(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 February 2007 (22.02.2007)

PCT

(10) International Publication Number
WO 2007/020433 A1

(51) International Patent Classification:
F16H 57/04 (2006.01) *F16H 63/32* (2006.01)

(21) International Application Number:
PCT/GB2006/003050

(22) International Filing Date: 15 August 2006 (15.08.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0516726.7 15 August 2005 (15.08.2005) GB

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

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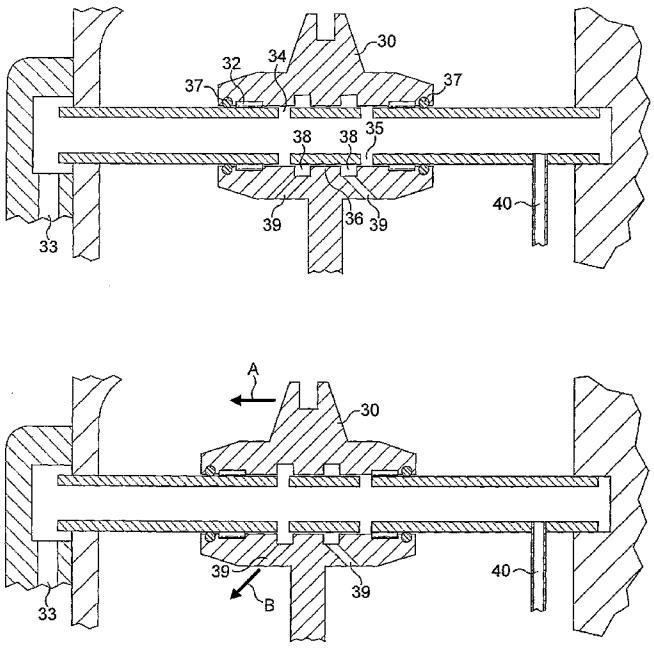
(54) **Title:** LUBRICATION OF A MULTI-SPEED GEAR TRANSMISSION BY USING A SHIFTFORK



(57) **Abstract:** Lubrication of gear pairs of a motor vehicle transmission is determined by the position of a respective selector fork (30). An internal lubricant supply is provided via the selector shaft (31), and a lubricant outlet passage (39) is closed except when the fork (30) is moved axially to permit torque transmission between an associated gear pair.

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LUBRICATION OF A MULTI-SPEED GEAR TRANSMISSION BY USING A SHIFTFORK

This invention relates to lubrication in a multi-speed gear transmission suitable for use in a motor vehicle.

Conventionally a gear transmission with multiple forward ratios has co-axial input and output shafts, and a single layshaft. Pairs of gears between the layshaft and input/output shafts provide different speed ratios, and are selectable one at a time by the vehicle driver. Multi-speed transmission of this kind are relatively long because the gear pairs usually lie side by side along the transmission drive axis.

For reasons of fuel economy, the number of forward speeds has increased in recent years, so that six-speed transmissions are now favoured. Such transmissions allow the vehicle engine to provide adequate acceleration whilst being economical and quiet at cruising speed. Multiple layshafts may be provided allowing short, but relatively wide transmissions.

In a typical gear transmission selector rails are provided for selector forks, one each of which is associated with a respective rotatable selector hub. Typically also, a selector hub will be axially reciprocal about a respective layshaft axis to engage one of two driven gears associated therewith. The selector shafts and forks may be substantially identical, and have axes in the same transverse positions with respect to the transmission input axis. The selector hubs are often substantially identical.

A reverse ratio is usually provided and may comprise an input gear associated with an input shaft, and sequential driven gears, one on an intermediate layshaft and one on an output shaft.

An adequate volume of lubricant, typically gear oil, is required to be carried by the gears for lubrication and cooling purposes. Oil may for example be distributed by

immersion of gears in a sump, but this arrangement results in churning losses and is somewhat imprecise. More recently it has been proposed to spray lubricant onto gear pairs via a network of pipes fed by a transmission oil pump.

Alternatively spray volume may be determined by the size and/or shape of an internal passageway of a selector fork, the passageway having an external aperture constituting a spray nozzle. The aperture itself may comprise a fluid restrictor.

In order to improve fuel economy it is desirable to reduce parasitic transmission losses to a minimum. Thus it would be advantageous to lubricate only the set of gears which are transmitting torque, so as to reduce the volume of spray lubricant required, and to reduce churning losses to a minimum.

According to the invention there is provided a selector shaft and selector fork assembly for a gear transmission, the selector shaft having a longitudinal axis and the selector fork being mounted on the shaft for reciprocal axial movement between unengaged and engaged conditions, wherein the shaft defines an internal lubricant conduit having a transverse outlet, the fork is adapted to block said outlet in the unengaged condition and to open said outlet in the engaged condition, and the assembly is adapted in the engaged condition to direct lubricant from said outlet to gears associated with said engaged condition.

Such an arrangement permits lubricant to be directed, e.g. by jet or spray, onto a torque transmitting gear train whenever the respective selector fork is engaged. Separate spray bars and control mechanisms are avoided since lubricant spray is automatically started and stopped according to selector fork position.

Typically the fork will be movably axially in both directions along the shaft, from the unengaged condition to one of two engaged conditions. The same fork/shaft assembly

may thus provide lubricant to two gears trains. Furthermore several forks may be provided on a single shaft which provides a common lubricant supply.

Different volumes of lubricant may be provided to each respective gear train, and controlled by the size of the associated outlet. For example the outlets may comprise holes of different cross-sectional area.

In a preferred embodiment, the outlet opens into the selector fork, the fork defining a spray passage orientated towards the associated gear set in the engaged condition. Each fork may define two such passages, one for each associated gear train. Several outlets may be provided for each fork, but preferably a single outlet is provided to distribute lubricant to a plurality of lubricant passages of each fork.

In this document, the terms selector shaft, selector fork and selector hub describe conventional means for supporting and axially moving the elements which cause a loose gear wheel to be engaged on demand with an associated through shaft. The terms are not intended to impose any constraint on the physical appearance of such components save to allow the necessary relative movements therebetween.

Lubricant is typically supplied to the selector shaft(s) from a suitable pump, for example a transmission driven gear pump.

Other features of the invention will be apparent from the following description of preferred embodiments shown by way of example only in the accompanying drawings in which:-

Fig. 1 is a developed schematic plan of a six speed, twin layshaft single clutch transmission.

Fig 2 is a respective end view showing the true spatial relationship of shafts.

Fig. 3 is a schematic axial section of a selector hub with internal lubricant supply.

Fig. 4 corresponds to Fig. 5 and shows active lubricant spray on engagement of a selector hub.

With reference to the drawings Figs. 1 and 2 illustrates a single clutch manual transmission having six forward speeds and reverse. An input shaft 10 and two layshafts 11,12 are provided with pairs of gears therebetween. Each layshaft 11,12 has an output gear 13,14 coupled to a common final drive gear 15, as best illustrated in Fig. 2.

Six forward speeds are provided by respective gear pairs and identified by the numbers '1-6'. Each pair comprises a driving wheel of the input shaft 10, and a respective driven wheel rotatable on one or other layshaft 11,12, and connectable thereto by conventional selector hubs 16. The hubs 16 are shifted, from the neutral position indicated in Fig. 1, either to the left or right to couple a respective gear wheel for rotation with the layshaft which is co-axial therewith.

Reverse gear ('R') is provided via two driven gears, one being provided on each layshaft, and the intermediate gear acting as an idler; in this way a separate layshaft for reverse is avoided. Alternatively reverse gear may be provided by separate gear train with appropriate reverse idler on a separate layshaft.

In use the transmission of Fig. 1 is operated conventionally in conjunction with the clutch 17. A selector mechanism not shown, allows selector hubs 16 to be engaged one at a time on demand to define a torque transmission path from engine to road wheels. The speed ratios can be selected in any order.

The invention is illustrated in Figs. 3 and 4.

A selector fork 30 is shiftable to the left and to the right on a selector shaft 31. Suitable plain bearings 32 are provided in the fork, which is typically a machined casting. The shaft 31 is tubular, the internal space being connected to a source of lubricant 33 under pressure.

The shaft has cross drillings 34,35 which in the neutral gear condition (Fig. 3) are blocked by the internal wall of the fork 30 and a land 36. O-ring oils seals 37 are provided in this embodiment.

Fig. 4 illustrates movement of the fork to the left, for example to engage 5th ratio of the transmissions of Fig. 1. The fork has two circumferential grooves 38 machined on the inside, and two corresponding spray passages 39 angled outwardly and towards the meshing surfaces of a respective pair of gear wheels. As will be appreciated from Fig. 4, engagement of the ratio by movement of the fork in the direction of arrow 'A' causes lubricant to be sprayed (in the direction of arrow 'B') in the region of torque transmission, and ceases when the selector fork returns. As illustrated, shifting of the fork 30 to the right causes a rightward spray of lubricant from the right hand passage 39. A lubricant return passage 40 is illustrated.

The spray passages 39 may be drillings. In one embodiment, not shown, relatively wide passages 39 may terminate distally of the spray openings, and the openings themselves may be provided by reduced diameter holes. In this way common forks may be adjusted to provide appropriate spray volumes by drilling an external opening of a desired size.

This arrangement reduces the lubricant spray volume requirement as compared with a simple spray bar installation, in which each gear pair is continually lubricated, and furthermore provides a simple and common method of lubricating each selected speed

ratio on demand. No additional components or control mechanisms are required. The volume of lubricant is easily controlled by regulating the size of the spray passage, for example by different sized drillings. Since only one gear pair is selected for drive at any one time, the invention inevitably results in lubrication of the selected gear pair only.

Although this description is made with reference to a transmission for a vehicle, it will be appreciated that the arrangements described herein are suitable for other kinds of installation where different speed ratios are required on demand.

Claims

1. A selector shaft and selector fork assembly for a gear transmission, the selector shaft having a longitudinal axis and the selector fork being mounted on the shaft for reciprocal axial movement between unengaged and engaged conditions, wherein the shaft defines an internal lubricant conduit having a transverse outlet, the fork is adapted to block said outlet in the unengaged condition and to open said outlet in the engaged condition, and the assembly is adapted in the engaged condition to direct lubricant from said outlet to gears associated with said engaged condition.

2. An assembly according to claim 1 wherein said fork is movable axially from an unengaged condition to either of two engaged conditions.

3. An assembly according to claim 2 wherein the unengaged condition is axially between the engaged conditions.

4. An assembly according to any preceding claim wherein several forks are provided on a single said shaft, said shaft having a lubricant outlet associated with each said fork.

5. An assembly according to any preceding claim and having several said outlets, the size of each outlet determining the volumetric flow rate to gears associated therewith.

6. An assembly according to any of claims 1-3 wherein said outlet opens into the selector fork, the fork defining a spray passage orientated towards the gears associated with an engaged condition thereof.

7. An assembly according to claim 6 wherein said fork is double acting and defines two spray passages, one for each gear train associated therewith.

8. An assembly according to claim 7 wherein the external opening of said spray passages comprises a restrictor for fluid passing therethrough.

9. An assembly according to claim 7 or claim 8, wherein said fork is substantially symmetrical.

10 A transmission incorporating an assembly according to any preceding claim and further including a transmission driven pump for supplying lubricant under pressure to said internal lubricant conduit.

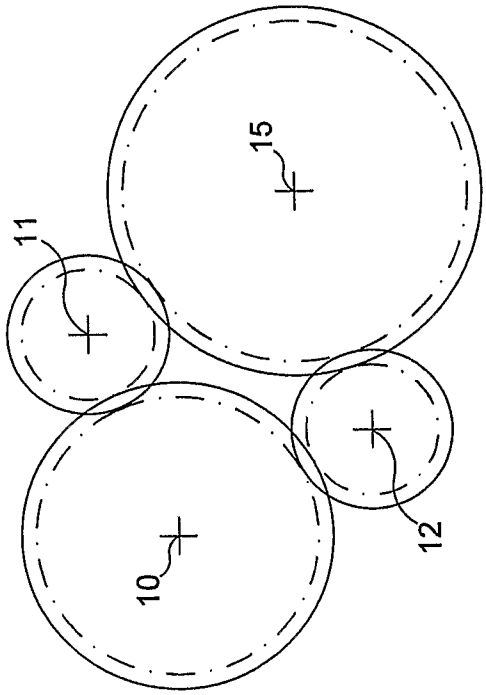

FIG. 2

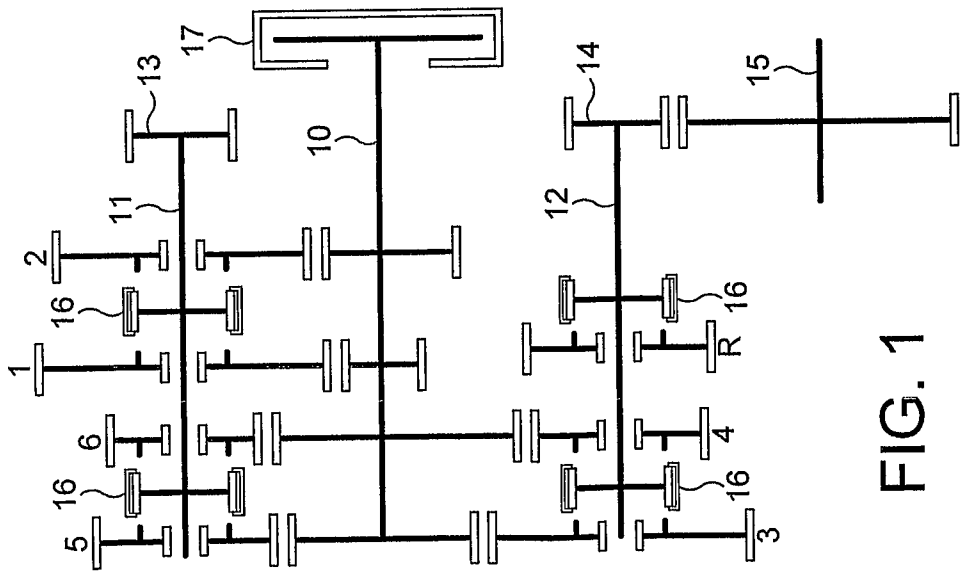

FIG. 1

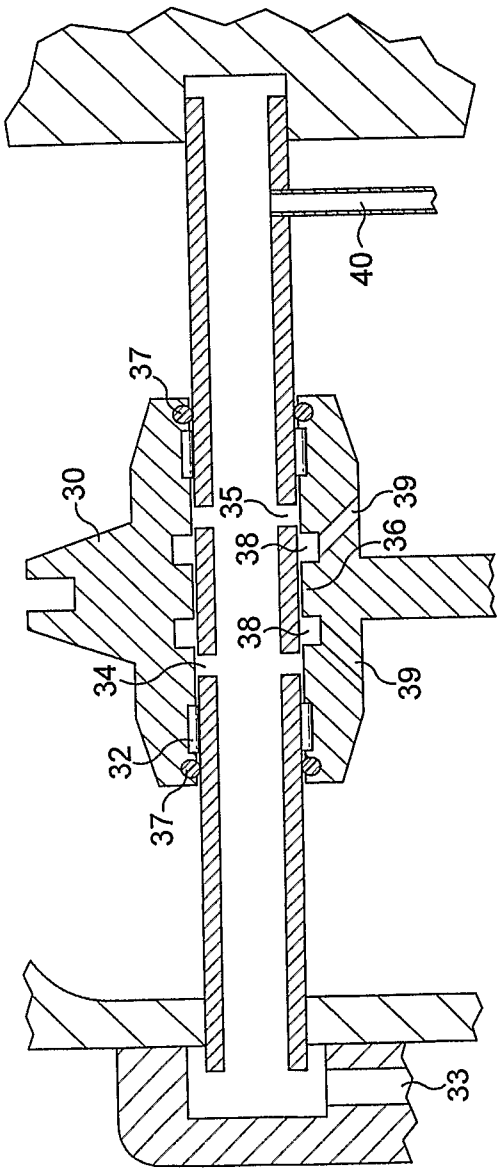

FIG. 3

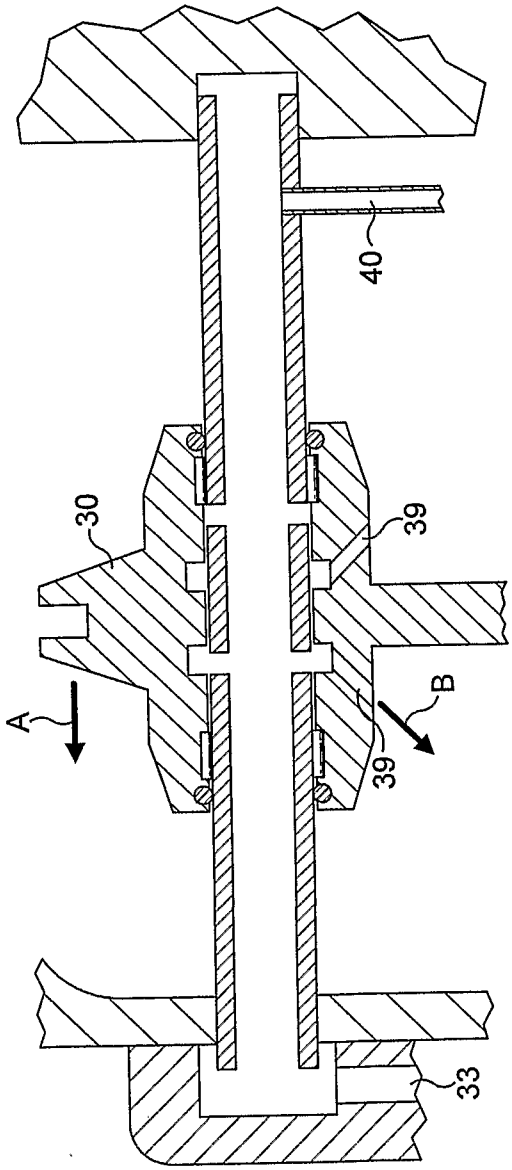

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/003050

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H57/04 F16H63/32

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)
F16H

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 199 12 328 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 21 September 2000 (2000-09-21) claims 1-4 figures 1,2 column 2, line 51 - line 52 column 3, line 4 - line 18	1-5,10
A		6-9
X	DE 103 37 908 A1 (ZAHNRADFABRIK FRIEDRICHSHAFEN [DE]) 17 March 2005 (2005-03-17) claims 1,2 figure 3 paragraph [0020]	1-5,10
A		6-9

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 October 2006	15/11/2006

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

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PCT/GB2006/003050

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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