and fourth selective coupler 568 is placed in the engaged configuration.

[0092] A third or subsequent forward ratio (shown as 3rd) in truth table 600 of FIG. 6 is achieved by having first selective coupler 562, fourth selective coupler 568, and fifth selective coupler 570 in an engaged configuration and second selective coupler 564, third selective coupler 566, and sixth selective coupler 572 in a disengaged configuration. Therefore, when transitioning between the second forward ratio and the third forward ratio, sixth selective coupler 572 is placed in the disengaged configuration and fifth selective coupler 570 is placed in the engaged configuration.

[0093] A fourth or subsequent forward ratio (shown as 4th) in truth table 600 of FIG. 6 is achieved by having first selective coupler 562, third selective coupler 566, and fourth selective coupler 568 in an engaged configuration and second selective coupler 564, fifth selective coupler 570, and sixth selective coupler 572 in a disengaged configuration. Therefore, when transitioning between the third forward ratio and the fourth forward ratio, fifth selective coupler 570 is placed in the disengaged configuration and third selective coupler 566 is placed in the engaged configuration.

[0094] A fifth or subsequent forward ratio (shown as 5th) in truth table 600 of FIG. 6 is achieved by having third selective coupler 566, fourth selective coupler 568, and sixth selective coupler 572 in an engaged configuration and first selective coupler 562, second selective coupler 564, and fifth selective coupler 570 in a disengaged configuration. Therefore, when transitioning between the fourth forward ratio and the fifth forward ratio, first selective coupler 562 is placed in the disengaged configuration and sixth selective coupler 572 is placed in the engaged configuration.

[0095] A sixth or subsequent forward ratio (shown as 6th) in truth table 600 of FIG. 6 is achieved by having second selective coupler 564, third selective coupler 566, and sixth selective coupler 572 in an engaged configuration and first selective coupler 562, fourth selective coupler 568, and fifth selective coupler 570 in a disengaged configuration. Therefore, when transitioning between the fifth forward ratio and the sixth forward ratio, fourth selective coupler 568 is placed in the disengaged configuration and second selective coupler 564 is placed in the engaged configuration.

[0096] A seventh or subsequent forward ratio (shown as 7th) in truth table 600 of FIG. 6 is achieved by having second selective coupler 564, third selective coupler 566, and fifth selective coupler 570 in an engaged configuration and first selective coupler 562, fourth selective coupler 568, and sixth selective coupler 572 in a disengaged configuration. Therefore, when transitioning between the sixth forward ratio and the seventh forward ratio, sixth selective coupler 572 is placed in the disengaged configuration and fifth selective coupler 570 is placed in the engaged configuration.

[0097] An eighth or subsequent forward ratio (shown as 8th) in truth table 600 of FIG. 6 is achieved by having second selective coupler 564, third selective coupler 566, and fourth selective coupler 568 in an engaged configuration and first selective coupler 562, fifth selective coupler 570, sixth selective coupler 572 in a disengaged configuration. Therefore, when transitioning between the seventh forward ratio and the eighth forward ratio, fifth selective coupler 570 is placed in the disengaged configuration and fourth selective coupler 568 is placed in the engaged configuration.

[0098] A ninth or subsequent forward ratio (shown as 9th) in truth table 600 of FIG. 6 is achieved by having second selective coupler 564, fourth selective coupler 568, and fifth selective coupler 570 in an engaged configuration and first selective coupler 562, third selective coupler 566, and sixth selective coupler 572 in a disengaged configuration. Therefore, when transitioning between the eighth forward ratio and the ninth forward ratio, third selective coupler 566 is placed in the disengaged configuration and fifth selective coupler 570 is placed in the engaged configuration.

[0099] A tenth or subsequent forward ratio (shown as 10th) in truth table 600 of FIG. 6 is achieved by having second selective coupler 564, fourth selective coupler 568, and sixth selective coupler 572 in an engaged configuration and first selective coupler 562, third selective coupler 566, and fifth selective coupler 570 in a disengaged configuration. Therefore, when transitioning between the ninth forward ratio and the tenth forward ratio, fifth selective coupler 570 is placed in the disengaged configuration and sixth selective coupler 572 is placed in the engaged configuration.

[0100] The present invention contemplates that downshifts follow the reverse sequence of the corresponding upshift (as described above). Further, several power-on skip-shifts that are single-transition are possible (e.g. from 1^{st} up to 3^{rd}, from 3^{rd} down to 1^{st}, from 6^{th} up to 8^{th}, and from 8^{th} down to 6^{th}).

[0101] In the illustrated embodiments, various combinations of three of the available selective couplers are engaged for each of the illustrated forward speed ratios and reverse speed ratios. Additional forward speed ratios and reverse speed ratios are possible based on other combinations of engaged selective couplers. Although in the illustrated embodiments, each forward speed ratio and reverse speed ratio has three of the available selective couplers engaged, it is contemplated that less than

three and more than three selective couplers may be engaged at the same time.

Claims

1. A transmission (100) comprising:

at least one stationary member (106);
an input member (102);
a plurality of planetary gearsets (108, 110, 112, 114) operatively coupled to the input member (102), each planetary gearset of the plurality of planetary gearsets including a sun gear (120, 130, 140, 150), a plurality of planet gears (124, 134, 144, 154) operatively coupled to the sun gear, a planet carrier (122, 132, 142, 152) operatively coupled to the plurality of planet gears, and a ring gear (126, 136, 146, 156) operatively coupled to the plurality of planet gears, the plurality of planetary gearsets including a first planetary gearset (108), a second planetary gearset (110), a third planetary gearset (112), and a fourth planetary gearset (114);
a plurality of selective couplers (162, 164, 166, 168, 170, 172) operatively coupled to the plurality of planetary gearsets, each of the plurality of selective couplers (162, 164, 166, 168, 170, 172) having an engaged configuration and a disengaged configuration, the plurality of selective couplers (162, 164, 166, 168, 170, 172) including a first number of clutches (166, 168, 170, 172) and a second number of brakes (162, 164), the first number being greater than the second number; and
an output member (104) operatively coupled to the input member (102) through the plurality of planetary gearsets, wherein the input member (102) is operatively coupled to the plurality of planetary gearsets only through a subset of the first number of clutches, the subset including a first clutch (166), a second clutch (168), and a third clutch (170), wherein
the first clutch (166), when engaged, fixedly couples the input member (102) to a first group of the plurality of planetary gearsets,
the second clutch (168), when engaged, fixedly couples the input member (102) to a second group of the plurality of planetary gearsets,
the third clutch (170), when engaged, fixedly couples the input member (102) to a third group of the plurality of planetary gearsets, and
each of the first planetary gearset (108), the second planetary gearset (110), the third planetary gearset (112), and the fourth planetary gearset (114) are included in at least one of the first group of the plurality of planetary gearsets, the second group of the plurality of planetary gearsets, and the third group of the plurality of planetary gearsets,
characterized in that
the first clutch (166), when engaged, fixedly couples the input member (102) to the planet carrier (132) of the second planetary gearset (110) and to the ring gear (156) of the fourth planetary gearset (114); the second clutch (168), when engaged, fixedly couples the input member (102) to the planet carrier (122) of the first planetary gearset (108) and to the planet carrier (142) of the third planetary gearset (112); and the third clutch (170), when engaged, fixedly couples the input member (102) to the sun gear (120) of the first planetary gearset (108).

2. The transmission (100) of claim 1, wherein the output member (104) is fixedly coupled to the fourth planetary gearset (114), and optionally wherein the output member (104) is further fixedly coupled to the third planetary gearset (112).

3. The transmission (100) of claim 1 or claim 2, further comprising:

a first interconnector (180) which fixedly couples the sun gear (130) of the second planetary gearset (110), the sun gear (140) of the third planetary gearset (112), and the sun gear (150) of the fourth planetary gearset (114) together;
a second interconnector (182) which fixedly couples the planet carrier (132) of the second planetary gearset (110) to the ring gear (156) of the fourth planetary gearset (114);
a third interconnector (184) which fixedly couples the ring gear (126) of the first planetary gearset (108) to the ring gear (136) of the second planetary gearset (110); and
a fourth interconnector (186) which fixedly couples the planet carrier (122) of the first planetary gearset (108) to the planet carrier (142) of the third planetary gearset (112), wherein the plurality of selective couplers (162, 164, 166, 168, 170, 172) includes the first clutch (166), the second clutch (168), the third clutch (170), a fourth clutch (172), a first brake (162) fixedly coupled to the at least one stationary member (106), and a second brake (164) fixedly coupled to the at least one stationary member (106).

4. The transmission (100) of claim 3, wherein

the first brake (162), when engaged, fixedly couples the sun gear (130) of the second planetary gearset (110), the sun gear (140) of the third planetary gearset (112), and the sun gear (150) of the fourth planetary gearset (114) to the at least one stationary member (106);

the second brake (164), when engaged, fixedly couples the ring gear (146) of the third planetary gearset (112) to the at least one stationary member (106);
the first clutch (166), when engaged, fixedly couples the input member (102) to the planet carrier (132) of the second planetary gearset (110) and to the ring gear (156) of the fourth planetary gearset (114);
the second clutch (168), when engaged, fixedly couples the input member (102) to the planet carrier (122) of the first planetary gearset (108) and to the planet carrier (142) of the third planetary gearset (112);
the third clutch (170), when engaged, fixedly couples the input member (102) to the sun gear (120) of the first planetary gearset (108); and
the fourth clutch (172), when engaged, fixedly couples the ring gear (146) of the third planetary gearset (112) to the sun gear (120) of the first planetary gearset (108).

5. The transmission (100) of any one of the preceding claims, wherein each of the first planetary gearset (108), the second planetary gearset (110), the third planetary gearset (112), and the fourth planetary gearset (114) is a simple planetary gearset.

6. The transmission (100) of any one of the preceding claims, wherein the at least one stationary member (106) includes a housing, the housing having a first end (116) and a second end (118), wherein

the input member (102) is accessible proximate the first end (116) of the housing;
the output member (104) is accessible proximate the second end (118) of the housing;
the first planetary gearset (108) is positioned between the first end (116) of the housing and the second planetary gearset (110);
the second planetary gearset (110) is positioned between the first planetary gearset (108) and the third planetary gearset (112);
the third planetary gearset (112) is positioned between the second planetary gearset (110) and the fourth planetary gearset (114); and
the fourth planetary gearset (114) is positioned between the third planetary gearset (112) and the second end (118) of the housing.

7. The transmission (100) of any one of the preceding claims, wherein the plurality of selective couplers (162, 164, 166, 168, 170, 172) are selectively engaged in a plurality of combinations to establish at least nine forward speed ratios and at least one reverse speed ratio between the input member (102) and the output member (104), each of the plurality of combinations having at least three of the plurality of selective couplers engaged.

Patentansprüche

1. Getriebe (100), umfassend:

mindestens ein stationäres Element (106);
ein Eingangselement (102);
mehrere Planetenradsätze (108, 110, 112, 114), die funktionsmäßig mit dem Eingangselement (102) gekoppelt sind, wobei jeder Planetenradsatz der mehreren Planetenradsätze ein Sonnenrad (120, 130, 140, 150), mehrere Planetenräder (124, 134, 144, 154), die funktionsmäßig mit dem Sonnenrad gekoppelt sind, einen Planetenträger (122, 132, 142, 152), der funktionsmäßig mit den mehreren Planetenrädern gekoppelt ist, und ein Hohlrad (126, 136, 146, 156), das funktionsmäßig mit den mehreren Planetenrädern gekoppelt ist, aufweist, wobei die mehreren Planetenradsätze einen ersten Planetenradsatz (108), einen zweiten Planetenradsatz (110), einen dritten Planetenradsatz (112) und einen vierten Planetenradsatz (114) aufweisen;
mehrere selektive Koppler (162, 164, 166, 168, 170, 172), die funktionsmäßig mit den mehreren Planetenradsätzen gekoppelt sind, wobei jeder der mehreren selektiven Koppler (162, 164, 166, 168, 170, 172) eine in Eingriff befindliche Konfiguration und eine entkoppelte Konfiguration aufweist, wobei die mehreren selektiven Koppler (162, 164, 166, 168, 170, 172) eine erste Anzahl von Kupplungen (166, 168, 170, 172) und eine zweite Anzahl von Bremsen (162, 164) aufweisen, wobei die erste Anzahl größer als die zweite Anzahl ist; und
ein Ausgangselement (104), das funktionsmäßig mit dem Eingangselement (102) über die mehreren Planetenradsätze gekoppelt ist, wobei das Eingangselement (102) funktionsmäßig mit den mehreren Planetenradsätzen nur über eine Teilmenge der ersten Anzahl von Kupplungen gekoppelt ist, wobei die Teilmenge eine erste Kupplung (166), eine zweite Kupplung (168) und eine dritte Kupplung (170) aufweist, wobei
die erste Kupplung (166), wenn sie in Eingriff ist, das Eingangselement (102) fest mit einer ersten Gruppe der mehreren Planetenradsätze koppelt,
die zweite Kupplung (168), wenn sie in Eingriff ist, das Eingangselement (102) fest mit einer zweiten Gruppe der mehreren Planetenradsätze koppelt,
die dritte Kupplung (170), wenn sie in Eingriff ist, das Eingangselement (102) fest mit einer dritten Gruppe der mehreren Planetenradsätze koppelt, und

jedes des ersten Planetenradsatzes (108), des zweiten Planetenradsatzes (110), des dritten Planetenradsatzes (112) und des vierten Planetenradsatzes (114) in mindestens einer der ersten Gruppe der mehreren Planetenradsätze, der zweiten Gruppe der mehreren Planetenradsätze und der dritten Gruppe der mehreren Planetenradsätze enthalten ist,

dadurch gekennzeichnet, dass

die erste Kupplung (166), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Planetenträger (132) des zweiten Planetenradsatzes (110) und mit dem Hohlrad (156) des vierten Planetenradsatzes (114) koppelt; die zweite Kupplung (168), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Planetenträger (122) des ersten Planetenradsatzes (108) und mit dem Planetenträger (142) des dritten Planetenradsatzes (112) koppelt; und die dritte Kupplung (170), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Sonnenrad (120) des ersten Planetenradsatzes (108) koppelt.

2. Getriebe (100) nach Anspruch 1, wobei das Ausgangselement (104) fest mit dem vierten Planetenradsatz (114) gekoppelt ist, und wobei optional das Ausgangselement (104) ferner fest mit dem dritten Planetenradsatz (112) gekoppelt ist.

3. Getriebe (100) nach Anspruch 1 oder Anspruch 2, ferner umfassend:

eine erste Verbindungsvorrichtung (180), die das Sonnenrad (130) des zweiten Planetenradsatzes (110), das Sonnenrad (140) des dritten Planetenradsatzes (112) und das Sonnenrad (150) des vierten Planetenradsatzes (114) fest miteinander koppelt;

eine zweite Verbindungsvorrichtung (182), die den Planetenträger (132) des zweiten Planetenradsatzes (110) fest mit dem Hohlrad (156) des vierten Planetenradsatzes (114) koppelt;

eine dritte Verbindungsvorrichtung (184), die das Hohlrad (126) des ersten Planetenradsatzes (108) fest mit dem Hohlrad (136) des zweiten Planetenradsatzes (110) koppelt; und

eine vierte Verbindungsvorrichtung (186), die den Planetenträger (122) des ersten Planetenradsatzes (108) fest mit dem Planetenträger (142) des dritten Planetenradsatzes (112) koppelt, wobei die mehreren selektiven Koppler (162, 164, 166, 168, 170, 172) die erste Kupplung (166), die zweite Kupplung (168), die dritte Kupplung (170), eine vierte Kupplung (172), eine erste Bremse (162), die fest mit dem mindestens einen stationären Element (106) gekoppelt ist, und eine zweite Bremse (164), die fest mit dem mindestens einen stationären Element (106) gekoppelt ist, aufweist.

4. Getriebe (100) nach Anspruch 3, wobei

die erste Bremse (162), wenn sie in Eingriff ist, das Sonnenrad (130) des zweiten Planetenradsatzes (110), das Sonnenrad (140) des dritten Planetenradsatzes (112) und das Sonnenrad (150) des vierten Planetenradsatzes (114) fest mit dem mindestens einen stationären Element (106) koppelt;

die zweite Bremse (164), wenn sie in Eingriff ist, das Hohlrad (146) des dritten Planetenradsatzes (112) fest mit dem mindestens einen stationären Element (106) koppelt;

die erste Kupplung (166), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Planetenträger (132) des zweiten Planetenradsatzes (110) und mit dem Hohlrad (156) des vierten Planetenradsatzes (114) koppelt;

die zweite Kupplung (168), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Planetenträger (122) des ersten Planetenradsatzes (108) und mit dem Planetenträger (142) des dritten Planetenradsatzes (112) koppelt;

die dritte Kupplung (170), wenn sie in Eingriff ist, das Eingangselement (102) fest mit dem Sonnenrad (120) des ersten Planetenradsatzes (108) koppelt; und

die vierte Kupplung (172), wenn sie in Eingriff ist, das Hohlrad (146) des dritten Planetenradsatzes (112) fest mit dem Sonnenrad (120) des ersten Planetenradsatzes (108) koppelt.

5. Getriebe (100) nach einem der vorhergehenden Ansprüche, wobei jeder von dem ersten Planetenradsatz (108), dem zweiten Planetenradsatz (110), dem dritten Planetenradsatz (112) und dem vierten Planetenradsatz (114) ein einfacher Planetenradsatz ist.

6. Getriebe (100) nach einem der vorhergehenden Ansprüche, wobei das mindestens eine stationäre Element (106) ein Gehäuse aufweist, wobei das Gehäuse ein erstes Ende (116) und ein zweites Ende (118) aufweist, wobei

das Eingangselement (102) benachbart zu dem ersten Ende (116) des Gehäuses zugänglich ist;

das Ausgangselement (104) benachbart zu dem zweiten Ende (118) des Gehäuses zugänglich ist;

der erste Planetenradsatz (108) zwischen dem ersten Ende (116) des Gehäuses und dem zweiten Planetenradsatz (110) angeordnet ist;

der zweite Planetenradsatz (110) zwischen dem ersten Planetenradsatz (108) und dem dritten

Planetenradsatz (112) angeordnet ist;
der dritte Planetenradsatz (112) zwischen dem zweiten Planetenradsatz (110) und dem vierten Planetenradsatz (114) angeordnet ist; und
der vierte Planetenradsatz (114) zwischen dem dritten Planetenradsatz (112) und dem zweiten Ende (118) des Gehäuses angeordnet ist.

7. Getriebe (100) nach einem der vorhergehenden Ansprüche, wobei die mehreren selektiven Koppler (162, 164, 166, 168, 170, 172) selektiv in mehreren Kombinationen in Eingriff gebracht werden, um mindestens neun Vorwärtsgeschwindigkeitsverhältnisse und mindestens ein Rückwärtsgeschwindigkeitsverhältnis zwischen dem Eingangselement (102) und dem Ausgangselement (104) einzurichten, wobei jede der mehreren Kombinationen mindestens drei der mehreren selektiven Koppler in Eingriff aufweist.

Revendications

1. Transmission (100) comprenant :

au moins un élément fixe (106) ;
un élément d'entrée (102) ;
une pluralité de trains planétaires (108, 110, 112, 114) accouplés fonctionnellement à l'élément d'entrée (102), chaque train planétaire de la pluralité de trains planétaires comportant une roue solaire (120, 130, 140, 150), une pluralité de satellites (124, 134, 144, 154) accouplés fonctionnellement à la roue solaire, un porte-satellites (122, 132, 142, 152) accouplé fonctionnellement à la pluralité de trains planétaires, et une couronne (126, 136, 146, 156) accouplée fonctionnellement à la pluralité de satellites, la pluralité de trains planétaires comportant un premier train planétaire (108), un deuxième train planétaire (110), un troisième train planétaire (112) et un quatrième train planétaire (114) ;
une pluralité de coupleurs sélectifs (162, 164, 166, 168, 170, 172) accouplés fonctionnellement à la pluralité de trains planétaires, chacun de la pluralité de coupleurs sélectifs (162, 164, 166, 168, 170, 172) ayant un configuration en prise et une configuration non en prise, la pluralité de coupleurs sélectifs (162, 164, 166, 168, 170, 172) comportant un premier nombre d'embrayages (166, 168, 170, 172) et un second nombre de freins (162, 164), le premier nombre étant supérieur au second nombre ; et
un élément de sortie (104) accouplé fonctionnellement à l'élément d'entrée (102) par la pluralité de trains planétaires, l'élément d'entrée (102) étant accouplé fonctionnellement à la pluralité de trains planétaires uniquement par un sous-ensemble du premier nombre d'embrayages, le sous-ensemble comportant un premier embrayage (166), un deuxième embrayage (168) et un troisième embrayage (170),
le premier embrayage (166), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) à un premier groupe de la pluralité de trains planétaires,
le deuxième embrayage (168), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) à un deuxième groupe de la pluralité de trains planétaires,
le troisième embrayage (170), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) à un troisième groupe de la pluralité de trains planétaires, et
chacun du premier train planétaire (108), du deuxième train planétaire (110), du troisième train planétaire (112) et du quatrième train planétaire (114) étant inclus dans le premier groupe de la pluralité de trains planétaires et/ou le deuxième groupe de la pluralité de trains planétaires et/ou le troisième groupe de la pluralité de trains planétaires,
caractérisé en ce que
le premier embrayage (166), lorsqu'il est en prise, accouple à demeure l'élément d'entrée (102) au porte-satellites (132) du deuxième train planétaire (110) et à la couronne (156) du quatrième train planétaire (114) ; le deuxième embrayage (168), lorsqu'il est en prise, accouple à demeure l'élément d'entrée (102) au porte-satellites (122) du premier train planétaire (108) et au porte-satellites (142) du troisième train planétaire (112) ; et le troisième embrayage (170), lorsqu'il est en prise, accouple à demeure l'élément d'entrée (102) à la roue solaire (120) du premier train planétaire (108).

2. Transmission (100) selon la revendication 1, l'élément de sortie (104) étant accouplé à demeure au quatrième train planétaire (114), et éventuellement, l'élément de sortie (104) étant en outre accouplé à demeure au troisième train planétaire (112).

3. Transmission (100) selon la revendication 1 ou la revendication 2, comprenant en outre :

un premier dispositif d'intercommunication (180) qui accouple à demeure la roue solaire (130) du deuxième train planétaire (110), la roue solaire (140) du troisième train planétaire (112) et la roue solaire (150) du quatrième train planétaire (114) ensemble ;
un deuxième dispositif d'intercommunication (182) qui accouple à demeure le porte-satellites (132) du deuxième train planétaire (110) à la couronne (156) du quatrième train planétaire

(114) ;
un troisième dispositif d'intercommunication (184) qui accouple à demeure la couronne (126) du premier train planétaire (108) à la couronne (136) du deuxième train planétaire (110) ; et
un quatrième dispositif d'intercommunication (186) qui accouple à demeure le porte-satellites (122) du premier train planétaire (108) au porte-satellites (142) du troisième train planétaire (112), la pluralité de coupleurs sélectifs (162, 164, 166, 168, 170, 172) comportant le premier embrayage (166), le deuxième embrayage (168), le troisième embrayage (170), un quatrième embrayage (172), un premier frein (162) accouplé à demeure à l'au moins un élément fixe (106), et un second frein (164) accouplé à demeure à l'au moins un élément fixe (106).

4. Transmission (100) selon la revendication 3,

le premier frein (162), lorsqu'il est en prise, accouplant à demeure la roue solaire (130) du deuxième train planétaire (110), la roue solaire (140) du troisième train planétaire (112) et la roue solaire (150) du quatrième train planétaire (114) à l'au moins un élément fixe (106) ;
le second frein (164), lorsqu'il est en prise, accouplant à demeure la couronne (146) du troisième train planétaire (112) à l'au moins un élément fixe (106) ;
le premier embrayage (166), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) au porte-satellites (132) du deuxième train planétaire (110) et à la couronne (156) du quatrième train planétaire (114) ;
le deuxième embrayage (168), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) au porte-satellites (122) du premier train planétaire (108) et au porte-satellites (142) du troisième train planétaire (112) ;
le troisième embrayage (170), lorsqu'il est en prise, accouplant à demeure l'élément d'entrée (102) à la roue solaire (120) du premier train planétaire (108) ; et
le quatrième embrayage (172), lorsqu'il est en prise, accouplant à demeure la couronne (146) du troisième train planétaire (112) à la roue solaire (120) du premier train planétaire (108).

5. Transmission (100) selon l'une quelconque des revendications précédentes, chacun du premier train planétaire (108), du deuxième train planétaire (110), du troisième train planétaire (112) et du quatrième train planétaire (114) étant un train planétaire simple.

6. Transmission (100) selon l'une quelconque des revendications précédentes, l'au moins un élément fixe (106) comportant un logement, le logement ayant une première extrémité (116) et une seconde extrémité (118),

l'élément d'entrée (102) étant accessible à proximité de la première extrémité (116) du logement ;
l'élément de sortie (104) étant accessible à proximité de la seconde extrémité (118) du logement ;
le premier train planétaire (108) étant positionné entre la première extrémité (116) du logement et le deuxième train planétaire (110) ;
le deuxième train planétaire (110) étant positionné entre le premier train planétaire (108) et le troisième train planétaire (112) ;
le troisième train planétaire (112) étant positionné entre le deuxième train planétaire (110) et le quatrième train planétaire (114) ; et
le quatrième train planétaire (114) étant positionné entre le troisième train planétaire (112) et la seconde extrémité (118) du logement.

7. Transmission (100) selon l'une quelconque des revendications précédentes, la pluralité de coupleurs sélectifs (162, 164, 166, 168, 170, 172) étant sélectivement en prise dans une pluralité de combinaisons pour établir au moins neuf rapports de vitesse avant et au moins un rapport de vitesse de marche arrière entre l'élément d'entrée (102) et l'élément de sortie (104), chacune de la pluralité de combinaisons ayant au moins trois coupleurs sélectifs de la pluralité de coupleurs sélectifs en prise.

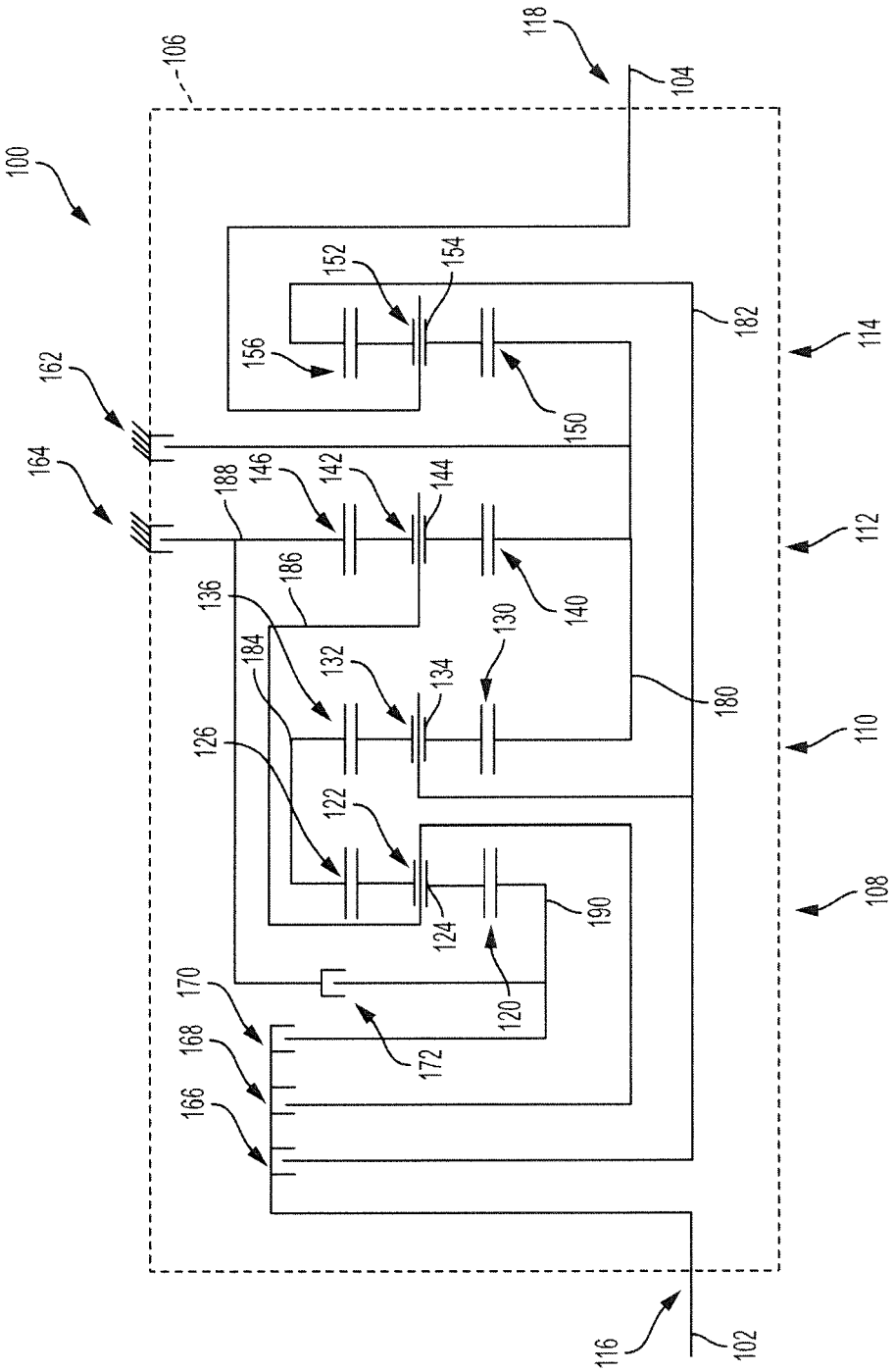
100
102
104
106
108
110
112
114
116
118
120
122
124
126
130
132
134
136
140
142
144
146
150
152
154
156
162
164
166
168
170
172
180
182
184
186
188
190

FIG. 1

			CLUTCH APPLY TABLE					
RANGE	RATIO	STEP	162	164	166	168	170	172
REV	-2.66		1	1			1	
1	3.32	-0.80	1				1	1
2	2.35	1.41	1			1		1
3	1.73	1.36	1			1	1	
4	1.36	1.27	1		1	1		
5	1.00	1.36			1	1		1
6	0.84	1.18		1	1			1
7	0.71	1.19		1	1		1	
8	0.61	1.16		1	1	1		
9	0.49	1.23		1		1	1	
10	0.42	1.19		1		1		1

"1" = ENGAGED CONFIGURATION
"BLANK" = DISENGAGED CONFIGURATION

FIG. 2

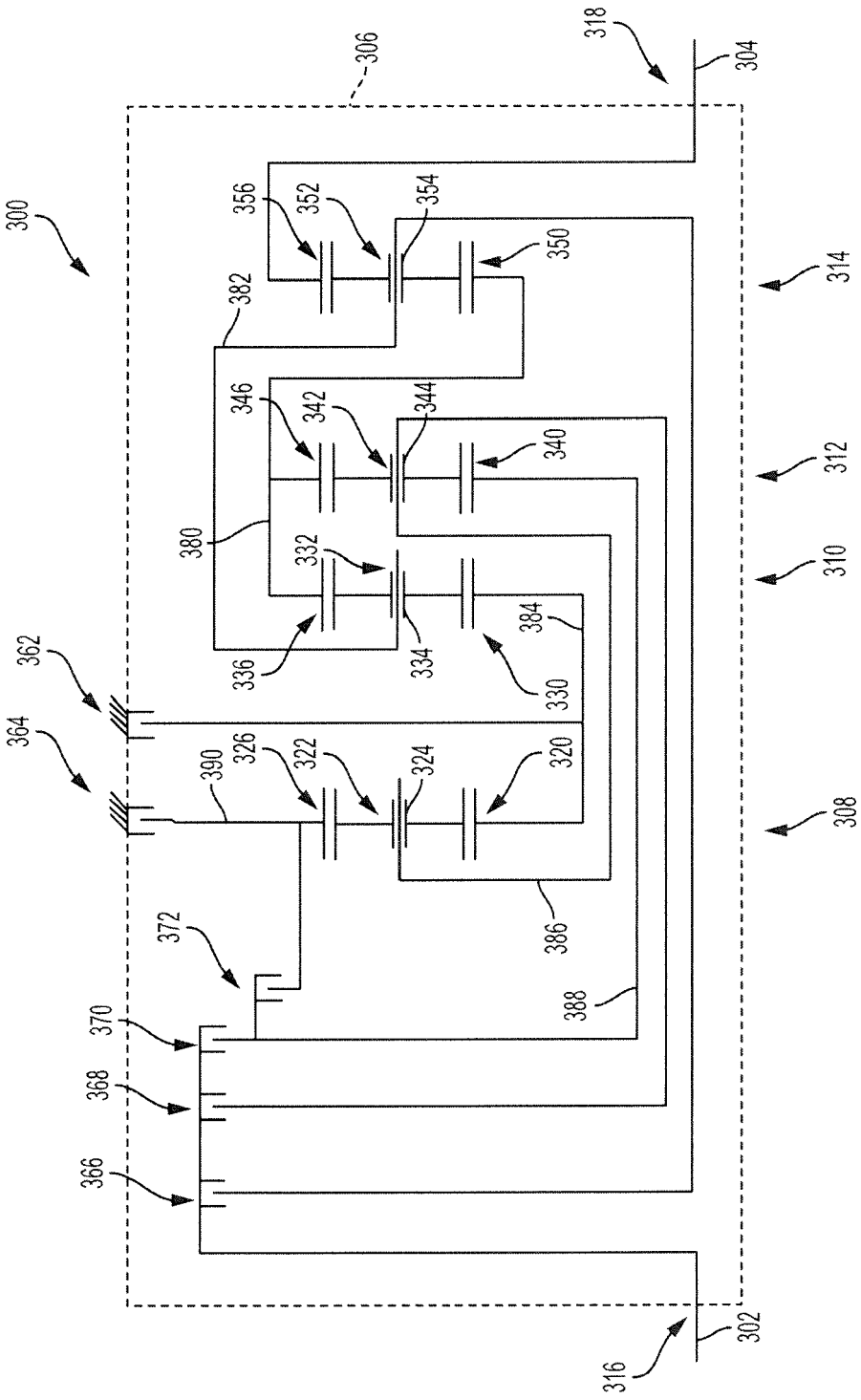
300
302
304
306
308
310
312
314
316
318
320
322
324
326
330
332
334
336
340
342
344
346
350
352
354
356
362
364
366
368
370
372
380
382
384
386
388
390

FIG. 3

RANGE	RATIO	STEP	CLUTCH APPLY TABLE					
			362	364	366	368	370	372
REV	-3.34		1	1			1	
1	3.54	-0.94	1				1	1
2	2.46	1.44	1			1		1
3	1.86	1.32	1			1	1	
4	1.34	1.39	1		1	1		
5	1.00	1.34			1	1		1
6	0.87	1.15		1	1			1
7	0.76	1.14		1	1		1	
8	0.64	1.20		1	1	1		
9	0.49	1.30		1		1	1	
10	0.43	1.15		1		1		1

"1" = ENGAGED CONFIGURATION
"BLANK" = DISENGAGED CONFIGURATION

FIG. 4

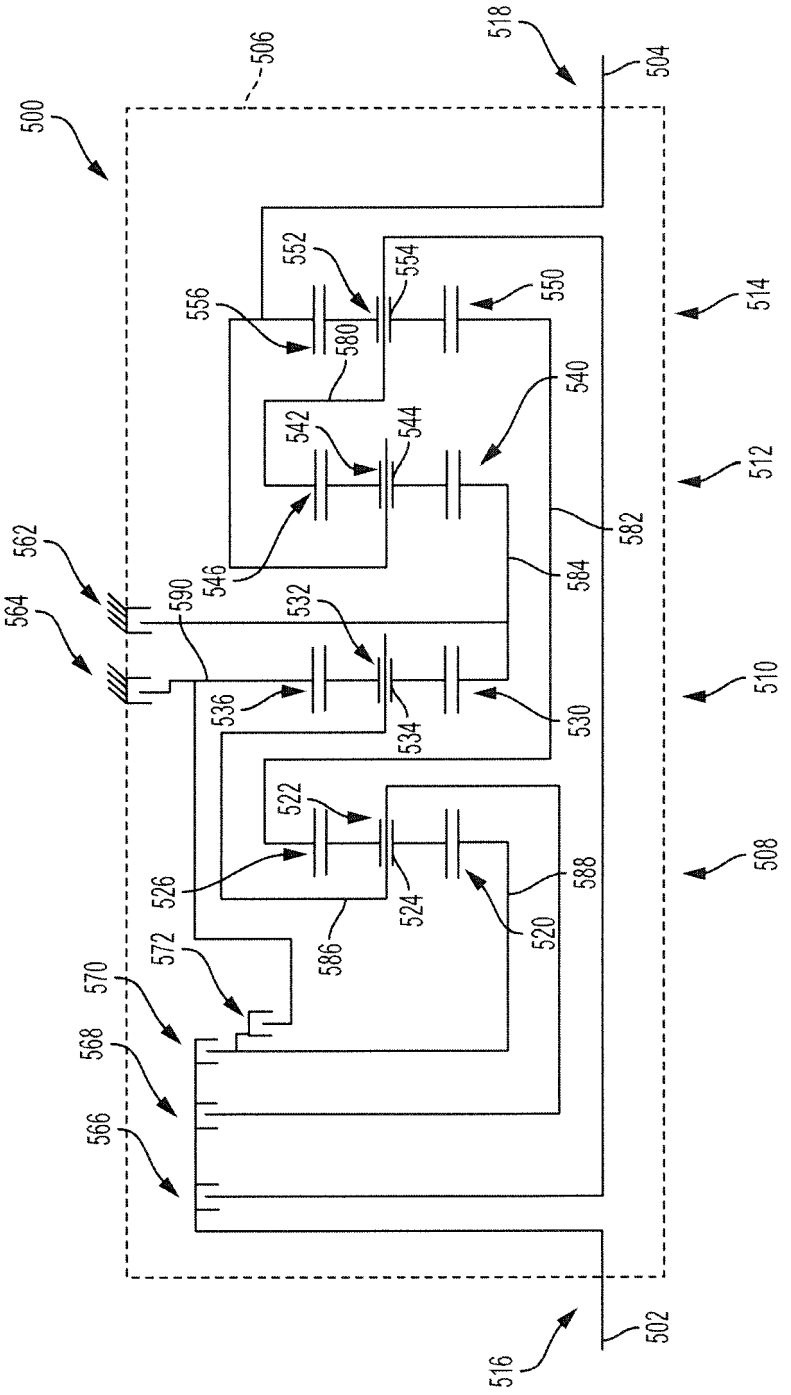
500
502
504
506
508
510
512
514
516
518
520
522
524
526
530
532
534
536
540
542
544
546
550
552
554
556
562
564
566
568
570
572
580
582
584
586
588
590

FIG. 5

			CLUTCH APPLY TABLE					
RANGE	RATIO	STEP	562	564	566	568	570	572
REV	-3.02		1	1			1	
1	3.43	-0.88	1				1	1
2	2.46	1.40	1			1		1
3	1.86	1.32	1			1	1	
4	1.34	1.39	1		1	1		
5	1.00	1.34			1	1		1
6	0.86	1.16		1	1			1
7	0.74	1.16		1	1		1	
8	0.61	1.22		1	1	1		
9	0.46	1.32		1		1	1	
10	0.40	1.15		1		1		1

"1" = ENGAGED CONFIGURATION
"BLANK" = DISENGAGED CONFIGURATION

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20160047440 A **[0002] [0010]**
- US 14457592 B **[0002]**
- EP 2817536 A1 **[0002]**