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F2L LE L102 L103 L111 L113 L114 L122 L132 L211 L301 L302 L501

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GB 2319817 A
GB 2310473 A
EP 0635391 A3
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UK CL (Edition W) F2L
INT CL[7] F16D
Other: ONLINE: EPODOC, JAPIO, WPI.

(54) Abstract Title: **Method of and device for up-dating a bite point of a clutch**

(57) A clutch is actuated by a hydraulic actuator which has a snifting bore (45, fig 2) and is operated by an electric motor (43) having a position indicator (32) which provides an underlying reference position of the clutch to a control device (14). The method comprises a routine which, in step 100, checks if torque at the clutch input shaft (17, fig 1) or output shaft (18) is less than a limit value GW. If this is the case then in step 102 a snifting process is carried out and the position of a piston (38) as it passes over the snifting bore (45) and which corresponds to fully closed position of the clutch is stored in the control device (14). Steps 104 to 110 relate to whether or not counters Z_1, Z_2 have been up-dated and if so a new torque GP and position RP are stored. If the torque in step 100 is above the value the method uses another emergency routine 112-120.

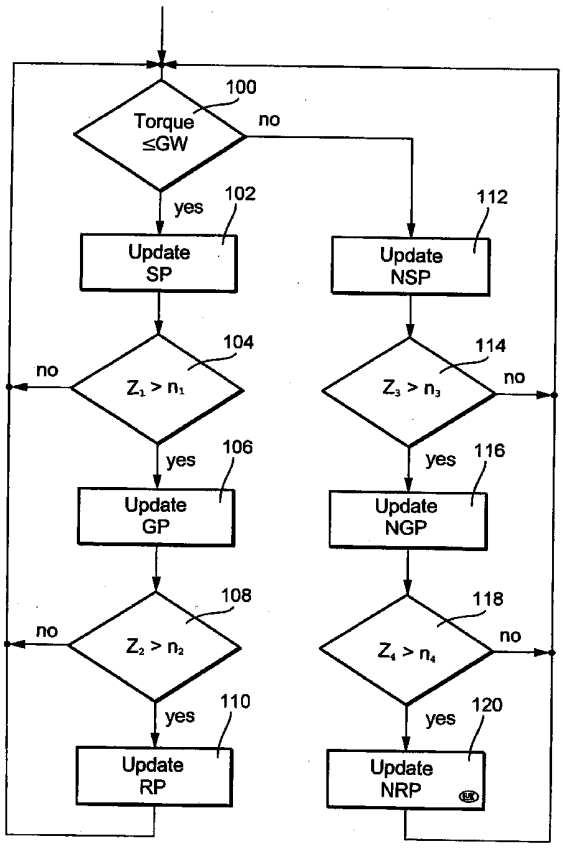

Fig. 3

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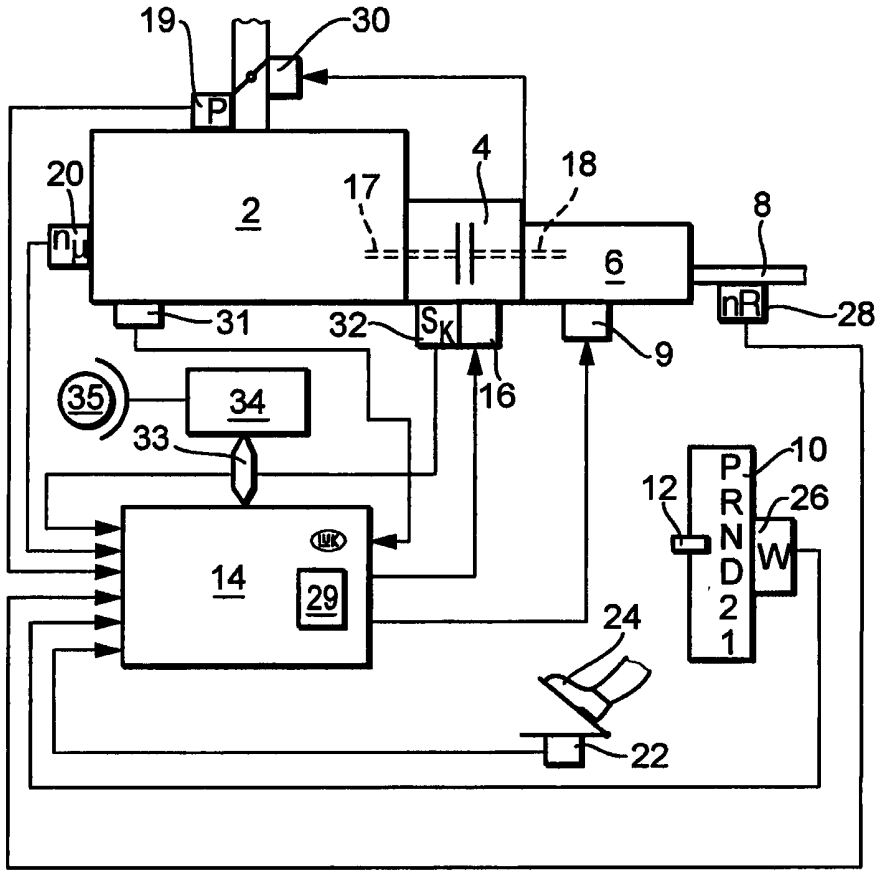
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Fig. 1

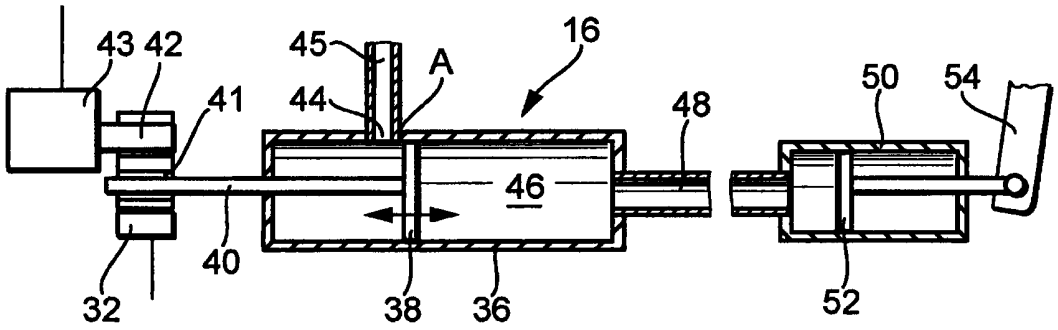
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Fig. 2

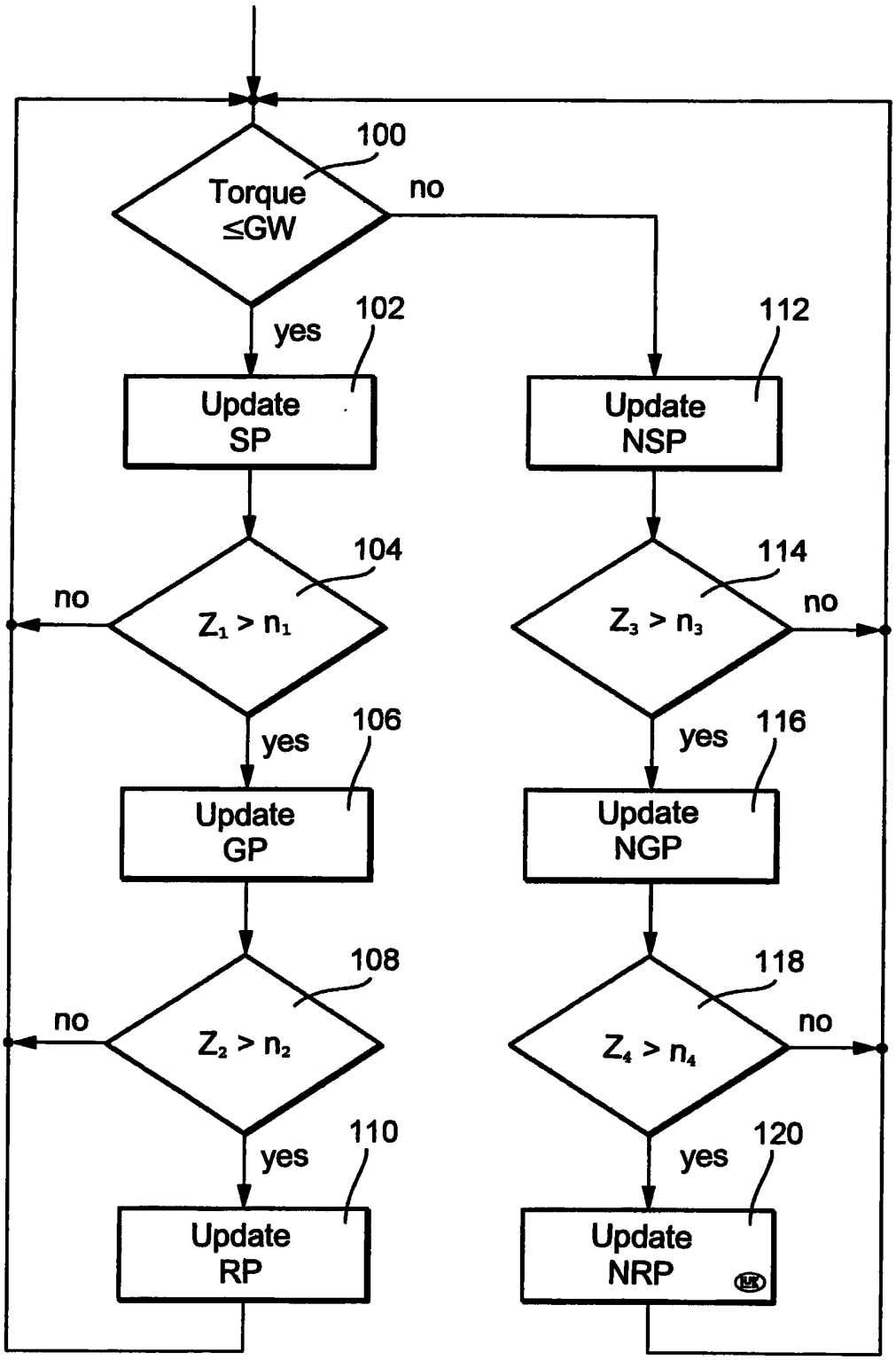
100
Torque ≤GW
no
yes
102
Update SP
112
Update NSP
104
$Z_1 > n_1$
no
114
$Z_3 > n_3$
no
yes
106
Update GP
yes
116
Update NGP
108
$Z_2 > n_2$
no
118
$Z_4 > n_4$
no
yes
110
Update RP
yes
120
Update NRP

Fig. 3

Method and device for preventing shifts in the reference position of a clutch

The invention relates to a method and device for preventing shifts in the reference position of a clutch actuated by an actuator which are conditioned by axial displacements between a clutch input shaft and a clutch output shaft.

Automatic clutches are used increasingly in motor vehicles not only because of the comfort which can be achieved therewith but also because of possible fuel savings.

Figure 1 shows a block diagram by way of example for a drive train of a motor vehicle equipped with an automatic clutch. The drive train contains an internal combustion engine 2, a clutch 4 and a gearbox 6 from which a drive shaft 8 leads to drive wheels (not shown). The gearbox 6 is by way of example an automated manual shift gearbox. For actuating and shifting the gearbox 6 there is a setting device 9 which can be controlled in known way by a selection device 10 by means of a selection lever 12 through a control device or a control system 14. The clutch 4 is for example a friction disc clutch of known construction with an actuator or an actuating device 16 which is formed hydraulically, electrically, electro-hydraulically or in some other known way. An input shaft of the clutch 4 is rigidly connected to the crankshaft of the internal combustion engine 2; an output shaft 18 of the clutch 4 is connected rigidly to the input shaft of the gearbox 6.

Sensors contained in the drive train, such as a pressure sensor 19 for detecting the pressure in the intake pipe of the engine 2, a speed sensor 20 for detecting the speed of the crankshaft of the engine, a sensor 22 for detecting the position of a drive pedal 24, a sensor 28 for detecting the position of the selection lever 12 and a further speed sensor 28 for detecting the speed of the drive shaft 2 are connected to the inputs of the control device 14.

Characteristic fields and programs are recorded in the control device 14 which contains in known way a micro computer with associated memories 29 and are used for controlling actuators such as a load position member 30 for adjusting the load of the engine 2, the actuating device 16 of the clutch 4 as well as the setting device 9 of the gearbox 6 and further consumers driven directly or indirectly by the engine. The individual actuators could be constructed so that their position is known directly in the control device 14 or additional position indicators, such as a position indicator 32 for detecting a parameter which is relevant for the position of the clutch can also be provided.

The construction and function of the described system which can be modified in many ways are known per se and are therefore not explained in detail.

For actuating the clutch 4 a characteristic is preferably recorded in the memory 29 of the control unit 14 which determines an ideal position of the clutch 4 which is set

by the actuating device 16 in dependence on the torque to be transferred by the clutch 4 at that time. For reasons of control quality, clutch wear and energy consumption of the actuating device the clutch torque transferable each time should only be as much as is absolutely necessary. The required amount of torque to be transferred results from the driver wish or position of the drive pedal 24 and for example the load of the engine 2 detected by the sensor 18 and where necessary further operating parameters such as for example the speed of the engine 2 etc.

The characteristic recorded in the control unit 14 and which provides the ideal position of a setting member of the clutch moved by the actuating device 16 in dependence on the calculated torque to be transferred has a decisive influence on comfortable smooth starting and comfortable transmission changes. The characteristic changes temporarily, for example as a result of temperature changes and also long term throughout the service life of the clutch, for example as a result of wear. It is therefore constantly up-dated and reset according to different strategies in the presence of predetermined operating conditions.

Figure 2 shows in detail an actuating device 16 with hydraulic path.

In a master cylinder 36 filled with hydraulic fluid there is a working piston 38 whose shaft 40 has external teeth which mesh with the internal teeth of a toothed wheel 41 which in turn engages with the external teeth of a pinion

42 of an electric motor 43 which is controlled by the control device 14 (Figure 1). The electric motor can be of any suitable construction and is for example controlled by a PWM signal. Advantageously the electric motor is a step motor. The master cylinder 36 has a snifting bore 44 which is connected to a compensating container (not shown) through a pipe 45. A further pipe 48 branches off from the pressure chamber 46 of the cylinder and leads to a slave cylinder 50 in which a piston 52 is working which is connected through its piston rod to the release lever 45 of the clutch forming the setting member. The position A which is termed generally as the snifting position, is the position where when the piston 38 travels over same to the right according to Figure 2 pressure builds up in the pressure chamber 46 to actuate the clutch.

In order to detect the actuating member formed by the piston 38 and its shaft 40 an incremental position indicator 32 of known construction is provided for example on the toothed wheel 41 and counts the teeth of the toothed wheel 41 passing by same and then sends corresponding impulses to the control device 14. The number of pulses is a direct measure for the displacement of the master piston 38 or if the master piston 38 according to Figure 9 is to the right of the snifting position A, the movement of the release lever 54.

With a so-called snifting process the master piston 38 in which is integrated in advantageous manner a non-return valve (not shown) which opens in the event of excess pressure on the left side of the piston 38, moves to the

left beyond the snifting position A so that the hydraulic path located between the pistons 38 and 52 connects with the pipe 45 and is pressureless. In this pressureless state of the hydraulic path the release lever 54 occupies its position corresponding to the fully closed or closing position of the clutch. If then the master cylinder 38 is moved to the right by the electric motor 42 actuation of the release lever 54 starts at that moment when the master piston 38 travels over the snifting position A. This position of the master piston 38 which can be detected for example by an increase in the current consumption of the electric motor 43, is then stored as the closing position in the control device 14 by storing the relevant dial count of the position indicator 32.

Apart from the closing position of the clutch an accurate knowledge of the bite position of the clutch is important which is that position at which the clutch transfers a predetermined torque of for example 4 Nm. The accurate knowledge of the bite point is important because it plays a significant role when driving off and when changing gear. Only if the clutch is opened beyond the bite position is it fully separated. Otherwise a gear change is not possible without a massive loss of comfort or even danger to the gearbox and the vehicle creeps too powerfully.

The bite position is normally set in that in certain operating states of the drive train, for example with the vehicle stationary and the brake actuated and the drive gear engaged the clutch is opened fully and then closed slowly whereby the engine torque is measured. If during

the slow closing of the clutch the engine torque which is given with engine idling control through the position of a setting member of the idling control, reaches the predetermined value the position indicator 32 is read and its value is stored as the bite position of the clutch. The bite position can then be rapidly reached and serve as orientation value for carrying out a starting process or a shift process. An adaptation or up-dating of the bite position lasts approximately 5 seconds and is typically carried out at least once per journey.

In a similar way individual points of the path/torque characteristic of the clutch recorded in the control device can be up-dated in that the clutch torque is determined and the associated position of the actuating device or position indicator 32 is read off and stored as the up-dated new position. The torque transferred by the clutch during engagement of the still slipping clutch is determined by determining the torque of the combustion engine taking into account its speed change and inertia moment. In this way it is possible to determine at certain points a clutch characteristic which indicates the transferable torque dependent on the position of the release lever 54. Adaptation of the clutch characteristic is required following change in the friction value of the clutch.

The bite position of the clutch or release lever 54 as well as the characteristic of the clutch which indicates the torque transferred by the clutch in dependence on the position of the release lever 54 are of decisive importance for a rapid satisfactory and comfortable operation of the

clutch. So that these positions are known independently of changes in the hydraulic path it is necessary to carry out routine snifting processes so that the snifting position and the dial states corresponding thereto form a reliable reference value.

One problem which occurs regarding the actual and accurate storage in the control device 14 of the memory values belonging to the closing position, bite position and positions for transferring a predetermined torque lies in the following:

The position of the release lever 54 with the clutch fully closed, i.e. the closing position, is equal to the snifting position of the piston 38 which can be entered directly into the control device 14 through the position indicator 32. This underlying reference position of the clutch is constantly up-dated, for example every 60 seconds when the clutch is fully closed, and is therefore constantly up-dated whereby changes in the geometry of the hydraulic path 46, 48, for example as a result of temperature changes are compensated and untight areas in the pressure system are likewise compensated. The clutch itself changes as a result of wear only insignificantly slowly so that an adaptation of the bite position or the positions of the release lever 54 belonging to the certain torques (clutch characteristic) is necessary only very rarely.

If in the transmission high torques are transferred then the gear input shaft can as a result of the inclined teeth of the toothed wheels connected to same move axially (up

to few millimetres) whereby the clutch disc is moved axially and also the bite or engagement position of the clutch and the clutch characteristic orientated therein are also displaced. The drive behaviour and shift behaviour of the vehicle can be uncomfortable if the actuation of the clutch takes place with reference positions which have been updated and stored at the time of high torque transfer of the gear input shaft if this high torque no longer exists.

The object of the invention is to provide a remedy for this problem.

One solution is achieved with a method for preventing shifts in the reference position of a clutch actuated by an actuator which are conditioned by axial displacements between a clutch input shaft and a clutch output shaft whereby the reference position is routinely determined, stored and thereby up-dated whereby an operating parameter which leads to an axial displacement between the shafts is determined and the routine determination and storage of the reference position is changed when the operating parameter exceeds a predetermined limit value.

The routine determination can be completely suspended for example if the operating parameter exceeds the predetermined limit value or however is taken into account in a way other than with operating parameters lying below the predetermined limit value.

Advantageously on exceeding the limit value the previously up-dated reference position remains stored whilst exceeding

the limit value so that it is still available after dropping below the limit value again. It is furthermore advantageous if whilst exceeding the limit value an emergency reference position is determined and stored and the operation of the actuator is controlled dependent on this emergency reference position whilst the limit value is exceeded.

The method according to the invention can be used for all clutches in which it leads in dependence on at least one operating parameter to axial displacements between the clutch input shaft and the clutch output shaft which cause shifts in the reference positions.

The method according to the invention can be used with particular advantage if the output shaft of the clutch is the input shaft of a gearbox connected on the output side of the clutches, and the operating parameter is the torque which can be transferred by the input shaft. In the example of Figure 1 the torque transferred by the input shaft of the gearbox 6 corresponds to the torque delivered by the engine 2.

The method according to the invention can then preferably be used if the clutch is connected to the actuator through a hydraulic path and the reference position, for example the closing position of the clutch is determined in a snifting process.

Preferably the method according to the invention can be carried out so that in the event of torque acting at the

input shaft of the gearbox and lying below the predetermined limit value a snifting process for determining and up-dating the normal closing position of the clutch is carried out at predetermined time intervals, for example every 60 seconds or with a transmission in neutral gear and the clutch closed, every 180 seconds, and in the event of torque lying above the predetermined limit value at least one emergency snifting process is carried out for determining the emergency closing position of the clutch, corresponding to which the operation of the actuator is controlled whilst the torque lies above the limit value.

It is further advantageous to set the actual bite position of the clutch after the torque has dropped below the predetermined limit value to the bite position stored prior to exceeding the limit value.

It is further preferred to store at least one torque transferable by the clutch with the associated position in the event of torque of the clutch lying below the predetermined limit value and to activate it again after the torque has dropped below the predetermined limit value.

A device according to the invention for preventing shifts in the reference position of a clutch actuated by an actuator which are conditioned by axial displacements between a clutch input shaft and a clutch output shaft contains a hydraulic path between the actuator and a setting member of the clutch, a control device for controlling the actuator, sensors connected to the control

device with at least one path sensor for detecting the position of the actuating member, a device for determining the force exerted by the actuator for adjusting the operating member and a device for detecting the torque transferred by the clutch, whereby the control device is suitable for carrying out one of the aforementioned methods.

The invention will now be explained below with reference to an example.

Figure 3 shows a flow chart of a method sequence. In step 100 it is checked whether the torque active at the clutch output shaft 18 or gear input shaft is less than a limit value GW. If this is the case then in step 102 the snifting position or the closing position SP is updated, in that a snifting process is carried out and the position which the piston 38 has on travelling over the snifting bore 44 is stored as the dial state of the position indicator 32 or incremental counter in the control device 14. It is ensured each time through a snifting process that the snifting position corresponds to the position of the actuating lever 38, 40 corresponding to the fully closed position of the clutch so that the dial state corresponding to the fully closed position of the clutch is not changed by a snifting process.

In step 104 it is then checked whether the dial state of a counter Z_1 which is increased by 1 after each up-date of the closing position exceeds a predetermined value n_1. If this is not the case, the system is switched back to step

100. If this is the case, i.e. a snifting process has taken place n_1 times, then in step 106 the bite position is up-dated and stored in the manner described above.

It is then checked in step 108 whether a counter Z_2 which is increased by 1 after each up-date of the bite position has reached the state n_2. If this is not the case then the system is switched back to step 100. If this is the case, then in step 110 a position RP of the clutch which corresponds to the transfer of the relevant torque and is characteristic of the actual friction value of the clutch is up-dated and the system switched back to step 100. In this way the actual dial states which correspond to reference positions of the clutch and can thus be arrived at, are thus are stored each time in the control device 14 (Figure 1). It is evident that the snifting, i.e. the up-dating of the closing position and the up-dating of the bite position and friction value can occur in different logical rhythm whereby the rhythm or beat times and dial states or dial changes are selected accordingly.

If it is established in step 100 that the torque is above the limit value GW then in step 112 an emergency snifting process is carried out by adapting the hydraulic path to a changed closing position of the release lever 54. The steps 114 to 120 then run through the steps 104 to 110 accordingly whereby the dial states, the beat times, the shifts etc can be different. In the memory of the control device an actual emergency bite position and emergency friction value of the clutch are stored each time

corresponding to the operation of the clutch under high torque of the gear input shaft.

If the torque 100 drops below the predetermined limit value then immediately a snifting process takes place and uses the values GP and RP last up-dated prior to exceeding the GW.

With the method according to the invention the normally unfolding up-dating routine is then changed above an engine torque GW.

In order however with longer journeys under high load to correct expansion effects of the hydraulic path, an emergency snifting can be carried out after time intervals which for example are clearly longer than the time intervals of the normal cyclical snifting. The emergency positions determined in steps 116 and 120 can remain stored so that with high torques they are preferably instantly available again after an emergency snifting.

Up-dating can proceed completely or with limitations.

In detail

a) the actual friction value of the clutch is stored

b) the long term bite point is no longer adapted

c) the friction value adaptation and the adaptation of the short-term and medium-term bite point run on

d) as soon as a snifting process takes place below the limit value GW the actual friction value is set to the

stored friction value and the adaptations of the long term bite point are permitted again.

If the drive train torque drops below the limit value GW a snifting process takes place immediately (provided that the conditions required therefor, fully closed clutch, are met). The usual snifting cycle is then carried out with further up-dates.

CLAIMS

1. Method for preventing shifts in the reference position of a clutch actuated by an actuator which are conditioned through axial displacements between a clutch input shaft and a clutch output shaft, whereby the reference position is determined, stored and up-dated routinely whereby an operating parameter which leads to an axial displacement between the shafts is determined and the routine determination and storage of the reference position is changed when the operating parameter exceeds a predetermined limit value.

2. Method according to claim 1 whereby on exceeding the limit value the previously up-dated reference position remains stored whilst the limit value is exceeded.

3. Method according to claim 2 whereby whilst exceeding the limit value an emergency reference position is determined and stored, and the operation of the actuator whilst exceeding the limit value is controlled in dependence on this emergency reference position.

4. Method according to one of claims 1 to 3 whereby the output shaft of the clutch is the input shaft of a gearbox connected on the output side of the clutch and the operating parameter is the torque transferred by the input shaft.

5. Method according to one of claims 1 to 4 whereby the clutch is connected to the actuator through a hydraulic

path and a reference position is determined in a snifting process.

6. Method according to claim 5 in which in the event of torque acting at the input shaft of the gearbox and lying beneath the predetermined limit value a snifting process is carried out at predetermined time intervals to determine and up-date the closing position of the clutch and in the event of torque lying above the predetermined limit value at least one emergency snifting process is carried out to determine the emergency closing position of the clutch.

7. Method according to claim 6 in which the actual bite position of the clutch after the torque has dropped below the predetermined limit value is set to the bite position stored prior to exceeding the limit value.

8. Method according to claim 7 in which at least one torque transferable by the clutch is stored with the associated position in the event of torque of the clutch lying below the predetermined limit value and after the torque has dropped below the predetermined limit value is activated once again.

9. Device for preventing shifts in the reference position of a clutch actuated by an actuator which are conditioned through axial displacements between a clutch input shaft and a clutch output shaft, containing
a hydraulic path between an actuating member of the actuator and a setting member of the clutch
a control device for controlling the actuator

sensors connected to the control device having at least one path sensor for detecting the position of the actuating member

a device for determining the force exerted by the actuator for adjusting the actuating member and

a device for detecting the torque transferred by the clutch whereby the control device is suitable for carrying out the method according to one of claims 5 to 8.

10. Method for preventing shifts in the reference position of a clutch substantially as herein described with reference to Figure 3 of the accompanying drawings.

11. Device for preventing shifts in the reference position of a clutch substantially as herein described with reference to Figure 3 of the accompanying drawings.

INVESTOR IN PEOPLE

Application No:	GB 0321619.9	**Examiner:**	Mike Mckinney
Claims searched:	1 to 11	**Date of search:**	26 February 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1 at least.	EP 1262360 A1	(EATON) see figs 5A, 5B and line 35 col 7 to line 21 col 8.
X	1 at least.	EP 0635391 A3	(EATON) see figs 5 to 7 and line 47 col 7 to line 28 col 8.
X	1 at least.	GB 2310473 A	(LUK) see whole document.
X	1 at least.	GB 2319817 A	(LUK) see whole document.
A		GB 2317933 A	(LUK)

Categories.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W]:

F2L

Worldwide search of patent documents classified in the following areas of the IPC[7].

F16D

The following online and other databases have been used in the preparation of this search report:

EPODOC, JAPIO, WPI