(57) Abstract: A vehicle (21) comprises a drive source E that drives the wheels L via a transmission system T₂. The transmission system T₂ has an epicyclic gearing P with three rotational members s, a, c of which a first rotational member a is connected to the drive source E, a second rotational member c is connected to the wheels L, via a first reduction R₁, and a final reduction R₅, and a third rotational member s is connected to a brake B. The brake B constitutes reaction means for balancing torque. The transmission system T₂ furthermore comprises a transmission A₁ which is parallel to the epicyclic gearing P and a transmission A₂ which is in series with the epicyclic gearing P. Moreover, the transmission system has a lock-up clutch K which can connect the first rotational member a to the second rotational member c. This transmission system T₂ enables shifting between the various transmission ratios without torque interruption, using only one brake. The transmission A₂ can directly be connected to the load L via the lock-up clutch K. Besides, transmission A₁ can be connected to the load L, by means of the 'braked' planetary set S.
Published:
—  with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Transmission system, in particular for a motor vehicle.

DESCRIPTION:

Field of the invention.

The invention relates to a transmission system, in particular for a vehicle, comprising an input shaft, which is connectable to a drive source, and an output shaft, which is connectable to a load, in particular the driven wheels of a vehicle, which transmission system furthermore comprises an epicyclic gearing with at least three rotational members, of which a first rotational member is connected to the input shaft via a first node, a second rotational member is connected to the output shaft via a second node, and a third rotational member is or can be connected to reaction means for balancing torque via a third node, and which transmission system comprises at least one transmission that includes at least one synchronesh and/or dog clutch necessary for changing the transmission ratio, which transmission has an input and output shaft the transmission ratio of which can have at least two values, and which transmission is parallel with the epicyclic gearing, where the input and output shafts of the transmission are connected to two of the three nodes, or is in series with the epicyclic gearing, where the input and output shafts of the transmission are connected to one of the nodes on the one hand, and the rotational member or the reaction means connected to that node or input or output shaft of the transmission system, on the other.

More particularly, the invention relates to transmission systems with a possibly (semi)automatic transmission consisting of an input and output shaft with gearwheel pairs that can transmit torque/power, where one gearwheel of each gearwheel pair can be connected to and disconnected from the shaft.

An epicyclic gearing can be a planetary gear set and a drive source can be a combustion engine, among others. A load can be the front- and/or rear wheels of a vehicle, but also a generator or auxiliary systems such as an air-conditioning system.

Technical state-of-the-art.
A similar transmission system is known from EP-A-0 952.023. In the known transmission system, the reaction means are constituted by an inertia element formed by a flywheel. The known auxiliary transmission system can be connected to generally known transmission systems comprising a transmission and a clutch, in order to improve such generally known transmission systems.

Summary of the invention.

An objective of the invention is to further improve a transmission system as described in the introduction. To this end, the transmission system according to the invention is characterized in that the reaction means do not necessarily include an inertia element, and if they exclusively do, that the transmission system comprises an electric motor that is connected to the transmission. The reaction means of the transmission system according to the invention also extend to reaction means that do not comprise inertia elements whatsoever or that have negligible inertia.

One embodiment of the transmission system according to the invention is characterized in that the reaction means include a brake. This way an inexpensive and simple transmission system is obtained. By appropriately activating the brake, more or less torque can be balanced. When the brake is fully closed, the epicyclic gearing forms a fixed transmission ratio between the input and output shafts of the transmission. This way, the transmission does not have to possess this transmission ratio, and hence one transmission ratio can be omitted from the transmission.

Preferably, the brake comprises a friction element which can dissipate substantial power (i.e., sufficient for severely braking or halting the third rotational member), or the brake comprises a hydrodynamical brake or electrodynamical brake, for instance a retarder or eddy current brake.

In an advantageous embodiment thereof, the reaction means are exclusively formed by the brake. The braking energy can either be exclusively dissipated, or can be directly or indirectly (by temporary storage in a buffer, such as a battery or flywheel) used for driving the load or auxiliaries, such as an air-conditioning installation.

In further advantageous embodiments, the brake comprises a generator
and/or a one-way clutch and/or a locking device, such as a locking pawl, or the brake is exclusively formed by one of these elements.

A further embodiment of the transmission system according to the invention is characterized in that the reaction means include a one-way clutch. Because the reaction means include a one-way clutch, the magnitude of the torque that can be balanced is practically unlimited (only bounded by the mechanical strength of the one-way clutch) and the time interval during which torque can be balanced is unlimited, contrary to a transmission system where the reaction means are exclusively formed by an inertia element, such as a flywheel, where the maximum amount of reaction torque is determined by the inertia of the flywheel and where the maximal time interval during which torque is balanced is determined by the maximally allowed flywheel speed.

Current one-way clutches have inertias which are so small that no torque can be balanced by the inertia. However, in a beneficial embodiment of the transmission system according to the invention, the one-way clutch has an inertia large enough to enable substantial balancing of the torque from the drive source.

Yet another embodiment of the transmission system according to the invention is characterized in that the reaction means comprise a secondary drive source formed by an electric motor/generator. A secondary drive source is to be interpreted as a drive source that by itself, i.e., as sole drive source without any assistance, cannot propel a vehicle or only for a short duration. The secondary drive source enables downscaling of the primary drive source.

Instead of using a brake or one-way clutch or electric motor/generator with a relatively large inertia, or in addition to that, the reaction means can comprise an inertia, such as a flywheel, and/or have inertia.

Furthermore, the reaction means can comprise a mechanical storage of potential energy and/or a further load. A mechanical storage of potential energy can be a torsional spring, or a hydraulic or pneumatic pressure vessel. The reaction means can also exclusively consist of one of the aforementioned elements. The brake, the electric motor/generator and the one-way clutch may or may not possess an inertia of such magnitude that torque can be balanced temporarily.

In yet another advantageous embodiment of the transmission according to the invention, the reaction means comprise an inertia element and/or a brake and the
transmission system comprises an electric motor, that is connected to the transmission or is located between one of the input and output shafts of the transmission and the node connected to it. By connecting an electric motor to the transmission at one of these locations in this embodiment, this electric motor can be favourably utilized for driving a vehicle.

Preferably, this embodiment of the transmission system furthermore comprises a disengager for the electric motor, that is located between the electric motor and the node connected to it, in case the electric motor is positioned between one of the input and output shafts of the transmission and the node connected to it, or is located between one of the input and output shafts of the transmission and the node connected to it, in case the electric motor is directly connected to the transmission.

Furthermore, the disengager for the electric motor can preferably connect the transmission to one of the nodes connected to the transmission, or it can connect this node to the other node that is connected to the transmission, or it can connect this node to neither.

Yet another embodiment of the transmission system according to the invention is characterized in that the reaction means comprise the first node, where the third node is connected to the first node otherwise than via the epicyclic gearing. Preferably, the input and output shafts of the transmission are connected to, respectively, the first rotational member and the input shaft of the transmission system, or to, respectively, the second rotational member and the output shaft of the transmission system, and the transmission system furthermore comprises a reduction, that is located between the third or first rotational member and the input shaft of the transmission system, as well as a reduction-clutch that is located between the third rotational member and the input shaft of the transmission system. This facilitates reverse driving via the epicyclic gearing, which removes the necessity for a reverse gear in the transmission, thus enabling a less complex transmission system. Through the presence of the reduction that reverses the direction of rotation, and as such realizes opposing rotational speeds of the third rotational member and the input shaft of the transmission system, the vehicle speed can be controlled with high accuracy by changing the transmission ratio. Also, by closing the reduction-clutch, in case it is a slip-clutch, reverse driving with this transmission system is possible without the need for a dedicated reverse gear.
Yet a further embodiment of the transmission system according to the invention is characterized in that the transmission system comprises an electric motor that is connected or connectable to a part of the transmission system, such as a node, the reaction means, the input or output shaft of the transmission system, one of the rotational members, or the transmission. The electric motor can, at least briefly, take over propelling the wheels from the drive source. This can be useful in certain situations, for instance when the drive source is temporarily disconnected, or to facilitate synchronization of the transmission. Using an electric motor in this configuration, it is furthermore possible to drive off forward and backwards, after which the desired gear can be activated synchronously. This enables omitting a launch clutch.

Preferably, the transmission system furthermore comprises a launch clutch, that can connect and disconnect the input and output shafts of the transmission system.

A further embodiment of the transmission system according to the invention is characterized in that the transmission system comprises a lock-up clutch, that is located between two of the three rotational members, preferably between the first and second rotational member. This lock-up clutch can connect two of the three rotational members. Through a suitable choice of the transmission ratios of the gear stages in the transmission and of the epicyclic gearing, the number of gear stages in the transmission can thus be reduced. Preferably, the lock-up clutch is constituted by the launch clutch.

Yet another embodiment of the transmission system according to the invention is characterized in that the transmission system comprises a disengager for the transmission that is located in the transmission system such that it can disengage the transmission from the input shaft of the transmission system. Preferably, the disengager for the transmission is constituted by the launch clutch.

Yet a further embodiment of the transmission system according to the invention is characterized in that the transmission system comprises at least one switch-clutch that is located between the reaction means or the input or output shaft of the transmission system, on the one hand, and the rotational member connected to it and one of the other two rotational members, on the other hand, where the switch-clutch can connect either the reaction means or the input or output shaft of the transmission system to one of the two said rotational members. In case the switch-clutch in this embodiment is located between the input shaft of the transmission system on the one hand, and the first and third
rotational member, on the other, the switch-clutch can connect the drive source to the first or to the third rotational member. By disconnecting the drive source from the first rotational member and connecting it to the third rotational member, the power is transmitted to the wheels both through the transmission that is parallel to the epicyclic gearing, and through the epicyclic gearing, thus via two branches. This enables omitting gear ratios from the transmission while retaining the same number of different gear ratios as without the possibility of switching the connection of the drive source to the epicyclic gearing. Further transmission ratios can be realized by disconnecting the driven wheels from the second rotational member and temporarily connecting them to the third rotational member. This is possible if in this embodiment the switch-clutch is located between the output shaft of the transmission system on the one hand, and the second and third rotational member on the other, where the switch-clutch can connect the driven wheels to the second or to the third rotational member.

A further embodiment of the transmission system according to the invention is characterized in that the transmission system comprises at least one pair of switch-clutches, where each switch-clutch is located between one of the rotational members on the one hand, and two elements from the group elements consisting of the reaction means and the input and output shaft of the transmission system, on the other hand, where each switch-clutch can connect the appropriate rotational member to either one of the elements from the group elements. Preferably, a switch-clutch is positioned between the first rotational member on the one hand, and the brake and the input shaft of the transmission system on the other, and the other switch-clutch is located between the third rotational member on the one hand, and the brake and the input shaft of the transmission system on the other. This way, the connections of the brake and the input shaft of the transmission system to the epicyclic gearing can be interchanged, enabling more braked transmission ratios, thus reducing the required number of gear stages in the transmission.

To enable the application of an even simpler transmission, a further embodiment of the transmission system according to the invention is characterized in that the epicyclic gearing comprises a fourth rotational member that is connected or connectable to a part of the transmission system, for instance to the reaction means or to the input or output shaft of the transmission system or to a further brake or to one of the other rotational members or to one of the nodes, or where the already present brake can be connected to the
third or fourth rotational member. This way, the epicyclic gearing enables the realization of several different gear ratios, which do not have to be present in the transmission.

Yet a further embodiment of the transmission system according to the invention is characterized in that, in case the reaction means comprise an inertia element, the transmission system comprises a disengager for the inertia element, which is present between the inertia element and the third rotational member. In case the reaction means also comprise a brake, the inertia element (preferably a flywheel) can be disconnected from the third rotational member if desirable. This can for instance be desirable when the brake is activated. In that case, the brake does not have to decelerate the flywheel in addition, but instead all braking energy can be usefully applied for torque balancing.

Preferably, the transmission system also has a further disengager for the inertia element, that is located between the inertia element and the first rotational member. This way, when combined with the aforementioned disengager for the inertia element, the inertia element can be disconnected from the third rotational member and connected to another rotational member. In doing so, additional functionality is created. For instance, in case the reaction means comprise a brake, the energy of the flywheel can be usefully applied when activating the brake. It is also possible to speed up the flywheel and maintain its speed using the drive source, especially when the vehicle is at rest. By activating the brake the flywheel will decelerate and its energy can be used to accelerate the vehicle. If the transmission is located between the drive source and the first rotational member, the speed of the drive source can be controlled independently from the flywheel speed by shifting or disengaging the transmission.

If both aforementioned disengagers for the inertia element are closed, together they function as a so-called lock-up clutch for the epicyclic gearing.

For reducing oscillations the transmission system according to the invention preferably comprises at least one torsional spring, which is located between a node on the one hand, and the reaction means or the input or output shaft of the transmission system, or the transmission or the epicyclic gearing on the other. The inertia of the reaction means (if indeed present) in this case contributes to the damping of oscillations, which moreover enables reducing of the inertias (of drive source and reaction means).

Furthermore, the transmission system according to the invention comprises at least one reduction, which is located between two parts of the transmission system, for
instance between a node on the one hand, and the reaction means or the input or output shaft of the transmission system or the transmission or the epicyclic gearing on the other, or between the transmission on the one hand, and the reaction means or the input or output shaft of the transmission system or the epicyclic gearing on the other, or between the reaction means and the input or output shaft of the transmission system. A reduction is to be interpreted here as a mechanical transmission stage.

If a reduction is located between the brake and the third rotational member, the brake load can be lowered because this way the rotational speed of the shaft at which the brake is acting can be reduced or increased such that the slip speed can be chosen optimally. Furthermore, the torque that is exerted on the shaft by the brake can be amplified towards the third rotational member, enabling a less forceful brake actuation.

If a reduction is located between the first rotational member and the first node and/or the second rotational member and the second node, the number of gear stages in the transmission can be reduced, without lowering the total amount of possible transmission ratios. By suitably choosing the transmission ratio of this reduction, two gear stages can be omitted from the transmission while retaining the same number of different transmission ratios as without this reduction.

Preferably, the transmission system furthermore comprises at least one disengager for the reduction, which is located between the reduction and one of the parts of the transmission system connected to the reduction.

Furthermore, the transmission system preferably comprises at least one further clutch that is located between two parts of the transmission system. The clutches in the transmission system according to the invention can for instance be friction clutches, synchroneshes, dog clutches, electromechanical clutches, powder clutches or torque converters.

The transmission can furthermore be equipped with less gear stages by dividing the input and/or output shaft of the transmission into two or more subshafts, which can be interconnected via one or more transmission clutches. This yields a so-called 'Windungsanordnung' where an additional transmission ratio can be created by using a series connection of a number of existing gear stages.

The invention also relates to an auxiliary transmission system for application in a transmission system of the aforementioned kind, where the transmission is parallel to
the epicyclic gearing and a clutch is furthermore located between the transmission and the input shaft of the transmission system, and where the epicyclic gearing and the reaction means are part of the auxiliary transmission system, where the epicyclic gearing comprises three rotational members of which a third rotational member is connected to the reaction means.

An auxiliary transmission system is therefore defined as a system that can be connected to an existing transmission system, comprising a transmission and a clutch. Regarding the auxiliary transmission system, the invention is characterized in that the reaction means do not necessarily comprise an inertia element, and if they exclusively do, that the transmission system comprises an electric motor that is connected to the transmission, and that the auxiliary transmission system furthermore comprises first connecting means which are connected to a first rotational member of the epicyclic gearing, for connecting the first rotational member to an input shaft of the transmission system or to the input shaft of the transmission, and second connecting means, which are connected to the second rotational member of the epicyclic gearing, for connecting the second rotational member to an output shaft of the transmission system or to an output shaft of the transmission.

The invention furthermore relates to a method for increasing the power that is transmitted from a drive source to a load, in particular the driven wheels of a vehicle, via a transmission system according to the invention with lock-up clutch and/or disengager for either transmission or electric motor. Regarding the method the invention is characterized in that the lock-up clutch and/or the disengager for either the transmission or the electric motor is opened when more power is demanded. By opening the lock-up clutch and/or the disengager for either the transmission or the electric motor, the power to the wheels is immediately increased.

**Brief description of the drawings.**

In the following, the invention is further elucidated by drawings depicting several examples of configurations of the transmission system according to the invention.

Figure 1 depicts a diagram of a vehicle equipped with a first configuration of the transmission system according to the invention, where the transmission is parallel to
the epicyclic gearing;

Figure 2 schematically depicts a constructional configuration of the transmission system, of the vehicle that was depicted in figure 1;

Figure 3 depicts a diagram of a vehicle equipped with a second configuration of the transmission system according to the invention, where one transmission is parallel to and one transmission is in series with the epicyclic gearing;

Figure 4 depicts a diagram of a vehicle equipped with a third configuration of the transmission system according to the invention, where the transmission is parallel to the epicyclic gearing and where an electric motor is connected to the transmission and a clutch may or may not be located between the drive source and the transmission;

Figure 5 schematically depicts a constructional configuration of the transmission system, of the vehicle that was depicted in figure 4, without a clutch between the drive source and the transmission;

Figure 6 schematically depicts a constructional configuration of the transmission system, of the vehicle that was depicted in figure 4, with a clutch between the drive source and the transmission;

Figure 7 depicts a diagram of a vehicle equipped with a fourth configuration of the transmission system according to the invention, where the transmission is in series with the epicyclic gearing;

Figure 8 schematically depicts a constructional configuration of the transmission system, of the vehicle that was depicted in figure 7;

Figure 9 depicts a diagram of a vehicle equipped with a fifth configuration of the transmission system according to the invention, where two additional reductions are present;

Figure 10 schematically depicts a constructional configuration of the transmission system, of the vehicle that was depicted in figure 9;

Figure 11 schematically depicts another constructional configuration of the transmission system, of the vehicle that was depicted in figure 9;

Figure 12 depicts a diagram of a vehicle equipped with a sixth configuration of the transmission system according to the invention, with only one reduction;

Figure 13 depicts a diagram of a vehicle equipped with a seventh configuration of the transmission system according to the invention, where the transmission
is in series with the epicyclic gearing;

Figure 14 schematically depicts a conventional transmission system;

Figure 15 depicts a constructional configuration of the conventional transmission system that was depicted in figure 14;

Figure 16 schematically depicts a vehicle equipped with an eighth configuration of the transmission system according to the invention; and

Figure 17 depicts a detail of a constructional configuration of the transmission system, of the vehicle that was depicted in figure 16.

**Detailed description of the drawings.**

Figures 1 and 2 depict a vehicle that is equipped with a first configuration of the transmission system according to the invention, in a schematic and concrete form respectively. The vehicle 1 has a drive source E, formed by a combustion engine, that drives a load L, formed by the driven wheels of the vehicle, via a transmission system T₁. The transmission system T₁ has an input shaft aᵢ that is connected to the drive source E via shaft-connection k₁, and an output shaft aᵢ that is connected to the driven wheels L via shaft-connection k₂. The transmission system T₁ furthermore comprises an epicyclic gearing P, and parallel to the epicyclic gearing P, a transmission A that can be connected to the input shaft aᵢ by a synchromesh C. The epicyclic gearing P is materialized as a planetary gear set comprising three rotational members s, a, c, of which a first rotational member a, formed by the ring gear, is connected to the input shaft aᵢ via a first node N₁, a second rotational member c, formed by the planet carrier, is connected to the output shaft aₒ via a first reduction R₁, a second node N₂ and a final reduction R₂, where the output shaft itself is connected to the driven wheels L of a vehicle, and a third rotational member s, formed by the sun gear, that is connected to a brake B via a third node N₃. The brake B forms the reaction means for balancing torque.

The synchromesh C can connect the input shaft aᵢ to the output shaft aₒ directly, position I, or via the transmission A, position III, or it can connect the input shaft aᵢ to the output shaft aₒ neither directly nor via the transmission A, neutral position II, in which latter case the input shaft aᵢ is connected to the output shaft aₒ via the epicyclic gearing P only.
The fixed gearwheels 5 are located on the input shaft 3 of the transmission A, and the free gearwheels 9 can be connected to the output shaft 7 via synchromeshes 11.

Launching the vehicle 1 that comprises this transmission system $T_1$, can be done by positioning the synchromesh C in its neutral position II, which is the position where the synchromesh C disconnects the output shaft 13 of the drive source E from the reduction R and the transmission A, and gradually closing the brake B. After that, upshifting can take place by selecting, for instance, the first gear of the transmission A, placing the synchromesh C in position III and releasing the brake B.

While driving, the drive source E can be decelerated by gradually closing the brake B, and accelerated by gradually releasing the brake B which was closed prior to that.

Next it is desirable that the speed difference of the shafts that are to be connected or disconnected, is as small as possible during the shift of the synchromesh C. This can be achieved by activating the brake appropriately.

Figure 3 schematically depicts a vehicle 21 equipped with a second configuration of the transmission system according to the invention. All components which are identical to those of the first configuration are referred to by the same symbols. This transmission system $T_2$ does not have a synchromesh between the transmission $A_1$ and the input shaft $a_{in}$ but a lock-up clutch instead, which can connect the first rotational member a to the second rotational member c. This can be used to lock the epicyclic gearing. Besides, a further transmission $A_2$ is located between the first rotational member and the first node $N_1$.

With this transmission system $T_2$, gear shifts can be performed without torque interruption using only one brake. This will be explained in the following. Here the transmission $A_1$ comprises the gear stages corresponding to 1st, 3rd and 5th gear, and transmission $A_2$ comprises the gear stages corresponding to 0th, 2nd and 4th gear (the transmission ratio in 0th gear is lower than that in 1st gear, though larger than 0).

The transmission $A_2$ can be directly connected to the load L via the lock-up clutch K. Besides, the transmission $A_2$ can be connected to the load L by means of the 'braked' planetary set P. This yields the transmission ratios of the 1st, 3rd and 6th gear, between the load L and the combustion engine E. The 0th gear is needed to obtain the 1st gear via the planetary set P.
By activating the brake B, launching the vehicle in 1st gear is possible via the planetary set P (A₂ is in 0th gear). By closing the brake B, 1st gear is obtained. The transmission A₁ can now take over 1st gear synchronously (brake B is released). The transmission A₂ no longer transmits torque and 2nd gear can be selected. By activating brake B transmission A₁ can be unloaded (and disengaged) and further upshifting can take place (decelerate engine). When the lock-up clutch K is synchronous it can be engaged. The 2nd gear via transmission A₂ is now engaged.

By activating the brake B, the lock-up clutch K can now be unloaded (and disengaged) and further upshifting can take place (decelerate engine). The brake B can now be closed yielding 3rd gear. The transmission A₁ can now take over 3rd gear synchronously (brake B is released). The transmission A₂ does no longer transmit torque and 4th gear can be selected. By activating brake B transmission A₁ can be unloaded (and disengaged) and further upshifting can take place (decelerate engine). When the lock-up clutch K is synchronous it can be engaged. The 4th gear via transmission A₂ is now engaged.

By activating the brake B, the lock-up clutch K can now be unloaded (and disengaged) and further upshifting can take place (decelerate engine). When the 5th gear in transmission A₁ is synchronous it can be engaged (brake B is released).

By activating the brake B, transmission A₁ can now be unloaded (and disengaged) and further upshifting can take place (decelerate engine). The brake B can now be closed yielding 6th gear.

The brake B should have an inertia as small as possible so that its inertia load during closing is minimal. When the brake B is closed the planetary reduction between the first and the second rotational member r and c should be approximately 1.5. The braked ratio is larger than the locked ratio.

From the braked ratio, preferably a synchronous shift is performed to an equally large parallel transmission ratio. After that, the future braked ratio can be changed by shifting transmission A₂. If the brake B is now activated, the planetary set P can be locked where the new ratio of transmission A₂ is engaged. By again activating the brake B, the shift towards the higher braked ratio can be performed.

In figure 4, a diagram of a vehicle 31 equipped with a third configuration of the transmission system according to the invention is depicted. All components which are identical to those of the second configuration are referred to by the same symbols. This
transmission system $T_3$ has no further transmission $A_2$. This transmission system $T_3$ does have an electric motor EM which is connected to the transmission $A$. Furthermore, the transmission system $T_3$ comprises a switch-clutch $S_1$ that is located between the input shaft $a_n$ on the one hand, and the first and third rotational member $a$ and $s$, respectively, on the other. Besides, the transmission system $T_3$ may or may not comprise a disengager $C$ for the transmission between the first node $N_1$ and the transmission $A$.

Figure 5 schematically depicts a constructional configuration of the transmission system $T_{3a}$ of the vehicle 31 that was depicted in figure 4, without a disengager $C$ for the transmission between the drive source and the transmission, whereas figure 6 schematically depicts the transmission system $T_{3b}$ with the disengager $C$ for the transmission between the drive source and the transmission.

Instead of an epicyclic gearing $P$ with three rotational members these transmission systems $T_{3a}$ and $T_{3b}$ can also be equipped with an epicyclic gearing comprising four rotational members, where the brake $B$ can be connected to the third rotational member $s$ or the fourth rotational member $r$. This enables more braked transmission ratios.

To enable more transmission ratios, these transmission systems $T_{3a}$ and $T_{3b}$ may comprise a switch-clutch $S_1$ that is located between the drive source $E$ and the first and third rotational member $a$, $s$. The switch-clutch $S_1$ can connect the input shaft $a_n$ to the first or to the third rotational member, $a$ and $s$, respectively. The transmission systems $T_{3a}$ and $T_{3b}$ may additionally comprise a further switch-clutch $S_2$ that is located between the output shaft $a_{out}$ and the second and third rotational members $c$, $s$. This further switch-clutch $S_2$ can connect the driven wheels $L$ to the second or third rotational member $c$ and $s$, respectively.

Next, the transmission systems $T_{3a}$ and $T_{3b}$ may comprise a pair of switch-clutches (not depicted) that can interchange the connections of the first and second rotational members $a$, $c$. This enables connecting the drive source $E$ to the second rotational member $c$ and the load $L$ to the first rotational member $a$. This also enables more transmission ratios.

Further transmission ratios can also be obtained by using one or more gear stages of the transmission(s) in a series connection. This is possible by dividing the input and/or output shaft of the transmission $A$ in figure 1 and 4 or $A_1$ and $A_2$ in figure 3, into two or more subshafts which can be disconnected by one or more transmission clutches.
Figure 7 depicts a diagram of a vehicle 41 equipped with a fourth configuration of the transmission system \( T_4 \) according to the invention. In this transmission system \( T_4 \), the transmission A is in series with the epicyclic gearing P. The epicyclic gearing P is constituted by a planetary gear set, where, contrary to the preceding configurations, the first rotational member s is formed by the sun gear and is connected to the transmission A, and the third rotational member a is formed by the ring gear and connected to the brake B. This transmission system \( T_4 \) furthermore comprises an inertia element formed by a flywheel F for additional torque support. To this end, the flywheel F can be connected to the third rotational member a via an inertia-clutch \( C_{11} \), or to the first rotational member s, via a further inertia-clutch \( C_2 \).

To enable driving in reverse using this transmission system \( T_4 \), without the need for a dedicated gear stage in the transmission A, the third rotational member a can be connected to the drive source E via a reduction R and a reduction-clutch \( C_3 \). Here, the brake B may be located between the reduction R and the reduction-clutch \( C_3 \) instead of being directly connected to the third rotational member a, thus decreasing the load on the brake B.

Figure 8 schematically depicts a constructional configuration of the transmission system \( T_4 \) of the vehicle 41 that was depicted in figure 7.

Figure 9 depicts a diagram of a vehicle 51 equipped with a fifth configuration of the transmission system \( T_5 \) according to the invention. In this case, there is no reduction R, but instead two additional reductions \( R_3 \) and \( R_4 \) are present, between the flywheel F and the clutch \( C_{11} \), and between the brake B and the third rotational member a, respectively. Furthermore, the clutch \( C_1 \) is not located between the flywheel F and the brake B, but between the third rotational member a on the one hand, and the reduction \( R_3 \) and the clutch \( C_2 \) on the other.

Figures 10 and 11 schematically depict two different constructional configurations of the transmission system \( T_5 \), of the vehicle 51 that was depicted in figure 9. In the configuration \( T_{5b} \) depicted in figure 11, the part of the transmission system that is located between the drive source E and the reduction \( R_1 \) is mirrored with respect to the configuration \( T_{5a} \), depicted in figure 10.

Figure 12 depicts a diagram of a vehicle 61 equipped with a sixth configuration of the transmission system \( T_6 \) according to the invention. This configuration
T₅ is a simplification of the fifth configuration T₄. Here, the three reductions R₁, R₃, and R₄ are replaced by one new reduction R* where the transmission ratio of the reduction R₂' is modified.

Figure 13 depicts a diagram of a vehicle 71 equipped with a seventh configuration of the transmission system T₇ according to the invention. This is a highly simplified version of the fourth configuration. Using this transmission system T₇, reverse driving is possible if a transmission A, which does not have a reverse gear, is placed in series with the epicyclic gearing P. To enable this, the third rotational member a is connected to the drive source E via a reduction R and a reduction-clutch C.

Figures 16 and 17 depict a vehicle 81 equipped with an eighth configuration T₈ of the transmission system according to the invention, in a schematic fashion and as a detail of a concrete form, respectively. This eighth configuration is highly suited for application in an existing transmission system. Figures 14 and 15 depict a vehicle 91 equipped with an existing transmission system T₉, in a schematic and concrete form, respectively. The most common existing transmission system T₅ for a car comprises a drive source E that is connected to the primary shaft tp of a transmission A via a clutch C. The secondary shaft ts of the transmission A is connected to a load L via a gear reduction rf, where the load L is constituted by a differential with driven wheels connected to that.

In this existing transmission system, the fifth gear stage fg, see figure 16, of the transmission A, can be easily replaced by an epicyclic gearing P with brake B and reduction rp, as is depicted in detail in figure 18 in side view and cross sectional view. The epicyclic gearing P is formed by a planetary gear set comprising a sun gear s, a planet carrier c and a ring gear a. The sun gear s is connected to the secondary shaft ts of the transmission A and the brake B is connected to the planet carrier c. The planet carrier c has double planets. The ring gear a has toothings at its outer circumference, which forms the reduction rp in combination with a gear wheel that is connected to the primary shaft tp of the transmission A.

Although above the invention has been elucidated using the drawings, it should be stated that the invention is in no way limited to the embodiments depicted in these drawings. The invention also extends to all embodiments that deviate from those depicted in the drawings, within the context defined by the appending claims. For instance, the input shaft a₁₉ of the transmission T can also be directly connected to the drive source
E, instead of via the shaft connection $k_1$. Also, a reduction can be located between the brake and the epicyclic gearing in order to reduce the load on the brake. Furthermore, in the depicted embodiments the brake may be replaced by or augmented with a one-way clutch and/or an electric motor/generator and/or a further load and/or a storage of potential energy. Also, in the first configuration the brake can be replaced by an inertia element, such as a flywheel, in which case also an electric motor is connected to the transmission.
CLAIMS:
1. Transmission system, in particular for a vehicle, comprising an input shaft, which is connectable to a drive source, and an output shaft, which is connectable to a load, in particular the driven wheels of a vehicle, which transmission system furthermore comprises an epicyclic gearing with at least three rotational members, of which a first rotational member is connected to the input shaft via a first node, a second rotational member is connected to the output shaft via a second node, and a third rotational member is or can be connected to reaction means for balancing torque via a third node, and which transmission system includes at least one transmission that comprises at least one synchromesh and/or dog clutch necessary for changing the transmission ratio, which transmission has an input and output shaft the transmission ratio of which can have at least two values, and which transmission is parallel with the epicyclic gearing, where the input and output shafts of the transmission are connected to two of the three nodes, or is in series with the epicyclic gearing, where the input and output shafts of the transmission are connected to one of the nodes on the one hand, and the rotational member or the reaction means connected to that node or input or output shaft of the transmission system, on the other, characterized in that the reaction means do not necessarily include an inertia element, and if they exclusively do, that the transmission system comprises an electric motor that is connected to the transmission.

2. Transmission system according to claim 1, characterized in that the reaction means comprise a brake.

3. Transmission system according to claim 2, characterized in that the brake comprises a friction element which can dissipate substantial power.

4. Transmission system according to claim 2, characterized in that the brake comprises a hydrodynamical brake or electrodynamical brake.

5. Transmission system according to claims 2, 3 or 4, characterized in that the brake comprises a generator.

6. Transmission system according to any of claims 2 to 5, characterized in that the brake comprises a one-way clutch.

7. Transmission system according to any of claims 2 to 6, characterized in that the brake comprises a locking device.

8. Transmission system according to any of the preceding claims, characterized
in that the reaction means comprise a one-way clutch.

9. Transmission system according to any of the preceding claims, characterized in that the reaction means comprise a secondary drive source constituted by an electric motor/generator.

10. Transmission system according to any of claims 2 to 7, characterized in that the reaction means comprise an inertia element and/or have inertia.

11. Transmission system according to any of the preceding claims, characterized in that the reaction means comprise an inertia element and/or a brake and the transmission system comprises an electric motor, that is connected to the transmission or is located between one of the input and output shafts of the transmission and the node connected to it.

12. Transmission system according to claim 11, characterized in that the transmission system furthermore comprises a disengager for the electric motor, that is located between the electric motor and the node connected to it, in case the electric motor is positioned between one of the input and output shafts of the transmission and the node connected to it, or is located between one of the input and output shafts of the transmission and the node connected to it, in case the electric motor is directly connected to the transmission.

13. Transmission system according to claim 12, characterized in that the disengager for the electric motor can connect the transmission to one of the nodes connected to the transmission, or it can connect this node to the other node that is connected to the transmission, or it can connect this node to neither.

14. Transmission system according to any of the preceding claims, characterized in that the reaction means comprise a mechanical storage for potential energy.

15. Transmission system according to any of the preceding claims, characterized in that the reaction means comprise a further load.

16. Transmission system according to any of the preceding claims, characterized in that the reaction means comprise the first node, where the third node is connected to the first node otherwise than via the epicyclic gearing.

17. Transmission system according to claim 16, characterized in that the input and output shafts of the transmission are connected to, respectively, the first rotational member and the input shaft of the transmission system, or to, respectively, the second
rotational member and the output shaft of the transmission system, and that the transmission system furthermore comprises a reduction, that is located between the third or first rotational member and the input shaft of the transmission system, as well as a reduction-clutch that is located between the third rotational member and the input shaft of the transmission system.

18. Transmission system according to any of the preceding claims 2 to 17, characterized in that the transmission system comprises an electric motor that is connected or connectable to a part of the transmission system, such as a node, the reaction means, the input or output shaft of the transmission system, one of the rotational members, or the transmission.

19. Transmission system according to any of the preceding claims, characterized in that the transmission system furthermore comprises a launch clutch, that can connect and disconnect the input and output shafts of the transmission system.

20. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises a lock-up clutch, that is located between two of the three rotational members, preferably between the first and second rotational member.

21. Transmission system according to claims 19 and 20, characterized in that the lock-up clutch is constituted by the launch clutch.

22. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises a disengager for the transmission that is located in the transmission system such that it can disengage the transmission from the input shaft of the transmission system.

23. Transmission system according to claims 19 and 22, characterized in that the disengager is constituted by the launch clutch.

24. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises at least one switch-clutch that is located between the reaction means or the input or output shaft of the transmission system, on the one hand, and the rotational member connected to it and one of the other two rotational members, on the other hand, where the switch-clutch can connect either the reaction means or the input or output shaft of the transmission system to one of the two said rotational members.

25. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises at least one pair of switch-clutches, where each
switch-clutch is located between one of the rotational members on the one hand, and two elements from the group elements consisting of the reaction means and the input and output shaft of the transmission system, on the other hand, where each switch-clutch can connect the appropriate rotational member to either one of the elements from the group elements.

26. Transmission system according to any of the preceding claims, characterized in that the epicyclic gearing comprises a fourth rotational member that is connected or connectable to a part of the transmission system, for instance to the reaction means or to the input or output shaft of the transmission system or to a further brake or to one of the other rotational members or to one of the nodes, or where the already present brake can be connected to the third or fourth rotational member.

27. Transmission system according to any of the preceding claims, characterized in that, in case the reaction means comprise an inertia element, the transmission system comprises a disengager for the inertia element, which is present between the inertia element and the third rotational member.

28. Transmission system according to claim 27, characterized in that the transmission system also has a further disengager for the inertia element, that is located between the inertia element and the first rotational member.

29. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises at least one torsional spring, which is located between a node on the one hand, and the reaction means or the input or output shaft of the transmission system, or the transmission or the epicyclic gearing on the other.

30. Transmission system according to any of the preceding claims, characterized in that the transmission comprises at least one reduction, which is located between two parts of the transmission system, for instance between a node on the one hand, and the reaction means or the input or output shaft of the transmission system or the transmission or the epicyclic gearing on the other, or between the transmission on the one hand, and the reaction means or the input or output shaft of the transmission system or the epicyclic gearing on the other, or between the reaction means and the input or output shaft of the transmission system.

31. Transmission system according to any of the preceding claims, characterized in that the transmission system furthermore comprises at least one disengager for the reduction, which is located between the reduction and one of the parts of the transmission
system connected to the reduction.

32. Transmission system according to any of the preceding claims, characterized in that the transmission system comprises at least one further clutch that is located between two parts of the transmission system.

33. Transmission system according to any of the preceding claims, characterized in that the input and/or output shaft of the transmission is divided into two or more subshafts, which can be interconnected via one or more transmission clutches.

34. Transmission system according to any of the preceding claims, characterized in that the transmission is parallel to the epicyclic gearing and a clutch is furthermore located between the transmission and the input shaft of the transmission system, and where the epicyclic gearing and the reaction means are part of an auxiliary transmission system.

35. Auxiliary transmission system for application in the transmission system according to claim 34, comprising reaction means and an epicyclic gearing with three rotational members of which a third rotational member is connected to the reaction means, characterized in that the reaction means do not necessarily comprise an inertia element, and if they exclusively do, that the transmission system comprises an electric motor that is connected to the transmission, and that the auxiliary transmission system furthermore comprises first connecting means which are connected to a first rotational member of the epicyclic gearing, for connecting the first rotational member to an input shaft of the transmission system or to the input shaft of the transmission, and second connecting means, which are connected to the second rotational member of the epicyclic gearing, for connecting the second rotational member to an output shaft of the transmission system or to an output shaft of the transmission.

36. Method for increasing the power that is transmitted from a drive source to a load, in particular the driven wheels of a vehicle, via a transmission system according to claims 13, 20, 21, 22 or 23, characterized in that the lock-up clutch and/or the disengager for either the transmission or the electric motor is opened when more power is demanded.
FIG. 3

FIG. 4

SUBSTITUTE SHEET (RULE 26)
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 B60K6/04

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B60K

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 practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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**Date of the actual completion of the international search**

9 September 2004

**Date of mailing of the international search report**

17/09/2004

Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-0040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016

Authorized officer

Tamme, H-M

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