



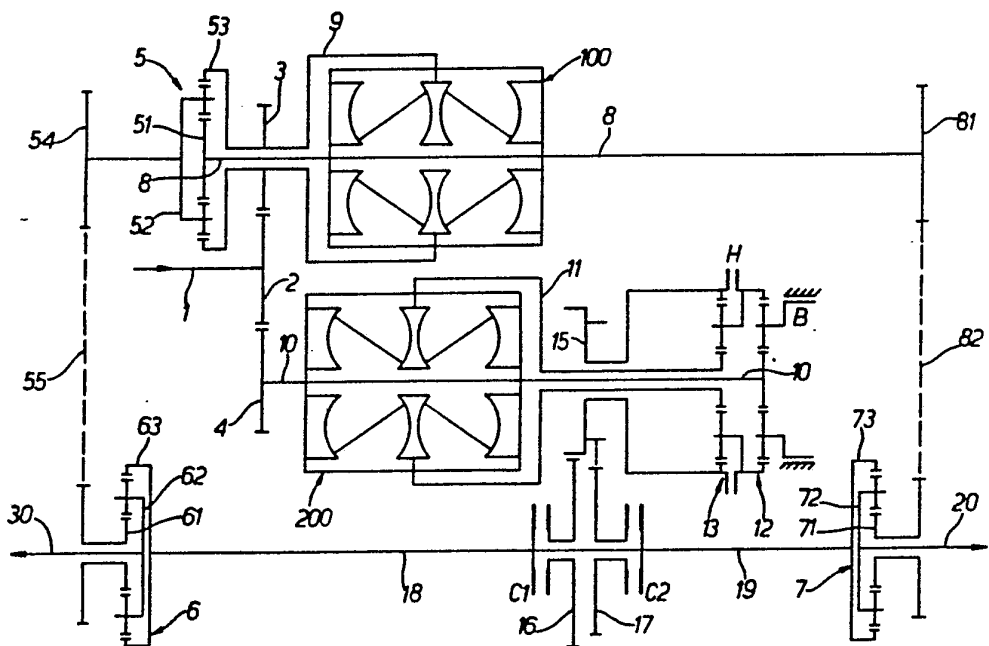
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB84/00296 (22) International Filing Date: 28 August 1984 (28.08.84) (31) Priority Application Number: 8322937 (32) Priority Date: 25 August 1983 (25.08.83) (33) Priority Country: GB  (71) Applicant: LEYLAND VEHICLES LIMITED [GB/GB]; Lancaster House, Leyland, Preston, Lancashire (GB). (72) Inventor: GREENWOOD, Christopher, John ; 14 Edinburgh Close, Leyland, Lancashire (GB). (74) Agent: ROCK, O., C.; LRL Patent, Trade Mark &amp; Licensing Department, Cowley Body Plant, Cowley, Oxford OX4 5NL (GB).</p>		<p>(81) Designated State: JP.  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

## (54) Title: DRIVE LINE FOR A TRACK-LAYING VEHICLE

## (57) Abstract

A tank engine drive shaft (1) drives respective tank track drive shafts (20, 30) by way of a continuously-variable ratio transmission variator (200), a transfer system (12, 13, 15) including coupling means (C1, C2, 16, 17), a cross shaft (18, 19) and respective summing epicyclic gears (7, 6). Steering of the tank is achieved by a steer variator (100) also driven (2, 3) by the engine, which outputs differential rotations as further inputs (82, 55) to the summing epicyclic gears (7, 6). The drive line operates in four distinct regimes: reverse, low I, low II and high, by means of an epicyclic gear brake (B), and clutches (H, C1 and C2). The two parts (16, 17) of the coupling means are made to rotate in opposite directions by the annulus (15) of the epicyclics. As the tank accelerates from rest in low I regime, with brake B applied and clutch C1 applied but clutch H disengaged, the cross shaft (18, 19) decelerates. At a predetermined forward speed, the cross shaft is stationary and the change to low II is effected synchronously. As the tank accelerates further forwards in low II regime, the cross shaft accelerates from rest in the opposite direction, with clutch C2 instead of clutch C1 engaged. The use of the same transfer system for both parts of the low regime enables the use of a smaller variator (200) for an equivalent performance.



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DRIVE LINE FOR A TRACK-LAYING VEHICLE

This invention relates to a drive line for a track-laying vehicle such as a military tank, and in particular to a drive line employing speed shaft steering.

5 The invention consists in a drive line for a track-laying vehicle having speed shaft steering, comprising two track drive shafts and a drive transmission whose output drives a shaft coupled to both track drive shafts by way of  
10 epicyclic gears having further inputs for steering, whereby the said shaft normally rotates while the vehicle is stationary, characterised in that the drive transmission has a continuously-variable ratio, and in that the  
15 drive transmission drives the shaft by way of a transfer system operable in at least low regime I and low regime II modes, the transfer system having a summing epicyclic gear arranged to sum the input and the output of the drive trans-  
20 mission and to provide a summed output, and coupling means for coupling the said summed



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5 output to the said shaft in either rotational sense to select either low regime I or low regime II modes, low regime I being operable for vehicle velocities from rest to a first predetermined velocity, and low regime II being operable from the first to a second, higher, predetermined velocity.

10 In the preferred form of drive line, the coupling means changes mode synchronously between low regime I and low regime II, the said shaft being stationary at the changeover point. Moreover, in the preferred embodiment the transfer system is further operable in a high regime mode in which the said summing epicyclic gear is locked and links the output of the drive transmission directly to the input of the coupling means, the input of the drive transmission being free to rotate relative to the transfer system.

20 In order that the invention may be better understood, two preferred embodiments will now be described with reference to the accompanying drawings, wherein:-



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Figure 1 is a schematic diagram of a drive line for a track-laying vehicle having speed shaft steering,

Figure 2 is a diagram showing a drive line in accordance with a first embodiment of the invention and

Figure 3 is a diagram of a drive line in accordance with a second embodiment of the invention.

10 Figure 1 is a schematic illustration of a drive line for a track-laying vehicle having speed shaft steering and incorporating a continuously-variable ratio steering transmission, in accordance with the invention of our British

15 patent application number 8322936. The drive line of Figure 1 is described in detail in our co-pending application, and no more than a brief description will be given here.

20 Drive I from the tank engine is coupled both to a summing epicyclic gear J and to the input of a continuously-variable ratio transmission K, for example of the toroidal race rolling traction



type. The output of the continuously-variable ratio steering transmission K is coupled both to a further input of the summing epicyclic gear J, and also through suitable gearing P to a further summing epicyclic gear M whose output drives one of the tank track drive shafts. The output of the summing epicyclic gear J is connected via suitable gearing N to a further summing epicyclic gear L whose output drives the other tank track drive shaft. Each summing epicyclic gear L, M has a further input driven I/ by the tank engine. The tank has speed shaft steering, as opposed to null shaft steering, i.e. there is a rotating steering input to both epicyclics L, M when the tank and its track drive shafts are stationary.

Figure 2 shows the first embodiment of the drive line according to the invention. In this example, a continuously-variable ratio transmission 100 acts as a steer variator, and a similar continuously-variable ratio transmission 200 transmits driving power from the engine through a transfer system to a cross shaft 18, 19 and thence to respective tank track drive shafts 20, 30.



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The steer variator 100 receives its drive input from the engine crankshaft 1 by way of gearing 2, 3. Gearing 3 is coupled to the input shaft 9 of the steer variator and also to the annulus 53 of a simple epicyclic gear 5. The output shaft 8 of the steer variator is connected at one end through gearing 81, 82 to the sun gear 71 of a simple epicyclic gear 7 which supplies drive to drive shaft 20. The other end of the output shaft 8 of the steer variator 100 is connected to the sun gear 51 of the simple epicyclic gear 5, of which the planet carrier 52 is connected to drive the sun gear 61 of simple epicyclic gear 6 by way of gearing 54, 55.

As explained in our co-pending patent application referred to above, the simple epicyclic gear 5 causes the gears 54 and 81 to rotate in opposite rotational senses. The change of ratio introduced by the simple epicyclic gear 5 is compensated for by suitably selecting the ratio of gearing 55 and 82; in this example, gearing 55 provides a ratio of - 2.86 and gearing 82 a ratio of + 1.0. Simple epicyclic gear 6 sums the drive from the cross



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shaft (at 18) and from the steer variator to provide a steered output on drive shaft 30. Simple epicyclic gear 7 sums the drive from the cross shaft (19) and from the steer variator to provide a steered output on drive shaft 20.

The drive line of the invention employs speed shaft steering, which means that the sun gears 61, 71 as well as the annuli 63, 73 of simple epicyclic gears 6, 7 respectively are made to rotate when the tank drive shafts 30, 20 are stationary. Both the steering input (from gearing 55, 82) and the cross shaft 18, 19 are rotating when the tank is stationary. The invention lies particularly in the manner in which drive is supplied from the drive transmission 200 to the track drive shafts 20, 30.

A transfer system comprising an epicyclic gear arrangement 12, 13, 15 and brake B and a coupling means consisting of clutches C1, C2 and gears 16, 17 allows the drive line to be operated in four distinct regimes for optimising its performance. The four drive regimes are:





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reverse, low I, low II and high, corresponding respectively to tank speeds in reverse, low forward, medium forward and high forward.

5 Input shaft 10 of drive variator 200 is joined to the sun gear of simple epicyclic gear 12 of which the planet carrier may be held by a brake B and of which the annulus is connected to the planet carrier of a second simple epicyclic gear 13. The output shaft 11 of the drive variator 10 200 is connected to the sun gear of the second simple epicyclic gear 13. The annulus 15 of the second simple epicyclic gear 13 provides an output in one rotational sense to gear 16, and in the opposite rotational sense to gear 17 of 15 the coupling means. The coupling means employs clutches C1 and C2 to engage to the cross shaft 18, 19 either gear 16 or gear 17 according to the regime selected. A clutch H is operable, in two of the regimes, to lock the planet carrier 20 to the annulus in the second simple epicyclic gear 13.

For the reverse regime, clutch H is engaged and clutch C1 is engaged. The input shaft 10



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rotates freely relative to the transfer system since brake B is not applied. Output shaft 11 drives annulus 15 directly, which in turn drives the cross shaft through gear 16 and clutch C1.

5 The high regime, for the highest forward speeds, is engaged by engaging clutch H, and engaging clutch C2. It operates in the same way as the reverse regime except that annulus 15 rotates gear 17 in the opposite rotational sense. For  
10 low I regime clutch H is not engaged, clutch C1 is engaged, and brake B is applied. Simple epicyclic gears 12, 13 then act to sum the inputs from input shaft 10 and output shaft 11 and supply a summed output through annulus 15  
15 and gear 16 to clutch C1. For low II regime, clutch C2 is engaged instead of clutch C1, effectively reversing the drive to the cross shaft.

20 The cross shaft 18, 19 is stationary only at the changeover between low I regime and low II regime, allowing this change to proceed synchronously. Thus, as the tank proceeds forwards from rest, it commences in low I regime



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with the cross shaft being decelerated as the tank is accelerated. At a first predetermined forward speed, when the cross shaft is stationary, the change of regimes is effected.

5 Upon further acceleration of the tank, the cross shaft accelerates in the opposite direction until a second predetermined forward speed is attained. The transfer system is preferably designed for synchronous change between low II

10 and high regimes, so that there is no relative movement between the plates of clutch H at the second predetermined forward speed. As the tank accelerates in high regime, the cross shaft accelerates from its second predetermined

15 forward speed to its highest speed.

Figure 3 shows the second embodiment of the invention, which also operates in the four regimes. The only significant difference from the first embodiment is that the clutch H is

20 replaced by clutches F and R, and a third simple epicyclic gear 14. This second drive line is more efficient than the first, since losses in the variator 200 are significantly reduced, but this is at the expense of the extra clutch and

25 gearing 14.



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For high regime, both clutches F and R are engaged, and have the same effect as the clutch H of Figure 2. For reverse regime only clutch R is engaged. For low I and low II regimes, the  
5 brake B is applied, clutch R is disengaged and clutch F is engaged. Apart from these differences, the transfer system operates in the same way as in the first embodiment of Figure 2.

The principal advantage obtained by the  
10 invention, which is apparent in both embodiments described above, is that the same transfer system is used for both parts of the low regime, low I and low II, enabling smaller variators to be employed than would otherwise be the case for  
15 an equivalent performance.

A further advantage with the second embodiment arises from the provision of both clutches F and R. In slippery conditions, for example, it is sometimes desirable to start the tank from rest  
20 with both clutches engaged; they then act effectively as a transmission brake, preventing the sudden acceleration of only one track. Moreover, with both clutches F and R engaged, a



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neutral turn can be achieved, with the tracks being propelled in opposite rotational senses while the tank is stationary.



CLAIMS

1. A drive line for a track-laying vehicle having speed shaft steering, comprising two track drive shafts and a drive transmission whose output drives a shaft coupled to both track drive shafts by way of epicyclic gears having further inputs for steering, whereby the said shaft normally rotates while the vehicle is stationary, characterised in that the drive transmission has a continuously-variable ratio, and in that the drive transmission drives the shaft by way of a transfer system operable in at least low regime I and low regime II modes, the transfer system having a summing epicyclic gear arranged to sum the input and the output of the drive transmission and to provide a summed output, and coupling means for coupling the said summed output to the said shaft in either rotational sense to select either low regime I or low regime II, low regime I being operable for



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vehicle velocities from rest to a first predetermined velocity, and low regime II being operable from the first to a second, higher, predetermined velocity.

- 5           2.    A drive line in accordance with claim 1, wherein the changeover between low regime I and low regime II occurs synchronously, with the said shaft being stationary at the changeover point.
- 10           3.    A drive line in accordance with claim 1 or claim 2, wherein the transfer system comprises a clutch which, when engaged, locks the said summing epicyclic gear to effect a high regime whereby drive is
- 15           transferred directly from the output of the drive transmission to the said coupling means.
- 20           4.    A drive line in accordance with claim 3, wherein the change from low regime II to high regime is effected synchronously, there being no relative movement between the plates of the said clutch at the



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changeover point.

- 5
5. A drive line in accordance with any preceding claim, wherein the said transfer system summing epicyclic gear comprises a first simple epicyclic gear having a sun gear driven by the input of the drive transmission, and a planet carrier connected to braking means, and a second simple epicyclic gear having a sun gear connected to the output of the drive transmission, a planet carrier connected to the annulus of the first simple epicyclic gear, and an annulus providing an output to the said coupling means.
- 10
6. A drive line in accordance with claim 5, comprising a clutch which, when engaged, couples the planet carrier to the annulus in the second simple epicyclic gear.
- 15
7. A drive line in accordance with claim 5, comprising a clutch arranged between the annulus of the second simple epicyclic gear and the output which drives the
- 20





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- 5 coupling means, and further comprising a third simple epicyclic gear having a sun gear connected to the drive transmission output, an annulus connected to the planet carrier of the second simple epicyclic gear, and a planet carrier coupled via a further clutch to the said output which provides drive to the coupling means.
- 10 8. A drive line in accordance with any preceding claim, wherein the coupling means comprises input gears coupled in opposite rotational senses to the remainder of the transfer system, each gear arranged to drive the said shaft through a respective clutch.
- 15 9. A drive line in accordance with any preceding claim, wherein the said shaft is a cross shaft driven by the coupling means and connected at either end to summing epicyclic gears each of which provides an output to a respective track drive shaft.
- 20 10. A tank incorporating a drive line in accordance with any preceding claim.



Fig.1.

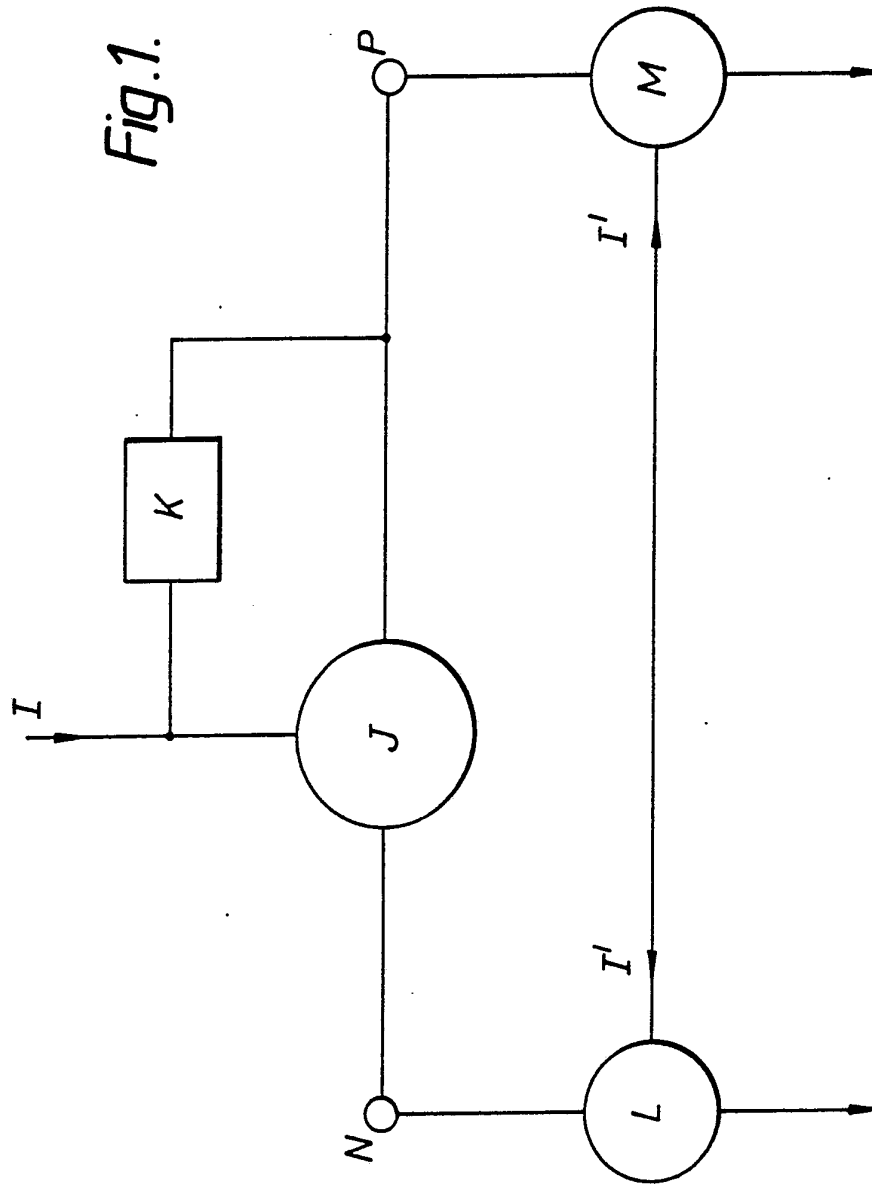


Fig. 2.

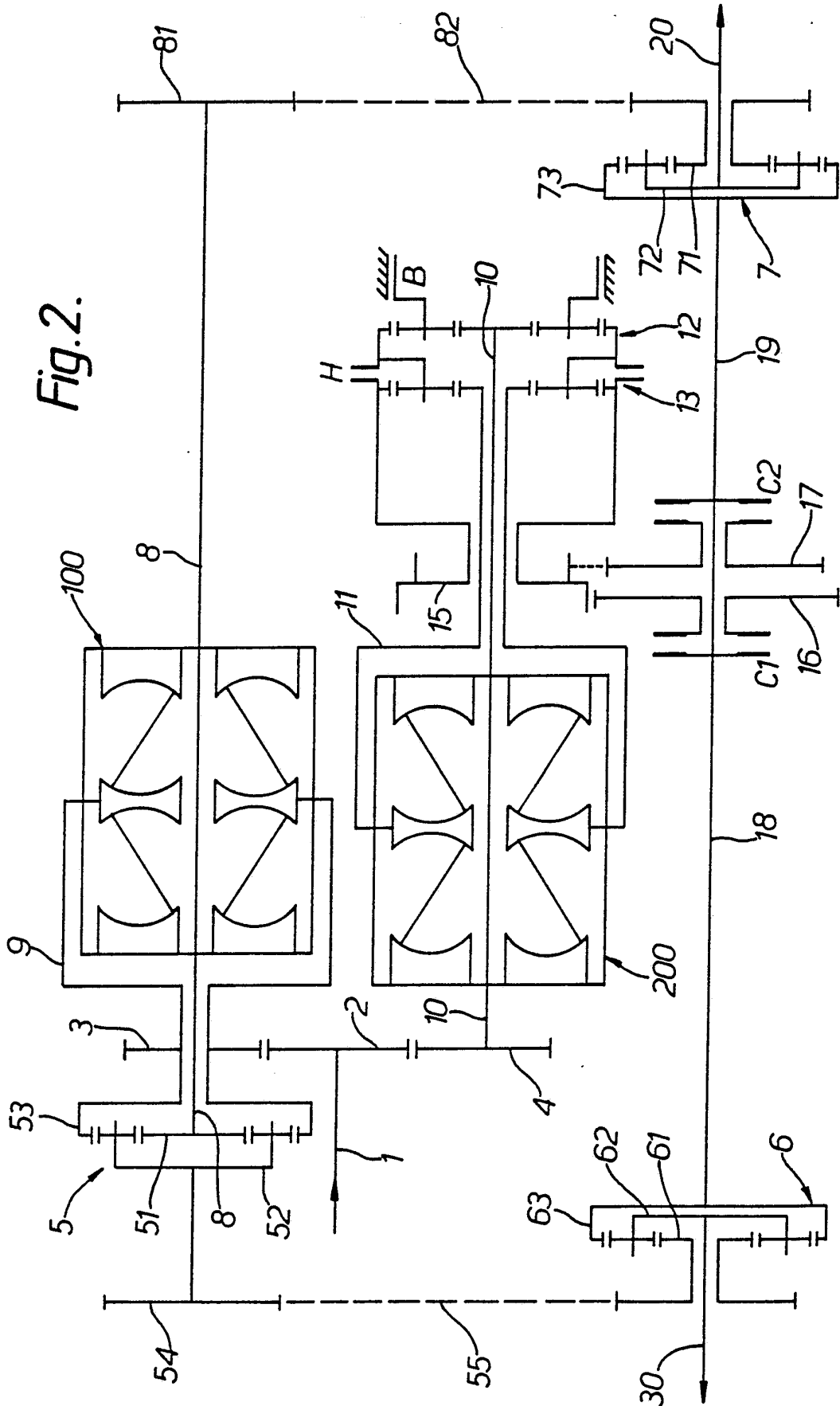
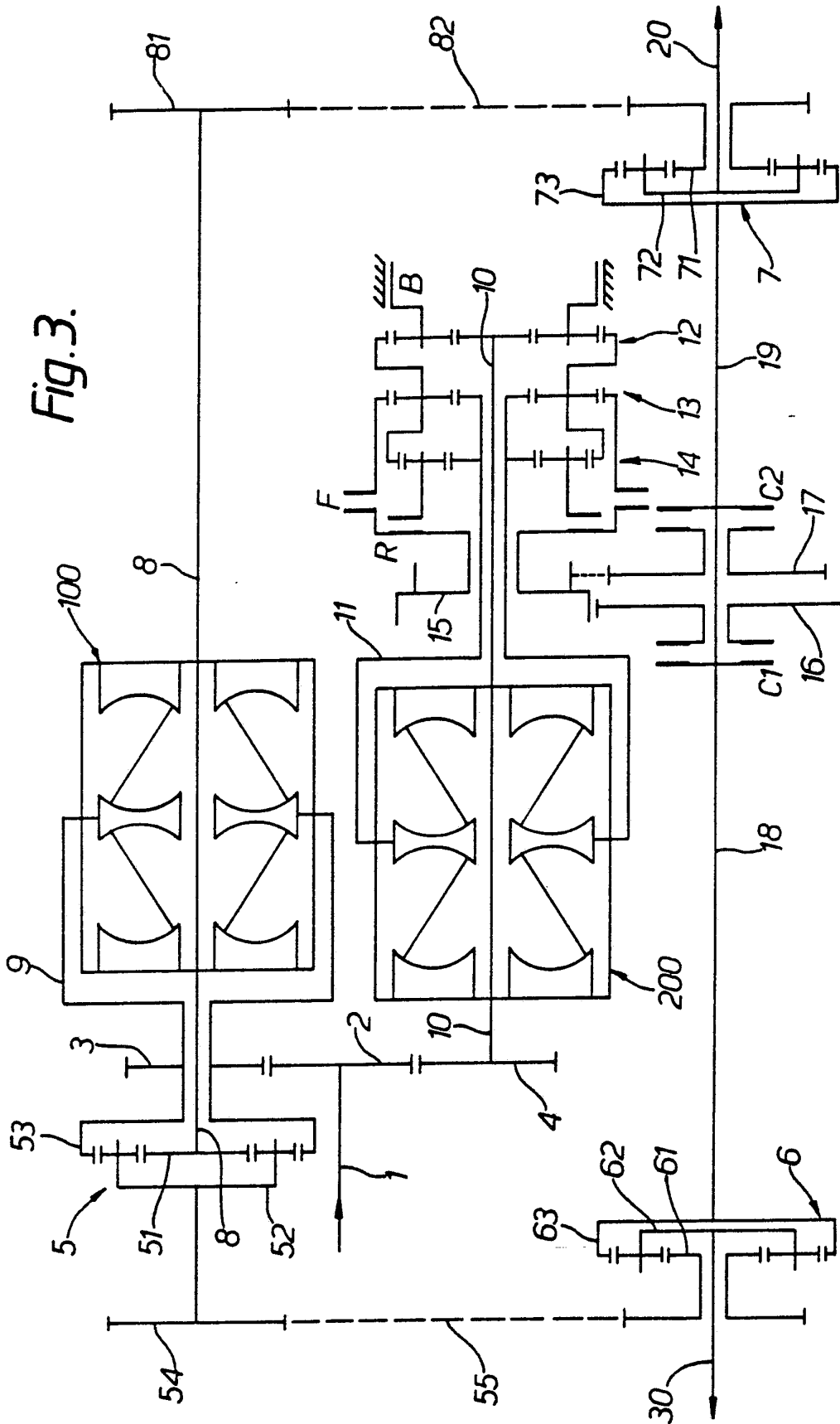


Fig. 3.



## ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 84/00296 (SA 7790)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 21/01/85

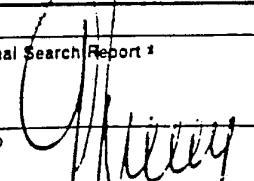
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GB-A- 2100373	22/12/82	None	
US-A- 2746319		None	
GB-A- 784120		None	
US-A- 2996933		None	
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GB-A- 2074519	04/11/81	None	
GB-A- 1303616	17/01/73	None	
US-A- 3450218	17/06/69	None	
US-A- 3530741	29/09/70	None	

For more details about this annex :  
see Official Journal of the European Patent Office, No. 12/82

# INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 84/00296

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>4</sup> : B 62 D 11/10; F 16 H 37/08		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
IPC <sup>4</sup>	B 60 K; B 62 D; F 16 H	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>13</sup>
A	GB, A, 2051265 (ZAHNRÄDERFABRIK RENK AKTIENGESELLSCHAFT) 14 January 1981 see the entire document --	1-9
A	EP, A, 0037183 (CATERPILLAR TRACTOR CO.) 7 October 1981 see claims; figures --	1-3,5-9
A	EP, A, 0043184 (BL TECHNOLOGY LTD.) 6 January 1982 see the entire document --	1-6
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A	GB, A, 784120 (ROLLS-ROYCE LTD.) 15 October 1954 see the entire document, figures --	1,3 ./.
<p><sup>*</sup> Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>2</sup>	Date of Mailing of this International Search Report <sup>1</sup>	
27th November 1984	28 JAN 1985	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>30</sup>	
EUROPEAN PATENT OFFICE	 G.L.M. Hübnerberg	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category*	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No <sup>18</sup>
A	US, A, 2996933 (G. BANISTER) 22 August 1961 see the entire document --	1,9
A	FR, A, 2520689 (ZAHNRÄDER FABRIK RENK AKTIENGESELLSCHAFT) 5 August 1983 see figures, claims --	1,9
A	GB, A, 2074519 (A.E. RIXMANN) 4 November 1981 see the entire document --	1
A	GB, A, 1303616 (A.J. WILDY) 17 January 1973 see figures; claims --	1
A	US, A, 3450218 (I.L. LOOKER) 17 June 1969 see figures; claims --	1
A	US, A, 3530741 (A. CHAREST) 29 September 1970 see the entire document -----	1