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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 September 2010 (10.09.2010)

PCT

(10) International Publication Number
WO 2010/101729 A1

(51) International Patent Classification:
F16N 13/20 (2006.01) *F01M 1/02* (2006.01)
F16H 57/04 (2010.01)

(21) International Application Number:
PCT/US2010/024976

(22) International Filing Date:
23 February 2010 (23.02.2010)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/156,904 3 March 2009 (03.03.2009) US

(71) Applicant *(for all designated States except US)*: **BORGWARNER INC.** [US/US]; Patent Department, 3850 Hamlin Road, Auburn Hills, Michigan 48326 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **BLAIR, Christopher, E.** [US/US]; 2230 W. Thompson Road, Fenton, Michigan 48329 (US). **REEVES, Branden, L.** [US/US]; 2311 Majestic Street, Oak Park, Michigan 48327 (US).

(74) Agents: **OBERHOLTZER, Steven, L.** et al.; Brinks Hofer Gilson & Lione, 524 South Main Street, Suite 200, Ann Arbor, MC 48104-2921 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

— *of inventorship (Rule 4.17(iv))*

[Continued on next page]

(54) Title: OFF-AXIS PUMP WITH INTEGRAL SHAFT FEED FEATURES

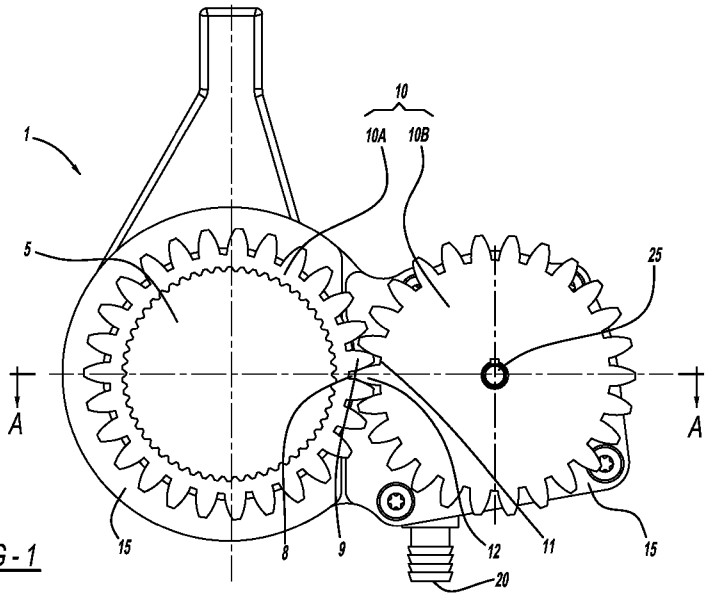


FIG - 1

(57) Abstract: A transfer case lubrication assembly for delivering lubrication fluid to various transmission components of a vehicle and a process thereof is presented. The transfer case lubrication assembly comprises a main torque carrying shaft; outer pump housing; and a lubrication pump. The lubrication pump is driven by an external spur gear set that is non-concentrically aligned with the torque carrying shaft; and delivers a pressurized lubrication fluid proximate to the torque carrying shaft through at least one fluid feed channel integrally formed with the outer pump housing.

WO 2010/101729 A1

Published:

— *with international search report (Art. 21(3))*

OFF-AXIS PUMP WITH INTEGRAL SHAFT FEED FEATURES

FIELD OF INVENTION

The present invention relates to a lubrication pump and a method of producing said lubrication pump. More specifically the invention relates to a lubrication pump with integral shaft feed features for causing a lubricant to flow through a passageway into and around a rotating shaft in a vehicle transfer case.

BACKGROUND OF INVENTION

Transfer case lubrication pumps traditionally utilize a gerotor style pump having an inner gear with a large aperture for a torque carrying shaft to pass through. In many applications, the torque capacity requirement dictates that the minimum shaft diameter to be in excess of about 50 mm (~ 2 inches). The aperture and the pumping elements of the gerotor set, therefore, in accordance with conventional design approaches have to be larger than this minimum shaft diameter in order for the shaft to be able to pass through them. A minimum shaft diameter of about 50 mm causes conventional pumps to have viscous shear losses that far exceed any pumping related losses or inefficiencies.

One method of reducing the viscous shear losses associated with transfer case lubrication pumps is to utilize an off-axis pumping arrangement. However, off-axis style pumps that are currently available suffer from multiple commercial issues that off-set any potential performance benefits. The primary issue with available off-axis pumping systems is the complexity associated with feeding pressurized lubricant into and around a rotating shaft. Commercially available systems require the use of additional housing components, as well as passages drilled into these housing components in order to provide the necessary degree of lubrication. These additional requirements lead to an increase in manufacturing cycle time and result in reduced manufacturing efficiencies due to high rejection rates.

There is a need and desire in the industry to provide an economical lubrication pump that can reduce viscous shear losses encountered in the transfer case, while maintaining the necessary flow rate capacity.

BRIEF SUMMARY OF THE INVENTION

The present invention generally provides a transfer case lubrication assembly for delivering lubrication fluid to various transmission components of a vehicle. In one

embodiment, the transfer case lubrication assembly comprises a main torque carrying shaft; outer pump housing; and a lubrication pump. The lubrication pump is driven by an external spur gear set that is non-concentrically aligned with the torque carrying shaft; and delivers a pressurized lubrication fluid proximate to the torque carrying shaft through at least one fluid feed channel integrally formed with the outer pump housing.

The lubrication pump is a positive displacement pump, such as a gerotor pumping unit, among others. The external spur gear set transfers torque from the main torque carrying shaft to the lubrication pump. This torque transfer may be accomplished when one of the spur gears engages a shaft that is coupled to the lubrication pump.

The gerotor pumping unit may further comprise an inner rotor with N teeth and an outer rotor with (N+1) root fillets. For example, the inner rotor may have four teeth while the outer rotor has five root filets.

Each fluid feed channel may be formed in the housing using a casting or powder forming method known to one skilled in the art. Although each fluid feed channel may be in either the body or cover of the outer pump housing, preferably such channels are located in the cover of the outer pump housing.

The transfer case lubrication system may incorporate the use of a rotating shaft seal. Such a seal may be selected as one from the group of fixed clearance-type seals and surface guided-type seals. Alternatively, the transfer case lubrication system may incorporate the use of a low radial clearance journal bearing.

In another aspect of the present invention, the transfer of less than about 1.25 Nm of torque from the torque carrying shaft to the lubrication pump establishes a flow rate for the pressurized lubrication fluid exiting the lubrication pump that is greater than about 11 liters per minute.

It is another objective of the present invention to provide a method of providing a lubrication fluid to a location proximate to the torque carrying shaft in a transfer case. This method comprising the steps of transferring torque from a main torque carrying shaft to a pumping unit using a spur gear set that is externally mounted to the pump housing; generating a vacuum or draw at the inlet passageway through the pump housing; drawing lubrication fluid from a reservoir into the inlet passageway of the pump housing; allowing un-pressurized lubrication fluid to pass through a 1st feed channel that connects the inlet passageway to the pumping unit;

pressurizing the lubrication fluid within the pumping unit; forcing the pressurized lubrication fluid to pass through a 2nd feed channel to exit the pumping unit; allowing the pressurized lubrication fluid to flow across the face of the pump housing into a 3rd feed channel; and delivering the pressurized lubrication fluid through the 3rd feed channel to a radial channel that is proximate to the rotating torque carrying shaft.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

Figure 1 is a perspective view of the transfer case lubrication assembly in accordance with one embodiment of the present invention.

Figure 2A is a perspective view of gerotor pumping unit used as part of the transfer case lubrication assembly in accordance with one embodiment of the present invention.

Figure 2B is a cross-sectional view of the gerotor pumping unit of Figure 2A taken along line B-B.

Figure 3 is a perspective view of the transfer case lubrication assembly in accordance with one embodiment of the present invention depicting the flow path for the lubrication fluid.

Figure 4 is a cross-sectional view of the transfer case lubrication assembly of Figure 1 taken along line A-A.

Figure 5 is a schematic representation of a method for providing a pressurized lubrication fluid from a reservoir to a location that is proximate to the torque carrying shaft in a transfer case in accordance with one embodiment of the present invention.

Figure 6A is a graphical representation of the torque transferred plotted as a function of the rotations per minute established in a transfer case lubrication assembly in accordance with one embodiment of the present invention.

Figure 6B is a graphical representation of the flow rate for the lubrication fluid plotted as a function of the rotations per minute established in a transfer case lubrication assembly in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The following description of the preferred embodiment is merely exemplary in nature and is in no way intended to limit the invention or its application or uses. It should be understood that throughout the description and drawings, corresponding reference numerals indicate like or corresponding parts and features.

One embodiment of the present disclosure provides a transfer case lubrication assembly for delivering lubrication fluid to various transmission components of a vehicle. Such a transfer case lubrication assembly includes a fluid reservoir and a pump assembly to pressurize the oil in order to cause it to flow over and through various transmission components. An example of such a pump assembly according to one embodiment of the present specification is shown in Figure 1. Referring to Figure 1, the pump assembly 1 comprises a torque carrying shaft 5 that engages an external spur gear set 10 comprising a first gear 10A and a second gear 10B. The splined teeth of each gear 10 project radially and may be aligned parallel to an axis of rotation. One skilled in the art of gears will understand that other gear designs, including but not limited to helical gears may be utilized. The splined teeth 9 of the first gear 10A actively set or engage the area 11 located between the teeth 12 of the second gear 10B. Similarly, the splined teeth of the second gear 10B actively set with or engage the area located between the teeth of the first gear 10A. The pitch and tooth profiles associated with the gear set 10 are predetermined to reduce the occurrence of frictional wear associated with the splined teeth of each gear.

The spur gear set 10 is located external to the pump housing 15 and is non-concentrically aligned with the torque carrying shaft 5. The pump housing comprises an inlet passageway 20 for low pressure oil to flow from a reservoir or sump (not shown) into the pumping unit 1. The second gear 10B is coupled to a shaft 25 that engages the inner rotor of the pumping unit. The pumping unit may be any type of positive displacement pump known to one skilled in the art. One benefit of using an off-axis pump is the ability to choose the gear ratio that will allow for the pump to be driven at an optimum speed. Any desirable gear ratio may be selected by changing the size of either gear 10A, 10B in the gear set 10.

In one embodiment of the present invention, a gerotor pump represents an example of one type of a positive displacement pumping unit that may be used in

accordance with one embodiment of the present invention. However, one skilled in the art will recognize that other types of positive displacement pumps may also be selected and used. Referring now to Figures 2A and 2B, a gerotor pumping unit comprises an inner 30 and outer 35 rotor. The inner rotor 30 has a predetermined number of lobes 31, and the outer rotor 35 has one more root fillet 36 than the inner rotor 30 has lobes 31. For example, the inner rotor 30 may have N lobes and the outer rotor 35 may have (N+1) root fillets. Although the gerotor depicted in Figure 2A shows the inner rotor 30 with four lobes 31 and the outer rotor 35 with five root fillets 36, one skilled in the art of pumps will understand that if desirable another number of lobes and fillets could be used. The inner rotor 30 may be located slightly off-center and both of the rotors 30, 35 typically rotate.

During each cycle of rotation associated with a gerotor pump 7, the area between the inner rotor 30 and outer rotor 35 initially increases, creating a low pressure regime. This low pressure generates suction, which pulls low or un-pressurized lubrication fluid from a reservoir or sump through an intake passageway 20 and into the gerotor pump 7. Then, as the cycle of rotation continues, the area between the rotors decreases, which causes the lubrication fluid to become compressed or pressurized. During this compression stage, the lubrication fluid can be pumped or forced to flow to various predetermined locations within the transfer case. The size of the pumping unit 1 may be determined based upon the knowledge of various desired parameters, such as rotational speed, eccentricity, and the required volume of lubrication fluid.

In one embodiment of the present invention, the pump housing 15 comprises at least one fluid feed channel with more than one channel being preferred. These fluid feed channels may be integrally formed with the pump housing 15 using any method known to one skilled in the art. Such techniques may include, but not be limited to, die casting, centrifugal casting, continuous casting, permanent mold casting, and powder forming. The diameter or width of the feed channels, as well as their shape may be selected based upon the amount of torque available to be transmitted from the torque carrying shaft 5 and the desired flow rate to be established and maintained by the pumping unit 1.

The pump housing 15 may be comprised of any material capable of being cast, including but not limited to steel, aluminum, steel alloys, and aluminum alloys. The pump housing 15 may be further comprised of more than one component, such

as a cover and a body. The components that make up the pump housing are fastened together creating a joint using a compression seal or any other method known in the art to limit or reduce the leakage of lubrication fluid from such a joint.

Referring now to Figures 3 and 4, un-pressurized lubrication fluid flows from a sump or reservoir (not shown) through an inlet passageway 20 into the pumping unit 1 via a fluid feed channel 40. Although the fluid feed channels may be located in either the body or cover of the pump housing, the feed channels are preferably located in the cover of the pump housing 15. The pumping unit pressurizes the lubrication fluid and the fluid exits the pumping unit through a second fluid feed channel 45. The lubrication fluid is caused to flow across the face 50 of the pump housing and into a third fluid feed channel 55. This third fluid feed channel 55 allows the pressurized lubrication fluid to be delivered into the radial channel 60 that is proximate to the torque carrying shaft. The pumping unit and the main torque carrying shaft preferably rotate in opposite directions.

In one embodiment of the present invention, the pump assembly 1, which utilizes rotating shaft seals (not shown) to seal around the torque carrying shaft 5, is a system that exhibits extremely low spin losses. The use of these rotating shaft seals provides for a dual function or purpose. The first function is to ensure that any leakage of lubrication fluid from the pump assembly 1 is reduced, thereby, allowing for pump displacement to also be reduced. Second, the flow path established for the lubrication fluid results in the occurrence of low viscous shear losses.

The rotating shaft seals (not shown) may include any seal known to one skilled in the art including both "surface guided" and fixed clearance types of seals. A "surface guided" seal may have one seal face flexibly mounted with respect to the shaft 5 or pump housing 15. This first seal face is designed to slidably engage a second seal face that is fixed relative to the other surface, e.g., pump housing 15 or shaft 5, respectively. Fixed clearance seals may include, but not be limited to viscous seals, labyrinth seals, bushing seals, and floating ring seals.

In another embodiment of the present invention, the pumping unit 1uses a low radial clearance journal bearing to perform the functions of locating the pump 7 proximate to the torque carrying shaft 5 and to reduce the occurrence of any leakage. In this embodiment, the radial journal bearing replaces the use of a rotating shaft seal and provides for the additional benefit of reducing the complexity of the

housing 15. This reduction in complexity in turn allows for greater freedom in regards to the axial placement of the pump 7.

The lubrication fluid may be any fluid known to one skilled-in-the-art of lubrication. Examples of lubricating fluids include, but are not limited to, multi-grade engine oils, synthetic engine oils, transmission fluid, mineral oils, silicones, and polyalphaolefins. The lubrication fluid may also include other performance additives, such as high molecular weight thickeners and viscosity index improvers.

It is another objective of the present invention to provide a method 2 for providing a pressurized lubrication fluid from a reservoir or sump in a transfer case to a location proximate to the torque carrying shaft. Referring now to Figure 5, this method comprises the steps of transferring 100 torque from a main torque carrying shaft to a pumping unit using a spur gear set that is externally mounted to the pump housing; generating 105 a vacuum or draw at the inlet passageway through the pump housing; drawing 110 lubrication fluid from a reservoir into the inlet passageway of the pump housing; allowing 115 un-pressurized lubrication fluid to pass through a first feed channel that connects the inlet passageway to the pumping unit; pressurizing 120 the lubrication fluid within the pumping unit; forcing 125 the pressurized lubrication fluid to pass through a second feed channel to exit the pumping unit; allowing 130 the pressurized lubrication fluid to flow across the face of the pump housing into a third feed channel; and delivering 135 the pressurized lubrication fluid through the third feed channel to a radial channel that is proximate to the rotating torque carrying shaft.

In another embodiment of the present invention, the step of pressurizing the lubrication fluid utilizes a positive displacement pumping unit, such as a gerotor pumping unit among others.

The following specific examples are given to illustrate the invention and should not be construed to limit the scope of the invention.

Example 1 – Performance Comparison with a Conventional Spline Drive Pump

Three prototype pump assemblies (A-C) were constructed according to the embodiments of the present invention. The performance of each of these pumping assemblies (A-C) were tested and compared to the performance of a conventional spline drive pump under substantially similar test conditions. In particular, the torque transmitted to the pump and the flow rate of lubrication fluid generated by the pump was measured for each pump as a function of the rotation per minute (RPM)

achievable by the pump as shown in Figures 6A and 6B. Each of the prototype pumps (A-C) were found to exhibit substantially similar performance to each other and superior performance with respect to a conventional spline drive pump.

Referring to Figure 6A, the torque (Nm) transferred from the torque carrying shaft to the gerotor pumping unit of the pump assembly according to an embodiment of the present invention that establishes a specific number of rotations per minute (RPM) with the pump is substantially the same for each of the three prototype pump assemblies (A-C). For example, in order to establish 3000 RPM by the lubrication pump, the torque transferred is on the order of about 0.9 Nm. In comparison, to establish 3000 RPM with respect to a conventional pumping assembly, the transfer of torque is on the order of 3.2 Nm.

Referring now to Figure 6B, the flow rate established for each of the pump assemblies (A-C) according to an embodiment of the present invention is similar to the flow rate established for a conventional spline drive pump up to about 1800 RPM. A further increase in rotations per minute allows the pump assemblies (A-C) to substantially outperform the conventional pump assembly. For example, at 3000 RPM, the flow rate established for each of the pump assemblies (A-C) ranged from about 12.5 to 13.5 liters per minute (LPM), while the flow rate for the conventional pump assembly was only about 9.5 liters per minute (LPM).

This example demonstrates that the pump assemblies (A-C) constructed according to an embodiment of the present invention result in less viscous shear losses than a conventionally utilized pump assembly. According to one embodiment of the present invention, the transfer of torque on the order of less than about 1.25 Nm from the torque carrying shaft to the lubrication pump may establish a flow rate for the pressurized lubrication fluid exiting the lubrication pump that is greater than about 11 liters per minute.

The foregoing disclosure is the best mode devised by the inventors for practicing this invention. It is apparent however, that devices incorporating modifications and variations will be obvious to one skilled in the art of pump assemblies. Inasmuch as the foregoing disclosure presents the best mode contemplated by the inventors for carrying out the invention and is intended to enable any person skilled in the pertinent art to practice this invention, it should not be construed to be limited thereby but should be construed to include such

aforementioned obvious variations and be limited only by the spirit and scope of the following claims.

CLAIMS

What is claimed is

1. A transfer case lubrication assembly for a vehicle comprising:

a main torque carrying shaft;

an outer pump housing; and

a lubrication pump;

wherein said lubrication pump is driven by an external spur gear set having one gear that is non-concentrically aligned with the torque carrying shaft; and

wherein said lubrication pump delivers a pressurized lubrication fluid to the torque carrying shaft through at least one fluid feed channels integrally formed with the outer pump housing.

2. The transfer case lubrication assembly according to Claim 1, wherein the lubrication pump is a positive displacement pump.

3. The transfer case lubrication assembly according to Claim 2, wherein the positive displacement pump is a gerotor pump.

4. The transfer case lubrication assembly according to Claim 1, wherein the external spur gear set transfers torque from the main torque carrying shaft to the lubrication pump.

5. The transfer case lubrication assembly according to Claim 4, wherein the one of the spur gears engages a shaft coupled to the lubrication pump.

6. The transfer case lubrication assembly according to Claim 3, wherein the gerotor pump further comprises an inner rotor with N teeth and an outer rotor with (N+1) root fillets.

7. The transfer case lubrication assembly according to Claim 6, wherein the inner rotor has four teeth and the outer rotor has five root filets.

8. The transfer case lubrication assembly according to Claim 1, wherein the pressurized lubrication fluid is delivered to a radial channel that is proximate to the torque carrying shaft.

9. The transfer case lubrication assembly according to Claim 1, wherein the fluid feed channel is formed in the housing using one selected from the group of die casting, centrifugal casting, continuous casting, permanent mold casting, and powder forming.

10. The transfer case lubrication assembly according to Claim 1, wherein the outer pump housing further comprises a body and a cover that are fastened together.

11. The transfer case lubrication assembly according to Claim 10, wherein the fluid feed channels are in the cover of the outer pump housing.

12. The transfer case lubrication assembly according to Claim 1, wherein the transfer case further comprises a rotating shaft seal.

13. The transfer case lubrication assembly according to Claim 12, wherein the rotating shaft seal is one selected from the group of fixed clearance-type seals and surface guided-type seals.

14. The transfer case lubrication assembly according to Claim 1, wherein the transfer case further comprises a low radial clearance journal bearing.

15. The transfer case lubrication assembly according to Claim 1, wherein the transfer of less than about 1.25 Nm of torque from the torque

carrying shaft to the lubrication pump establishes a flow rate for the pressurized lubrication fluid exiting the lubrication pump that is greater than about 11 liters per minute.

16. A method of providing a lubrication fluid to a location proximate to the torque carrying shaft in a transfer case, the method comprising the steps of:

transferring torque from a main torque carrying shaft to a pumping unit using a spur gear set that is externally mounted to the pump housing;

generating low pressure at the inlet passageway through the pump housing;

drawing lubrication fluid from a reservoir into the inlet passageway of the pump housing;

allowing un-pressurized lubrication fluid to pass through a 1st feed channel that connects the inlet passageway to the pumping unit;

pressurizing the lubrication fluid within the pumping unit;

forcing the pressurized lubrication fluid to pass through a 2nd feed channel to exit the pumping unit;

allowing the pressurized lubrication fluid to flow across the face of the pump housing into a 3rd feed channel; and

delivering the pressurized lubrication fluid through the 3rd feed channel to a radial channel that is proximate to the rotating torque carrying shaft.

17. The method according to Claim 15, wherein the step of pressurizing the lubrication fluid utilizes a positive displacement pumping unit.

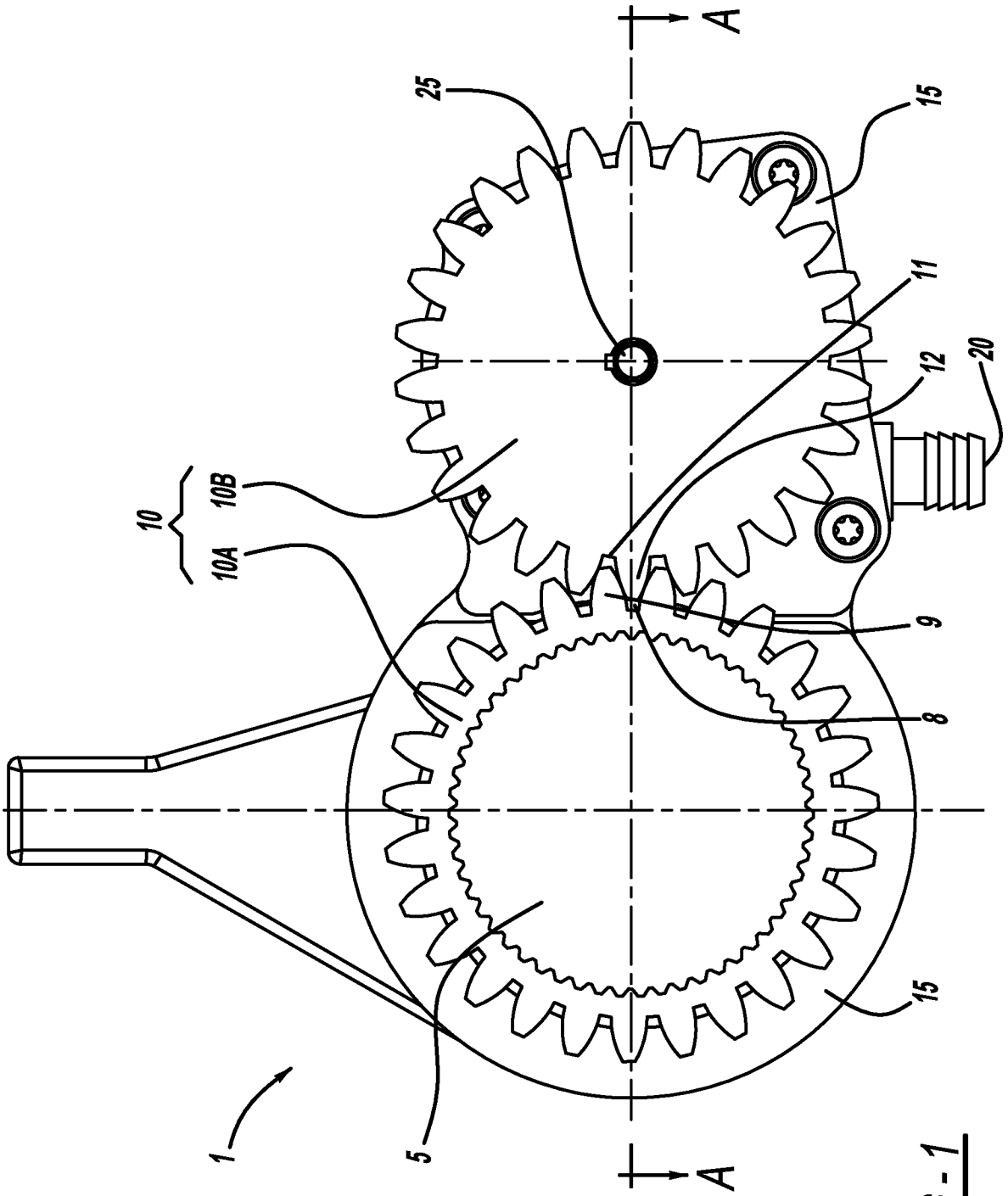


FIG - 1

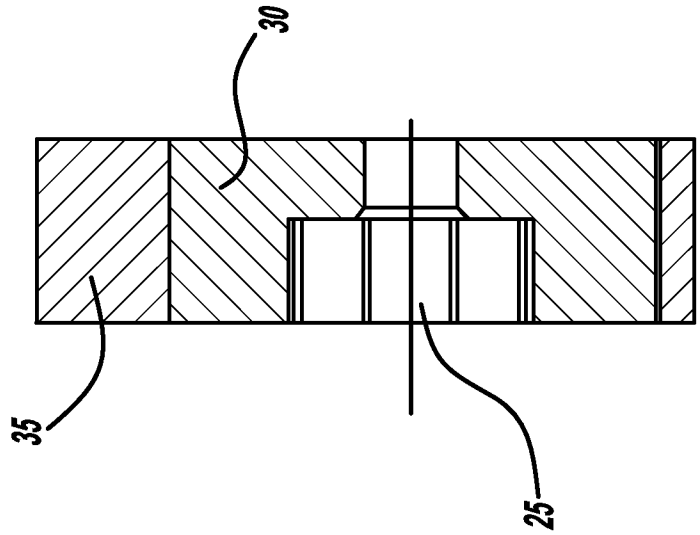


FIG - 2B

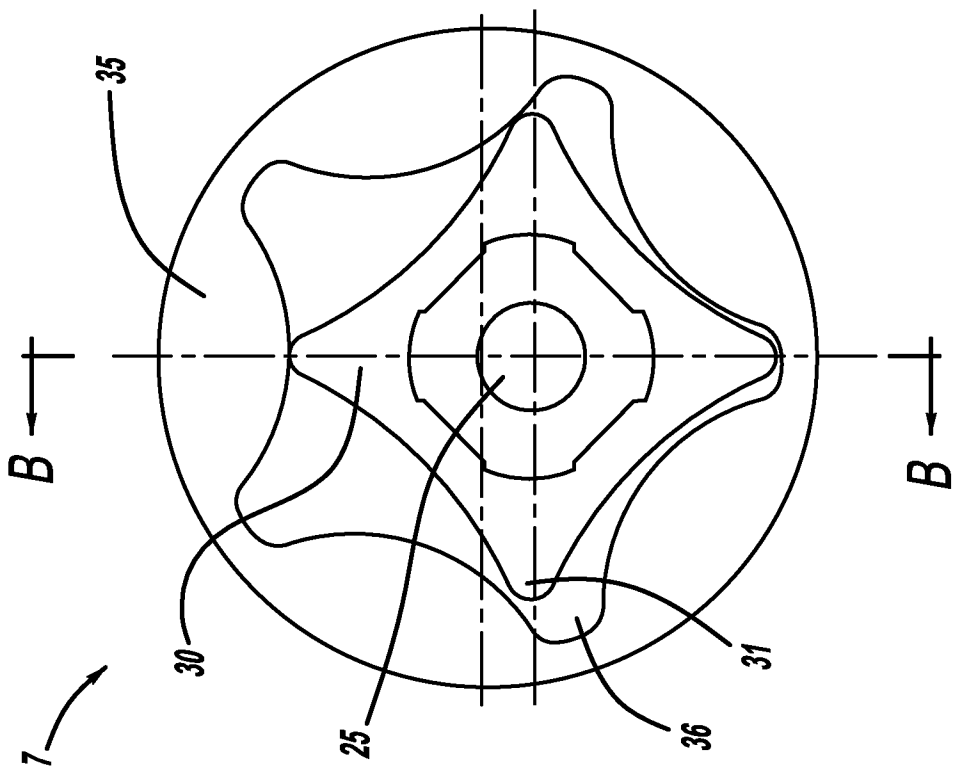


FIG - 2A

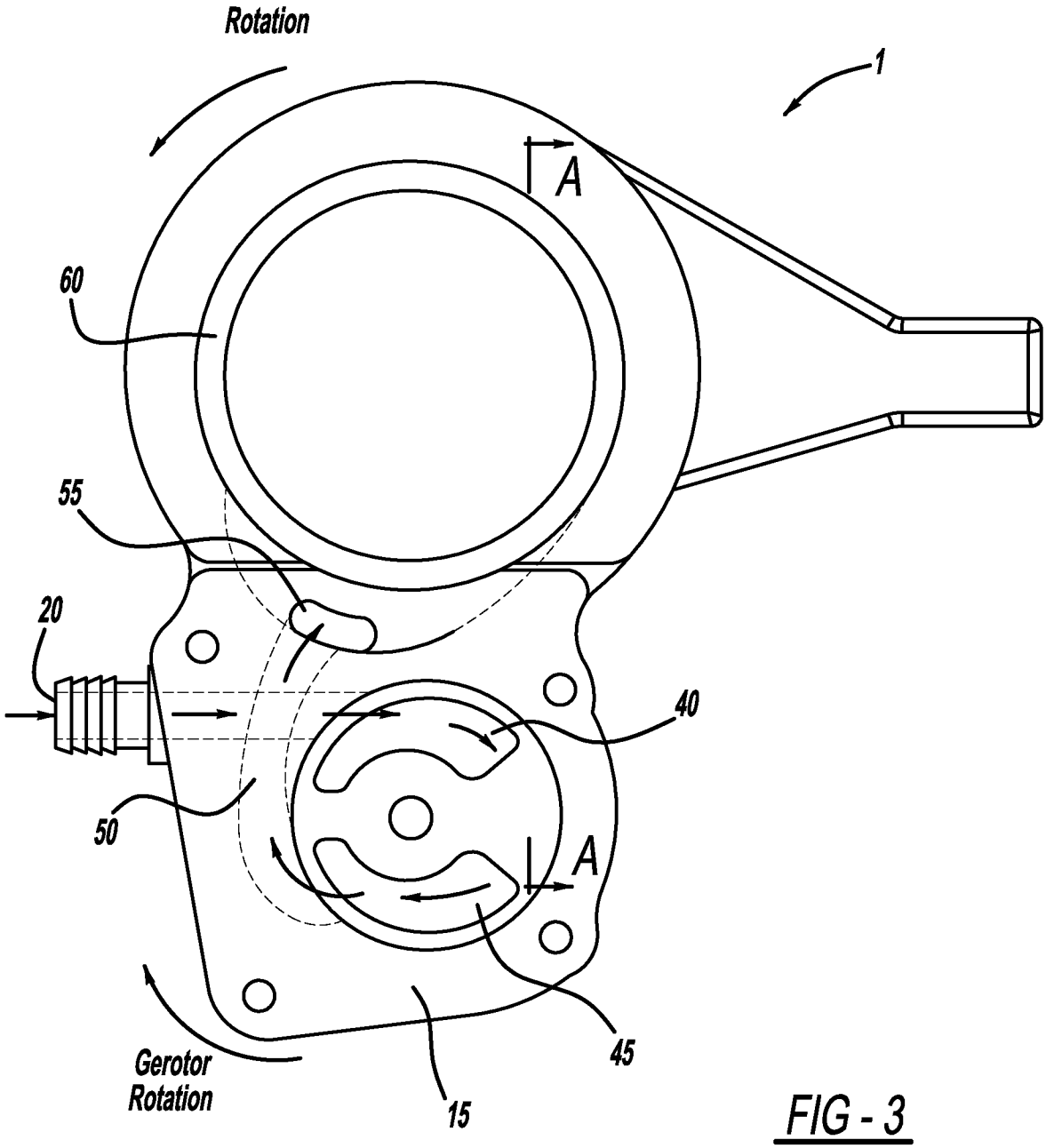


FIG - 3

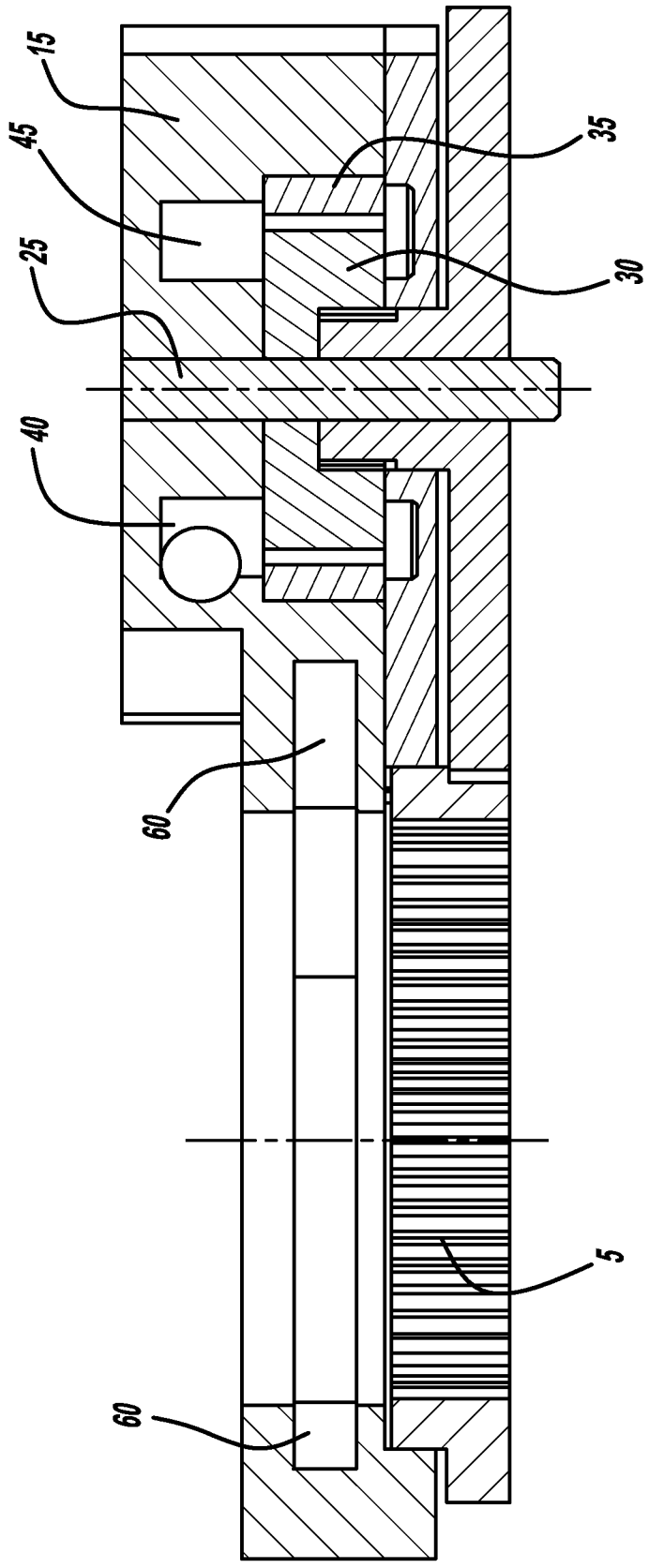
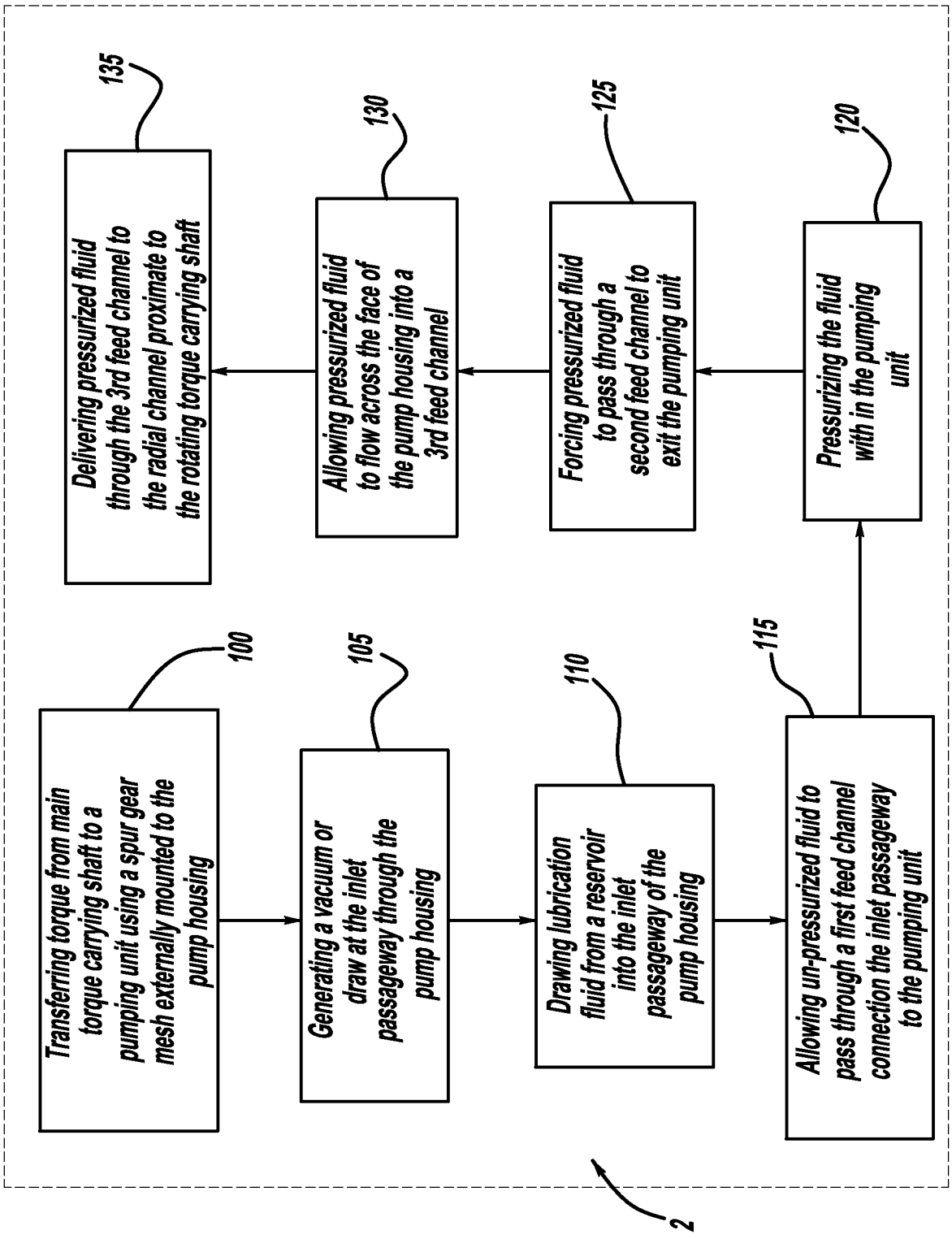


FIG - 4

FIG - 5


Transferring torque from main torque carrying shaft to a pumping unit using a spur gear mesh externally mounted to the pump housing
100
Generating a vacuum or draw at the inlet passageway through the pump housing
105
Drawing lubrication fluid from a reservoir into the inlet passageway of the pump housing
110
Allowing un-pressurized fluid to pass through a first feed channel connection the inlet passageway to the pumping unit
115
Pressurizing the fluid with in the pumping unit
120
Forcing pressurized fluid to pass through a second feed channel to exit the pumping unit
125
Allowing pressurized fluid to flow across the face of the pump housing into a 3rd feed channel
130
Delivering pressurized fluid through the 3rd feed channel to the radial channel proximate to the rotating torque carrying shaft
135
2

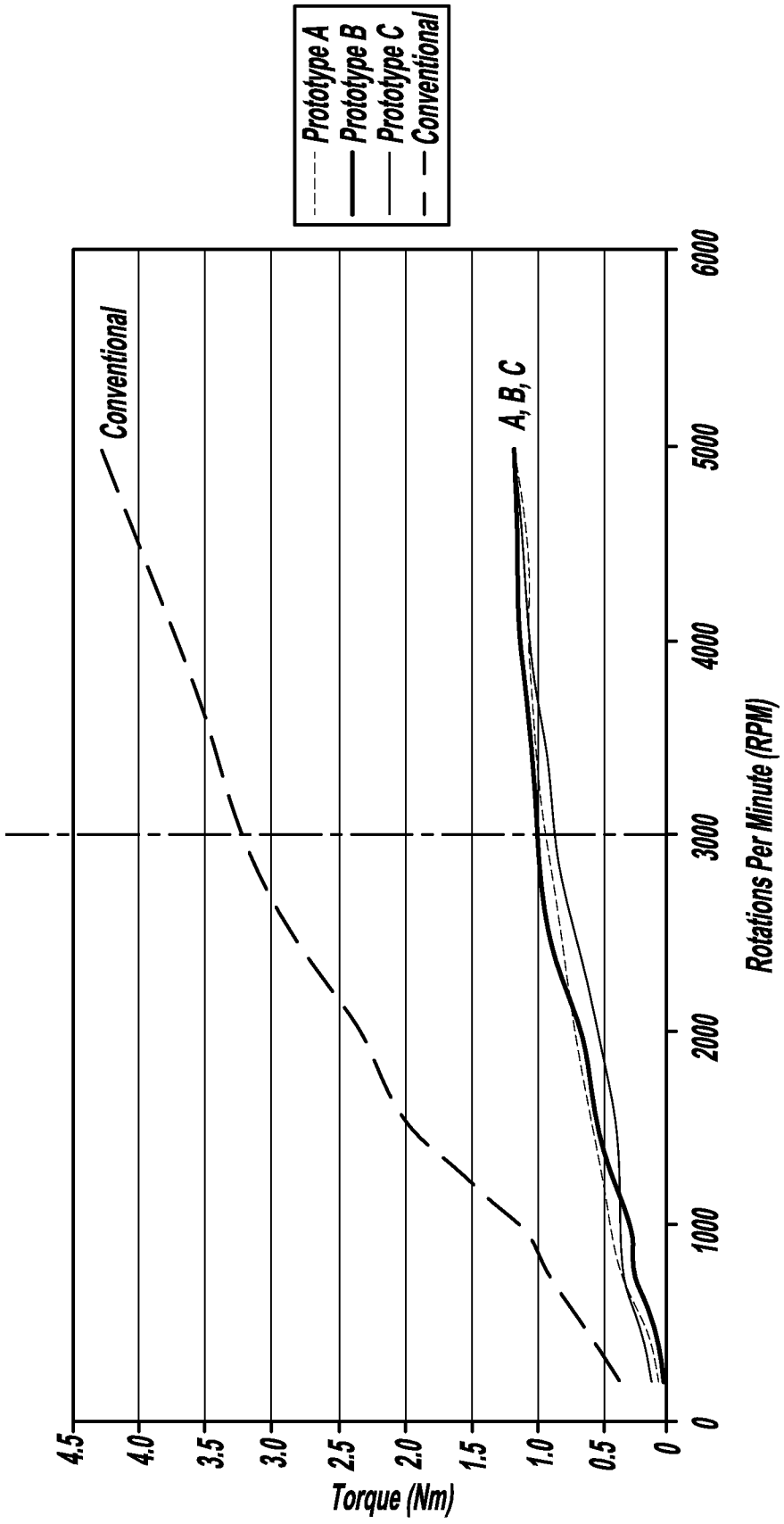

Prototype A
Prototype B
Prototype C
Conventional
Conventional
A, B, C
Torque (Nm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
Rotations Per Minute (RPM)
0
1000
2000
3000
4000
5000
6000

FIG - 6A

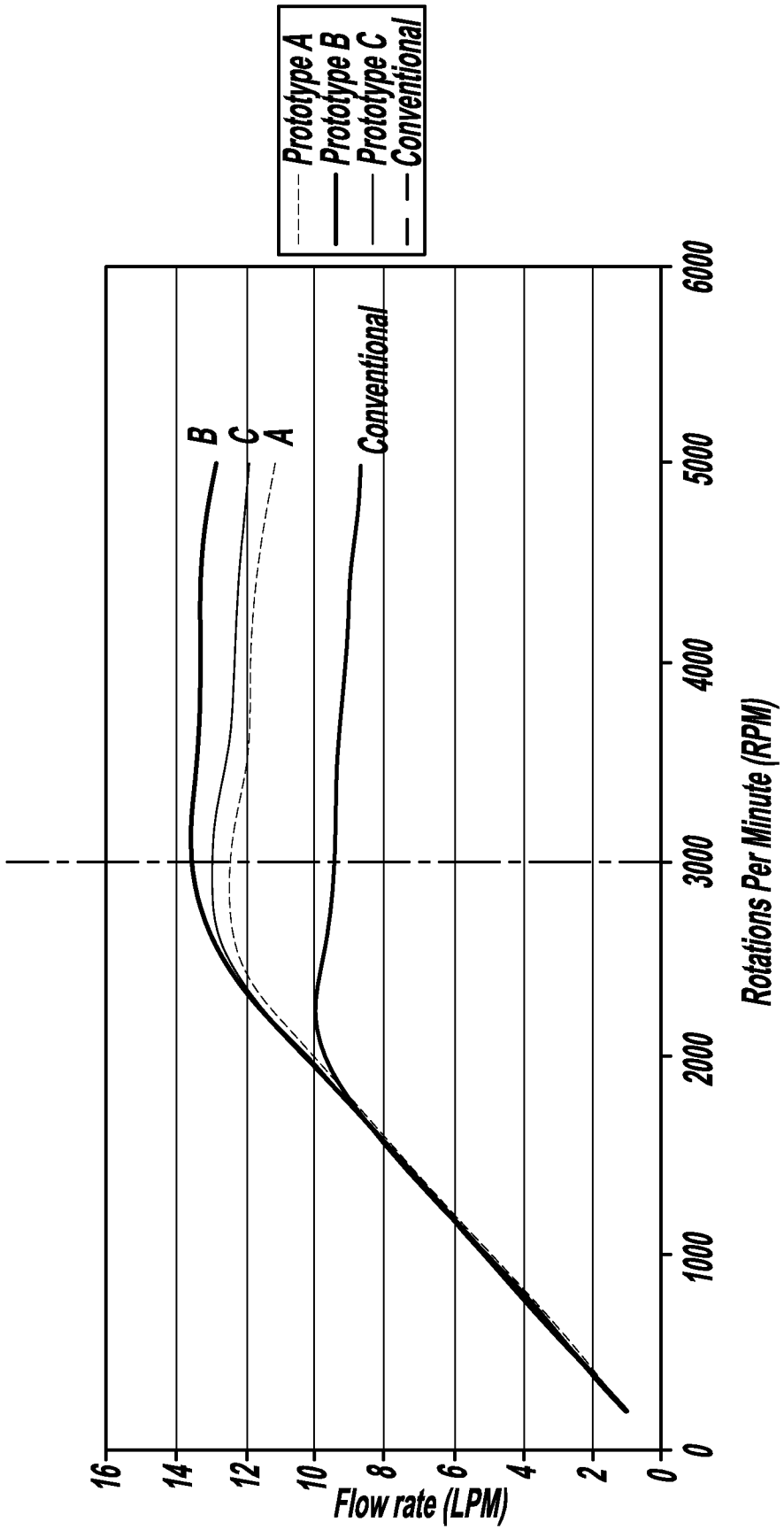

Prototype A
Prototype B
Prototype C
Conventional
B
C
A
Conventional
Flow rate (LPM)
16
14
12
10
8
6
4
2
0
0
1000
2000
3000
4000
5000
6000
Rotations Per Minute (RPM)

FIG - 6B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/024976

A. CLASSIFICATION OF SUBJECT MATTER

F16N 13/20(2006.01)i, F16H 57/04(2010.01)i, F01M 1/02(2006.01)i

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)

F16N 13/20; F01M 1/02; F04C 11/00; F04C 2/10; F16C 1/10; F16H 57/04

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models
(Chinese Patents and application for patent)

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

eKOMPASS(KIPO internal) & Keywords: vehicle, transmission, lubrication, gerotor pump, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5544540 A (HOLMAN, JAMES L.) 13 August 1996 See abstract; description, from column 2, line 12 to column 7, line 34;	1-7,9,10,12-15
A	claims 1 and 9; figures 1 to 4.	8,11,16,17
A	US 6679692 B1 (FEULING, JAMES J.) 20 January 2004 See abstract; claim 1; figure 1.	1-17
A	EP 0457489 A1 (CONCENTRIC PUMPS LIMITED) 21 November 1991 See abstract; claim 1; figure 1.	1-17

☐ 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 APRIL 2010 (28.04.2010)	**03 MAY 2010 (03.05.2010)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea	KONG, Ho Jin
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8310

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2010/024976

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5544540 A	13.08.1996	None	
US 6679692 B1	20.01.2004	None	
EP 0457489 A1	21.11.1991	FI912282A	13.11.1991
		FI912282D0	10.05.1991
		GB 2243869 A	13.11.1991
		GB 9010685 D0	04.07.1990
		GB 9109932 D0	03.07.1991
		JP 07-102927 A	18.04.1995
		NO911815A	13.11.1991
		NO911815D0	10.05.1991
		US 5152264 A1	06.10.1992