Abstract: A hybrid drive system for a vehicle comprises: a driving engine (100) having an output shaft (101); a motor generator (111); a planetary gear system having at least one staged planet gear set (105) mounted on a planet carrier (104) coupled to the output shaft (101) of the driving engine (100); the planetary gear system having a first sun gear (108) and a second sun gear (109); the motor-generator (111) being coupled to the first sun gear (108); the staged planet gear set (105) includes a first planet gear (106) and a second planet gear (107); the first planet gear (106) meshes with the first sun gear (108) and the second planet gear (107) meshes with the second sun gear (109); the ratio of working pitch diameter of first planet gear (106) to the second planet gear (107) being greater than one; the ratio of working pitch diameter of the second sun gear (109) to the first sun gear (108) being greater than one; a transmission (113) coupled between the second sun gear (109) and driven wheels (401); and a clutch (110) configured to selectively lock the planetary gear system, to bypass the planetary gear system.
A HYBRID DRIVE SYSTEM FOR DELIVERING POWER
AND ITS METHOD THEREOF

FIELD OF THE INVENTION
The invention is related to a hybrid drivetrain for a vehicle. More specifically it is related to a hybrid drive system for delivering power and its method thereof.

BACKGROUND OF THE INVENTION
Drive systems for vehicles customarily comprise an internal combustion engine as the driving machine and a subsequent transmission. The transmission normally plays an important role in operating the engine in its efficient regions and also needs to efficiently transmit power to the wheels resulting in better fuel economy. Conventionally additional motor-generator is used to operate the system and the engine for further efficiency improvement.

OBJECTS OF THE INVENTION
The main object of the invention is to develop a hybrid drive system for delivering power.

Another object of the invention is to operate the engine in its efficient region by making the transmission behave closer to CVT (Continuously Variable Transmission).

Another object of the invention is to have more efficiency than a CVT, with help of a motor-generator, an epicyclic unit

and a clutch added in between an automated manual / automatic transmission and the internal combustion engine.

Another object of the invention is to provide an additional motor / generator that can be connected to the transmission output shaft.
SUMMARY OF THE INVENTION Accordingly the present invention discloses a method for delivering power through a hybrid drive system comprising the steps of; a) selectively opening the clutch (110) to unlock the planetary gear system of the hybrid drive system; b) selectively engaging the gear in the transmission (113); c) operating the motor-generator (111) in same direction of engine (100) or in a direction opposite to engine (100); d) controlling the speed of the motor-generator (111) in a predetermined low speeds; i) to achieve a drive ratio of the system in-between the current gear ratio of transmission and the next lower gear ratio of the transmission, ii) to minimize the power of the motor-generator (111), iii) to improve the operating point of the engine, iv) to increase the efficiency of the engine and, v) to increase the efficiency of the drive system.

A method for delivering power through a hybrid drive system comprising the steps of; a) selectively opening the clutch (110) to unlock the planetary gear system of the hybrid drive system; b) selectively engaging the gear in the transmission (113); c) operating the motor-generator (111) in same direction of engine (100) or in a direction opposite to engine (100); d) controlling the speed of the motor-generator (111) in a predetermined band (B) comprising various combination of speeds of engine transmission input shaft and speeds of motor-generator i) to minimize the power of the engine, ii) to improve the operating point of the engine, iii) to increase the efficiency of the engine and, iv) to increase the efficiency of the drive system, v) to reduce the overall utilization of the battery.

The change in the transmission gear comprising further steps of a) opening the clutch (110) if not open already, b) reducing the torque on the motor-generator (111) and the engine (100), c) disengaging the current gear of the transmission, d) controlling the motor-generator speed to change the transmission input shaft speed for synchronization to the next gear, e) engaging the next gear of the transmission.

The engine speed is different for each selected gear of the transmission.
The motor-generator speed is dependent upon the efficiency of the motor-generator (111) and the drive system.

The engine speed can additionally be varied for aiding synchronization of the transmission gears.

Varying the speed of the engine (100) by fueling or by engine braking or by a combination of fueling and engine braking to increase the efficiency of the system. The step of applying torque on the first sun gear (108) by the motor-generator (111), before opening the clutch (110).

The step of applying torque on the first sun gear (108) by the motor-generator as long as the clutch (110) is open and the gear is engaged.

An additional motor-generator (400) drives or gets driven by the transmission output / the vehicle wheels.

The transmission is in neutral, the engine (100) is off and the additional motor-generator (400) drives or gets driven by the transmission output / the vehicle wheels (401).

The transmission is engaged in any one of the gears, the clutch (110) is open, the engine (100) is running, the motor-generator (111) is rotating in a direction opposite to engine (100), and the additional motor-generator (400) drives or gets driven by the transmission output / the vehicle wheels (401).

The change in transmission gear is dependent upon the efficiency of the drive system.
The engine speed and the first motor-generator (111) speed is dependent upon the efficiency of the drive system.

Accordingly the present invention also discloses a hybrid drive system for a vehicle comprising: a driving engine (100) having an output shaft (101); a motor generator (111); a planetary gear system having at least one staged planet gear set (105) mounted on a planet carrier (104) coupled to the output shaft (101) of the driving engine (100); the said planetary gear system also having a first sun gear (108) and a second sun gear (109); the motor-generator (111) being coupled to the first sun gear (108); the said staged planet gear set (105) includes a first planet gear (106) and a second planet gear (107); the first planet gear (106) meshes with the first sun gear (108) and the second planet gear (107) meshes with the second sun gear (109); the ratio of working pitch diameter of first planet gear (106) to the second planet gear (107) being greater than one; the ratio of working pitch diameter of the second sun gear (109) to the first sun gear (108) being greater than one.a transmission (113) coupled between the second sun gear (109) and driven wheels (401); and a clutch (110) configured to selectively lock the planetary gear system, to bypass the planetary gear system.

An envelope (115) is mounted on the input shaft (112) of the transmission (113), wherein the planetary gear system is enclosed in the said envelope (115) which contains the lubricating oil for the planetary unit. The system is having an engine braking arrangement (114) or retarding arrangement. The braking arrangement (114) is adapted to control the speed of the engine (100).

The braking arrangement (114) is an exhaust brake or a friction brake or fluid pump, or electric brake or a combination thereof. The system along with a motor-generator (111) and an epicyclic unit is configured for achieving improved efficiency than a CVT (Continuously Variable Transmission).

The system is configured to add a planetary system, a clutch (110) and an electric motor-generator (111) in between an automated manual/automatic transmission (113) and the internal combustion engine (100).
The system is configured to connect an additional motor / generator (400) to the transmission output shaft either directly or through a gear drive. The system is configured such that the additional motor-generator (400) drives or get driven by the transmission output/vehicle wheels (401).

The said additional motor/generator (400) is configured to drive the transmission output/vehicle wheels (401) during the gear shift operation, to aid in gear shifting without power interruption, provides power for vehicle acceleration, launch, drive and supports vehicle braking or coasting.

BRIEF DESCRIPTION OF THE DRAWINGS
The invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. 1 is a sketch of the drive system according to the present invention.

FIG. 1A is a perspective schematic view of the planetary system used in the drive system according to the present invention.

FIG. 2 is a sketch of saw tooth curve of vehicle, engine and transmission speeds.

FIG. 3 is a sketch of saw tooth curve of vehicle, engine, transmission and motor-generator speeds, during the launch and drive mode with a stable engine speed and clutch continuously open.

FIG. 4 is a sketch of the drive system according to the present invention with an additional motor-generator at the output end of the transmission.

BRIEF DESCRIPTION OF THE INVENTION
The present invention discloses hybrid drivetrain for a vehicle. More specifically it is related to a hybrid drive system for delivering power.

To operate the engine in its efficient region by making the transmission behave closer to CVT (Continuously Variable Transmission), and to have more efficiency than a CVT, a motor-generator, an epicyclic unit / planetary gear system and a clutch are added in
between an automated manual / automatic transmission and the internal combustion engine
The hybrid drive system contains a planetary gear system having a first and a second sun gears, a planet carrier and at least one staged planet gear set. The staged planet gear set includes a first planet gear and a second planet gear. Of these elements, the second sun gear meshes with second planet of staged planet gear set and the first sun gear meshes with first planet of staged planet gear set and is coupled with the electric motor-generator. The transmission is connected to the second sun gear and the engine is connected to the planet carrier. The electric motor-generator is of four quadrant type. A clutch is introduced for the lockup or bypass of the planetary gear drive. An additional motor / generator can be connected to the transmission output shaft / wheels to provide power for vehicle acceleration, launch, drive and supports vehicle braking or coasting and aids in gear shifting without power interruption, by driving the vehicle momentarily during gear shift operation.
A battery / electric energy storage device is provided for storing the electrical energy produced and reuse it when required.

DETAILED DESCRIPTION OF THE INVENTION
Referring now to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting the same.

FIG. 1 presents a sketch of the arrangement of the invented system. The prime mover engine (100) drives the crank shaft or flywheel (101). The crank shaft / engine output shaft or flywheel (101) is connected to torsional damper system (102), which drives the input shaft (103). The input shaft (103) is connected to the planet carrier (104). The planet carrier (104) has atleast one staged planet gear set (105). The staged planet gear set (105) is having first planet gear (106) and second planet gear (107) which is integral with each other. The ratio of working pitch diameters of first planet gear (106) to second planet gear (107) is greater than 1. The planetary system has a first sun gear (108) and second sun gear (109). The ratio of working pitch diameters of second sun gear (109) to first sun gear (108)
is greater than 1. The first planet gear (106) meshes with the first sun gear (108), while the second planet gear (107) meshes with the second sun gear (109). The first sun gear (108) drives or gets driven by the motor-generator (111). The motor-generator (111) is directly coupled to the first sun gear (108). In an another embodiment of the present disclosure, the motor-generator (111) is rotationally coupled to the first sun gear (108) through a gear drive. The second sun gear (109) is connected to the input shaft (112) of the transmission (113). The clutch (110) can couple and decouple the first sun gear (108) with the input shaft (103) / planet carrier (104) by closing and opening the clutch (110) respectively, thereby locking and unlocking the planetary system. In an alternate arrangement, a clutch similar to clutch (110) can couple and decouple the planet carrier (104) with the second sun gear (109) by closing and opening the clutch respectively, thereby locking and unlocking the planetary system. In an another alternate arrangement, a clutch similar to clutch (110) can couple and decouple the second sun Gear (109) with the first sun gear (108) by closing and opening the clutch respectively, thereby locking and unlocking the planetary system. The clutch (110) can be friction clutch or a dog clutch. In an embodiment of the present invention the staged planet gear system may have one or more than one planet gear set. The envelope (115) mounted on the transmission input shaft (112) encompasses all elements the planetary unit to contain the lubricating oil for the planetary unit. The drive system has a braking arrangement (114) for controlling the speed of the engine for better efficiency of the drive system. The braking arrangement (114) can be an exhaust brake or a friction brake or auxiliary equipments acting as a brake or fluid pump or electric brake etc or a combination all these brakes to retard the engine to assist the vehicle braking.

FIG. 1A presents a perspective schematic view of the planetary system used in the drive system according to the present invention.

Referring to FIG. 1, when the clutch (110) is opened, the engine is directly driving only the Input shaft (103), the first sun gear (108) can have same or different speed as that of the engine (100). In this condition the motor-generator (111) and hence the speed of the first sun gear (108) is maintained very low or zero by controlling the motor-generator. This will result in the speed of the second sun gear (109) and hence the speed of the
transmission input shaft (112) becoming less than the speed of the engine (100) to have a lower speed of transmission output. 'R' is the ratio of speed of the engine (100) to the speed of transmission input shaft (112) in the above mentioned situation, that is when the speed of the first sun gear (108) is zero and the clutch (110) is open. In actual operation, it is advisable to operate the motor-generator (111) at speeds above zero (for example 100 rpm) that is clockwise (same direction as engine), or slightly below zero (for example -100 rpm) that is counterclockwise, for purposes of supplementing the engine power or charging the battery during vehicle driving and also for efficient operation of the system. The planetary gear ratio and hence the ratio R should be such that while operation of the transmission in a particular gear, will result in a drive ratio (ratio of engine output speed to transmission output speed) which is in between the ratios of the current gear and next lower gear of the transmission. For example, when the transmission is in 2\textsuperscript{nd} gear, the transmission output speed will become closer to a speed in between the 2\textsuperscript{nd} gear and the 1\textsuperscript{st} gear speeds, because of the ratio R. In clutch closed condition, the transmission output speed would be equal to 2\textsuperscript{nd} gear speed, because the speeds of the motor-generator, the engine and the transmission input shaft are same in clutch closed condition. In effect if a 6 speed transmission is used, the effective speeds available with this arrangement is 12 speeds. These multiple gear ratio options can help in operating the engine in its efficient regions like a CVT. Operating the motor-generator (111) in low speeds also minimizes the power of the motor-generator (111) hence improves the fuel economy of the drive system.

Referring to FIG. 2, which shows the example of engine speeds versus vehicle speeds for various gears, open / close conditions of clutch and speeds of the motor-generator. The clutch open condition with sun gear speed controlled will result in ratios 1c0, 2c0, 3c0 etc. and clutch closed condition will result in ratios 1c, 2c, 3c etc. The multiple ratio steps (1c, 1c0, 2c, 2c0, 3c, 3c0, etc.) result in operating of the engine in efficient region. Whereas in the conventional systems with limited drive ratios, the engine needs to work in larger speed ranges to achieve drivability, which will affect fuel economy. The efficient engine operating speed range in this example is between 1450 to 1800 rpm. The engine efficient operating speed range can be determined by engine performance characteristics. Further, the operating range of engine can be modified to user selective operating modes such as...
sporty, normal and economy to set engine efficient operating speed accordingly for each case.

Referring to FIG 1 and 2, during vehicle driving in clutch open state, it is further possible to shift the engine operation to its further efficient regions by having the motor-generator rotate in clockwise direction that is a direction same as the engine rotation. This would improve the fuel economy depending on the engine specific fuel consumption map.

Referring to FIG 1 and 2, during vehicle driving in clutch open state, the motor-generator can supplement engine power by having the motor-generator rotate in clockwise direction that is a direction same as the engine rotation. This would further improve the fuel economy.

When the vehicle is being driven with the clutch in open, for the aid of the driving or accelerating and coasting or decelerating of the vehicle, the power and hence the torque on the motor-generator is controlled along with the fuelling control of the engine.

When there is a need to close the clutch, the engine and the motor-generator speeds are made to rapidly approach the transmission input shaft speed, so that the clutch can be closed and the motor-generator can be relieved and the system works in a traditional way - This happens in an extremely short time and without torque interrupt.

In order to get back to the clutch open mode, the motor-generator (111) is made to apply a torque on the first sun gear (108) and then the clutch (110) is opened, so that there is no torque interrupt in the driveline. During clutch (110) opening and closing, when one of the gears of the transmission (113) is already engaged, the motor-generator (111) provides a reaction torque to the first sun gear (108), hence the torque interrupt is absent in the driveline for the period of clutch opening and closing. Hence during gear shifting in the transmission, the clutch open and close times are not accounted as a part of total shift time. Hence reduced shift time is possible. Post synchronization and after gear engagement, if there is a need to close the clutch, and if there is a speed differential existing in the
planetary unit, the clutch closing can be delayed to a suitable extent conveniently, as the
torque interrupt is not there while the clutch is still open.

When a gear change is needed,

a) The clutch is opened if not already open
b) The Torque on the motor-generator and the engine is reduced significantly.
c) The current gear is disengaged.
d) The motor-generator speed and the engine speed are varied to change the transmission input shaft speed for synchronization to the next gear.
e) The next gear is engaged.

For a short burst acceleration request while the clutch is open and in an adequate battery situation, the engine and the motor-generator speeds are made to rapidly approach the transmission input shaft speed, when the clutch is closed and the motor-generator assists the engine for vehicle acceleration.

For a short burst acceleration request in an inadequate battery situation, a gear downshift is done.

When the clutch is closed, the motor-generator can assist the engine or the brakes by pumping in or drawing out high torques from the driveline.

During vehicle deceleration while the clutch is closed, when the engine speed approaches its idle speed and while the transmission is in 1st gear, the clutch is opened and the motor-generator is controlled for further reduction in vehicle speed requirements.

When the driver is accelerating or decelerating the engine, while in vehicle launch mode through engine and the driver is also applying the vehicle brakes, or in a condition when the vehicle is stationary and the vehicle brakes are applied and the transmission is engaged in a gear and the clutch is open, the engine acceleration or deceleration is assisted by the motor-generator. This is because of the high reflected inertia of the motor-generator felt at the engine and also for fuel efficiency.
Referring to FIG 1, the method of running the engine at efficient speeds with the assistance of motor-generator is explained with help of FIG. 3. It is desirable to run the vehicle, partly by the engine without sweeping the engine across its inefficient speed ranges, with the motor-generator (IMG) supplying a significant portion of the power requirement of the vehicle. The graph of FIG. 3 describes such a situation depicting the speeds of the engine, motor-generator (IMG), transmission input shaft and the vehicle. The clutch is open throughout this mode of operation. While the engine speed is fairly stable in each selected gear of the transmission, the transmission input shaft speed and hence the vehicle speed is changed mainly because of changes in motor-generator (IMG) speed. The gear shifting is also done to further bring about changes in vehicle speed. As engine is fairly stable (either during gear shifting or during vehicle acceleration) in stable engine speed mode, the fuel consumption is reduced. This is in addition to the fuel consumption reduction due to efficient operating point of the engine.

The engine speed can be different for different selected gear of the transmission. The speed synchronization for gear shift is done by the motor-generator. The engine speed can additionally be varied when quicker synchronization is needed.

The motor-generator speed and torque is varied for vehicle acceleration and deceleration. The engine torque is also varied along with the motor-generator. The engine speed can additionally be varied for aiding quicker acceleration and deceleration of the vehicle.

The motor-generator normally operates in a speed band B which is in clockwise direction (direction same as the engine) for better fuel economy. The operation of the motor-generator is out of this speed band B only during launch and when the vehicle is stationary or in low speeds.

If the battery is low or if the transmission gear ratio steps are large then the motor-generator would also work in a speed band, which has partial operation of the motor-generator in the clockwise direction and partial operation in counter clockwise direction.

In a vehicle having auxiliaries driven by engine, the engine (100) needs to be running as needed to drive the auxiliaries. The auxiliaries may also form a part of the engine braking
arrangement (114). In such a vehicle, while braking of the vehicle is needed, the engine is maintained at low speed like idle speed to drive the auxiliaries, while the clutch (110) is open and one of the gears in the transmission is engaged, the IMG (111) operates at varying speeds and is used to absorb the vehicle braking energy. The gear shifting is done while the clutch (110) is open and while maintaining a fairly stable and low engine speed, and the speed change of transmission input shaft for gear synchronization being mainly achieved by IMG (111). When the vehicle braking is needed, when one of the gears in the transmission is already engaged and when the IMG speed is clockwise or in the same direction of the engine and operating in a speed band (B), the IMG applies a braking torque. This braking torque of the IMG, assists the braking of the vehicle and also drives the engine or assists the driving of engine through the planetary system. No fueling of the engine is done as long as the engine speed does not drop below the idle speed. If the engine accelerates due the braking torque of the IMG, the engine speed is maintained at a low speed or idle speed with the aid of braking arrangement (114). Maintaining the engine at low speeds, lead to higher diversion of vehicle braking energy to the IMG, because of the planetary system. This improves the efficiency of the system. If the engine speed tries to drop below idle speed, the engine braking is reduced. This process is continued till the engine braking can no more be reduced, and after this the engine starts to drop below its idle speed. At this point of time the fuelling is done just adequate to maintain the engine at its idle speed. This process helps in improving the efficiency of the system, as the engine is able to drive the auxiliaries with very less or no fuel, and at low speed. Also the battery utilization is reduced as only a part of the vehicle braking energy is diverted to the IMG. This lower battery utilization also increases the life of the battery. The IMG is made to stop applying the braking torque once its speed reaches zero.

1. For vehicle launch, drive as explained by Fig. 3 and braking operation and gear shift operation when the clutch is open, the following sequence of steps are followed: Engine speed is fairly stable in each gear. The engine speed can be different for different selected gear of the transmission.

2. When gear change is needed,

   a) The Torque on the motor-generator and the engine is reduced significantly.
b) The current gear is disengaged.
c) The motor-generator speed is varied to change the transmission input shaft speed for synchronization to the next gear. The engine speed can additionally be varied for aiding synchronization when needed.
d) The next gear is engaged.

3. The motor-generator speed and torque is varied for vehicle acceleration and deceleration. The engine can additionally be used by varying its speed and torque for aiding quicker acceleration and deceleration of the vehicle.

In the above step 2.c and step 3, the motor-generator operates in a speed band as explained above, i.e. in a band B which is in clockwise direction (direction same as the engine) for better fuel economy. The operation of the motor-generator is out of this speed band B only during launch and when the vehicle is stationary or in low speeds.

During driving with stable engine speed, if the battery is low or if the transmission gear ratio steps are large then the motor-generator would also work in a speed band, which has partial operation of the motor-generator in the clockwise direction and partial operation in counter clockwise direction.

When the vehicle is being driven with the clutch in open, for the aid of the driving or accelerating and coasting or decelerating of the vehicle, the power and hence the torque on the motor-generator is controlled along with the fuelling control of the engine.

Referring to FIG. 4, presents a sketch of another embodiment of the invented system with an additional motor / generator at the transmission output. The additional motor-generator (4G0) drives or gets driven by the transmission output / the vehicle wheels (401). The additional motor-generator (400) is directly coupled to the transmission output through a gear drive. The additional motor / generator (400) drives the transmission output / vehicle wheels (401) during the gear shift operation, provides power for vehicle acceleration, launch, drive and supports vehicle braking or...
coasting. Thus the additional motor-generator (400) aids in gear shifting without power interruption, by driving the vehicle momentarily during gear shift operation.

The details of the operating processes using the additional motor-generator (400) are as follows.

In the first process, the additional motor-generator (400) drives the transmission output / vehicle wheels (401) independently, while the transmission is in Neutral, the clutch (110) is closed and the engine (100) is kept OFF or ON. When the battery is low, the engine (100) is kept ON. With the clutch (110) closed, the engine (100) drives the IMG (111) so that the IMG (111) generates power to charge the battery and or drive the additional motor-generator (400). With the engine (100) put OFF as required, it will help in improving the fuel economy.

In another process possibility, the additional motor-generator (400) drives the transmission output / vehicle wheels (401), while the engine (100) through the transmission (113), also aids for vehicle driving. In this situation, the transmission (113) is already engaged in any one of the gears and the clutch (110) is open. The IMG (111) is operated in anticlockwise direction that is in the opposite direction of the engine, so that it operates as a generator. The generated power from the IMG (111) will charge the battery and or drive the additional motor-generator (400). With the engine also driving the transmission output, the power conversion losses are reduced. The speed of the engine (100) and the speed of the motor-generator / IMG (111) are varied to operate the system efficiently. Also the gear change is done in the transmission to operate the engine (100), the motor generator (111) and the additional motor-generator (400) in the best possible efficient regions thereby improving the fuel efficiency of the system.

**Part list**

The major components of the drive system according to the present invention are described below:

100  Prime mover engine
101  Crank shaft or fly wheel
102  Torsional damper system
The foregoing description is a specific embodiment of the present invention. It should be appreciated that this embodiment is described for purpose of illustration only, and that numerous alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended that all such modifications and alterations be included insofar as they come within the scope of the invention as claimed or the equivalents thereof.
1. A method for delivering power through a hybrid drive system comprising the steps of:
   a) selectively opening the clutch (110) to unlock the planetary gear system of the
      hybrid drive system;
   b) selectively engaging a gear in the transmission (113)
   c) operating the motor-generator (111) in same direction of engine (100) or in a
c      direction opposite to engine (100);
   d) controlling the speed of the motor-generator (111) in a predetermined low speeds:
i) to achieve a drive ratio of the system in-between the current gear ratio of
t      transmission and the next lower gear ratio of the transmission,
ii) to minimize the power of the motor-generator (111)
iii) to improve the operating point of the engine
iv) to increase the efficiency of the engine
v) to increase the efficiency of the drive system.

2) A method for delivering power through a hybrid drive system comprising the steps of:
   a) selectively opening the clutch (110) to unlock the planetary gear system of the
      hybrid drive system;
   b) selectively engaging a gear in the transmission
   c) operating the motor-generator (111) in same direction of engine (100) or in a
direction opposite to engine (100);
   d) controlling the speed of the motor-generator (111) in a predetermined band (B)
      comprising various combination of speeds of engine (100), transmission input shaft
      (112) and speeds of motor-generator (111).
i) to minimize the power of the engine
ii) to improve the operating point of the engine
iii) to increase the efficiency of the engine
iv) to increase the efficiency of the drive system.
v) to reduce the overall utilization of the battery
3. The method as claimed in any one of the preceding claims wherein a change in the transmission gear comprising further steps of
a) opening the clutch (110) if not open already
b) reducing the torque on the motor-generator (111) and the engine (100),
c) disengaging the current gear of the transmission (113),
d) controlling the motor-generator speed to change the transmission input shaft speed for synchronization to the next gear,
  e) engaging the next gear of the transmission.

4. The method as claimed in the claims 2 and 3 wherein the engine speed is stable.

5. The method as claimed in claim 2, 3 and 4 wherein the engine speed is different for each selected gear of the transmission.

6. The method as claimed in any one of the preceding claims wherein the motor-generator speed is dependent upon the efficiency of the motor-generator and the drive system.

7. The method as claimed in claim 3 wherein the engine speed can additionally be varied for aiding synchronization of the transmission gears.

8. The method as claimed in any one of the preceding claims wherein varying the speed of the engine by fueling or by engine braking or by a combination of fueling and engine braking to increase the efficiency of the system.

9. The method as claimed in any one of the preceding claims further comprising a step of applying torque on the sun gear by the motor-generator, before opening the clutch.

10. The method as claimed in any one of the preceding claims further comprising a step of applying torque on the sun gear by the motor-generator as long as the clutch is open and a gear in the transmission is engaged.
11. The method as claimed in any one of the preceding claims wherein an additional motor-generator drives or gets driven by the transmission output / the vehicle wheels.

12. The method as claimed in claim 11, wherein the transmission is in neutral, the engine is off and the additional motor-generator drives or gets driven by the transmission output / the vehicle wheels.

13. The method as claimed in claim 11, wherein the transmission is in neutral, the clutch is closed, the engine is running the motor-generator and the additional motor-generator drives or gets driven by the transmission output / the vehicle wheels.

14. The method as claimed in claim 11, wherein the transmission is engaged in any one of the gears, the clutch is open, the engine is running, the motor-generator is rotating in a direction opposite to engine, and the additional motor-generator drives or gets driven by the transmission output / the vehicle wheels.

15. The method as claimed in claim 14, wherein the change in transmission gear is dependent upon the efficiency of the drive system.

16. The method as claimed in claim 14, wherein the engine speed and the motor-generator speed is dependent upon the efficiency of the drive system.

17. A hybrid drive system for a vehicle comprising:
   a driving engine (100) having an output shaft (101);
   a motor generator (111);
   a planetary gear system having at least one staged planet gear set (105) mounted on a planet carrier (104) coupled to the output shaft (101) of the driving engine (100); the said planetary gear system also having a first sun gear (108) and a second sun gear (109); the motor-generator (111) being coupled to the first sun gear (108); the said staged planet gear set (105) includes a first planet gear (106) and a second planet gear (107); the first planet gear (106) meshes with the first sun gear (108) and the second planet gear (107) meshes with the second sun gear (109); the ratio of working pitch...
diameter of first planet gear (106) to the second planet gear (107) being greater than one; the ratio of working pitch diameter of the second sun gear (109) to the first sun gear (108) being greater than one,

a transmission (113) coupled between the second sun gear (109) and driven wheels (401); and

a clutch (110) configured to selectively lock the planetary gear system, to bypass the planetary gear system.

18. The drive system as claimed in preceding claims further comprising an envelope (115) mounted on the input shaft (112) of the transmission (113), wherein the planetary gear system is enclosed in the said envelope (115) which contains the lubricating oil for the planetary unit.

The driving system as claimed in any one of the preceding claims wherein the system is having an engine braking arrangement (114) or retarding arrangement, adapted to control the speed of the engine (100), wherein the braking arrangement (114) is an exhaust brake or a friction brake or fluid pump, or electric brake or an auxiliary equipment or a combination thereof.

19. The drive system as claimed in the preceding claims wherein the transmission (113) in the said system is an automated manual/automatic transmission (113).

20. The drive system as claimed in the preceding claims wherein said system is configured to connect an additional motor I generator (400) to the transmission output shaft.

21. The drive system as claimed in the preceding claims wherein said system is configured to have an additional motor-generator (400) for driving or get driven by the transmission output/the vehicle wheels (401) by coupling to the transmission output through a gear drive.
22. The drive system as claimed in the preceding claims wherein said additional motor/generator (400) is configured to provide power for vehicle acceleration, launch, drive and supports vehicle braking or coasting and aids in gear shifting without power interruption, by driving the vehicle / transmission output (401) momentarily during gear shift operation.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60K6/365 B60K6/387 B60K6/48 F16H3/72 B60W10/02
B60W10/08 B60W10/11 B60W30/188 B60W30/19 B60W20/00
F16H3/56

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F16H B60K B60W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>wo 2012/140665 Al (TATA MOTORS LTD [IN] ; VENKATAPATHI JANARDHANAN [IN] ) 18 October 2012 (2012-10-18) claims 1,4 page 3, line 5 - page 7, line 9 page 11, line 23 - page 14, line 9 figures 1,3A ----</td>
<td>1-22</td>
</tr>
<tr>
<td>X</td>
<td>wo 2012/140664 Al (TATA MOTORS LTD [IN] ; VENKATAPATHI JANARDHANAN [IN] ) 18 October 2012 (2012-10-18) page 14, last paragraph - page 17, line 13 figures 1,2G ----</td>
<td>1-22</td>
</tr>
<tr>
<td>A</td>
<td>DE 10 2007 042949 Al (HI ENZ GEORG [DE] ) 2 April 1 2009 (2009-04-02) figure 1 ----</td>
<td>1-22</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search

6 August 2014

Date of mailing of the international search report

14/08/2014

Name and mailing address of the ISA

European Patent Office, P.B. 5018 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Nie lles, Daniel
| Category | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|----------|--------------------------------------------------------------------------------|
| A        | US 2010/273605 Al (KAWASAKI KOJI [JP] ET AL) 28 October 2010 (2010-10-28) figures 1 (a), 1 (b) |
|          | US 2011/220428 Al (ANDO MASAHI KO [JP]) 15 September 2011 (2011-09-15) figure 1 |
|          | 1-22 |

Relevant to claim No. 1-22
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EP 2686585 A1</td>
<td>22-01-2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2012140664 A1</td>
<td>18-10-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2012140665 A1</td>
<td>18-10-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2686585 A1</td>
<td>22-01-2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2012140664 A1</td>
<td>18-10-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2012140665 A1</td>
<td>18-10-2012</td>
</tr>
<tr>
<td>DE 102007042949 A1</td>
<td>02-04-2009</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 2010273605 A1</td>
<td>28-10-2010</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 2011220428 A1</td>
<td>15-09-2011</td>
<td>CN 102189921 A</td>
<td>21-09-2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2011183947 A</td>
<td>22-09-2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2011220428 A1</td>
<td>15-09-2011</td>
</tr>
</tbody>
</table>