

(19) World Intellectual Property Organization
International Bureau



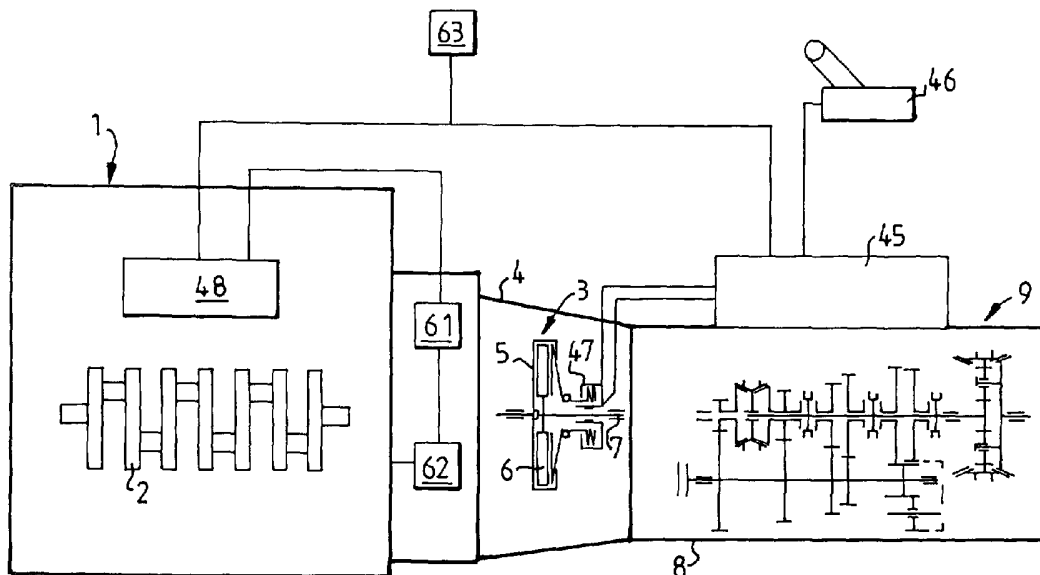
(43) International Publication Date
18 December 2003 (18.12.2003)

PCT

(10) International Publication Number
WO 03/104015 A1

- (51) International Patent Classification⁷: **B60K 41/06**, F16H 61/02, F02B 67/00
- (21) International Application Number: PCT/SE03/00951
- (22) International Filing Date: 10 June 2003 (10.06.2003)
- (25) Filing Language: Swedish
- (26) Publication Language: English
- (30) Priority Data:
0201793-7 11 June 2002 (11.06.2002) SE
- (71) Applicant (for all designated States except US): **VOLVO LASTVAGNAR AB** [SE/SE]; S-405 08 Göteborg (SE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **BRÅTHE, Lars** [SE/SE]; Stillestörpsgratan 21, S-417 13 Göteborg (SE). **ERIKSSON, Anders** [SE/SE]; Lövsckogsgatan 14, S-413 20 Göteborg (SE). **STEÉN, Marcus** [SE/SE]; Fotbollsvägen 31, S-424 33 Angered (SE).
- (74) Agent: **ALBIHNS STOCKHOLM AB**; P O Box 5581, S-114 85 Stockholm (SE).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- 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.

(54) Title: DRIVE MEANS FOR MOTOR VEHICLES



(57) Abstract: Drive means for motor vehicles, comprising an internal combustion engine (1) and an unsynchronised automated multi-stage gearbox (9). The clutch and the gearbox are controlled by an electronic transmission control unit (45) which communicates with an engine control unit (48), to which are fed signals representing the selected gear from a gear selector (46) and signals representing various engine and vehicle data. At least one auxiliary unit (61) is engagable to and disengagable from a power takeoff (62) with the aid of manual and/or automatic switch means (63). An override function can be programmed into the transmission control unit so that the transmission control unit takes over the control of the auxiliary unit at the beginning of shifting and returns control of the auxiliary unit to the switch means after completed shifting.

Drive means for motor vehicles

The present invention relates to a drive means for motor vehicles, comprising an internal combustion engine and, connected to the crankshaft of the engine via a disc clutch, an input shaft of a multi-stage gearbox which has at least one intermediate shaft which is mounted in a casing and has at least one gear wheel in engagement with a gear wheel on the input shaft, a main shaft, mounted in the casing, with gear wheels which engage with gear wheels on the intermediate shaft, at least one gear wheel in each pair of mutually engaging gear wheels on the intermediate shaft and the main shaft being mounted rotatably on its shaft and being lockable on its shaft by engaging means, of which the engaging means for at least some of the forward gears lack synchronisation function, and also operating means which interact with the engaging means and are controlled by a control means, connected to a gear selector, and having a transmission control function and an engine control function, and to which are fed signals representing the selected gear and various engine and vehicle data, which comprise at least engine speed, rotational speed of the transmission input shaft and vehicle speed, and at least one auxiliary unit, which can be coupled by manual and/or automatic switching means can be coupled to or decoupled from a power take-off on the vehicle.

Drive means of this type with automated stepped gearboxes known as autoshift gearboxes have become increasingly common in heavy-duty vehicles as microcomputer technology has developed further and made it possible to use a control computer and a number of actuators, for example servo motors, to precision-regulate engine speed, engagement and disengagement of the clutch and also the engaging means of the gearbox in relation to one another,

so that smooth shifting is always obtained even when shifting between unsynchronised gear steps. The synchronisation during shifting is done in this gearbox type by controlling the engine speed. The advantage of this type of automatic gearbox compared with a conventional automatic gearbox constructed with planetary gear stages and with a hydrodynamic torque converter on the input side is, firstly, especially as far as use in heavy-duty vehicles is concerned, that it is simpler and more robust and can be produced at a considerably lower cost than the conventional automatic gearbox, and, secondly, it has greater efficiency, which means that lower fuel consumption is possible. In a gearbox consisting of an unsynchronised stepped main group and a range group the absence of synchronizations reduces costs even further. The absence of synchronization means makes it possible to make the gearbox shorter or, alternatively, with a set length, make the gears wider than in a synchronized gearbox of the same length, to thereby make it possible to transmit higher torque.

Generally, at least three control parameters, namely: engine rpm, torque on the gearbox input shaft and vehicle speed determine when shifting shall occur according to a shifting strategy stored in an engine and transmission control computer. The torque on the gearbox input shaft is equated here with the engine torque, i.e. the load on the engine, which is obtained from sensors indicating the amount of fuel supplied to the engine, for example a flowmeter or sensor indicating accelerator pedal position. When initiating shifting, i.e. disengagement of an engaged gear, the torque transmission between the engine and the gearbox must be as small as possible. Preferably the drive chain should be torqueless to achieve jerk-free disengagement. In to the control computer there are programmed values of how large the supplied fuel amount should be for different shifting points so that the torque on the

gearbox input shaft will be close to zero or in any case so low that an engaged gear can be disengaged without any unpleasant jerking. After disengagement of the gear, the control computer controls the engine speed for synchronisation with the rpm of the gear to be engaged. When the rotational speeds have been
5 synchronized, the new gear is engaged.

If one or more auxiliary units, such as a hydraulic pump, air compressor, cooling fan and or AC compressor are coupled to power take offs on the engine before the clutch, the engine torque signal will indicate torque
10 transmission even when the torque transmission between the engine and the gearbox is zero. The torque levels to the auxiliary units must therefore be estimated and fed back in the control computer and the engine control must take into account whether one or more auxiliary units are engaged or
disengaged.

15

The auxiliary units can be completely manual, completely automatic or switchable between manual or automatic. An example of the first category would be a hydraulic pump for driving various hydraulic equipment in the vehicle. An air compressor or a cooling fan is usually controlled automatically
20 via a sensor which senses the pressure in a compressed air accumulator or a sensor which senses the engine temperature. An AC compressor can, on the other hand, usually be controlled either manually via manual controls or automatically via automatic controls settable to the desired cab temperature.

25 If the operating state of the auxiliary equipment is changed after the transmission control computer has initiated shifting, but before the synchronisation of the engine speed with the rotational speed for the selected

gear has been completed, the engine speed control will be affected, making it imprecise or slow.

5 A general purpose of the present invention is to achieve a motor vehicle drive unit of the type described by way of introduction, which permits rapid and exact control of the engine speed during shifting, by preventing manual or automatic engagement or disengagement of one or more auxiliary units during the shifting process.

10 This is achieved according to the invention by virtue of the fact that the control means are arranged, at initiation of shifting to take over from the switching means the control of the engagement or disengagement of the auxiliary unit and, upon completed shifting to allow the controlling of the auxiliary unit to return to the associated switching means.

15

In one embodiment of the drive unit according to the invention, said control means are disposed at initiation of shifting to hold the auxiliary unit in its current operational state regardless of the switching means and at completed shifting to lift the hold. Thus the auxiliary units cannot disturb and delay the
20 synchronisation process.

In a preferred further development of the drive unit according to the invention, the purpose is to achieve active control of the engagement and disengagement of the auxiliary units in such a manner that the time for rotational speed
25 adjustment during synchronisation will be optimally short. This is achieved according to the invention by virtue of the fact that the control means, at the beginning of shifting to a higher gear, involving a drop in engine speed, to control all of the auxiliary units, if the circumstances permit, to load the

engine maximally. Upon initiation of shifting to a lower gear, involving increasing the engine speed, the control is converse, so that all of the auxiliary units, as circumstances allow, are disengaged from the engine.

- 5 The invention will be described in more detail with reference to examples shown in the accompanying drawings, where Fig. 1 shows a schematic representation of a drive unit according to the invention and Fig. 2 shows the clutch and the gearbox of Fig. 1 on a larger scale.
- 10 In Fig. 1, 1 designates a six-cylinder internal combustion engine, e.g. a diesel engine, the crankshaft 2 of which is coupled to a single-disc dry-disc clutch, generally designated 3, which is enclosed in a clutch bell 4. Instead of a single disc clutch, a dual disc clutch can be used. The crankshaft 2 is solidly joined to the clutch housing 5, while its disc 6 is solidly joined to an input
- 15 shaft 7 (Fig. 2) which is rotatably mounted in the housing 8 of a gearbox, generally designated 9. A main shaft 10 (Fig. 2) and an intermediate shaft 11 (Fig. 2) are rotatably mounted in the housing 8.

- As is most clearly evident from Fig. 2, a gear 12 is rotatably mounted on the
- 20 input shaft 7 and can be locked to such shaft with the aid of an engaging sleeve 13 provided with synchronizing means. Said engaging sleeve 13 is non-rotatably but axially displaceably mounted on a hub 14 non-rotatably connected to the input shaft. With the aid of the engaging sleeve 13, a gear 15, rotatably mounted on the main shaft 10, is lockable relative to the input shaft
- 25 7. The gears 12 and 15, respectively, engage gears 16 and 17, respectively, which are non-rotatably joined to the intermediate shaft 11. Additional gears 18, 19 and 20, respectively, are non-rotatably joined to the intermediate shaft 11 and engage gears 21, 22 and 23, respectively, on the main shaft 10 and

lockable to the main shaft with the aid of engaging sleeves 24 and 25, respectively, which in the example shown do not have synchronizing means. On the main shaft 10, an additional gear 28 is rotatably mounted and engages an intermediate gear 30 rotatably mounted on a separate shaft 29. The
5 intermediate gear 30 engages in turn an intermediate shaft gear 20. The gear 28 is lockable to its shaft with the aid of an engaging sleeve 26.

The gear pairs 12, 16 and 15, 17 and the engaging sleeve 13 form a splitter group with a low stage LS and a high stage HS. The gear pair 15, 17 together
10 with the gear pairs 21, 18, 22, 19, 23, 20 and 28, 30 form a main group with four speeds forward and one reverse. At the output end of the main shaft 10, a gear 31 is non-rotatably mounted to form the sun gear in a two-range group of planetary type, generally designated 32, the planet carrier 33 of which is non-rotatably mounted to a shaft 34, forming the output shaft of the gearbox. The
15 planet gears 35 of the range group 32 engage a ring gear 36 which, with the aid of an engaging sleeve 37, can be locked relative to the gearbox housing 8 for low range LR and relative to the planet carrier 33 for high range HR. The engaging sleeve 37 also has a neutral position NR lying between low range LR and high range HR, in which neutral position the output shaft 34 is
20 released from the main shaft 10.

The engaging sleeves 13, 24, 25, 26 and 37 are displaceable as indicated by the arrows in Fig. 2, providing the gear positions indicated above the arrows. Displacement is achieved by servo means 40, 41, 42, 43 and 44, schematically
25 indicated in Fig. 2, which can be pneumatically operated piston-cylinder devices of the type used in a gearbox of the above described type, which is marketed under the name Geartronic[®]. The servo means are controlled by an electronic control unit 45 (Fig. 1), comprising a microcomputer depending on

signals fed into the control unit representing various engine and vehicle data, including at least engine speed, vehicle speed, clutch and accelerator pedal position and, where applicable, engine brake on-off, when an electronic gear selector 46 coupled to the control unit 45 is in its automatic position. When
5 the selector is in its position for manual shifting, the shifting occurs at the command of the driver via the gear selector 46. The control unit 45 also controls the fuel injection, i.e. the engine speed, depending on the accelerator pedal position and the air supply to a pneumatic piston-cylinder device 47, by means of which the clutch 3 is engaged and disengaged.

10

The transmission control unit 45 is programmed in a known manner so that the clutch 3 is held engaged when the vehicle is standing still and the gear selector 46 is in the neutral position. This means that the engine is driving the input shaft 7 and thus also the intermediate shaft 11, while the output shaft 34
15 is disengaged. Supplementary apparatus driven by the intermediate shaft, e.g. an oil pump for lubricating the gearbox, is driven in this position. The control unit 45 is also programmed, when the vehicle is standing still and then brake the intermediate shaft 11 to stop with the aid of the intermediate shaft brake 50 indicated in Fig. 2 , and which can be a braking device of a type known per
20 se and controlled by the control unit 45. With the intermediate shaft 11 braked to stop or at least nearly to stop, the control unit 45 now initiates shifting in the main group a starting off gear which provides the total gear ratio selected by the automatic transmission or by the driver. When the driver, after engagement of the selected starting off gear, e.g. first gear, depresses the accelerator,
25 the accelerator pedal will function as a reversed clutch pedal, which, via the transmission control unit successively increases the clutch engagement with increasing throttle opening.

When shifting- initiated either directly by the driver or by automatic control means in accordance with a gear selection strategy stored in the transmission control unit 45, which can take into account how the vehicle surroundings will appear in the immediate future, the transmission control unit 45 first controls
5 the engine control unit 48 to regulate the fuel supply to the engine, so that a torqueless or practically torqueless state is created in the vehicle drive chain. In other words, the torque transmission from the engine crankshaft 2 to the input shaft 7 of the gearbox 9 must be zero or at least practically zero. The transmission control unit 45 receives continuous information on, and registers
10 the current engine torque via, the amount of fuel injected.

61 designates generally one or more auxiliary units, which are driven from one or more engine driven/engine mounted power take-offs 62 before the clutch 3. The auxiliary units 61, for example a hydraulic pump, a cooling fan,
15 a generator, an air compressor or an AC compressor, can be engaged to be driven by the engine or can be disengaged by manual and/or automatic controls 63 coupled to the engine control unit 48. If one or more auxiliary units 61 are engaged via the controls 63 the engine load will be increased and more fuel will be required for synchronisation than if no auxiliary unit were
20 engaged and the torque levels. The transmission control unit 45 can compute the torque levels for these and can direct the engine control unit 48 to regulate the fuel amount to the engine towards zero torque to the transmission input shaft when disengaging the current gear and for speed synchronisation with the gearbox speed for the new gear.

25

In order to prevent automatic or unintentional manual switching of one or more controls 63 from being able to engage or disengage one or more auxiliary units 61, from initiation of shifting until the synchronisation has

been completed, which would affect the engine control during the shifting process and make it imprecise or slower than otherwise, the transmission control unit 45 is programmed according to the invention to take over, with an override function, control of the auxiliary units 61 from the controls 63 from
5 initiation of shifting until completion of shifting. Thereafter the transmission control unit 45 returns control of the auxiliary units to the controls 63.

This can mean that in one embodiment the transmission control unit 45 is programmed to hold all auxiliary units 61 in the operational state which they
10 are in when the shifting has been initiated, and lift the hold upon complete shifting.

In a preferred further development of the present invention, the transmission control unit 45 is programmed to actively control the auxiliary units 61 to
15 achieve a more rapid shifting than when the auxiliary units 61 as described above are merely held in their current operating state. The transmission control unit 45 is programmed to load, when shifting up, the engine with as many auxiliary units 61 as are suitable with regard to operating conditions. For example it may be unsuitable to engage an air compressor, if there is
20 maximum pressure in the associated pressure accumulator. Conversely, the transmission control unit 45 is programmed when downshifting to disengage as many auxiliary units 61 as suitable with regard to operating conditions. Here, for example, it can be unsuitable to disengage a cooling fan if the engine temperature is higher than normal.

Claims

1. Drive unit for motor vehicles, comprising an internal combustion engine (1) and a step gearbox input shaft (7) connected via a disc clutch (3) to the engine crankshaft (2), said step gearbox (9) having at least one intermediate shaft (11) mounted in a housing, said intermediate shaft (11) having at least one gear (16, 17) in engagement with a gear (12, 15) on the input shaft, a main shaft (10) which is mounted in the housing and has gears (15, 21, 22, 23) engaging gears (17, 18, 19, 20) on the intermediate shaft, at least one gear in each pair of interengaging gears on the intermediate shaft and the main shaft being rotatably mounted on its shaft and lockable by engaging means (13, 24, 25) of which at least some forward gears lack a synchronization function, and operating means (40,41,42), cooperating with the engaging means and being controlled by control means (45,48) which are connected to a gear selector (46) and have transmission control function and engine control function, signals being fed into said control means representing the selected gear and various engine and vehicle data, at least including engine speed, gearbox input shaft speed and vehicle speed, and at least one auxiliary unit (61), which, by means of manual and/or automatic switching means (63), can be engaged to or disengaged from a power takeoff (62) on the engine, **characterized in** that the control means (45,48) are arranged, at initiation of shifting to take over from the switching means (63) the control of the engagement or disengagement of the auxiliary unit (61) and , upon completed shifting to allow the controlling of the auxiliary unit to return to the associated switching means.

2. Drive unit according to claim 1, **characterized in** that said control means (45, 48) are disposed at initiation of shifting to hold the auxiliary unit (61) in its current operational state regardless of the switching means (63) and at completed shifting to lift the hold.

5

3. Drive unit according to claim 1, **characterized in** that said control means (45,48) are disposed, upon initiation of shifting to a higher gear than the current gear, regardless of the settings of said switch means (63), to control the auxiliary unit (61) to load the engine.

10

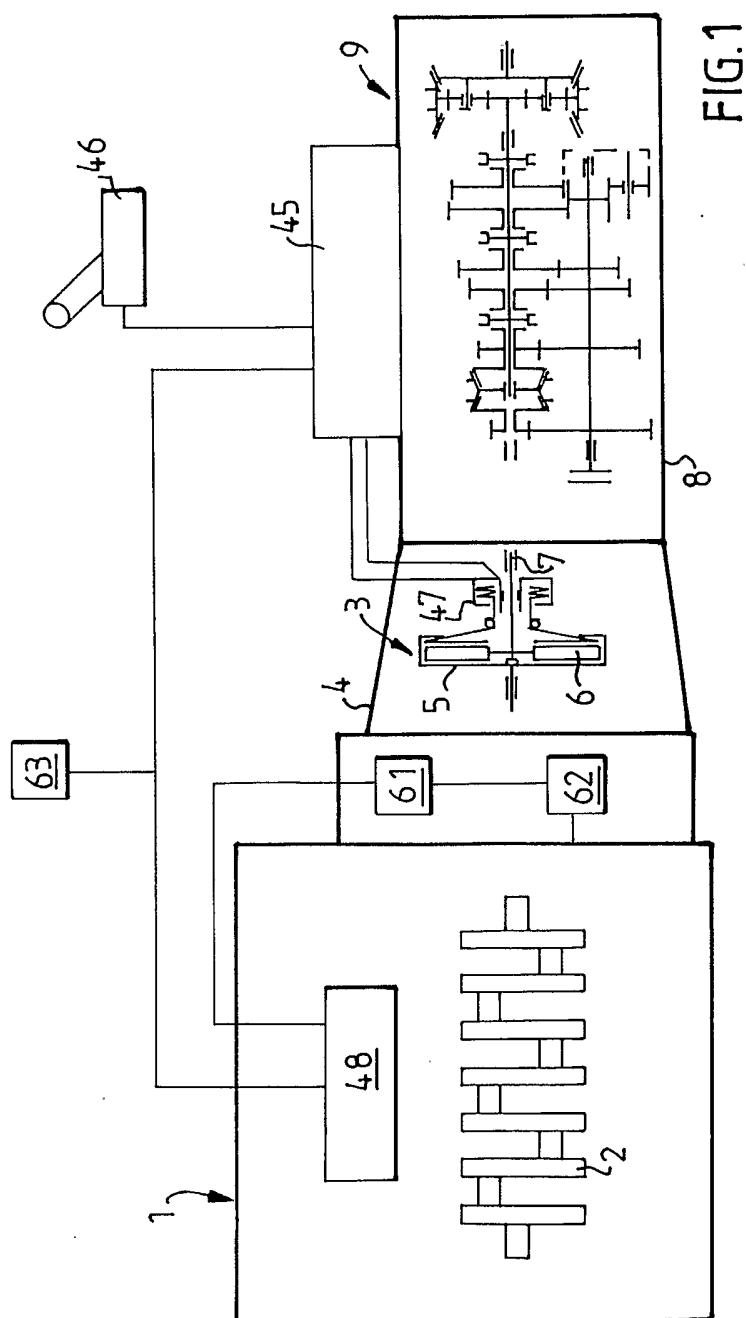
4. Drive unit according to claim 3, **characterized in** that said control means (45, 48) are disposed to control the auxiliary unit (61) to maximally load the engine.

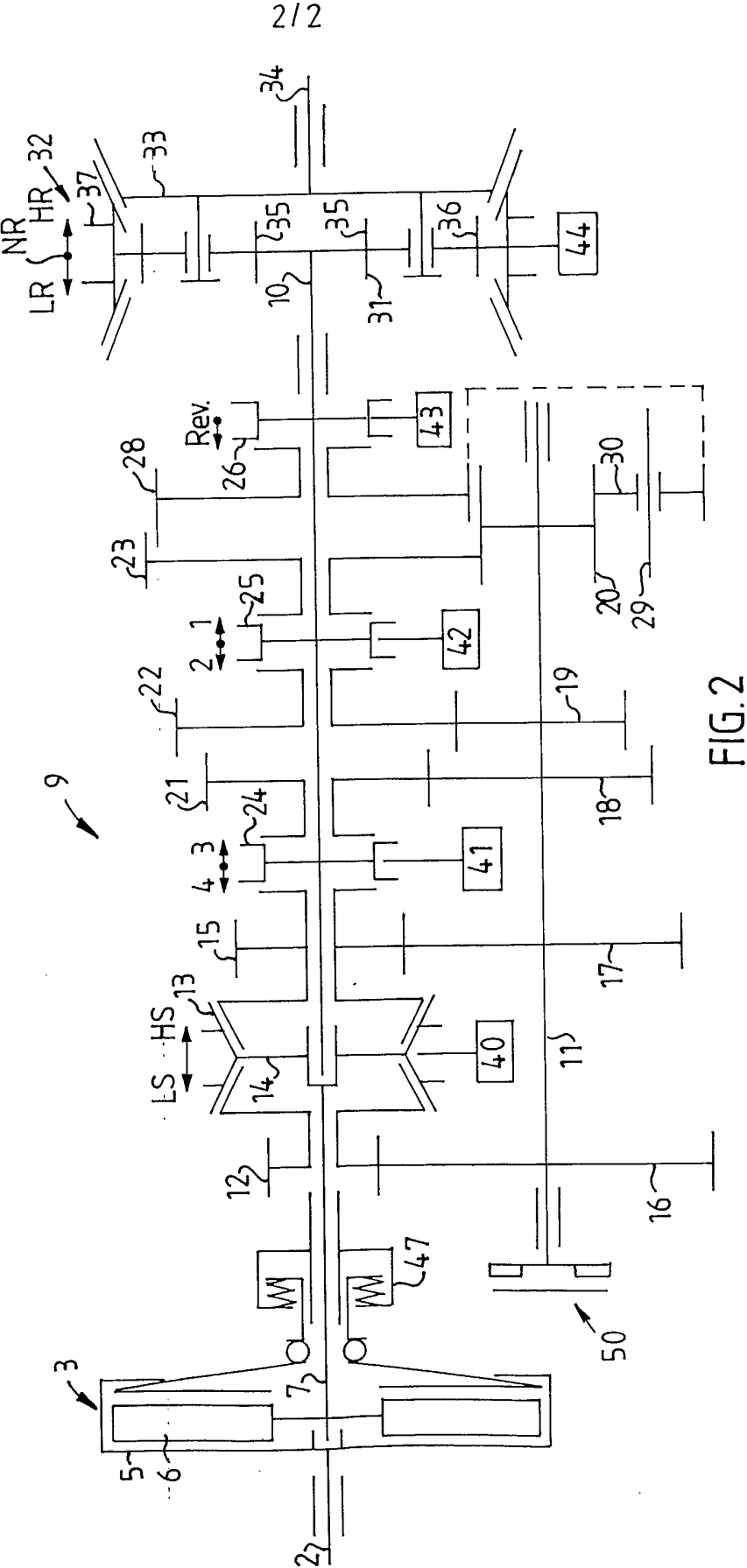
15

5. Drive unit according to Claim 1, **characterized in** that said control means (45,48) are disposed, upon initiation of shifting to a gear lower than the current gear, regardless of the setting to said switch means (63), to control the auxiliary unit (61) to load the engine to a minimum.

20

6. Drive unit according to one of Claims 1-5, **characterized in** that said control means (45,48) comprise a transmission control unit (45) and an engine control unit (48) which communicate with each other.





INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/00951

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60K 41/06, F16H 61/02, F02B 67/00

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)

IPC7: B60K, F16H, F02B

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4339935 A1 (MERCEDES-BENZ AKTIENGESELLSCHAFT), 17 November 1994 (17.11.94) --	1-6
A	WO 0192048 A1 (VOLVO LASTVAGNAR AB), 6 December 2001 (06.12.01) -- -----	1-6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

5 August 2003

06-08-2003

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Per-Olof Warnbo / MRo

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/00951

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
DE	4339935	A1	17/11/94	NONE		

WO	0192048	A1	06/12/01	AU	1183101 A	30/04/01
				AU	6094601 A	11/12/01
				BR	0111021 A	17/06/03
				EP	1234330 A	28/08/02
				EP	1286847 A	05/03/03
				JP	2003512723 T	02/04/03
				SE	516707 C	19/02/02
				SE	0002012 A	01/12/01
