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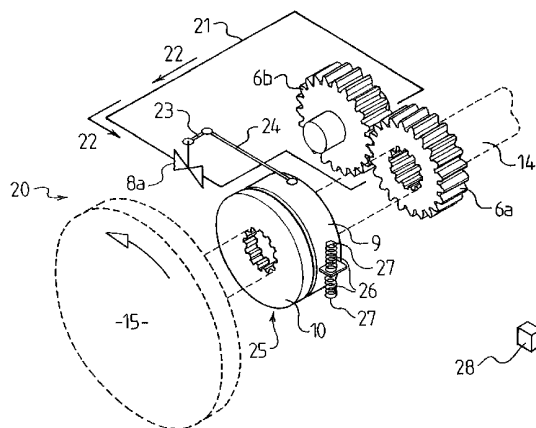
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ning of each regular issue of the PCT Gazette.

(54) Title: TRAILER BRAKE



(57) **Abstract:** A hydraulic brake assembly (20) for braking a wheel of a vehicle including a hydraulic pump (6a, 6b) having an inlet and an outlet, the pump (6a, 6b) is operably connected to the wheel in use so as to be driven by the wheel, a valve (8a) is provided to create a closed hydraulic circuit (21) between the inlet and outlet, a valve control means (23) is also provided for controlling the valve (8a) dependent upon changes of inertia of the vehicle to in use control the resistance to flow of hydraulic fluid in the circuit (21). In a further embodiment a further pump operated by an electrical motor can be provided in addition to the hydraulic brake assembly (20) so as to selectively drive the wheel.



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TRAILER BRAKE

TECHNICAL FIELD OF THE INVENTION

This invention relates to hydraulic braking and driving systems and apparatus. One application
5 of the invention is for braking a vehicle wheel, or to driving a vehicle wheel, but the invention is not limited to these particular applications.

BACKGROUND

10 It is frequently desirable to brake rotary assemblies. In particular, vehicles including towed vehicles such as trailers and the like frequently need braking assistance. During deceleration of towed vehicles, it is frequently desirable to have brakes of the trailer applied to augment the braking effect provided by the brakes of the towing vehicle. Presently, such a braking effect is usually provided by means of a hydraulic piston and cylinder arrangement provided in the
15 towing assembly. The piston and cylinder arrangement is usually actuated by the force tending to compress the towing assembly when the towing vehicle applies its brakes. The piston and cylinder arrangement then mechanically activates disc or drum brakes provided on the trailer wheels to assist braking.

20 The disadvantage with these known systems is that they rely on complex and expensive linkages in the towing assembly, and in particular rely on the towed vehicle having a set of vehicle brakes. Often towed vehicles are left idle for long periods of time, or in the case of caravans and boat trailers for example are frequently used by the oceanside. This means that vehicle brakes are often corroded or otherwise inoperable. Also, corrosion or lack of use can
25 mean that rather than being inoperable, such brakes tend to overreact and provide uncontrolled braking when braking is required.

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One other known construction which has advantages over the construction as discussed above is disclosed in US 4,451,094 (Martin). Martin discloses a closed hydraulic circuit which is operated by a plurality of pistons moved by a wobble plate attached to the wheel axle. A valve which is operated selectively by air pressure provides resistance to the path of fluid in the hydraulic circuit thereby providing a braking effect. This construction has a number of disadvantages, in particular, it is relatively complex requiring some 8 sealed pistons which provide the hydraulic pumping effect. Each piston needs to be individually sealed and is susceptible to wear which creates significant maintenance problems. Furthermore, the control of the valve is a manual pneumatic control whereas it would be desirable to have some form of self-actuating or automatic braking control.

Towed vehicles are often difficult to move in certain situations, for example manoeuvring a boat trailer out of the water, or parking a trailer in a confined space.

15 OBJECT OF THE INVENTION

It is an object of the present invention to provide a brake system or apparatus which will at least go some way toward overcoming disadvantages associated with the prior art, or which will at least provide the public with a useful choice.

20

STATEMENT OF THE INVENTION

Accordingly in one aspect the invention may broadly be said to consist in a hydraulic brake assembly for braking a wheel of a vehicle, the assembly including;

25 a hydraulic pump having an inlet and an outlet, the pump being operably connected to the wheel in use so as to be driven by the wheel,

a valve connected between the inlet and outlet to create a closed hydraulic circuit therebetween,

30 a valve control means for controlling the valve dependent upon changes of inertia of the vehicle to in use control the resistance to flow of hydraulic fluid in the circuit.

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In a further aspect the invention may broadly be said to consist in a hydraulic brake system for braking a wheel of a vehicle, the system including;

a hydraulic gear pump having an inlet and an outlet, the pump being operably connected to the wheel in use so as to be driven by the wheel,

5 a valve connected between the inlet and the outlet to create a closed hydraulic circuit therebetween,

a valve control means for controlling the valve and thus controlling the flow of hydraulic fluid in the circuit in use.

10 In a further aspect the invention may broadly be said to consist in apparatus for driving a wheel of a vehicle, the apparatus including;

a first reversible hydraulic pump,

a hydraulic braking circuit means for allowing the pump to be used to selectively brake the wheel in use, and

15 a second hydraulic pump to selectively drive the first pump in reverse or forward to selectively drive the wheel.

These and other aspects of this invention, which should be considered in all its novel aspects, will become apparent from the final description, which is given by way of example only.

20

DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagrammatic exploded perspective view of a braking assembly in accordance with the present invention.

25 **Figure 2** is an exploded side elevation of a braking assembly in accordance with the present invention.

Figure 3 is a plan view in partial cross-section of the apparatus of figure 2 in an assembled configuration.

Figure 4 is a front elevation of a plate incorporating a valve seat in accordance with the present invention.

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DETAILED DESCRIPTION

Referring to figure 1, a hydraulic brake assembly for braking a wheel of a vehicle is shown generally referenced 20. A shaft 14 which in use comprises a wheel axle or part thereof has a disc 15 at the end thereof for affixing to a wheel such as the wheel of a vehicle. The shaft 14 is splined in desired places so as to accommodate a gear 6a which rotates and is directly connected to the wheel of the vehicle by the splined interconnection. The gear teeth on the gear 6a drive a corresponding gear 6b, and the two gears together operate as a gear pump for pumping hydraulic fluids. The fluid pumped by the gear pump travels in a path represented by path 21 in the direction of arrows 22 to the inlet of a valve assembly 8a. Usually, the fluid passes through valve 8a and back to the gear pump. However, the valve 8a can be controllably closed to selectively restrict flow of fluid therethrough.

Valve 8a is controllably opened or closed by valve actuation lever 23 which may be connected by a ball joint assembly 24, or other means, to a clutch assembly generally referenced 25.

The clutch assembly 25 preferably comprises a plate 10 which is splined onto shaft 14 in a similar fashion to that described with reference to gear wheel 6a. Therefore, clutch plate 10 rotates with shaft 14, and thus rotates with the wheel. The other part of the clutch assembly is an electromagnet 9 which does not rotate with shaft 14 but is free to rotate to a limited extent, being biased in a substantially uniform position by springs 26, ends 27 of which are connected to a housing (not shown in figure 1).

Operation of the clutch 25 is as follows. Upon a sensor, preferably a known electronic sensor, registering a change in inertia of the vehicle, the change corresponding to any deceleration, the sensor activates the electromagnet 9. The sensor is diagrammatically illustrated by box 28 in figure 1 and is preferably provided on the towing vehicle, but may be provided on the towed vehicle. The sensor can be directly connected by electric cables to the electromagnet 9 to deliver a current to the electromagnet 9 that is proportional to the braking effect that inertial sensing system detects. Alternatively the sensor may transmit an electromagnetic signal, such as a radio frequency signal, to receiver apparatus on the towed vehicle which in turn actuates the electromagnet 9 to the required degree. The magnetic flux generated by the electromagnet 9

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draws the electromagnet 9 slightly axially along a boss on casting 8 (refer to figure 2) so that the magnet brushes against clutch plate 10, thus generating friction between these two elements, causing the electromagnet 9 to tend to rotate in the direction of rotation of shaft 14. Because the electromagnet is constrained by springs 26, only a small amount of rotation occurs, dependent
5 on the force applied by the springs 26, and this movement is transmitted to the valve actuation lever 23 by the linkage 24. The direction of movement of the actuation lever is such as to cause restriction in the flow of hydraulic fluid through the valve. Because the hydraulic fluid flow path is restricted, the gear pump comprising gears 6a and 6b has more work to do to cause fluid flow through the closed circuit, causing the pump to slow, and therefore ultimately providing a
10 braking effect to the wheel attached to plate 15.

If the brakes of the towing vehicle are applied with still greater intensity, then the current supplied to electromagnet 9 will be greater which will in turn cause a greater frictional effect between the electromagnet 9 and the clutch plate 10, in turn causing further restriction of the
15 valve as the electromagnet 9 moves further against the springs 26. It will be seen that only one spring, or some other biasing arrangement could be used.

Turning to figure 2, apparatus which embodies the schematic illustrated in figure 1 is shown in an exploded view. The apparatus of figure 2 generally consists of a three piece casting
20 comprising a first side 4 of a gear casing and a second side 11 of the casing and a plate 8 which includes the valve seat arrangement for the valve assembly 8a.

Therefore, listing the items in figure 2, a plate cover 1 is provided together with a nut 2 for fastening to the end of shaft 14, and a washer 3 between the nut 2 and the first side of the casing
25 4. The casing 4 in use has a bearing 5 to support the end of the shaft 14 and also supports one side of the shaft of gear wheel 6b. The other side of gear wheel 6b is supported by the plate 8 which has a boss that supports the electromagnet 9 in a concentric fashion about shaft 14. The clutch plate 10 is provided adjacent to the electromagnet 9 by circlips (not shown). The assembly is further supported and enclosed by the other side 11 of the casing. In use it has been
30 found desirable to bronze coat the surface of the clutch plate nearest the electromagnet as the bronze material has been found to wear well. Finally, bearing 12 and seal 13 are provided between the casing 11 and the shaft 14.

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Turning to figure 3, the apparatus of figure 2 is shown in assembled form and the flow path of fluid through the apparatus is illustrated by arrows 30. As will be seen, there are spaces between components, such as regions 32 which allow a reservoir of fluid for the hydraulic circuit. However, the spaces between the outlet to the gear pump and the valve are tightly controlled so as to ensure effective braking.

Finally, turning to figure 4, some detail of the plate 8 is shown, in particular, the inlet 34 and outlet 36 to and from the valve seat 38 is shown in more detail. It will be seen that the inlet 34 and outlet 36 are provided as grooves in the plate with corresponding holes 40 which lead directly to the valve seat. The proximity of the plate to gears 6a and 6b ensures that there is a relatively tight fit so that there is adequate transfer of fluid.

It will be seen that advantageously there is only one seal required in the unit, being seal 13 between the shaft 14 and the casing. The size of the teeth on gears 6a and 6b, the number of teeth in their design can be varied to enable varying amounts of hydraulic fluid to be pumped in the circuit. The unit is relatively small and compact and since it is provided in a sealed housing, corrosion or problems from long periods of non-use are very unlikely. Also, the pump is very simple and robust, so very little maintenance is required. Furthermore, the various spacings in the housing or tolerances between the gear wheels and the remainder of the housing including the valve plate 8 can be varied to provide a desired amount of "hysteresis" in the overall hydraulic circuit i.e. to prevent the braking effect being established too quickly with too much intensity. Finally, the electronics which apply the current to the electromagnet can be varied to give various braking effects, for example supplying more current at lower rotational speeds of axle 14 to compensate for the reduced pumping effect of the gear pump at lower speeds. It will be seen that the system has the ability to function equally well in either direction of wheel rotation.

Although not shown in the drawings, the invention also envisages use of the gear pump formed by gears 6a and 6b to selectively drive the wheel. This may be achieved by providing a further pump operated by an electric motor powered from the 12 volt supply of the towing vehicle for example. The further pump and any electric motor can be provided so as to provide an auxiliary

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unit which can be added onto the existing assembly or system, and carried around. Preferably, it is attached to the front of trailers and connected to the braking unit by hydraulic lines or tubes. In essence, the auxiliary unit is a power unit. The existing hydraulic braking circuit can be modified to include an additional circuit that allows the further pump to drive fluid into the outlet of the gear pump and thus selectively drive the gear pump and in turn the wheel. In addition, the speed of the wheel can be varied by lever 23. The lever 23 allows the gear pump to drive more oil (or fluid) through the tubes to the additional circuit and causes the wheel to turn faster. This is very advantageous when a towed vehicle such as a trailer needs to be manoeuvred.

10

VARIATIONS

A skilled person in the art will appreciate that the clutch and the electromagnet can be replaced by a proportionate solenoid which is directly coupled to the control valve by the existing linkage. The control valve is connected to and controlled by the lever as previously described.

15

CLAIMS

1. A hydraulic brake assembly for braking a wheel of a vehicle including a hydraulic pump having an inlet and an outlet, the pump being operably connected to the wheel in use so as to be driven by the wheel and a valve connected between the inlet and outlet to create a closed hydraulic circuit therebetween, and a valve control means for controlling the valve dependent upon changes of inertia of the vehicle to in use control the resistance to flow of hydraulic fluid in the circuit.
2. A hydraulic brake assembly as claimed in claim 1, wherein the hydraulic pump includes a gear pump.
3. A hydraulic brake assembly as claimed in any of claims 1 and 2, wherein the valve control means includes an inertial sensing means.
4. A hydraulic brake assembly as claimed in claim 3, wherein the inertia sensing means is provided on a towing vehicle.
5. A hydraulic brake assembly as claimed in any of claims 1 to 3, wherein the valve control means includes a clutch means.
6. A hydraulic brake assembly as claimed in claims 1, 3 and 5, wherein the clutch means includes an electromagnet which is selectively activated by the valve control means.
7. A hydraulic brake assembly as claimed in claim 6, wherein the electromagnet engages the clutch means.
8. A hydraulic brake assembly as claimed in any of claims 5 to 7, wherein changes in angular position of the clutch means actuate the valve.
9. A hydraulic brake assembly as claimed in any of claims 1 to 4, wherein the control means includes a solenoid means.

- 9 -

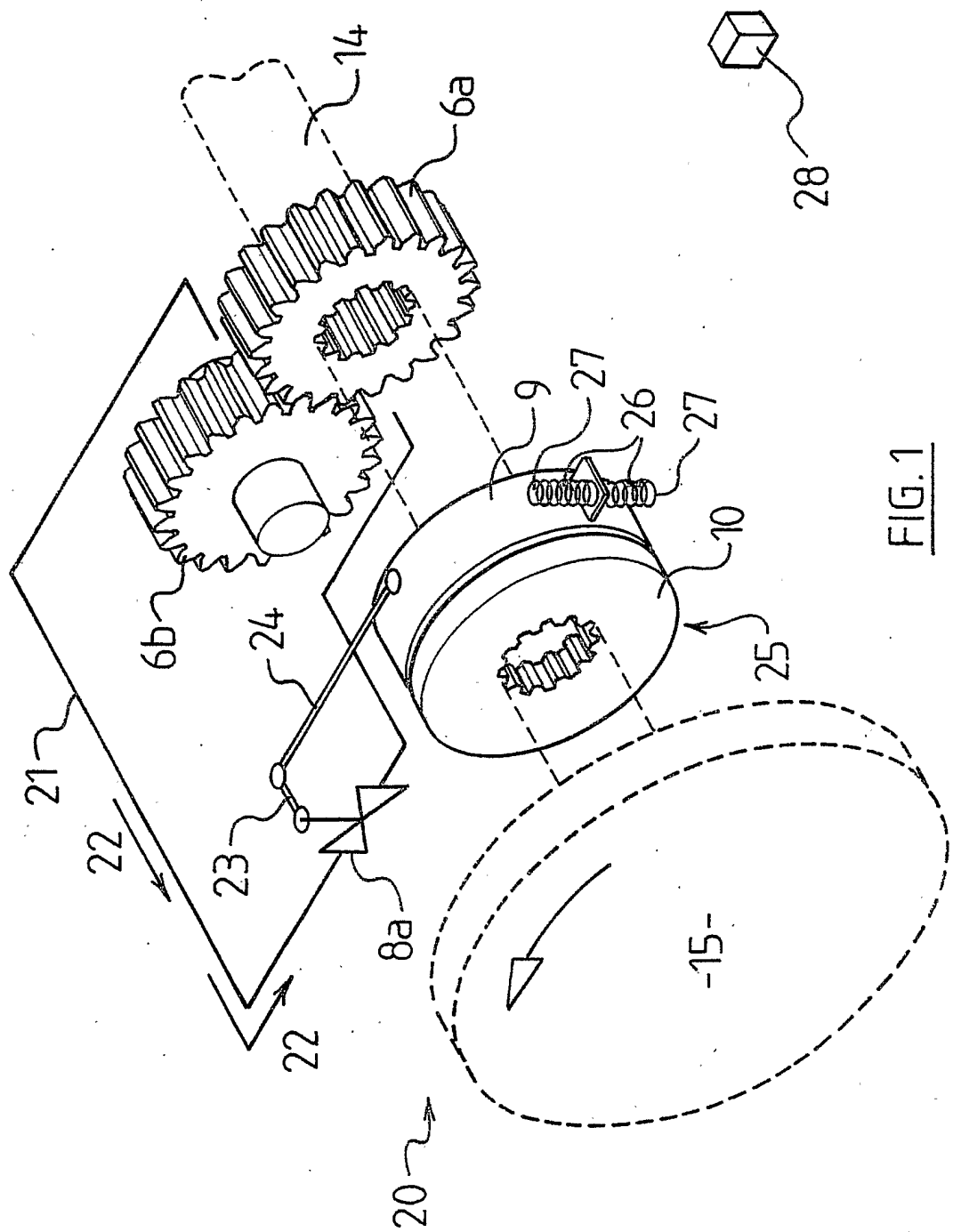
10. A hydraulic brake assembly as claimed in any of claims 1 to 4, wherein the solenoid means includes a proportionate solenoid means.
- 5 11. A hydraulic brake assembly as claimed in any of claims 1 to 4 and 9, wherein changes in the solenoid means actuate the valve.
12. A hydraulic brake assembly as claimed in any of claims 3 to 11, wherein the inertia sensing means transmits a sensed signal to the valve control means by being directly connected to the control means or by radio frequency transmission.
- 10 13. A hydraulic brake assembly as claimed in any of the previous claims, wherein the assembly is contained within a housing.
14. A hydraulic brake assembly as claimed in any of the previous claims, wherein the
15 hydraulic circuit includes a reservoir means.
15. A hydraulic brake assembly as claimed in any of the previous claims, wherein the assembly includes a further pump constructed and arranged to pump fluid back to the hydraulic pump to selectively drive the wheel.
- 20 16. A hydraulic brake system for braking a wheel of a vehicle including a hydraulic gear pump having an inlet and an outlet, the pump being operably connected to the wheel in use so as to be driven by the wheel, and a valve connected between the inlet and the outlet to create a closed hydraulic circuit therebetween, and a valve control means for
25 controlling the valve and thus controlling the flow of hydraulic fluid in the circuit in use.
17. A hydraulic brake system as claimed in claim 16, wherein the control means includes an inertial sensing means.
- 30 18. A hydraulic brake system as claimed in claim 17, wherein the inertia sensing means is provided on a towing vehicle.

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19. A hydraulic brake system as claimed in claims 16 and 17, wherein the control means includes a clutch means.
20. A hydraulic brake system as claimed in any of claims 16 to 19, wherein the clutch means includes an electromagnet which is selectively activated by the control means.
21. A hydraulic brake system as claimed in claim 20, wherein the electromagnet engages the clutch means.
22. A hydraulic brake system as claimed in any of claims 19 to 21, wherein changes in angular position of the clutch means actuate the valve.
23. A hydraulic brake system as claimed in any of claims 16 to 18, wherein the control means includes a solenoid means.
24. A hydraulic brake system as claimed in any of claims 16 to 18 and 23, wherein the solenoid means includes a proportionate solenoid means.
25. A hydraulic brake system as claimed in any of claims 16 to 18, 23, and 24, wherein changes in the solenoid actuate the valve.
26. A hydraulic brake system as claimed in any of claims 17 to 25, wherein the sensing means transmits a sensed signal to the control means by being directly connected to the control means or by radio frequency transmission.
27. A hydraulic brake system as claimed in any of the previous claims, wherein the system is contained within a housing.
28. A hydraulic brake system as claimed in any of the previous claims, wherein the hydraulic circuit includes a reservoir means.

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29. A hydraulic brake system as claimed in any of the previous claims, wherein the system includes a further pump constructed and arranged to pump fluid back to the hydraulic pump to selectively drive the wheel.
- 5 30. Apparatus for driving a wheel of a vehicle including a first reversible hydraulic pump, and a hydraulic braking circuit means for allowing the pump to be used to selectively brake the wheel in use, and a second hydraulic pump to selectively drive the first pump in reverse or forward to selectively drive the wheel.



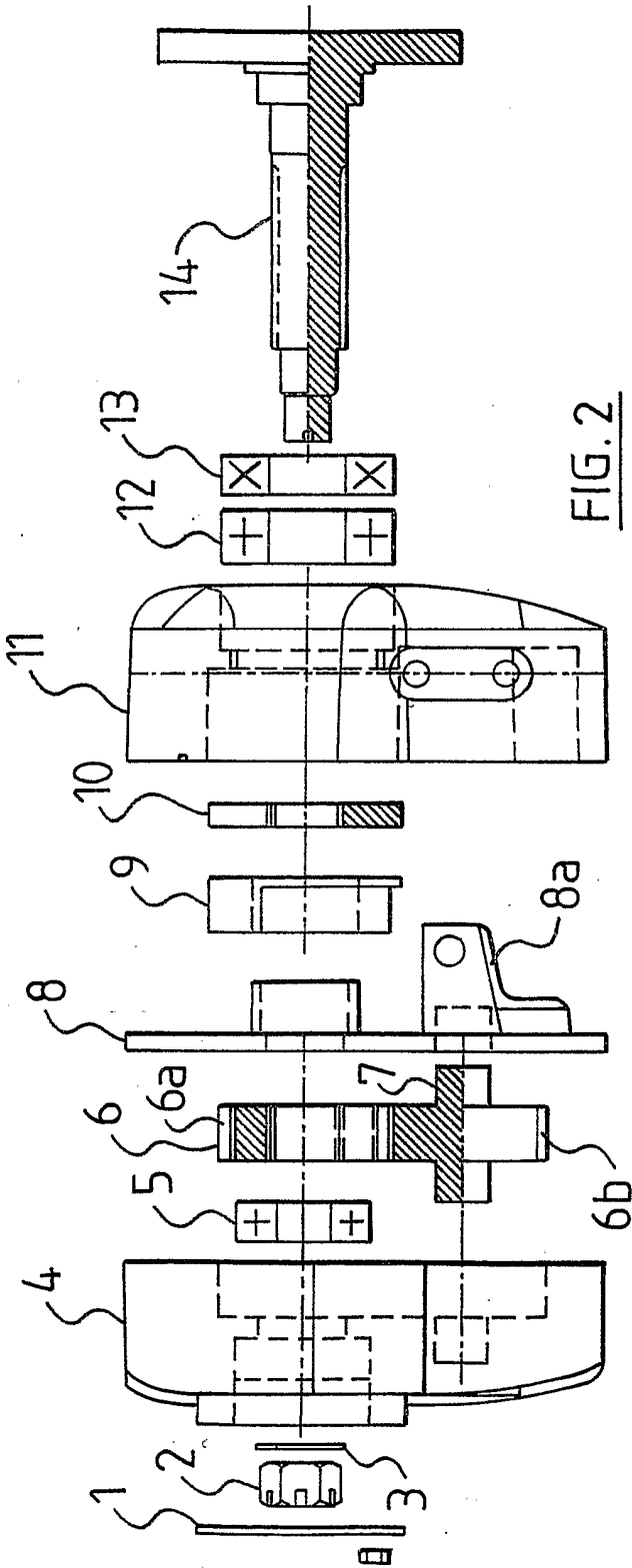
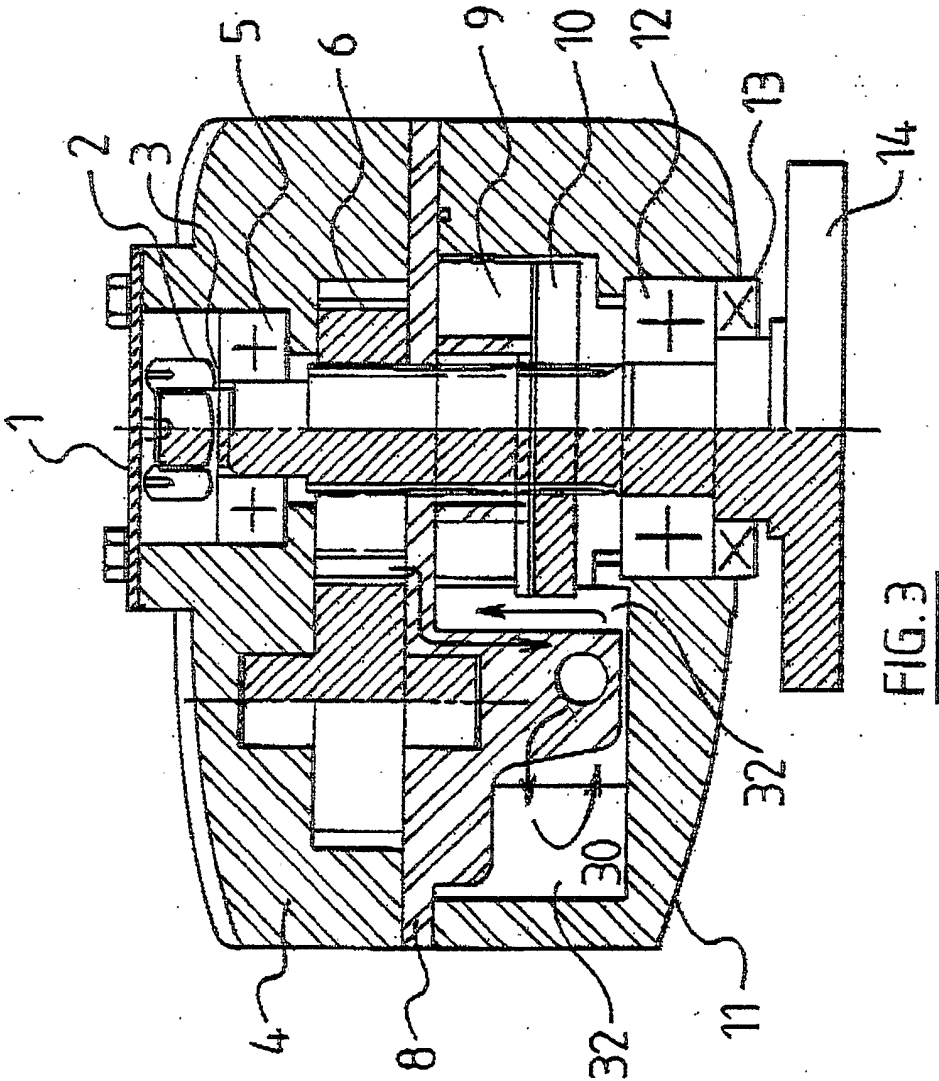


FIG. 2



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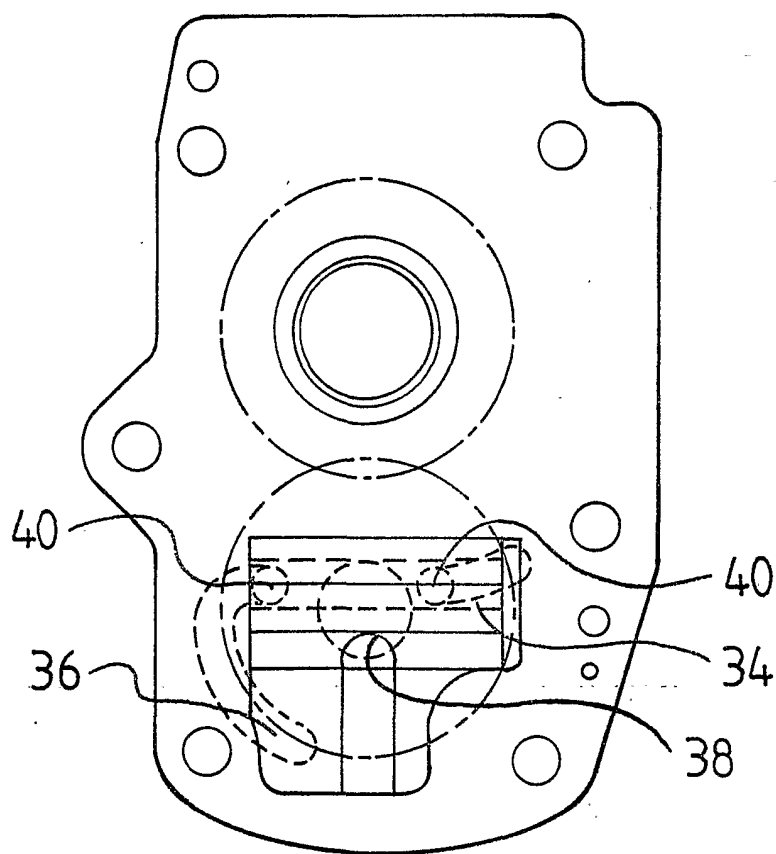


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ01/00121

A. CLASSIFICATION OF SUBJECT MATTERInt. Cl. ⁷: B60T 7/20, 1/10, 13/08; F16D 57/06, 59/00

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)

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

AU: IPC B60T 7/20, 1/10, 13/08; F16D 57/06, 59/00

US: Sub-Class 188/292

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

DWPI: IPC B60T 7/20, 1/10, 13/08 and WHEEL, T#RE, DRIV+, POWER+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5325944 A (LIVINGSTON, Sr.) 5 July 1994 Whole document	1, 3-4, 9-14, 16-18, 23-29
Y	Whole document	5-8, 19-22,
X	US 2786553 A (BOONE et al.) 26 March 1957 Whole document	1-3, 16-19, 27-29
X	DE 4408900 A (HUBER) 16 November 1995 Whole document	1, 3-8, 13-14, 16-19, 22, 27-29

☒ 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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

18 October 2001

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ01/00121

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5927418 A (MATSUOKA) 27 July 1999 Whole document	1
X	US 3498420 A (FAWICK) 3 March 1970 Whole document	1
Y	US 5088041 A (TANAKA et al.) 11 February 1992 Whole document	5-8, 19-22

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ01/00121

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-29

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

Supplemental Box

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-15 are directed to a hydraulic brake assembly for braking a wheel of a vehicle involving the features as defined.
2. Claims 16-29 are directed to a hydraulic brake system for braking a wheel of a vehicle involving the features as defined.
3. Claim 30 is directed to an apparatus for driving a wheel of a vehicle involving the features as defined.

In assessing whether these claims possess a single general inventive concept the International Search Authority concludes as follows:

- (a) Independent claims 1 and 16 share the common features of *a hydraulic pump driven by the wheel of a vehicle, a valve connected between the inlet and outlet of the pump to create a closed hydraulic circuit there between, and a valve control means to control the valve and the flow of the hydraulic fluid in the circuit*. It is considered that unity exists *a priori* between the inventions defined in claims 1 and 16 since they possess the same special technical features.
- (b) Independent claims 1, 16 and 30 share the common features of *a hydraulic pump, a hydraulic circuit allowing the pump to be used to brake a wheel of a vehicle in use*. However these features are known, and are disclosed ie in the document US 3498420 A (FAWICK) 3 March 1970, therefore these common features are not special technical features within the meaning of PCT Rule 13.2, second sentence, since they make no contribution over the prior art. As claims 1, 16 share no other technical features in common with the invention defined in claim 30, these claims lack unity of invention.

It is therefore considered that there are 2 inventions in the application.

International application No.
PCT/NZ01/00121

Patent Document Cited in Search Report				Patent Family Member			
US	4626044	DE	3331064	EP	141069	JP	60078124
US	5927418	DE	19725110	FR	2749809	JP	10002352
US	50088041	EP	366095	JP	2117437		
							END OF ANNEX