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(54) **TRANSMISSION**

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(60) Provisional application No. 60/866,993, filed on Nov. 22, 2006.

(51) **Int. Cl.**
F16H 3/72 (2006.01)
F16H 37/08 (2006.01)

(52) **U.S. Cl.** **475/5**; 475/9; 475/201

(58) **Field of Classification Search** 475/5, 6, 475/9, 151, 201, 218, 225
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,386,540 A 10/1945 Campodonico
5,823,281 A 10/1998 Yamaguchi et al.
6,327,935 B1 12/2001 Joslin et al.
6,428,438 B1 8/2002 Bowen
6,478,705 B1 11/2002 Holmes et al.
6,631,651 B2 10/2003 Petrzik
6,811,508 B2 11/2004 Tumback
6,852,054 B2 * 2/2005 Tumback et al. 475/5
6,957,731 B2 10/2005 Lawson, Jr.
7,073,407 B2 7/2006 Stefina
7,107,870 B2 9/2006 Kuhstrebe et al.
7,155,993 B2 1/2007 Koenig et al.
7,163,480 B2 1/2007 Supina et al.
7,220,200 B2 5/2007 Sowul et al.
7,261,660 B2 8/2007 Sowul et al.
7,300,374 B2 11/2007 Bucknor et al.
7,631,719 B2 * 12/2009 Wenthen 180/243
2003/0069103 A1 * 4/2003 Ibamoto et al. 475/5
2003/0199353 A1 10/2003 Bowen
2005/0288149 A1 12/2005 Kuhstrebe et al.
2006/0101932 A1 5/2006 McCrary

* cited by examiner

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(57) **ABSTRACT**

A motor vehicle transmission includes a power splitter connected with the vehicle engine and having two outputs. A differential and a clutch are connected with the outputs of the splitter. Separate gearboxes including alternating sequential gear mechanisms are connected with the differential and clutch. The differential and clutch are independently operated under control of an electronic control unit to provide continuous flow of power from the engine to the gearboxes which may be simultaneously operated.

10 Claims, 5 Drawing Sheets

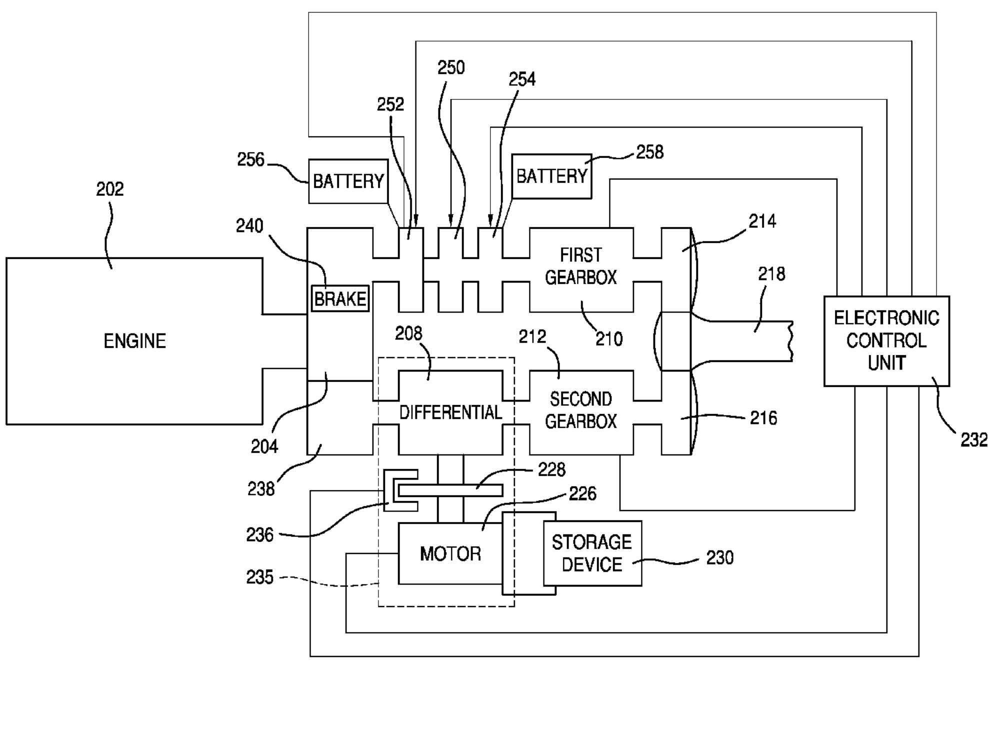
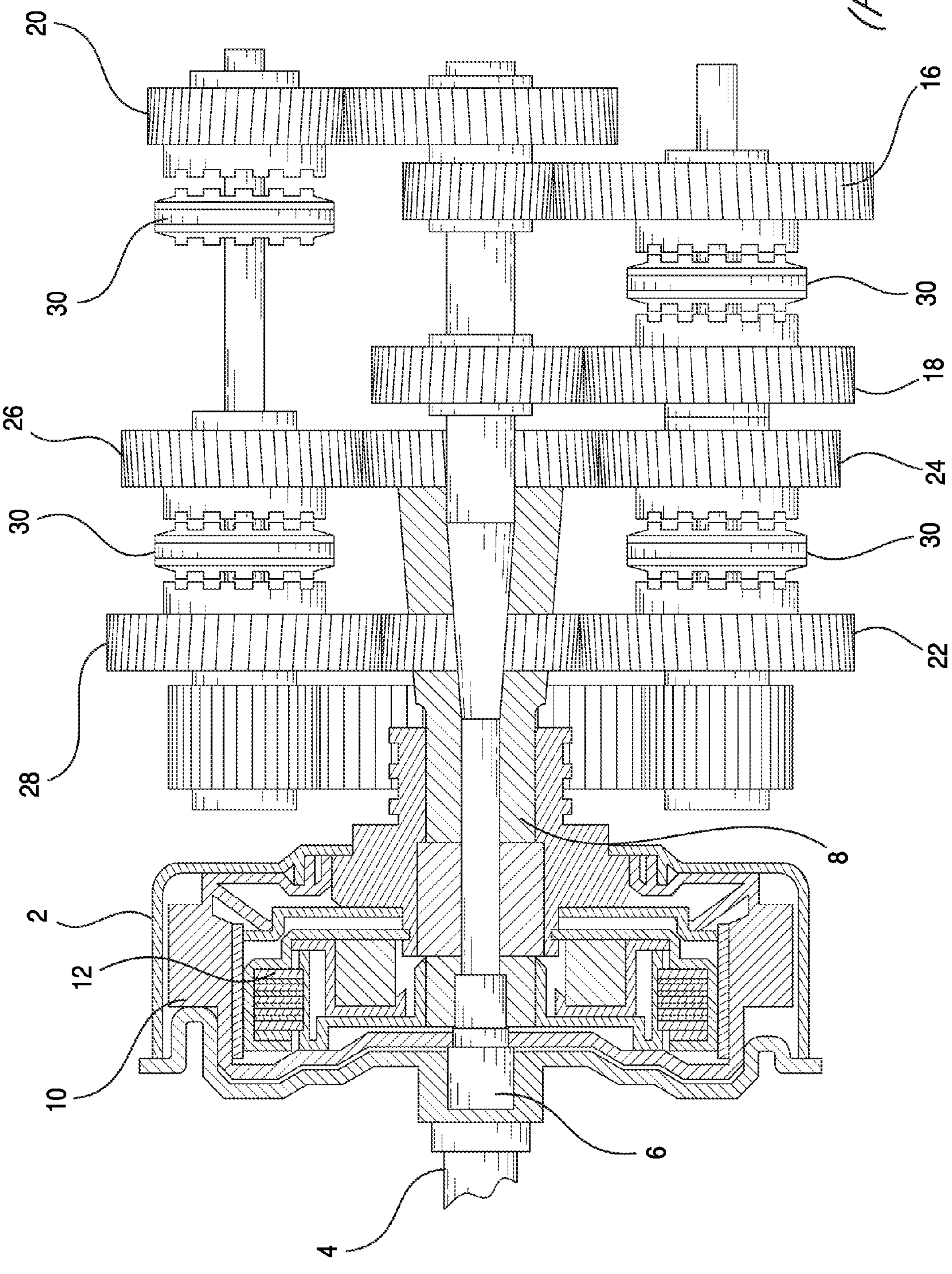
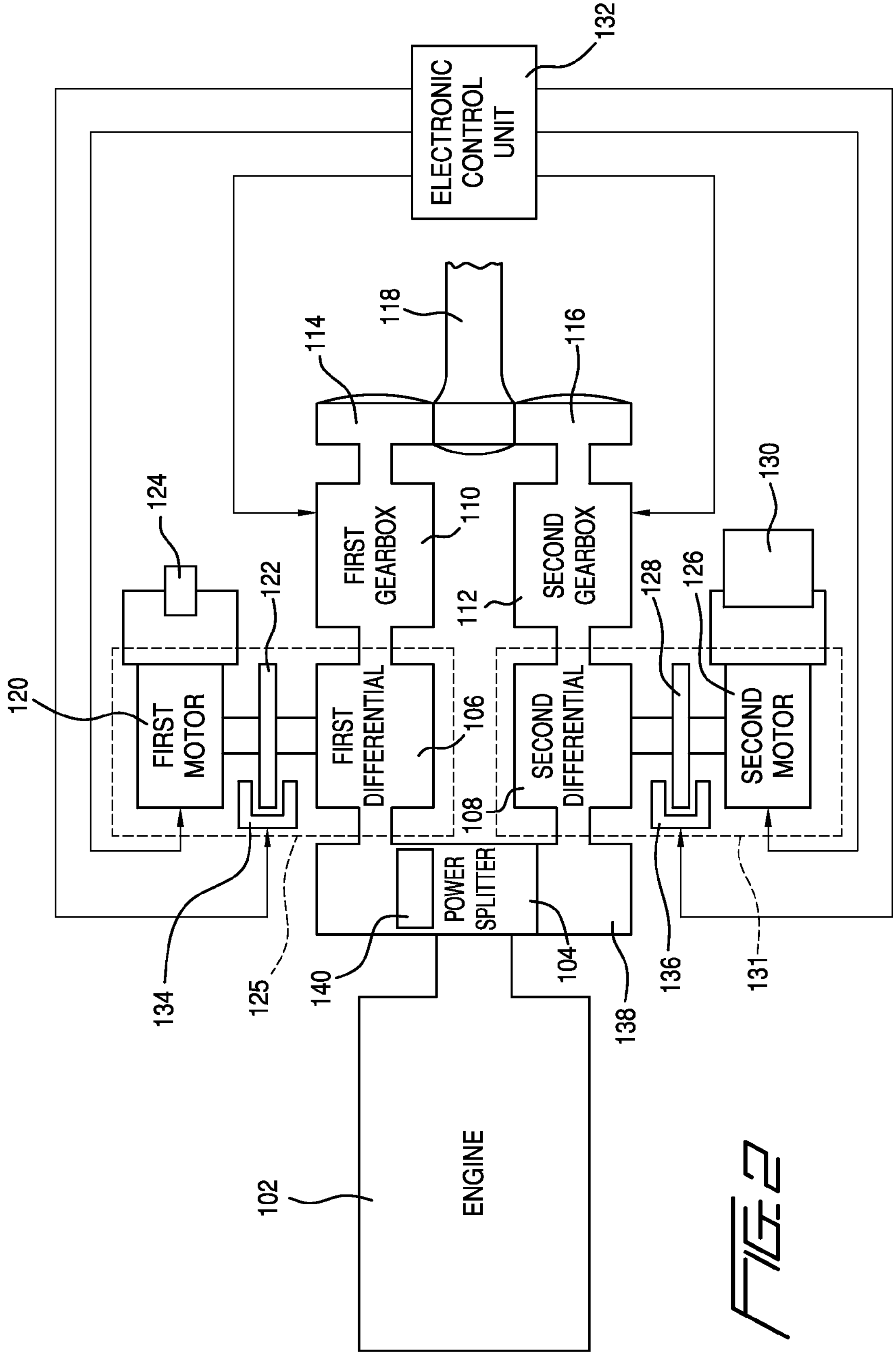


FIG. 1 (PRIOR ART)





ELECTRONIC CONTROL UNIT
132
118
114
116
FIRST GEARBOX
110
SECOND GEARBOX
112
124
130
122
128
126
120
FIRST MOTOR
FIRST DIFFERENTIAL
106
SECOND DIFFERENTIAL
108
SECOND MOTOR
POWER SPLITTER
134
125
140
104
138
136
131
ENGINE
102

FIG. 2

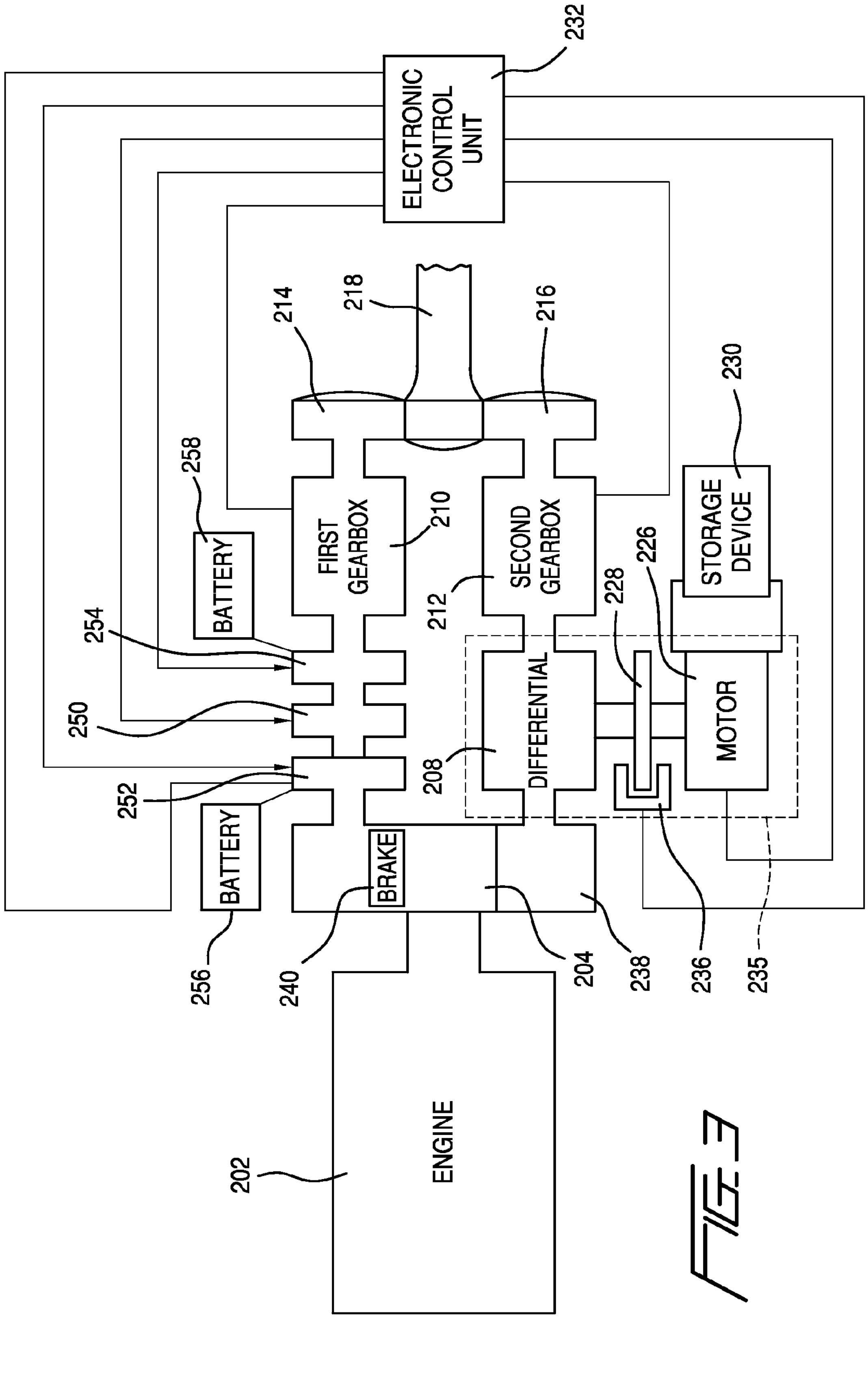

ELECTRONIC CONTROL UNIT
232
218
214
216
230
STORAGE DEVICE
258
BATTERY
FIRST GEARBOX
210
SECOND GEARBOX
212
226
228
254
250
DIFFERENTIAL
MOTOR
208
252
BATTERY
BRAKE
256
240
204
238
236
235
ENGINE
202

FIG. 3

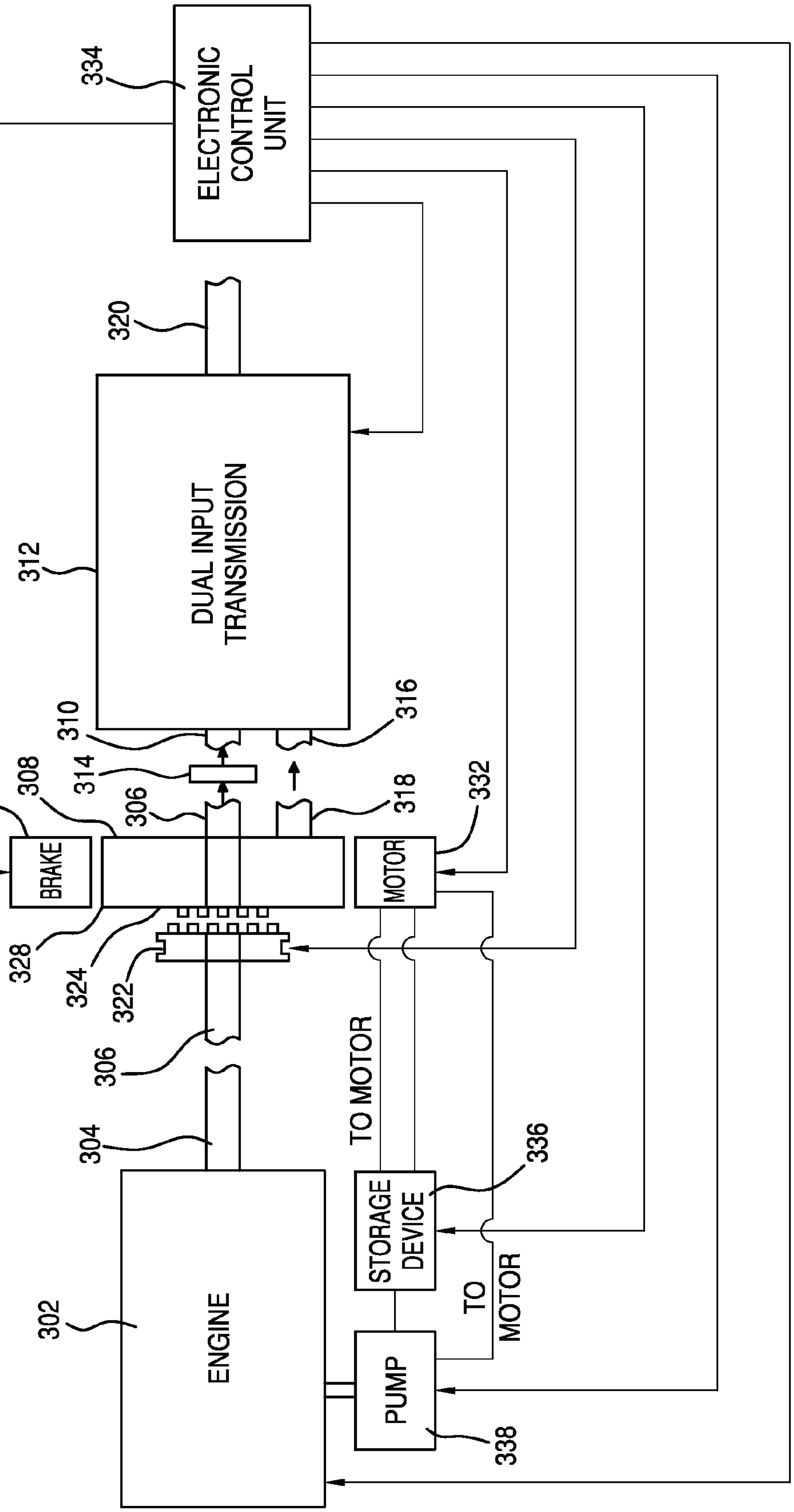

ELECTRONIC CONTROL UNIT
334
320
DUAL INPUT TRANSMISSION
312
310
316
314
330
308
306
318
332
BRAKE
MOTOR
328
324
322
306
TO MOTOR
304
STORAGE DEVICE
336
TO MOTOR
302
ENGINE
PUMP
338

FIG. 4a

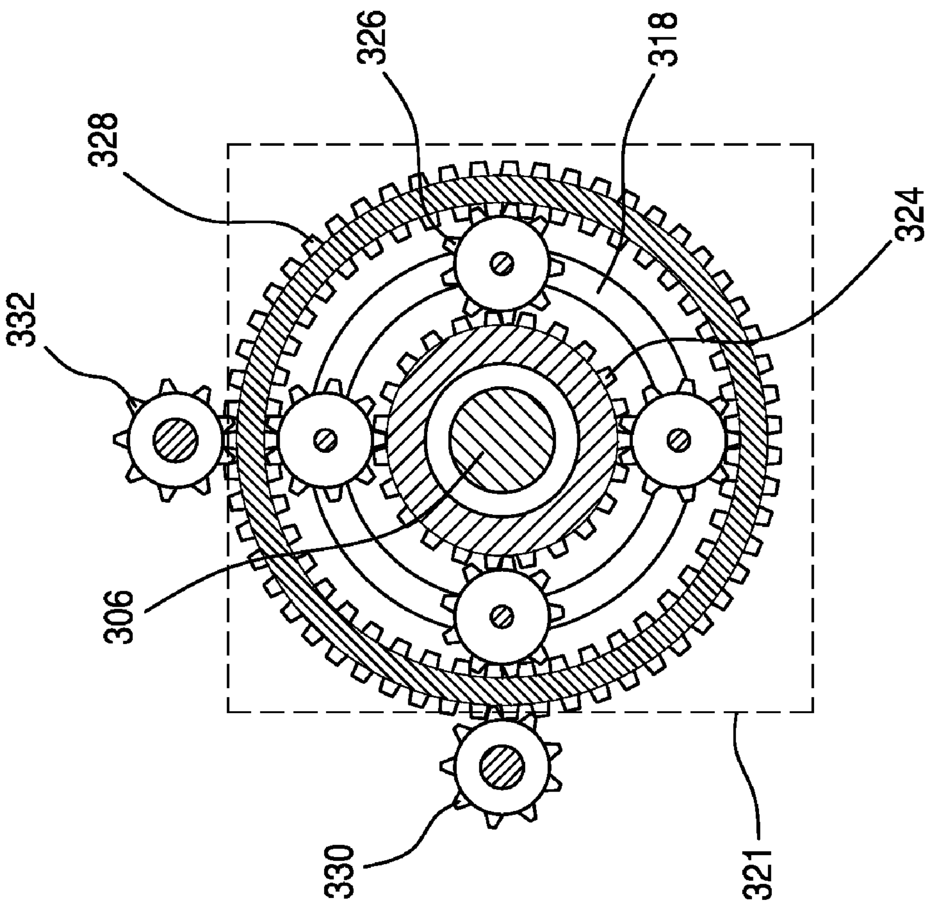


FIG. 4b

TRANSMISSION

This application is a continuation-in-part of U.S. patent application Ser. No. 11/942,961 filed Nov. 20, 2007 which claims the benefit of U.S. provisional application No. 60/866,993 filed Nov. 22, 2006.

BACKGROUND OF THE INVENTION

The two primary types of transmissions for vehicles are manual and automatic transmissions. In a manual transmission, a gear box contains a plurality of gears and a clutch mechanism is used to engage and disengage the gears upon manual operation of a shift lever by the operator. In an automatic transmission, planetary gears and a torque converter are used to shift the gears automatically in accordance with the speed of the vehicle and the speed of the engine used to propel the vehicle.

Traditional manual transmissions are more efficient and provide more vehicle control with reduced reliance on the brakes of a vehicle. Automatic transmissions are generally easier to operate and the torque converter acts as a non-rigid link between the engine and the drive shaft to protect the power train of the vehicle and reduce shock during shifting of the gears. A major drawback of the automatic transmission is the tendency for the torque converter to slip which reduces its efficiency.

The present invention relates to an improved transmission which combines the benefits of the manual and automatic transmissions without the need for traditional clutches and torque converters.

BRIEF DESCRIPTION OF THE PRIOR ART

Recent advancements in both manual and automatic transmissions have incorporated computer controls and links between the engine control computer and the transmission control computer. One advancement is the automated (as opposed to automatic) manual transmission (AMT). An AMT includes the basic components of a manual transmission, the clutch and gearbox, but a computer controls actuators which physically move the gear shift forks to change gears, thereby obviating the need for a clutch pedal. Automated manual transmissions still incur a pause between shifting of the gears and the pressure plate of the clutch acts on the engine's flywheel, thus generating unwanted longitudinal thrust. However, the cost of an automated manual transmission can be 1/10 the cost of a comparable automatic transmission.

Also known in the art are transmissions having two gearboxes with interspersed gear ratios and a dual clutch mechanism. One gearbox has first, third and fifth gears driven by one clutch and the other gearbox has second, fourth, and sixth gears driven by the other clutch. A computer determines which gear to pre-select, manipulates the engine for shifting of the gears, and controls the clutches to implement the shift. The clutches engage and disengage their respective gears simultaneously so that flow of power from the engine to the drive wheels is uninterrupted. The computer can control the entire process automatically or by responding to signals from the operator. The dual clutch transmission can be disassociated from the engine flywheel in order to eliminate thrust loads on the engine crankshaft.

Computer control of automatic transmissions allows for smoother shifting and more efficient torque converters. In addition, the transmission computer can control the engine computer to temporarily reduce torque output for the duration

of a shift. This momentary torque reduction reduces the slip and shock absorption of the torque converter which facilitates its operation.

Gear ratios of an automatic transmission are controlled by friction bands on planetary gear sets. In some applications, the torque converter could be eliminated. However, starting the vehicle from a stopped condition and shock loads are still a problem in such transmissions.

The present invention was developed in order to overcome these and other drawbacks of the prior transmissions by providing a dual gearbox transmission wherein differentials operated by separate motors are used to effect shifting of the gears in each box.

SUMMARY OF THE INVENTION

In accordance with the invention, a transmission is connected with the engine of a vehicle and includes a power splitter connected with the engine and having two outputs. A differential is connected with one of the outputs and a clutch is connected with the other output. Gear mechanisms are connected with the outputs of the differential and clutch. Preferably, each gear mechanism includes gears of different ratios which alternate sequentially. A motor is connected with the differential to provide torque to the differential to control the operation thereof. A controller is connected with the clutch and the differential to control the torque delivered through the differential and clutch to simultaneously control shifting of gears within the gear mechanisms in accordance with operator input.

A brake mechanism under control of the controller is connected between the motor and the respective differential to further control the torque between the motor and the differential. Preferably, the motor is a hydraulic motor and a storage device such as a hydraulic reservoir or accumulator is connected with each motor.

In an alternate embodiment of the invention, the transmission includes a drive shaft which is connected with the output of an engine and a dual input transmission has one input connected with the drive shaft. A planetary gear assembly is connected with the drive shaft and has an output connected with a second input of the transmission. A controller is connected with the planetary gear assembly to control the inputs to the dual input transmission.

BRIEF DESCRIPTION OF THE FIGURES

Other objects and advantages of the invention will become apparent from a study of the following specification when viewed in the light of the accompanying drawing, in which:

FIG. **1** is a schematic view of a dual clutch transmission according to the prior art;

FIG. **2** is a schematic view of a transmission according to a preferred embodiment of the invention;

FIG. **3** is a schematic view of a transmission according to an alternate embodiment of the invention;

FIG. **4***a* is a schematic views of a preferred compact embodiment of the transmission; and

FIG. **4***b* is a view of the planetary gear assembly of FIG. **4***a*.

DETAILED DESCRIPTION

In FIG. **1** there is shown a dual-clutch or semi-automatic transmission as is known in the prior art. A clutch housing **2** contains a central dual shaft having an input end **4** connected with the engine (not shown) of a vehicle. The shaft is a dual shaft with independently rotating inner **6** and outer **8** portions.

The clutch case contains a first clutch **10** associated with inner shaft **6** and a second clutch **12** which is fixed to outer shaft **8**. Six gear sets are connected with the shafts of the clutch case and provide outputs to a differential (not shown) of the engine. First **16**, third **18**, and fifth **20** gear mechanisms are connected with the inner shaft and second **22**, fourth **24**, sixth **26**, and reverse **28** gear mechanisms are connected with the outer shaft to provide the first through fifth and reverse gears for the transmission. Gear selectors **30** are arranged adjacent to each gear mechanism. Because the clutches operate independently and the gear mechanisms alternate sequentially between the inner and outer shafts, shifting of the gears from first through sixth can overlap without interrupting the power flow from the engine for smooth transition between the gears

Turning now to FIG. **2**, the transmission according to the present invention will be described. It relates to a dual clutch transmission but with computer controlled differential clutches for improved performance. More particularly, an engine **102** provides power flow to the transmission. A simple power splitter **104** where torque and horsepower are divided equally is connected with the output from the engine to split the power flow in two. A first differential **106** of known type such as epicyclic, spider gear, miter gear or spur gear is connected with one output of the power splitter and a second differential **108** similar to the first differential is connected with the other output of the power splitter. A first gear box **110** is connected with the first differential **106** and a second gearbox **112** is connected with the second differential **108**. The gearboxes contain sequentially alternating gear mechanisms. For example, the first gearbox contains mechanisms for second, fourth, and reverse gears, while the second gearbox contains mechanisms for first, third, and fifth gears. Additional (or fewer) gear mechanisms may be provided, depending on the type of vehicle with which the transmission is being used. The outputs of the first and second gearboxes are connected with output gears **114** and **116**, respectively, which in turn are geared to one another and connected with a drive shaft **118** of the vehicle.

Each differential includes a drive mechanism to control the operation thereof. More particularly, a first motor **120** is connected with the first differential via a braking device **122**. The first motor has a storage device **124** connected thereto. The first differential **106**, first motor **120** and braking device **122** operate as a first differential clutch **125**. Similarly, a second motor **126** is connected with the second differential via a braking device **128** and a storage device **130** is connected with the second motor. The second differential **108**, second motor **126** and braking device **128** operate as a second differential clutch **131**. The first and second motors are electric, air or hydraulic motors and the storage devices may be batteries, capacitors, air tanks, or hydraulic reservoir or accumulators depending on the type of motor being used.

In order to control the operation of the transmission, an electronic control unit **132** is provided. This unit receives input from the operator of the vehicle, such as throttle control, brake application, and gear selector input and controls the operation of the clutches and gearboxes accordingly. More particularly, the electronic control unit is connected with the first and second motors **120**, **126**, the first and second gearboxes, **110**, **112**, and with brake calipers **134** and **136**, respectively, of the braking devices **122**, **128**. In accordance with signals from the unit, the amount and direction of torque applied by the motors to the associated differentials is controlled to automatically control the shifting of the gear mechanisms in each gearbox.

A further gearbox or clutch **138** may be provided between the power splitter and one of the differentials. In the embodiment shown, the further gearbox is between the power splitter **104** and the second differential **108**. When the second gearbox **112** is in neutral, the further gearbox allows rotation to cease in the gearbox to reduce friction. In addition, a further brake mechanism **140** can also be provided to prevent the engine from rotating during certain operating cycles.

The operation of the transmission from standing to cruising speed using maximum acceleration will now be described for an electrical embodiment where the motors **120** and **126** are electric motors and the storage devices **124** and **130** are batteries. First and second gears are simultaneously engaged in gearboxes **112** and **110**, respectively. The engine **102** runs at full revolutions per minute. When the service brake is released, the electronic control unit signals negative torque to be applied by the second motor **126**. The first and second motors **120** and **126** are spinning because the engine is spinning, but the output shafts from the first and second differentials **106** and **108** are stopped because they are geared through first and second gearboxes **110** and **112**, respectively, to the wheels, and the vehicle is stationary. The negative torque applied by the second motor **126** supplies enough load to slow the engine to its torque peak. This generates electricity to the second storage device (battery) **130**. Meanwhile, the first motor **120** receives electricity from the storage device (battery) **124** and applies positive torque to its output and the first differential **106** to supplement the torque from the engine **102** while at the same time sending the same amount of negative torque to the first gearbox **110** to operate second gear.

The net effect is to increase the acceleration of the vehicle over what could be achieved by only applying the negative torque of second motor **126** because that torque reacts against the engine torque plus the torque of the first motor **120** and is driving the deeper gear ratio, namely first gear of the second gearbox **112**. Depending on the torque available from the second motor **126**, activation of the brake caliper **136** may be needed to counteract all of the power coming from the engine.

The vehicle accelerates unless there is wheel spin in which case less torque will be applied by one or both of the first and second motors **120**, **126** and/or the throttle opening of the engine is reduced. In addition, negative torque could be applied from the first motor **120** and allow the second gearbox **112** to shift to third gear. This is analogous to a race car driver losing traction and simply going to the next gear rather than modulating the throttle.

The use of the motors **120** and **126** to provide negative torque or braking force has the same affect as engaging the clutch in a traditional manual transmission. The second motor **126** decelerates more quickly than the first motor **120** because the speed of the output shaft from the second differential is higher for a given vehicle speed because of the lower ratio of first gear. The second motor **126** slows to a stop and then begins to spin in the opposite direction, now drawing from the storage device **130** and still applying torque in the same direction with the same force.

Since the second motor **126** is now drawing electricity from the storage device **130**, the first motor **120** begins applying negative torque effectively engaging second gear but also generating electricity which is sent to storage device **124**. When the second motor **126** approaches its speed limit, the first brake caliper **134** assists the first motor **120** to apply negative torque. This unloads the second differential **108** and the second gearbox **112** so that the second gearbox can be easily shifted to third gear. If the brake caliper **134** is properly modulated, the flow of torque to the drive shaft is uninterrupted. Once third gear is engaged in the second gearbox **112**, the second motor **126** begins applying positive torque to the engine **102** and subtracting it from the second gearbox **112**.

However, as was the case then the first and second gears were engaged, the torque is multiplied more by the lower gear, in this case the second gear in the first gearbox **110**. The first motor **120** is accelerating because brake caliper **134** has been released after the gear shift. As the first motor **120** approaches its speed limit, the brake caliper **136** allows the second motor **126** to unload the first differential **106** and the first gearbox **110** so that fourth gear can be selected in the first gearbox **110**. The process is repeated for fourth gear until the first motor **120** is stopped and brake caliper **134** is engaged.

The overall drive ratio is determined so that at cruising speed on flat ground, the engine is at just a high enough revolutions per minute to maintain the cruise at wide open throttle. The additional clutch **138** is a conventional clutch or a simple synchronized single gear power transmitter that is either engaged or not engaged. No significant torque will be transmitted through the additional clutch during its engage or disengaged conditions because all of the torque from the engine is directed through the first differential **106** and first gearbox **110** during this period. The additional clutch **138** is disengaged and the second gearbox **112** is shifted to neutral to eliminate rotation in that part of the drive train during cruising speed.

Cruise is maintained during different driving conditions such as when the vehicle is climbing a hill or into a headwind. When additional load from such conditions is placed on the vehicle, the first brake caliper **134** is released and the first motor **120** spins in order to allow the engine to increase in revolutions per minute. If not enough torque is immediately available, then third gear in the second gearbox **112** is selected and the second motor **126** increases to an appropriate speed to allow easy engagement of the further (input/output) gearbox **138**. The second motor **126** now supplies torque to help accelerate the vehicle. At this point, the storage device **124** may not be experience a net loss because the second motor **126** is applying negative torque and therefore generating electricity. The situation where both motors are spinning is employed if the storage device capacity (i.e. battery charge) drops below a minimum. Many different modes can be employed to recharge the storage device. If even more power is needed, the engine revolutions per minute can rise and the second motor **126** can slow to where, if it stops, the vehicle can be said to be in third gear, or further downshifting may occur to select second gear in the first gearbox **110**.

In an alternate acceleration mode, the engine **102** remains off and the first and second motors **120** and **126** spin against the engine to drive the vehicle. In order to accomplish this, the further brake mechanism **140** is operated to stop the engine, and thus the power splitter, from spinning.

The electronic control unit **132** uses the first and second motors **120**, **126** to synchronize the ground speed and engine speed for a given gear ratio, thus reducing the shift effort and mechanical synchronizer wear. With proper selection and control of the motors, the need for synchronizers may be reduced or eliminated.

FIG. **3** shows another embodiment which uses a traditional clutch such as a disk clutch of the single or multiplate type, either dry or wet. Preferably a dry clutch is used because of the lower frictional losses than occur in a wet clutch and because the added cooling abilities of wet clutches are not necessary. While the embodiment drawn in FIG. **2** has many advantages over known systems, including the ability of the engine to operate at a constant desirable RPM, an even simpler system is depicted in FIG. **3**.

The bottom half of FIG. **3** is much the same as FIG. **2** but with different reference numbers. An engine **202** provides power flow to the transmission. A simple power splitter **204** where torque and horsepower are divided equally is connected with the output from the engine to split the power flow in two. A clutch **250** is connected to one output of the power splitter **204** and a differential **208** is connected with the other output of the power splitter. A first gear box **210** is connected with the clutch **250** and a second gearbox **212** is connected with the differential **208**. The gearboxes contain sequentially alternating gear mechanisms. For example, the first gearbox contains mechanisms for second, fourth, and reverse gears, while the second gearbox contains mechanisms for first, third, and fifth gears. Additional (or fewer) gear mechanisms may be provided, depending on the type of vehicle with which the transmission is being used. The outputs of the first and second gearboxes are connected with output gears **214** and **216**, respectively, which in turn are geared to one another and connected with a drive shaft **218** of the vehicle.

The differential **208** includes a drive mechanism to control the operation thereof A motor **226** is connected with the differential **208** via a braking device **228** including a brake caliper **236** and a storage device **230** is connected with the second motor. The differential **208**, motor **226** and braking device **228** operate as a differential clutch **235**. The motors are electric, air or hydraulic motors and the storage devices may be batteries, capacitors, air tanks, or hydraulic reservoirs

or accumulators depending on the type of motor being used. The braking device need not be of the disk type as depicted. It could be a drum brake or an electric eddy brake, or any other means of stopping a spinning shaft.

The top half of FIG. **3** incorporates a traditional clutch **250** and may also include motors **252**, **254** The motors have storage devices such as batteries **256** and **258** connected therewith, respectively. Instead of a traditional clutch a simple synchronized dog gear, or the selective engagement of two spur gears may be provided, depending on the application.

In order to control the operation of the transmission, an electronic control unit **232** is provided. This unit receives input from the operator of the vehicle, such as throttle control, brake application, and gear selector input and controls the operation of the clutches and gearboxes accordingly. Sensors for providing such input from these devices are known and commonly used, so that the electronic control unit **232** can receive signals from a variety of types of sensors without the sensors themselves being inventive. More particularly, the electronic control unit is connected with the motors **226**, **252**, and **254**, the first and second gearboxes, **210**, **212**, and with the brake caliper **236**, respectively, of the braking device **228**. In accordance with signals from the electronic control unit, the amount and direction of torque applied by the motors to the associated differential, clutch, gearbox or power splitter is controlled.

It is significant that the first gearbox **210** has even gears because the differential clutch **235** is what should be used to start the vehicle moving from a standstill and should contain first gear. Acceleration from a start using a transmission constructed according to the embodiment depicted in FIG. **3** proceeds as follows. First gear in the second gearbox **212** and second gear in the first gearbox **210** are selected. Clutch **250** is open and the engine is running. Motor **252** spins with the power splitter **204** and gearbox or clutch **238** would be closed between the power splitter and the differential clutch **235**. Brake mechanism **240** is not engaged so that the input shafts of clutch **250** and differential clutch **235** are both spinning with the engine.

Upon receiving input from the driver such as movement of the accelerator pedal or release of the brake, motor **226** begins to apply negative torque to the shaft of differential **208** to which the motor **226** is attached. This causes engine torque to be routed through first gear in the second gearbox **212** and to the wheels. In the simplest arrangement, the negative torque would be applied by brake **228** by action of the caliper **236**. The motor **226** continues to cause the shaft between it and differential **208** to slow and eventually stop. This process is analogous to clutch engagement in a traditional manual gearbox, except that there is considerable flexibility in the operation. In a traditional manual transmission the engagement should be done at low rpm and partial throttle and as quickly and smoothly as possible, but none of these constraints apply to the present invention.

Once first gear is effectively engaged, a rise in engine RPM causes a proportional increase in vehicle speed. When an appropriate engine speed is reached, whether it be horsepower peak, torque peak or efficiency peak, or whatever is best for a given set of parameters, the motor **226** begins to spin adding torque in the same rotational direction as it was previously, and thus also adds power to the system. The input shaft to differential **208** from motor **226** begins to spin in the opposite direction from what it was originally. This causes the vehicle to continue to accelerate, though the engine speed remains constant. At some speed of the motor **226** as determined by the fixed ratios of the first and second gears, clutch **250** can be engaged with both faces going equal speed. Power flows from the engine to the wheels through clutch **250** and then through second gear in the first gearbox **210**. Motor **226** is then manipulated to allow third gear to be selected in the second gearbox **212**, and once engine speed has reached its shift point, motor **226** begins to apply negative torque to associated the shaft of differential **208** and the process starts over.

If motors **226**, **252**, and **254** are eliminated, the system operates like the dual clutch transmission in FIG. **1** except that the primary torque transmission device at the critical start off period of initial acceleration is a brake **228** rather than a clutch which is the drawback of the device in FIG. **1**. The advantages of using a braking mechanism rather than a clutch are manifold but two significant facts should be noted. Very rarely are road vehicles designed with clutches that can transmit full engine potential in a partially engaged position. Slipping the clutch with the accelerator in the maximum position burns the clutch up immediately. The clutch engagement should be at an RPM well below the torque peak and at partial throttle. If the vehicle is designed with a very large clutch, the rotating mass is greatly increased which has a much more drastic efficiency and performance penalty than adding non-rotating weight. The brakes on all vehicles are designed to stop the vehicle from any speed much faster than it can accelerate. The brakes are therefore capable of transmitting far greater horsepower than the clutch on a given vehicle.

The brake mechanisms in the present invention can be external to the path of the drive line. Clutch replacement requires breaking the transmission apart from the engine. This is expensive in terms of both time and materials and requires special tools. The inventive system can be made where replacing all or part of the braking elements is much less costly, and might even be performed in the field.

If motors **252** and **254** are provided, motor **252** can drive the vehicle with clutch **250** disengaged and the engine off. Motor **252** may or may not work in conjunction with motor **226** for this purpose of engine off driving. A wide variety of gear ratios may be chosen in these modes. When the first gearbox **210** is in neutral, motor **254** can start the engine if the clutch **250** is engaged, and may be able to drive the vehicle at the same time. Similar advantages are possible if both motors **252** and **254** are included. If neither is included but motor **226** is included, then a transmission which includes only one motor/generator can provide continous power delivery through multiple gear ratios with only one differential/epicyclic gearbox being provided as shown in FIG. **3**.

The dual clutch arrangement shown in FIG. **1** is a compact transmission, and the mounting of its two clutches on concentric shafts means that the engine's flywheel is analogous to the power splitter described herein.

A very compact alternate embodiment of the present invention is shown in FIGS. **4***a* and **4***b*. An engine **302** has an output shaft **304**. A central shaft **306** is connected with the output shaft. The central shaft is connected with a planetary gear assembly **308** and with a first input shaft **310** to a dual input transmission **312** via a clutch **314**. The transmission has a second input shaft **316** connected with a carrier **318** of the planetary gear assembly. The dual input transmission further includes an output shaft **320**.

A gear selector **322** is connected with the central shaft **306** via splines (not shown) to control the operation of the planetary gear assembly **308**. Referring to FIG. **4***b*, the planetary gear assembly includes a central sun gear **324** mounted on the central shaft. The sun gear may be integral with the shaft **306** or may contain an opening for receiving the shaft **306**. A plurality of planetary gears **326** are connected with the carrier **318** and mesh with the sun gear **324**. A ring gear **328** is connected with the planetary gears **326** via teeth on the inner surface of the ring gear. A brake **330** and motor **332** are connected with the ring gear via teeth on the outer surface thereof. As will be developed below, the planetary gear assembly **308** may operate as an epicyclic differential.

An electronic control unit **334** is connected with the gear selector **322**, the dual input transmission **312**, the brake **330**, and the motor **332**. The gear selector, under control of the control unit **334**, engages and disengages the sun gear **324**. When the sun gear is engaged, the planetary gears are engaged to drive the second input shaft **316** to the dual input transmission via the planetary gear carrier **318**. When the sun gear is disengaged, the planetary gears are in neutral and do not drive the second input shaft **316** to the dual input transmission. Accordingly, losses associated with the epicyclic/differential are avoided during certain phases of operation.

As set forth above, the planetary gears **326** mesh with the sun gear **324** on the inside and with the ring gear **328** on the outside. The ring gear **328** in turn has gear teeth on its outside which mesh with the motor **332**. The speed of the motor **332** and and the speed of the engine **302** are therefore combined by the planetary gear carrier **318** and determine the behavior of the second transmission input shaft **316**. Because the planetary gear carrier **318** and the central shaft **306** operate independently and the gear mechanisms alternate sequentially between the inner and outer shafts, shifting of the gears can occur without interrupting the power flow from the engine for smooth transition between the gears. Motor **332** and transmission **312** are under control of the electronic control unit which also receives operator input from sensors on the throttle, brake gear selector and any other useful commonly used inputs for dual clutch, automated or automatic transmissions. These include RPM sensors on various shafts including the dual input transmission output shaft **320**, on the motor **332**, on the wheels for detecting wheel speed, and on the engine for detecting engine output.

In operation, first gear, which is associated in the transmission with second input shaft **316** and therefore with the planet carrier **322**, is selected with the vehicle service brakes applied and motor **332** spins at a speed and in a direction which holds the vehicle still. No other gears are selected. As the operator depresses the accelerator and releases the brake, the motor **332** provides negative torque to the ring gear **328**. The vehicle begins to move as the motor **332** and ring gear **328** slow down. When the motor **332** comes to a standstill, the vehicle accelerates or decelerates in direct proportion to engine RPM. This is a description of acceleration which continues as the engine RPM increases. If the motor **332** has enough torque to overcome the engine's torque, then when the engine has reached a certain RPM, the motor can cause the vehicle to continue to accelerate while keeping the engine RPM from increasing further. The motor can also be sized to force the engine to slow. The result is that it is possible for the electronic control unit **334** to then command the gear selector in the transmission **312** to engage second gear. The engine can drive the vehicle though second gear and continue to accelerate while the electronic control unit commands the motor **332** to manipulate the ring gear **328** and planetary gear carrier **318** to go to an RPM appropriate for the smooth engagement of third gear. The process can be repeated as the motor **332** applies negative torque to the ring gear, thus transmitting power through third gear which allows pressure to be taken off second gear so that the transmission **312** may move into a neutral position on its way to engaging fourth gear.

Alternatively, first and second gears are selected with the engine not running. When the operator releases the brake and depresses the accelerator (or gives some other "go" command) the motor **332** spins in the correct direction to make the vehicle move forward. The electronic control unit **334** also commands fuel and spark to the engine which is backdriven through second gear and starts.

On deceleration, the motor **332** is employed to recharge the battery or other storage device **336**. A pump, compressor or generator **338** may be included or replace storage device **336** to provide a source of power for motor **332**. During a full throttle shift, motor **332** could be commmanded to spin and drive the vehicle forward, while the pump is commanded to send power to the motor **332**. Both of these events tend to slow the engine while increasing vehicle speed. The need to reduce engine power for the shift is thereby eliminated, and the vehicle continues to accelerate during both forms of gear engagements. These two forms of engagement are when the motor **332** slows the ring gear **328** to send power through the ratios associated with the second input shaft **316**, and when the motor **332** accelerates the ring gear **328** in order that the ratios associated with the second input shaft **316** are synchronized with the engine speed so that a clutch is not needed for their engagement.

A clutch can obviously be included if necessary, and one place to put it would be as the interface between the central shaft **306** and the second input shaft **316**. The central shaft **306** may be hollow to accommodate a rod therein. The rod slides back and forth to engagge the clutch, or the bore of the shaft can serve as a galley for fluid used to actuate the clutch. If such a clutch is used, then the motor **332** can be eliminated and only the brake **330** is used. In this embodiment the brake **330** and differential/epicyclic arrangement is analogous to the primary clutch in FIG. **1** and would be used for launching. The clutch is for the less rigorous even gear engagements, and can therefore be dry which is more efficient than the current wet clutches used on dual clutch transmissions. The brake **330** is external and can therefore be easily replaced.

Various software strategies may be applied to this mechanical system to best acheive safety and energy recovery during braking. FIG. **4***a* represents a multiple ratio hybrid drive which requires only one planetary gear assembly (differential) **308** and one motor. FIG. **4***a* also represents a multiple gear transmission which allows direct drive with no clutches or torque converters which may also incorporate existing devices. The design in FIG. **2** will allow for a constant engine RPM. The design in FIG. **3** represents one of the various manifestations that are envisioned as part of the present invention, which allow greater design flexibility including utilization of modular construction using commercial industry proven devices.

Although the gearboxes of the invention have been described as being connected with the drive shaft of a vehicle, alternate arrangements may be devised for different applications. For example, in a four wheel drive vehicle or piece of machinery, one gearbox can be connected with the front axle of the vehicle and the other gearbox can be connected with the rear axle of the vehicle. Another example is that different members of the planetary gear type epicyclic differential **308** in FIG. **4***a* can serve as input and output elements from engine shaft **304** and to input shaft **306** of the transmission. In an alternate embodiment of FIGS. **2**, **3**, and **4***a*, a pump or generator may replace or supplement the storage devices.

While the preferred forms and embodiments of the invention have been illustrated and described, it will be apparent to those of ordinary skill in the art that various changes and modifications may be made without deviating from the inventive concepts set forth above.

What is claimed is:

1. A transmission connected with an engine of a vehicle, comprising

(a) a power splitter connected with the engine and having two outputs;

(b) a differential device connected with one of the power splitter outputs said differential device including a differential and a motor;

(c) a clutch connected with the other of the power splitter outputs;

(d) first and second gearboxes connected with the clutch and the differential device, respectively, and having outputs connected with a drive shaft, said first and second gearboxes including gear mechanisms of different ratios;

(e) a controller connected with the clutch and the differential device for controlling the torque delivered through the clutch and through the differential device, respectively, to simultaneously control shifting of gear mechanisms within said first and second gearboxes, said differential device further comprises a first brake arranged between said motor and said differential, said motor and first brake operating as a drive mechanism for said differential to control the operation thereof.

2. A transmission as defined in claim **1**, wherein said controller is further connected with said motor and with said first brake.

3. A transmission connected with an engine of a vehicle, comprising

(a) a power splitter connected with the engine and having two outputs;

(b) a differential device connected with one of the power splitter outputs;

(c) a clutch connected with the other of the power splitter outputs;

(d) first and second gearboxes connected with the clutch and the differential device, respectively, and having outputs connected with a drive shaft, said first and second gearboxes including gear mechanisms of different ratios;

(e) a controller connected with the clutch and the differential device for controlling the torque delivered through the clutch and through the differential device, respectively, to simultaneously control shifting of gear mechanisms within said first and second gearboxes; and

(f) a brake mechanism connected with said power splitter to prevent the engine from rotating under certain conditions.

4. A transmission as defined in claim **3**, wherein said differential device comprises a differential between the engine and the second gearbox and a motor connected with said differential.

5. A transmission as defined in claim **4**, and further comprising a storage device connected with said motor.

6. A transmission as defined in claim **5**, wherein said storage device comprises one of a battery, capacitor, air tank, hydraulic reservoir, and accumulator.

7. A transmission as defined in claim **4**, wherein said motor comprises one of an electric, air, and hydraulic motor.

8. A transmission as defined in claim **3**, wherein said controller is further connected with said first and second gearboxes.

9. A transmission as defined in claim **3**, wherein said gear mechanisms of said first and second gearboxes have alternating sequential ratios.

10. A transmission as defined in claim **3**, and further comprising a third gearbox connected with one of the outputs of said power splitter, said third gearbox being operable to disconnect said differential and its associated gear mechanisms.

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