



(51) International Patent Classification:
F16H 37/02 (2006.01)

(21) International Application Number:
PCT/IN2009/000122

(22) International Filing Date:
24 February 2009 (24.02.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
451/CHE/2008 22 February 2008 (22.02.2008) IN

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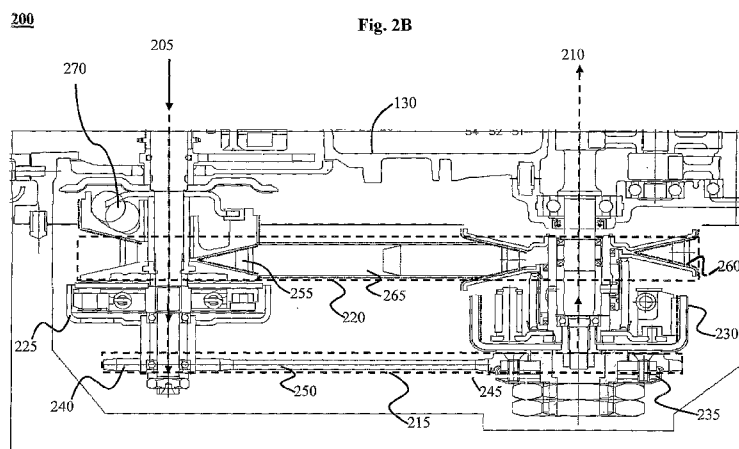
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM,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

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) Title: AUTOMATIC HYBRID TRANSMISSION SYSTEM



(57) Abstract: The present subject matter relates to an automatic hybrid transmission (AHT) system (200). The AHT system includes a fixed speed transmission mechanism (FSTM) (215), a continuously variable transmission mechanism (CVTM) (220), and a clutch mechanism. The clutch mechanism further includes a first clutch (225), a second clutch (230), and a one-way clutch (235). The first clutch (225) operationally engages the FSTM (215) to an output shaft (210) at a first preset rpm value of a prime mover (125). Whereas, the second clutch (230) operationally engages the CVTM (220) to the output shaft (210) at a second preset rpm value of the prime mover (125). A one-way clutch (235) disengages the FSTM (215) from the output shaft (210) at an instance when the CVTM (220) is engaged.



AUTOMATIC HYBRID TRANSMISSION SYSTEM

TECHNICAL FIELD

The subject matter described herein in general relates to an automatic hybrid transmission system, and in particular relates to an automatic hybrid transmission system having a continuously variable transmission mechanism and a fixed speed transmission mechanism.

BACKGROUND

Transmission systems are required to transmit power from one rotating member to another rotating member of an equipment, machine or vehicle through various transmission components including, for example, shafts, gears, pulleys, etc. A typical transmission system provides adequate torque needed to rotate rotating members of a machine under a variety of load conditions. The overall performance of the machine is dependent on the transmission mechanism employed. In general, there are two types of transmission mechanisms: a continuously variable transmission mechanism (CVTM) and a fixed speed transmission mechanism (FSTM). Both of these transmission mechanisms have certain operating conditions under which the mechanisms work most efficiently to provide optimum transmission output.

In use, the CVTM provides a range of continuously varying transmission ratios. The CVTM, in general, employs a driver pulley, a driven pulley, and a belt. The belt operationally connects the driver and driven pulleys. The varied range of transmission ratios can be achieved through varying the diameters of driver and driven disk/pulley engagements. While doing so, the belt has to be adjusted to accommodate the change in diameters. However, in the process, frequent belt slips take place, which results in transmission losses and reduced efficiency. The phenomenon of belt slip is more predominant at low speeds and when there is a frequent change in the acceleration of the rotating members. Belt slippage is low at high speed and where rotating members rotate at a relatively constant acceleration, in which case the CVTM achieves maximum power output without compromising on the transmission efficiency. Thus, the CVTM is preferred in applications where acceleration of rotating members is relatively constant like small tractors, drill press, etc., while they have limited applicability in applications like automobiles meant for city driving.

In contrast, the FSTM can provide one or more fixed transmission ratios by employing one or more transmission drivers such as gear drive, belt pulley drive, chain

sprocket drive, etc. However, the number of transmission ratios that can be achieved in the FSTM is limited, hence, power transmission is not smooth. Still, the FSTM, as compared to the CVTM, provides a better initial acceleration for rotating members. Even more, the FSTM provides a suitable transmission ratio at low speeds. However, at high speeds and constant speed conditions, the FSTM does not provide the desired transmission ratios for achieving maximum speed and smooth operation.

Therefore, a transmission system is required that provides high transmission efficiency at all operating speeds irrespective of frequent acceleration.

SUMMARY

The subject matter as described herein is directed towards an automatic hybrid transmission (AHT) system including a fixed speed transmission mechanism (FSTM) and a continuously variable transmission mechanism (CVTM).

According to one embodiment of the present subject matter, the AHT system includes, in addition to the FSTM and the CVTM, a clutch mechanism. The clutch mechanism transmits power from an input shaft to an output shaft by automatically selecting either the FSTM or the CVTM. The input shaft is operationally connected to a prime mover, such as an IC engine, whereas the output shaft is operationally coupled to the wheel of a vehicle, equipment, or a machine. The clutch mechanism includes a first clutch, a second clutch, and a one-way clutch. The first clutch operationally engages the FSTM to the output shaft at a first preset rpm (revolution per minute) range of the prime mover. The second clutch operationally engages CVTM to the output shaft at a second preset rpm value of the prime mover. The first preset rpm value is a relatively lower rpm of the input shaft whereas the second preset rpm value is a relatively higher rpm of the input shaft. Thus, the AHT system advantageously provides for utilizing the FSTM at a low rpm range and the CVTM at a high rpm range. Further, the one-way clutch is disposed between the second rotating member and the output shaft for operationally disengaging the FSTM from the output shaft at the instance when the CVTM is engaged.

In one implementation, the first clutch and the second clutch are centrifugal clutches, which engage or disengage based on preset rpm values. Moreover a pulley roller mechanism based on the rpm of the input shaft governs the speed ratio of the CVTM. The centrifugal clutches along with the CVTM renders the operation of the AHT transmission system automatic, requiring no operator's intervention.

The aforesaid AHT system transmits power through the FSTM at relatively low speeds and through the CVTM at relatively high speeds. Hence, the AHT system provides a hybrid transmission system incorporating advantages of both. The AHT system can be used in various applications such as automobiles, machine tools, etc. In a specific
5 implementation, the AHT system is employed in a vehicle, such as, for example, a two-wheeler.

These and other features, aspects, and advantages of the present subject matter will become better understood with reference to the following description and appended claims. This summary is provided to introduce a selection of concepts in a simplified
10 form. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features, aspects and advantages of the subject matter will
15 become better understood with regard to the following description, appended claims, and accompanying drawings where:

Fig.1 illustrates a side view of an exemplary two-wheeled vehicle having an automatic hybrid transmission (AHT) system in accordance with an embodiment of the present subject matter.

Fig.2A shows a front view of the AHT system of **Fig.1**.

Fig.2B shows a top sectional view of the AHT system, as shown in **Fig.2A**.

DETAILED DESCRIPTION

The subject matter described herein is directed to an automatic hybrid transmission (AHT) system having a combination of a fixed speed transmission mechanism (FSTM)
25 and a continuously variable transmission mechanism (CVTM).

In one embodiment, the AHT system is employed in a two-wheeled vehicle, for example, a motorcycle, scooter, step-through vehicle, all terrain bikes, etc. The AHT system described herein, for the purpose of illustration, has been explained in the context of a two-wheeler. However, the AHT system can also be employed in three-wheelers,
30 four-wheeled vehicles and hybrid vehicles, and so on. Furthermore, the automatic hybrid transmission system can be employed in various other equipment and machines, such as, snowmovers, machine tools, conveyors, etc..

The AHT system is deployed in a two-wheeled vehicle to transmit power from an input shaft to an output shaft of the vehicle. Further, the AHT system includes an FSTM, a CVTM and a clutch mechanism. The input shaft is operationally connected to a prime mover, for example, an electric motor or an internal combustion engine. The output shaft selectively transmits output power in response to input power provided by the input shaft. The output shaft is operationally connected to a rear wheel of the two-wheeled vehicle. The FSTM provides fixed speed ratios whereas the CVTM provides a range of continuously varying speed ratios.

The FSTM includes a first rotating member mounted on the input shaft, a second rotating member mounted on the output shaft, and a first transmission member, which operationally interconnects the first rotating member and the second rotating member. In one embodiment, the FSTM may be a chain sprocket drive, gear drive, or a belt pulley drive. The CVTM includes a third rotating member mounted on the input shaft, a fourth rotating member mounted on the output shaft, and a second transmission member, which operationally interconnects the third rotating member and the fourth rotating member. The CVTM may be a V-belt pulley drive. The clutch mechanism selectively engages and disengages the FSTM and the CVTM to transmit power from the input shaft to the output shaft

Further, the clutch mechanism includes a first clutch, a second clutch, and a one-way clutch. The first clutch operationally engages the FSTM to the output shaft, thereby transmitting the input power to the output shaft during a first preset range of rpm of the prime mover. When the rpm of the input shaft exceeds the first preset range of rpm, the second clutch operationally engages the CVTM to the output shaft, thereby transmitting the input power to the output shaft during a second preset range of rpm of the prime mover. The one-way clutch disposed between the second rotating member and the output shaft operationally disengages the FSTM from the output shaft, at the instance at which the second clutch engages the CVTM to the output shaft. Thus, during the first preset range of rpm, power to the output shaft is transmitted through the FSTM whereas during the second preset range of rpm, power is transmitted through the CVTM.

The first preset range of rpm usually occurs when the vehicle is running at a relatively low speed and when the frequency of the speed variation is high, for example, while riding in city traffic conditions. When the vehicle operates within the first preset range of rpm, the first clutch is engaged, thus transmitting the power through the FSTM.

When the rpm of the prime mover exceeds the first preset range of rpm, the vehicle operates at the second preset range of rpm. The second preset range of rpm occurs under a condition where the vehicle is moving at a relatively high speed and frequency of speed variation is less, for example, highway driving conditions. While the vehicle operates at the second preset range of rpm, the second clutch is engaged; thereby power is transmitted through the CVTM. Also, the one-way clutch operationally disengages the FSTM from the AHT system. This ensures that at a given instance, only one transmission mechanism is operationally engaged to the output shaft within the AHT system.

Fig.1 illustrates a side view of an exemplary two-wheeled vehicle **100** having an automatic hybrid transmission (AHT) system (shown in the Fig. 2) in accordance with an embodiment of the present subject matter. The embodiments disclosed herein are described in the context of a step-through two-wheeler. However, the embodiments and the subject matter herein can also be applied to other vehicles, such as step-over two-wheelers, all terrain vehicles, and other vehicles with more than two wheels.

As used herein, the terms “front”, “rear”, “left”, “right”, “up”, and “down”, correspond to the position assumed by a rider of the vehicle with respect to the direction in which he is facing. The two-wheeled vehicle **100** includes a frame **105** for supporting a handlebar **110** disposed towards a front end thereof. The frame **105** is rested on a chassis, which is further supported on a front wheel **115** and a rear wheel **120** at two distant ends of the vehicle **100**. A prime mover **125**, along with a transmission case **130**, is mounted on the chassis. In different embodiments, the prime mover **125** can be a motor, an internal combustion (IC) engine, or both.

The prime mover **125**, for example, an IC engine **125**, generates power for driving the two-wheeled vehicle **100**. Depending upon the load and the road conditions, the AHT system selectively transmits power from the IC engine **125** to a traction member of the two-wheeled vehicle **100**. The traction member herein includes the rear wheel **120**. The AHT system is enclosed by the transmission case **130**.

Fig.2A shows a front view of an exemplary AHT system **200** for a two-wheeled vehicle such as the two-wheeled vehicle **100**.

Fig.2B shows a top sectional view of the exemplary AHT system **200** of **Fig.2A**, along a sectional line A-A’.

As shown in **Fig.2A** and **Fig.2B**, according to an embodiment of the present subject matter, the AHT system **200** includes an input shaft **205**, an output shaft **210**, an

FSTM 215, a CVTM 220, and a clutch mechanism. The clutch mechanism further includes a first clutch 225, a second clutch 230, and a one-way clutch 235. The AHT system 200 is enclosed in the transmission case 130 and selectively transfers power from the IC engine 125 to the rear wheel 120.

5 The FSTM 215 includes a first rotating member 240 mounted on the input shaft 205, a second rotating member 245 mounted on the output shaft 210, and a first transmission member 250, which operationally interconnects the first rotating member 240 and the second rotating member 245.

10 In one implementation, the FSTM 215 is a chain sprocket drive wherein the first rotating member 240, the second rotating member 245, and the first transmission member 250 are respectively a driver sprocket, a driven sprocket, and a chain. In another implementation, the FSTM 215 can be a belt drive wherein the first rotating member 240, the second rotating member 245, and the first transmission member 250 are respectively a driving pulley, a driven pulley, and a belt.

15 The CVTM 220 includes a third rotating member 255 mounted on the input shaft 205, a fourth rotating member 260 mounted on the output shaft 210, and a second transmission member 265, which operationally interconnects the third rotating member 255 and the fourth rotating member 260.

20 In one implementation, the CVTM 220 is a V-belt drive wherein the third rotating member 255, the fourth rotating member 260, and the second transmission member 265 are respectively a driver pulley, a driven pulley, and a V-belt. The third rotating member 255 and fourth rotating member 260 are interchangeably referred to as the driver pulley 255 and driven pulley 260 respectively, hereinafter. Each of the driver pulley 255 and driven pulley 260 has two coaxial conical parts facing such that the face with a smaller
25 diameter of each part faces each other. The two conical parts are mounted in such a way that one is fixed while the other is movable axially. The second transmission member 265 interchangeably is referred to as the V-belt 265 hereinafter.

30 The driver pulley 255 and the driven pulley 260 provide a variable engagement diameter to the V-belt 265 by varying the distance between the two conical parts. The distance can be controlled or varied by a pulley roller mechanism, including a roller 270 that is operationally connected to the driver pulley 255, based on the rpm value of the input shaft 205.

Further, the first clutch 225 is mounted on the input shaft 205 and is operationally coupled to the first rotating member 240. The second clutch 230 is mounted on the output shaft 210 and is operationally coupled to the fourth rotating member 260. The one-way clutch 235 is mounted on the output shaft 210 and is operationally coupled to the second rotating member 235

In one implementation, the first clutch 225 and the second clutch 230 are centrifugal clutches. Either of the first clutch 225, interchangeably referred to as first centrifugal clutch 225 hereinafter, and the second clutch 230, interchangeably referred to as second centrifugal clutch 225 hereinafter, engage whenever the rpm value of the IC engine 125 exceeds preset values.

The input shaft 205 is operationally connected to the IC engine 125, whereas the output shaft 210 is operationally connected to the rear wheel 120. In one embodiment, the output shaft 210 is connected to the rear wheel 120 through secondary a gear box. In another embodiment, the output shaft 210 is directly connected to the rear wheel 120.

The IC engine 125 has a number of ranges of rpm identified through different preset rpm values, wherein the first preset rpm range is always lower than the second preset rpm range.

During the first preset range of rpm, preferably during the city riding conditions, the power transmission to the rear wheel 120 operationally takes place through the FSTM 215. While during the second preset range of rpm, preferably during highway riding conditions, the power transmission to the rear wheel 120 operationally takes place through the CVTM 220.

When the IC engine 125 is cranked, the input shaft 205 drives the shoes of the first clutch 225. When throttle is increased to move the vehicle 100 and when rpm of the IC engine 125 exceeds the lower limit of first preset rpm range, which is above the idling speed, the shoes of the first clutch 225 are engaged. This drives the first rotating member 240, which is coupled to the first clutch 225. The rotational movement of the first rotating member 240 is transmitted to the second rotating member 245 by means of the first transmission member 250. The rotational movement of the second rotating member 245 is transmitted to the output shaft 210 via the one-way clutch 235. Torque transmitted to the output shaft 210 is thereby transferred to the rear wheel 120, which consequently provides traction force for driving the two-wheeled vehicle 100.

During the first preset range of rpm, the third rotating member 255 also rotates with the input shaft 205. The rotational movement of the third rotating member 255 is operationally transferred to the fourth rotating member 260 by means of the second transmission member 265. The rotational movement of the fourth rotating member 260 is transferred to the shoes of the second clutch 230. The shoes of the second clutch 230 remain disengaged and the second clutch 230 freely rotates along with the fourth rotating member 260, about the output shaft 210. Thus, during the first preset rpm range, torque is not transferred by the CVTM 220 to the output shaft 210.

Furthermore, when the rpm of IC engine 125 is further increased, the rpm reaches the lower limit of the second preset rpm range, which is equal to the higher limit of the first preset rpm range. At this moment, the shoes of the second clutch 230 get engaged, thereby transferring torque from the CVTM 220 to the output shaft 210.

During the second preset range of rpm, the one-way clutch 235 disengages, operationally disengaging the second rotating member 235 from the output shaft 210. The one way clutch 235 and second clutch 230 are coupled in such a way that when second clutch 230 engages the one way clutch 235 disengages. As a result, the FSTM 215 is operationally disengaged from the output shaft 210. This ensures that at a given instance, only one transmission mechanism is in operation.

Further, during the first range of rpm, power is operationally transferred by means of the FSTM 215. The employment of the FSTM 215 during the first range of rpm ensures availability of high torque at low speeds with high transmission efficiency. On the other hand, during the second range of rpm, power is operationally transferred by means of the CVTM 220. The employment of the CVTM 220 during the second range of rpm ensures that better acceleration and maximum speed is achieved, and that too, without compromising on transmission efficiency. The hybrid transmission system 135 provides higher transmission efficiency both for city and highway riding conditions and at various speeds and acceleration levels.

In an embodiment, the first centrifugal clutch 225 and the second centrifugal clutch 230 engage or disengage based on the preset rpm values of the prime mover 125. Moreover, the pulley roller mechanism, based on the rpm value of prime mover 125, governs the speed ratio of the CVTM 220. The transmission ratio of the AHT 200 varies automatically during the entire speed range of the vehicle 100. The centrifugal clutches along with the CVTM 220, which is governed by pulley roller mechanism, renders the

operation of the AHT system **200** automatic, requiring no intervention from a rider of the vehicle **100**.

Although the subject matter has been described in considerable detail with reference to certain preferred embodiments thereof, other embodiments are possible. As
5 such, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiment contained therein.

I/We claim:

1. An automatic hybrid transmission (AHT) system (200), said system (200) comprising:
 - 5 a fixed speed transmission mechanism (FSTM) (215);
 - a continuously variable transmission mechanism (CVTM) (220); and
 - a clutch mechanism;
 - characterized in that,
 - said clutch mechanism transmits power from an input shaft (205) to an
 - 10 output shaft (210) by automatically selecting either said (FSTM) (215) or said (CVTM) (220).
2. The system (200) as claimed in claim 1, wherein said clutch mechanism comprising:
 - 15 a first clutch (225) for operationally engaging said FSTM (215) to said output shaft (210) for a first preset range of rpm values of a prime mover (125);
 - a second clutch (230) for operationally engaging said CVTM (220) to said output shaft (210) for a second preset range of rpm values of said prime mover (125);
 - 20 a one-way clutch (235) disposed between said FSTM (215) and said output shaft (210), wherein said one-way clutch (235) operationally disengages said FSTM (215) from said output shaft (210) at the instance said CVTM (220) is engaged to said output shaft (210) and wherein said one-way clutch (235) engages said FSTM (215) to said output shaft (210) at the instance said CVTM (220) is
 - 25 disengaged from said output shaft (210).
3. The system (200) as claimed in claim 2, wherein said first clutch (225) and second clutch (230) are centrifugal clutches.
- 30 4. The system (200) as claimed in claim 1, wherein said FSTM (215) comprises a driver gear and a driven gear, wherein said driver gear is operationally coupled to said driven gear.
5. The system (200) as claimed in claim 1, wherein said FSTM (215) comprises a first rotating member (240) mounted on said input shaft (205), a second rotating

member (245) mounted on said output shaft (210) and a first transmission member (250) operationally interconnecting said first rotating member (240) and said second rotating member (245).

- 5 6. The system (200) as claimed in claim 5, wherein said first rotating member (240), said second rotating member (245), and said first transmission member (250) are a driver sprocket, a driven sprocket, and a chain respectively.
- 10 7. The system (200) as claimed in claim 5, wherein said first rotating member (240), said second rotating member (245), and said first transmission member (250) are a driver pulley, a driven pulley, and a belt respectively.
- 15 8. The system (200) as claimed in claim 1, wherein said CVTM (220) comprising a third rotating member (255) mounted on said input shaft (205), a fourth rotating member (260) mounted on said output shaft (210), and a second transmission member (265) operationally interconnecting said third rotating member (255) and said fourth rotating member (260).
- 20 9. The system (200) as claimed in claim 8, wherein said third rotating member (255), said fourth rotating member (260), and said second transmission member (265) are a driver pulley, a driven pulley, and a V-belt respectively.
- 25 10. The system (200) as claimed in claim 9, wherein said driver pulley and said driven pulley provide variable engagement diameters to said V-belt, wherein said engagement diameters vary according to speed of rotation of said input shaft (205).
- 30 11. The system (200) as claimed in claim 10, wherein said engagement diameter of driver pulley and driven pulley is controlled by a pulley roller mechanism.
- 35 12. The system (200) as claimed in claim 2, wherein said one-way clutch (235) is disposed between a second rotating member (245) and said output shaft (210).
13. The system (200) as claimed in claim 2, wherein said first clutch (225) is mounted on said input shaft (205), said second clutch (230) and said one-way clutch (235) are mounted on said output shaft (210).

14. The system (200) as claimed in claim 1, wherein said input shaft (205) is connected to a prime mover (125) wherein said prime mover (125) is an internal combustion engine.

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15. A two- wheeled vehicle (100) comprising said automatic hybrid transmission (AHT) system (200), as claimed in any of the preceding claims.

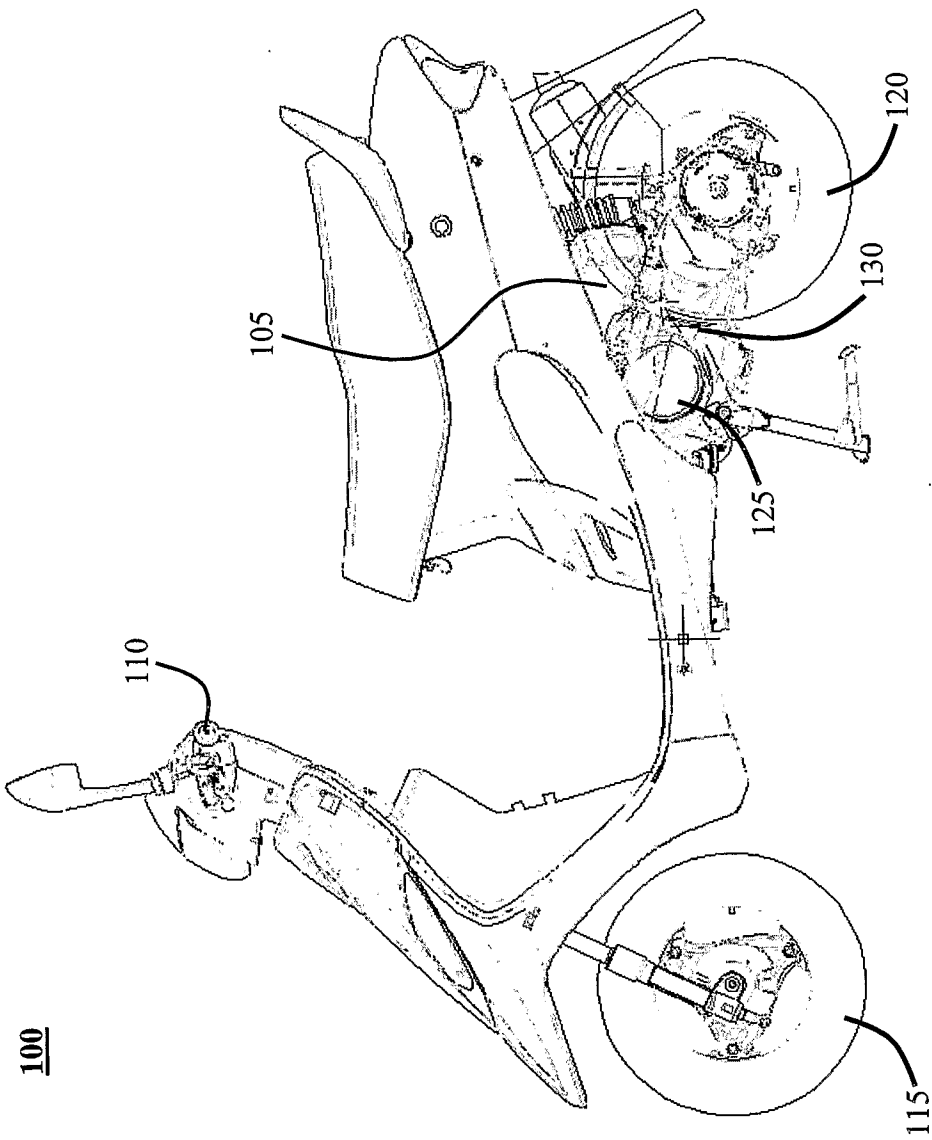


Fig. 1

200

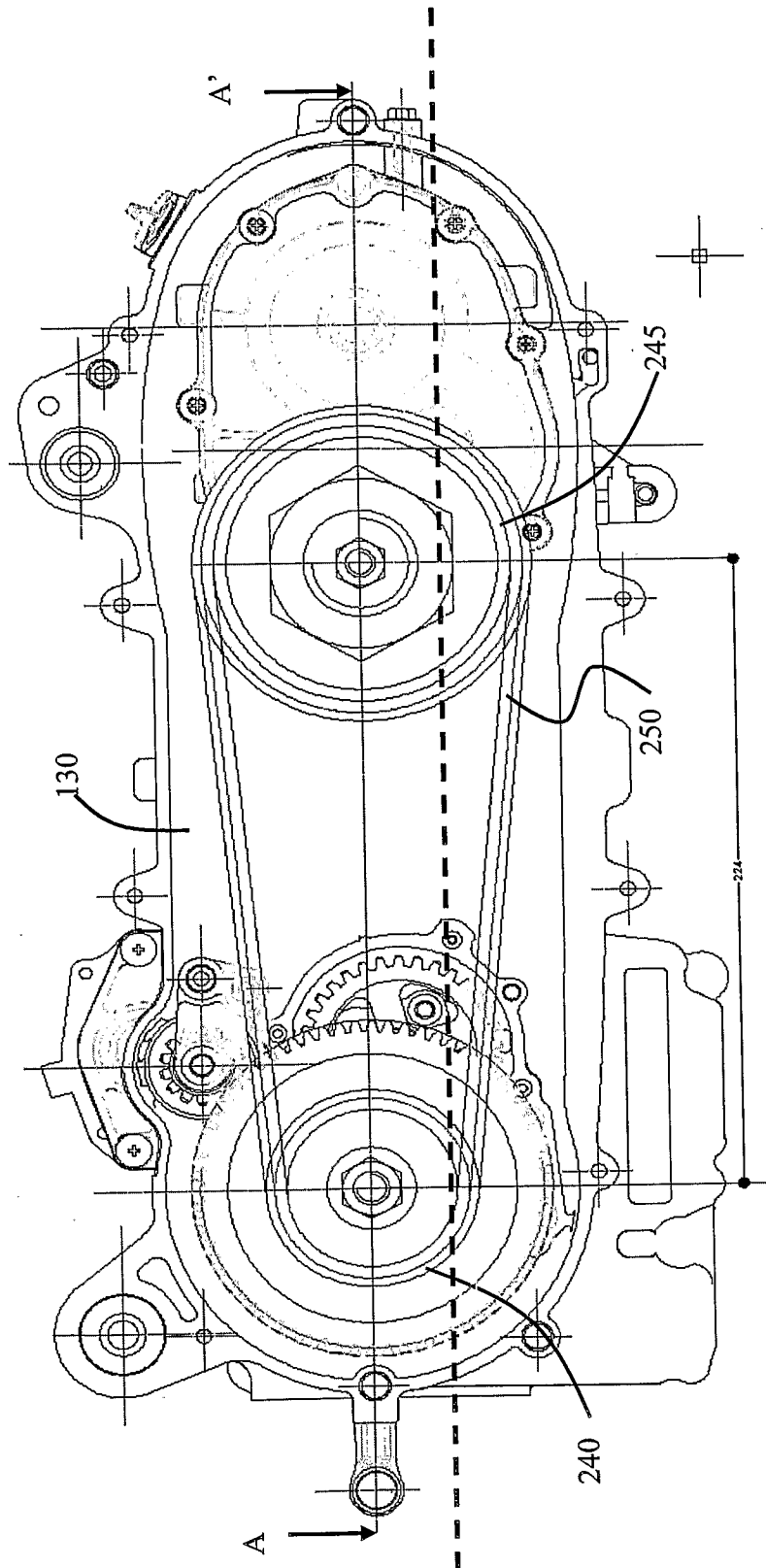


Fig. 2A

200

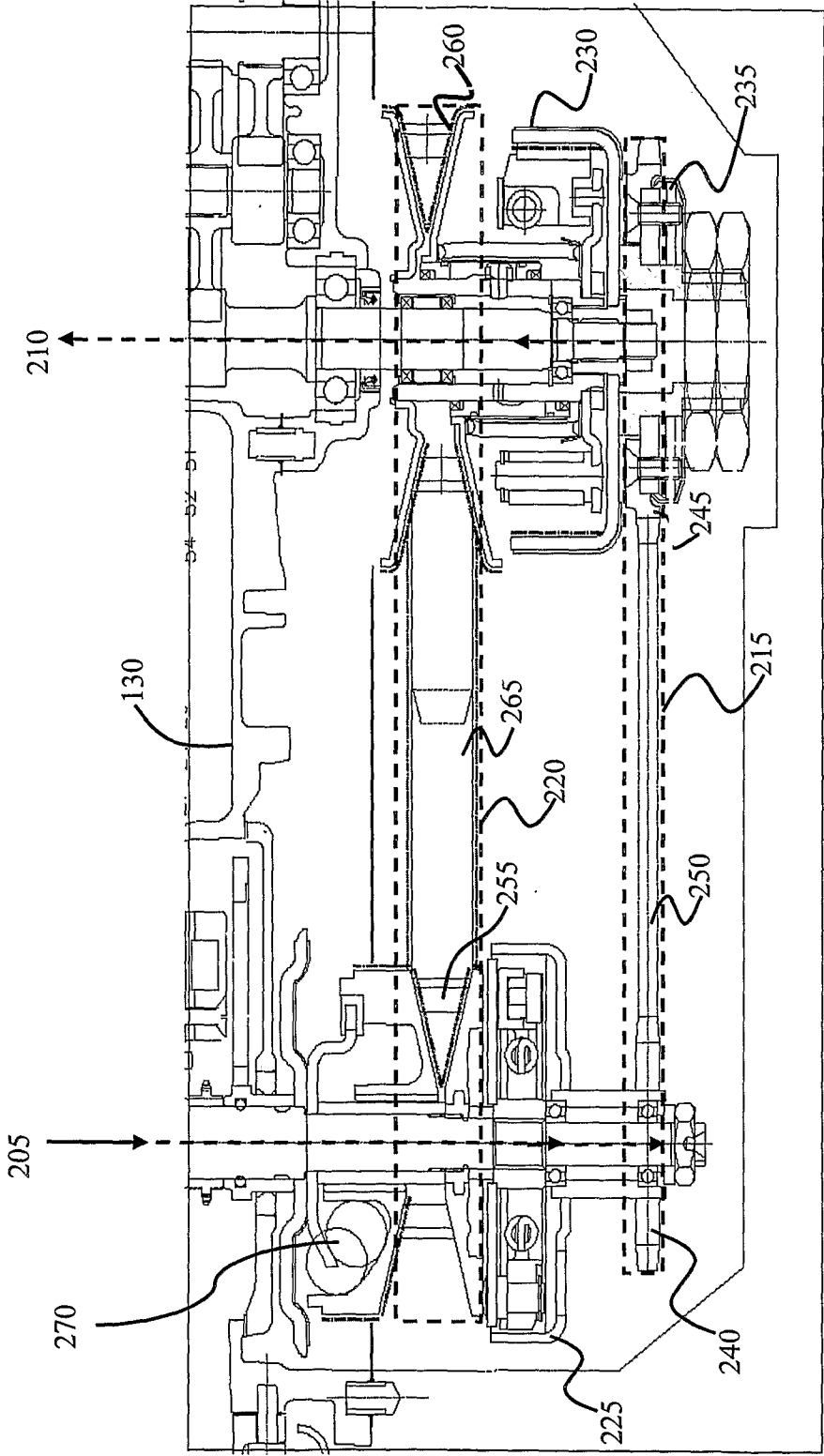


Fig. 2B