Title: A VEHICLE FINAL DRIVE ASSEMBLY

Abstract: A vehicle final drives assembly operable between a pair of wheels across an axle. The assembly comprises an axle (89) connected to two half shafts (91, 92) by respective hydraulically actuated couplings (56, 57), the half shafts (91, 92) in use driving respective wheels, and each coupling (56, 57) comprising a clutch (93) for transmitting drive between the axle (89) and a respective half shaft (91, 92) when actuated. Each coupling (56, 57) is independently actuated upon relative rotational movement between the axle (89) and a respective half shaft (91, 92).
A Vehicle Final Drive Assembly

Field
This invention relates to a final drive assembly for a vehicle and in particular but not exclusively to vehicles having an all wheel drive facility, and to transmissions assemblies therefor.

Background of the Invention
10 In the present trend towards more and more compact vehicles, vehicles having longitudinally arranged engines with front wheel drives are known to have gearboxs and drive lines arranged around the engine.

15 In GB-A-2345 041, the gearbox is arranged at the rear of the engine with a final drive assembly and differential unit located to one side of the engine with a drive shaft extending transversely between the wheels below the engine sump. The differential unit is driven by an input shaft located within the transmission assembly and the whole unit is in a separate casing which is secured to the gearbox housing thereby avoiding mounting the final drive assembly on the engine lower structure. However, with more and more stringent space requirements, the arrangement with the final drive unit in some applications occupies too much space on that particular side of the engine.

In US Patent 3213 958 (Muller) the gear box is arranged
alongside the engine and the final drive train extends transversely through the engine sump below the crankshaft. The drive train has a split differential with a differential input unit located on one side of the engine and a differential output located on the other side of the engine. This arrangement has disadvantages in that the drive shaft passes through the engine sump and the drive may become inoperable owing to the fact that wheel spin may occur.

The present invention provides an improved vehicle final drive assembly which is particularly useful for vehicles having a primary wheel drive and a secondary wheel drive.

Statements of Invention

According to a first aspect of the present invention there is provided a vehicle final drive assembly operable between a pair of wheels across an axle and comprising an axle connected to two half shafts by respective hydraulically actuated couplings, the half shafts in use driving respective wheels, each coupling comprising a clutch for transmitting drive between the axle and a respective half shaft when actuated, characterised in that each coupling is independently actuated upon relative rotational movement between the axle and a respective half shaft.

Suitably, each coupling comprises a hydraulic pump and
hydraulic clutch actuator.

Each coupling may comprise a casing for housing the clutch, hydraulic pump and clutch actuator, the casings of each coupling being rotationally fast with the axle.

Preferably, the hydraulic pump comprises an impeller coupled to the half shaft and an eccentric ring gear coupled to the casing.

The clutch actuator preferably comprises a hydraulic piston which is actuated by hydraulic pressure generated by the hydraulic pump.

Each clutch suitably comprises a plurality of coaxial annular friction plates wherein alternating plates are rotationally fast with the respective axle and half shaft, the plates being biased into frictional engagement by hydraulic actuation.

A similar hydraulically operable coupling is described in US 5310388 which discloses details of operation of the hydraulic controls for operation of the multi-plate clutch.

According to a second aspect of the invention, there is provided a transmission assembly for a motor vehicle and which further includes a final drive assembly according to
the first aspect of the invention, the transmission assembly comprising a change speed transmission having a transmission input shaft connectable to a vehicle engine, a transmission main drive shaft coupled to a primary drive axle, and a secondary drive shaft also drivably coupled to and between the transmission main drive shaft and final drive assembly axle.

The secondary drive shaft preferably includes a universal joint, more preferably a constant velocity joint. The use of a universal joint allows the drive shaft to be routed to avoid other components in the engine compartment when space is tight e.g. steering racks.

The change speed transmission has a casing which is attached to a bell housing which in use is mounted on the engine and encloses a drive coupling, typically a friction clutch, and the final drive assembly housing is mounted to the transmission casing.

The final drive assembly is arranged with the two hydraulically operated couplings being spaced apart and located one on each side of the transmission assembly, preferably either side of the bell housing.

A further aspect of the invention provides a motor vehicle having a final drive assembly according to the first aspect of the invention, drivably connected to either of a
pair of front wheels or a pair of rear wheels not being on the primary drive axle.

Yet another aspect of the invention relates to a motor vehicle having a transmission assembly according to the second aspect of the invention.

Another aspect provides a motor vehicle having a secondary drive assembly driven by means of a transmission main drive shaft coupled to a vehicle primary drive axle, the transmission main drive shaft also being coupled to a secondary drive assembly axle to independently drive each wheel connected to the secondary drive assembly only when there is relative rotational movement between a wheel and the secondary drive assembly axle.

Description of the Drawings
The invention will be described by way of example and with reference to the accompanying drawings in which:

Fig.1 is schematic view of a motor vehicle having a final drive assembly and transmission assembly according to the present invention,

Fig.2 is an isometric view of a transmission assembly according to the present invention,

Fig.3 is a sectional side view of the
transmission assembly of Fig.2 showing the final drive input shaft and one hydraulic coupling,

Fig. 4 is a sectional view taken on the line IV-IV of Fig.3,

Fig. 5 is a schematic layout of the final drive assembly of Fig. 2 in part section,

Fig. 6 is a schematic layout showing the transmission speed change gears and the final drive assembly, and

Fig. 7 is a schematic view of a second motor vehicle with a final drive assembly according to the present invention.

Detailed Description of the Invention

With reference to Fig.1, there is shown a motor vehicle 10 having an engine 11 arranged longitudinally of the vehicle. A transmission assembly 13 is mounted on the rear of the engine and includes a final drive assembly 14 which drives the front wheels 15 and 16, and the rear wheels 17 and 18. The primary drive is to the rear wheels 17 & 18 which are driven by the transmission main shaft 51 (see Fig 5) via a conventional drive shaft 21 and differential unit 22 having the typical ring gear R and pinion P.

A secondary drive for the front wheel 15 & 16 is taken off the main transmission shaft 51 via gears 52,53,54 shown in detail in Fig 5. The gear 54 drives a drive shaft 55 of
the final drive assembly 14. The drive shaft 55 is connected in parallel to a pair of hydraulically operated couplings 56 and 57 which are in turn connected to respective wheels 15 or 16 through constant velocity joints 58 & 59.

Referring also to Figs. 2-6, the transmission assembly 13 includes a gear box casing 23 which houses a plurality of change speed gears 62 having a power input shaft 61 which in use engages a drive coupling (not shown), typically a friction clutch, mounted on the rear of the engine 11 and enclosed in bell housing 24. The bell housing 24 is secured to, or formed integrally with, the gear box casing 23. The change speed gears 62 drive the transmission main drive shaft 51 extending rearwardly from the transmission assembly. The drive shaft 51 is supported for rotation in the casing 23 by bearings 71, 72.

The final drive assembly 14 is substantially located in a final drive housing 25 which in turn is mounted to the gear box casing 23 and bell housing 24. The final drive assembly 14 and its housing 25 are arranged so as to have a particular shape and configuration within the vehicle engine compartment so as to avoid other components mounted on the engine or within the engine compartment.

The main drive shaft 51 has a drive flange 65 rotationally fast therewith for connection to the primary drive shaft
21 to the rear wheels. A driving gear 52 is also mounted on the main drive shaft 51 rotationally fast therewith, and meshes with an idler gear 53 which is rotably mounted within the casing 23 by bearings 73, 74. The idler gear 53 in turn meshes with the driven gear 54 fixed to an end portion 55A of the secondary drive shaft 55 of the final drive assembly 14 to the front wheels 15 & 16.

The secondary drive shaft 55 is rotatably supported in its housing 25 to one side of casing 22 by bearings 75, 76, 77, and 78. The shaft 55 is split into two portions, an upper portion 55A and a lower portion 55B. The driven gear 54 is fixed to the upper portion 55A which extend substantially parallel with the transmission shaft 51 and has a short rearwardly extending portion 63 which co-operates with a speedometer drive 64 for operation of the vehicle speedometer (not shown). The upper portion 55A is connected to the lower portion 55B through a constant velocity joint 66. The lower portion 55B of the drive shaft 55 is inclined downwardly and forwardly of the constant velocity joint 66. A pinion gear 67 on the lower end of shaft 55 is drivably connected to a differential system 80.

Splitting the drive shaft 55 into two portions 55A & 55B linked via a universal joint enables the shaft and its portion of the housing 25 to be routed and shaped to avoid other components within the engine compartment.
The differential system 80 is mounted in a housing 81, forming part of the final drive housing 25, and extending across the front lower portion of the gear box casing 23 and bell housing 24. The housing 81 is suitably sealed and contains hydraulic fluid for operation of the hydraulically operated couplings 56 and 57.

The two couplings 56 & 57 are mounted for coaxial rotation in the housing on bearings 82,83,84,85. The coupling 56 has a casing 86 of hollow construction which has a bevel gear ring 87 extending around its outer surface which meshes with the pinion 67 to form the differential 80. The casing 86 is mounted in the housing 81 by the bearings 82,83 so that rotation of the shaft 55 causes the casing 86 to rotate. The casing 86 is connected to a similar casing 88 of the second hydraulic coupling 57 by a coaxial cross shaft or axle 89 so that the pinion 67 drives both casings 86 and 88 in parallel. The two couplings 56 and 57 drive respective coaxial half shafts 91,92 which are in turn connected to the wheels 15 and 16 through constant velocity joints 58.

The hydraulically operated couplings 56 and 57 are of similar construction and therefore only coupling 57 will be described in detail, the other operating in a similar manner. The casing 88 encloses a multi-plate friction clutch 93 operable in hydraulic fluid. The multi-plate
clutch 93 comprises a stack of annular friction plates having alternate plates rotationally fast with the casing 88, or half shaft 92 through their outer and inner peripheries respectively. The casing 88 becomes rotationally fast with the half shaft 92, and so capable of transmitting drive between the casing 88 and half shaft 92, when the clutch 93 is compressed by a hydraulic piston 94. The piston is actuated by hydraulic pressure generated by an oil pump 95. The oil pump 95 comprises an internal ring gear 96 mounted in the casing 88 for eccentric rotation relative to a multi-lobed impeller 97 mounted on the half shaft 92. Hydraulic fluid in the housing enters the pump via apertures 98 in the casings 86 and 88.

The hydraulic pressure generated by the pump operates the piston 94 to actuate the clutch when there is relative rotational movement between the half shafts 91, 92 and their respective casings 86, 88. A more detailed explanation of the operation of the couplings is given in US 5310388.

When a vehicle is driving normally along a highway, the primary drive is through the differential 22 and back axle. Since the front wheel half shafts 91, 92 are rotating at the same speed as the casings there is essentially no drive through the front wheels. If in a particular situation, the rear wheels slip, this will cause an increase in the speed of rotation of the
transmission main drive shaft 51 and corresponding increases in the speed of rotation of the secondary drive shaft 55, axle 89 and casings 86, 88. Hence, there arises a difference in rotational speed between a half shaft 91, 92 and its respective casing 86, 88. The oil pump 95 then operates to develop sufficient pressure to actuate the piston 94 and clamp the friction clutch 93, thereby transmitting drive from a casing 86 or 88 to a respective wheel. The drive is supplied to each wheel completely independently of the other wheel across the front axle.

With reference to Fig.7, there is shown a motor vehicle 110 having an engine 111 arranged transversely of the vehicle. A transmission assembly 113 is mounted on the engine and includes a final drive assembly 114 which supplies a primary drive to the front wheels 15 and 16, and a secondary drive to the rear wheels 17 and 18.

The front wheels 15 & 16 are driven by the main transmission output shaft via conventional constant velocity joints 58 & 59. Secondary drive is supplied from the main transmission output shaft to a rear wheel drive shaft 121 and differential assembly 122 having the typical ring gear R and pinion P. The drive for the rear wheels 17 & 18 is taken off the main transmission shaft in a similar manner to that previously described. The ring gear R of differential 122 is a bevel gear connected to a coaxial cross shaft 123 in turn connected, via constant velocity
joints 124 125, at each end to a hydraulically operated coupling 56 and 57.

The drive shaft 121 is connected in parallel to the two hydraulically operated couplings 56 and 57 which are in turn connected to respective rear wheels 17 and 18. The hydraulic couplings operate in a similar manner to that previously described.
Claims

1. A vehicle final drive assembly operable between a pair of wheels across an axle and comprising an axle connected to two half shafts by respective hydraulically actuated couplings, the half shafts in use driving respective wheels, each coupling comprising a clutch for transmitting drive between the axle and a respective half shaft when actuated, characterised in that each coupling is independently actuated upon relative rotational movement between the axle and a respective half shaft.

2. A drive assembly as claimed in Claim 1, wherein each coupling further comprises a hydraulic pump and hydraulic clutch actuator.

3. A drive assembly as claimed in Claim 2, wherein the hydraulic pump comprises an impeller coupled to one of a respective half shaft or axle, and an eccentric ring gear coupled to the other of such members.

4. A drive assembly as claimed in Claim 3, wherein each coupling further comprises a casing for housing the clutch, hydraulic pump and clutch actuator, the casings of each coupling being rotationally fast with the axle.
5. A drive assembly as claimed in Claim 4, wherein the impeller is coupled to the half shaft and the eccentric ring gear is coupled to the casing.

6. A drive assembly as claimed in any one of Claims 5, wherein the clutch actuator comprises a hydraulic piston which is actuated by hydraulic pressure generated by the hydraulic pump.

7. A drive assembly as claimed in any preceding claim, wherein each clutch comprises a plurality of coaxial annular friction plates wherein alternating plates are rotationally fast with the respective axle and half shaft, the plates being biased into frictional engagement by hydraulic actuation.

8. A transmission assembly for a motor vehicle and which further includes a final drive assembly as claimed in any one of Claims 1 to 7, the transmission assembly comprising a change speed transmission having a transmission input shaft connectable to a vehicle engine, a transmission main drive shaft coupled to a primary drive axle, and a secondary drive shaft also drivably coupled to and between the transmission main drive shaft and final drive assembly axle.

9. A transmission assembly as claimed in claim 8, wherein
the secondary drive shaft includes a universal joint.

10. A transmission assembly as claimed in claim 9, wherein the universal joint comprises a constant velocity joint.

11. A transmission assembly as claimed in any of claims 8 to 10, wherein the change speed transmission has a casing which is attached to a bell housing which in use is mounted on the engine and encloses a drive coupling, and a housing for the final drive assembly is mounted to the transmission casing.

12. A transmission assembly as claimed in claim 11, wherein the two couplings are located one on each side of the bell housing.

13. A motor vehicle having a final drive assembly connected to either a pair of front wheels or a pair of rear wheels and which is a final drive assembly as claimed in any one of Claims 1 to 7.

14. A motor vehicle having a transmission assembly as claimed in Claim 8 or 9.

15. A motor vehicle having a secondary drive assembly driven by means of a transmission main drive shaft coupled to a vehicle primary drive axle, the
transmission main drive shaft also being coupled to a secondary drive assembly axle to independently drive each wheel connected to the secondary drive assembly only when there is relative rotational movement between a wheel and the secondary drive assembly axle.
# INTERNATIONAL SEARCH REPORT

PCT/GB 03/01772

## A. CLASSIFICATION OF SUBJECT MATTER

<table>
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<th>IPC</th>
<th>B60K17/35</th>
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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)

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Documentation searched either 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).

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<td>WO 00 12915 A (MCLAREN AUTOMOTIVE) 9 March 2000 (2000-03-09) abstract; figures 1-4</td>
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Further documents are listed in the continuation of box C.

| X | Patent family members are listed in annex. |

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### Date of the actual completion of the international search

23 July 2003

### Date of mailing of the international search report

30/07/2003

Names and mailing address of the ISA

European Patent Office, P.B. 5818 Patentdienst 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2060, Tx. 31 551 epo NL
Fax (+31-70) 340-3016

Authorized officer

Krieger, P.

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