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(71) Applicant: VALEO ELECTRICAL SYSTEMS, INC. [US/US]; 3000 University Drive, Auburn Hills, MI 48326 (US).

(72) Inventors: BUSCHUR, Jeffrey, J.; 4598 Windmill Court, Lake Orion, MI 48359 (US). HILL, John, S.; 629 Banbury Road, Dayton, OH 45459 (US). MIENTUS, Michael, J.; 424 Kingsbury, Metamora, IL 61548 (US).

(74) Agents: JENKINS, Matthew, R. et al.; Jacox, Meckstroth & Jenkins, 2310 Far Hills Building, Dayton, OH 45419-1575 (US).

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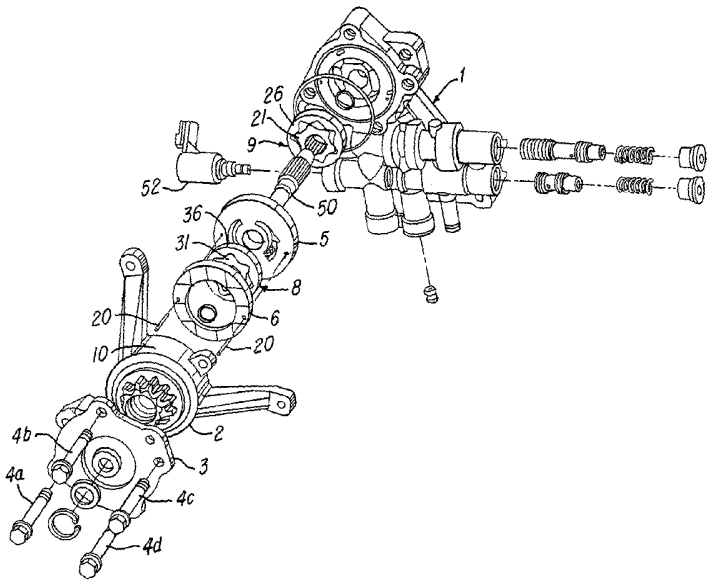
(54) Title: HYDRAULIC MOTOR SYSTEM



(57) Abstract: An improved hydraulic motor system, suitable for driving an automotive cooling fan or the like. The system is driven by grade gerotor set and and idle gerotor set which are stacked between a center plate and against a rear wall of a cylindrical cavity in a front face of a manifold. A fluid-tight chamber is established by securing an end frame can around the stacked gerotor sets and against the perimeter of the manifold cavity. Tightness of the seal is controlled by positioning a resilient cover plate against the end frame can from a position opposite the manifold, and adjustably clamping the resilient cover against the manifold until the resilient cover has undergone a predetermined amount of elastic deformation.

WO 03/006830 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HYDRAULIC MOTOR SYSTEM

Background of the Invention

[0001] This invention relates to an arrangement of cooperatively driven hydraulic motors for use in powering an automotive cooling fan or the like. Automotive engines are typically supplied with a liquid coolant, which is circulated through a radiator. The radiator is a heat exchanging device which collects heat generated by an internal combustion process and radiates it to the ambient air. Under ideal conditions, the heat transfer would proceed at the rate at which it is generated. Unfortunately, this is easier said than done.

[0002] When an automotive engine is idling, there is no natural airflow across the radiator surfaces, and it is customary to supplement the airflow with forced air from a cooling fan. As an automotive vehicle moves forward from an idle condition and gains speed, it suffers gradually increasing energy losses from air drag, road friction and internal frictional losses. These energy losses are made up by increasing the rate of internal combustion. That in turn increases the rate of heat generation, thereby increasing the work which must be done by the radiator. However, increases in vehicle speed cause an increase in the natural airflow through the radiator. This increase in natural airflow increases natural cooling at a rate which rises faster than the rate of heat generation. As a consequence, the workload on the cooling fan generally decreases with vehicle speed.

[0003] The above energy considerations are discussed in detail in Buschur U.S. Patent 5,561,978. That patent teaches that improved energy efficiency may be achieved by providing an automotive cooling system having a plurality of hydraulic motors which are switched into driving relationship with the cooling fan in response to pressure conditions in the hydraulic fluid supply. By way of example, the Buschur patent teaches a hydraulic motor system comprising two segregated spur gear hydraulic motors, communicating with a hydraulic fluid supply and driving a common fan shaft. It is taught that the fluid supply lines may be connected either in parallel or in series and that one or more

clutches may be provided for selectively placing the hydraulic motors into driving relationship with the fan shaft. The patent also suggests the use of gerotor type hydraulic motors.

[0004] Fig. 1 hereof illustrates a prior art hydraulic motor drive **300** for an automotive cooling fan (not illustrated). The drive unit **300** comprises a first hydraulic motor **302** and a second hydraulic motor **304**, both of which are of the gerotor type. Hydraulic motors **302**, **304** are supported by a manifold body **306** and are sealed against opposite faces of a coupling block **308**. The assembly is secured to manifold body **306** by four bolts **309a - 309d** and an end plate **310**. It is readily apparent that motor system **300** is quite complex, difficult to assemble and susceptible to fluid leakage at approximately a dozen seals to atmosphere. There is a need for an improved dual displacement hydraulic motor system which is more simple to manufacture and easier to maintain.

Summary of the Invention

[0005] This invention provides an improved motor system, suitable for driving an automotive cooling fan or the like. In a first aspect, the motor system has two hydraulic drive mechanisms, circumferentially fixed to a common shaft and surrounded by a common, fluid-tight chamber, In this first aspect, the hydraulic drive mechanisms preferably are gerotor sets, each comprising an inner rotor, circumferentially fixed to the common shaft, and an outer rotor eccentrically positioned about the inner rotor. The fluid-tight chamber is established by securing an end frame can against the perimeter of a manifold cavity. The two gerotor sets are stacked on opposite sides of a center plate, one gerotor set being placed in the manifold cavity, and the center plate and other gerotor set being placed in the can.

[0006] In a second aspect, the invention provides an improved method of preventing leakage of hydraulic fluid from a dual drive hydraulic motor system. The method involves the steps of:

(1) stacking the hydraulic motor components against a manifold,

(2) placing a sealing ring around the hydraulic motor components and in contact with the manifold,

(3) moving an end frame can enclosingly about the hydraulic motor components and into contact with the sealing ring,

(4) urging a resilient cover plate toward the end frame can from a position opposite the manifold, and

(5) adjustably clamping the resilient cover against said manifold until the resilient cover has undergone a predetermined amount of elastic deformation.

[0007] It is therefore an object of the invention to provide an improved dual displacement hydraulic motor system which is more simple to manufacture and easier to maintain.

[0008] It is another object of the invention to provide an improved method of assembling a hydraulic motor system.

[0009] Other and further objects and advantages of the invention will be apparent from the following specification, with its appended claims, and the attached drawings.

Brief Description of the Drawings

[0010] Fig. 1 is an exploded perspective drawing of a prior art hydraulic motor system;

[0011] Fig. 2 is an exploded perspective drawing of a hydraulic motor system according to the present invention;

[0012] Fig. 3 is a side elevation drawing of the hydraulic motor system, sectioned to show an axially extending hydraulic fluid return channel in a side wall of a can;

[0013] Fig. 4 is a side elevation drawing of the hydraulic motor system, sectioned to show an enclosed, axially extending, hydraulic fluid return passage and a radially extending notch which feeds hydraulic fluid thereto;

[0014] Fig. 5 is a side elevation drawing of the hydraulic motor system, sectioned to illustrate clamping of a cover plate;

[0015] Fig. 6 is a schematic illustration of an offset cylindrical cavity in a front face of a manifold;

[0016] Fig. 7 is an illustration of a center plate; and

[0017] Fig. 8 is a side elevation drawing of the hydraulic motor system, sectioned to show a path for conveying hydraulic fluid between a manifold and an idle gerotor set.

Description of the Preferred Embodiment

[0018] The improved hydraulic motor system is illustrated in the exploded perspective drawing of Fig. 2 shown therein are a manifold **1**, an end frame **2** and a cover plate **3**. Four threaded bolts **4a - 4d**, preferably of the MIO type, extend through cover plate **3** and engage manifold **1** to clamp end frame **2** therebetween. A shaft **50** extends from manifold **1** through end frame **2** and cover plate **3** for engagement with an automotive cooling fan (not illustrated). An idle gerotor set **8**, comprising inner and outer idle rotors **31**, **36**, respectively, is stacked on shaft **50** inside a circular opening **53** in eccentric ring **6**. Idle gerotor set **8** is stacked between end frame **2** and a center plate **5**. Also, a grade gerotor set **9**, comprising inner and outer grade rotors **21**, **26**, respectively, is stacked on shaft **50** between center plate **5** and manifold **1**. Outer grade rotor **26** is received within a cylindrical cavity **51** in manifold **1**, as illustrated on Fig. 3. Inner grade rotor **21** and inner idle rotor **31** are circumferentially fixed to shaft **50** by axially extending rectangular teeth. Circular opening **53** and cylindrical cavity **51** are positioned eccentrically with respect to the axis of shaft **50**. Alignment is maintained between the above-described parts by means of a pair of alignment pins **20**, **20** extending parallel to shaft 50.

[0019] Note also that when end frame **2** is positioned on manifold **1**, the pins **20** eccentrically align ring **6**, center plate **5** and manifold **1**, thereby reducing human errors and facilitating reduction of assembly time.

[0020] Numerous interface seals required by the prior art configuration of Fig. 1 are eliminated through use of the metal to metal stack construction as shown in Figs. 2 and 3. In the present invention, clamped surfaces at interface **A** (between end frame **2** and eccentric ring **6**), interface **B** (between eccentric ring **6** and center plate **5**) and interface **C** (between center plate **5** and manifold body **1**) define the principle fluid boundaries to enclosed operation pockets for gerotor sets **8** and **9**. (Details on the passage of oil through the stacked plate interfaces to the two gerotor sets are shown in Figs. 6 - 8). Leakage past the interfaces is captured by an overall cylindrical can **10** integral to end frame **2**. This leakage hydraulic fluid is collected within the can and channeled radially through grooves created by chamfers **11** on center plate **5** and eccentric ring **6**. and further on to axial channel **12** in the interior wall of can **10**. Leakage hydraulic fluid is then carried out of the general motor area and vented to near atmospheric pressure through notch **13** (Fig. 4) on the face of manifold **1** and passage **14** as shown on Fig. 4. Given that the restriction to hydraulic fluid flow through interfaces **A, B** and **C** is considerably tighter than through notch **13** and passage **14** the pressure within the can **10** is low. Thus, multiple high pressure seals required in the prior art are replaced by one low pressure seal **15** in this invention.

[0021] Requirements for traditional dowels in the construction are eliminated by dividing the alignment feature provided by close tolerance dowels into two functions. Referring now to Fig. 5, the can **10** which is an extension of end frame **2** provides centerline to centerline alignment to eccentric ring **6** and center plate **5**. Further, the interface ID **16** allows alignment through interface OD **17** on manifold **1**. These features facilitate the alignment of bearings **18** and **19** on shaft **50**, given that proper tolerances have been established and maintained.

[0022] Referring again to Fig. 3, one alignment pin **20** feeds through all parts as shown to provide proper angular alignment for port timing to the two gerotor sets. The second alignment pin **20** (shown on Fig. 2) is used on the remote side of the motor stack to

better balance and provide initial alignment prior to the introduction of can **10** during assembly. In this manner, both the centerline alignment and angular positioning of parts may be accomplished without traditional multiple tight tolerance dowels between each interface of the hydraulic stack.

[0023] Fig. 6 shows cylindrical cavity **51**, as viewed from interface **C**, with end frame **2**, idle gerotor set **8** and center plate **5** being removed. The figure shows kidney-shaped inlet and outlet ports **23**, **25** respectively for circulating hydraulic fluid through grade gerotor set **9**. High pressure hydraulic fluid is admitted from inlet port **23** to grade gerotor set **9** between inner grade rotor **21** and outer grade rotor **26**. Projections of inner grade rotor **21** and outer grade rotor **26** are indicated by dotted lines on Fig. 6. Projections of inner and outer idle rotors **31**, **36**, respectively are also shown in dotted lines. Projections of inlet and outlet ports **33**, **35** respectively for circulating hydraulic fluid through idle gerotor set **8**, are indicated in phantom lines.

[0024] Outer rotors **26**, **36** each have one more tooth than their associated inner rotors **21**, **31** respectively. This plus the eccentric positioning of outer rotors **26**, **36** causes an outer rotor sliding action which creates continuously opening and closing pockets **57** at each outer rotor tooth, as the gerotor pairs rotate. For each complete rotation of an outer rotor, the pocket **57** at each outer rotor tooth progresses through a cycle between fully opened and substantially closed conditions. The pockets generally increase in size while overlapping an inlet port and decrease in size while overlapping an outlet port.

[0025] As hydraulic fluid fills the space between inner and outer grade rotors **21**, **26** all pockets **57** which overlap inlet port **23** rise to high pressure, and grade gerotor set **9** rotates CW (when viewed in an axially rearward direction looking from end frame **2** toward manifold **1**, as in Fig. 6). All pockets **57** which overlap outlet port **35** are at low pressure. When taken in aggregate, this creates a large force imbalance bearing force **F1** on the inner grade rotor, as shown. This force is transferred to shaft **50** resulting in deflection and frictional loads at bearings **18**, **19** (Fig. 5). However, the fluid flow direction is reversed for idle gerotor set **8**. This produces an oppositely acting bearing force **F2**. The two resultant shaft loads oppose each other greatly reducing shaft deflection and net bearing load. The fluid flow through idle gerotor set **8** also produces a

net CW torque on shaft **50**, even though the radial force **F2** is opposite **F1**. This is due to the fact that outer grade rotor **26** and outer idle rotor **36** are radially offset in opposite directions from the axis of shaft **50**.

[0026] A solenoid **52** (Fig. 2) controls the flow of hydraulic fluid to gerotor sets 8 and 9. The timing of the flow sequence to gerotor sets **8** and **9** may be in accordance with the teachings of Buschur 5,561,978, which is incorporated herein and made a part hereof. The connections to grade gerotor set **9** run more or less directly to ports **23**, **25**. Figs. 7 and **8** show the connections to idle gerotor set **8**. Fig. 7 is a view of the front face **74** of plate **5**. That figure shows the inlet and outlet ports **33** and **35** respectively for idle gerotor set **8**. Hydraulic fluid flows to inlet port **33** via an internal supply passage 46 connected to an opening **43** on the rear face **76** of center plate **5**. Upon entry into inlet port **33**, the hydraulic fluid causes CW rotation of gerotor set **8**, meanwhile undergoing pocketed flow from inlet port **33** to outlet port **35**. Thereafter, the flow path through center plate **5** is via an internal passage **48** to a rear face opening **45**.

[0027] Fig. 8 is a sectioned side elevation view of an assembled hydraulic motor system, according to the present invention. Shown there are passages **71** and **73** in manifold **1**. Passages **71**, **73** are in communication with openings **43**, **45**. This completes the flow path between manifold **1** and idle gerotor set **8**.

[0028] Referring again to Fig. 5, attention is directed at cover plate **3**. This element should be fabricated from a resilient material. Any one of a wide range of materials would be suitable, but ferrous stock is preferred due to its relatively low cost and its temperature insensitive modulus of elasticity. Cover **3** has two important functions.

[0029] First, cover **3** serves as a massive wave washer allowing a predictable axial clamping load to be applied to the motor stack to resist pressure forces and prevent leakage at the stack interfaces. During assembly, a relatively light torque load (< 10 N-m) is applied to each of bolts **4a - 4d** to seat the cover plate in a starting position. Then each bolt is turned a set number of degrees, thereby deflecting the cover plate. This applies a predetermined clamping pressure to interfaces **A**, **B**, and **C** (Fig. 3). The only significant variables thus determining the resultant clamping load are the thickness and modulus of the plate and pitch of the bolt threads, all of which are highly controllable. Given that the

cover plate is not a perfect washer shape due to packaging issues, the drive angles of the four bolts are modified to allow a uniform clamping load around the clamp load circle. Significant deflection of the plate is desirable as it then easily compensates for any long term creep of the threads.

[0030] The second design function of cover plate 3 is to allow manipulation of the location of the resultant clamping loads on the motor stack caused by the bolt tensile loads. It is apparent that bolts 4a - 4d must be placed outside the seal perimeter as defined by seal 15 resulting in clamping loads outside the desired clamp load circle and increasing the diameter of the disk which hydraulic loads can attempt to deflect. However, cover plate 3 transfers the loads generated by the bolts to a circular area inside the arrows F3, thereby minimizing bending moments applied to the stacked motor elements.

[0031] While the form of apparatus and the method herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus and method, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

Claims

1. The hydraulic motor system comprising:

a shaft situated on a manifold;

a first hydraulic drive mechanism mounted in driving relationship with said shaft;

a second hydraulic drive mechanism mounted in driving relationship with said shaft;

a cover mounted on said manifold to define a common fluid-tight environment in which said first and second drive hydraulic mechanisms are located.

2. The hydraulic motor system according to claim 1 wherein said first and second hydraulic drive mechanisms each comprise a gerotor set, including an inner rotor and an outer rotor.

3. The hydraulic motor system according to claim 2, further comprising a center plate, said center plate and said gerotor sets being stacked on said shaft in face-to-face relationship.

4. The hydraulic motor system according to claim 3 wherein said center plate is stacked between said gerotor sets.

5. The hydraulic motor system according to claim 1, said hydraulic motor system, further comprising an end frame and a plurality of bolts, said bolts joining said end frame to said cover to said manifold and clamping said gerotor sets and said center plate therebetween.

6. The hydraulic motor according to claim 5 wherein said bolts are adjustable for controlling interface pressure within said hydraulic motor system.

7. The hydraulic motor system according to claim 5 wherein at least one of said plurality of bolts secures said gerotor sets to said manifold.

8. The hydraulic motor system according to claim 7 wherein a center plate is stretched between said first and second hydraulic drive mechanisms, said plurality of bolts joining said center plate and said first and second hydraulic drive mechanisms.

9. The hydraulic motor system according to claim 1 wherein said system further comprises a gasket mounted between said cover and manifold.

10. A method of sealing a hydraulic motor system comprising the steps of:
providing driving components for said motor system;
providing a member on which to mount said driving components;
moving a cover enclosingly about said driving components; and
adjustably clamping said cover until said driving components are sealed therein.

11. The method according to claim 10 wherein said driving components comprise a plurality of gerotors.

12. The method according to claim 11, further comprising the step of providing a center plate, said center plate stacked on said shaft between tow of said plurality of gerotors.

13. The method according to claim 11, wherein said method comprises the steps of providing an end frame and a plurality of bolts and securing said bolts to said manifold to clamp said gerotor sets and said center plate therebetween.

14. The method according to claim 13 wherein said method comprises the step of adjusting said bolts to control interface pressure within said hydraulic motor system.

15. The method according to claim 13 wherein at least one of said plurality of bolts secures a plurality of gerotor sets to said manifold.

16. The method according to claim 10, wherein said driving components comprises a first drive mechanism and a second drive mechanism, wherein the method further comprises the steps of situating a center plate between said first and second hydraulic drive mechanisms, and a providing a plurality of bolts to join said center plate and said first and second hydraulic drive mechanisms.

17. The method according to claim 10 wherein said adjusting step further comprises the step of clamping said cover to a manifold.

18. A method of assembling a hydraulic motor system comprising the steps of:

(1) providing driving components for said motor system in stackable form;

(2) providing a manifold having a substantially flat stacking face;

(3) stacking said driving components against said stacking face;

(4) placing a sealing ring around said driving components and in contact with said manifold;

(5) moving an open-ended can enclosingly about said driving components and into contact with said sealing ring; and

(6) adjustably clamping said can between a resilient cover and said manifold until said resilient cover has undergone a predetermined amount of elastic deformation.

19. An hydraulic motor system comprising:

(a) a shaft;

(b) a first inner rotor mounted on said shaft;

(c) a first outer rotor mounted on said shaft radially surrounding said first inner rotor;

(d) an eccentric ring mounted on said shaft radially surrounding said first outer rotor;

(e) a center plate stacked on said shaft in face-to-face contact with said first inner rotor; said first outer rotor and said eccentric ring;

(e) a second inner rotor stacked on said shaft in face-to-face contact against said center plate, opposite said first inner rotor;

(f) a second outer rotor stacked on said shaft radially surrounding said second inner rotor and in face-to-face contact against said center plate;

(g) a manifold supportingly receiving said shaft and being in fluidic communication with said second inner rotor and said second outer rotor;

(h) a can mounted fast on said manifold so as to receive said shaft and sealingly enclose said first and second inner and outer rotors, said eccentric plate and said center plate while maintaining axial alignment therebetween; and

(i) a pin received and positioned for maintaining circumferential alignment between said can, said eccentric plate, said center plate and said manifold.

20. A hydraulic motor system according to claim 19 further comprising a second pin circumferentially disposed with respect to said first mentioned pin to facilitate initial alignment of elements comprising said hydraulic motor system.

21. A hydraulic motor system according to claim 20 wherein said first inner and outer rotors define a first gerotor pair, and said second inner and outer rotors define a second gerotor pair.

22. A hydraulic motor system comprising first and second gerotor-type motors mounted on a common shaft, the method of reducing net shaft deflection and bearing load by operating said gerotor-type motors in opposite angular directions.

23. An hydraulic motor system comprising:

(a) a shaft;

(b) a first inner rotor mounted on said shaft;

(c) a first outer rotor mounted on said shaft radially surrounding said first inner rotor;

(d) an eccentric ring mounted on said shaft radially surrounding said first outer rotor;

(e) a center plate stacked on said shaft in face-to-face contact with said first inner rotor; said first outer rotor and said eccentric ring;

(e) a second inner rotor stacked on said shaft in face-to-face contact against said center plate, opposite said first inner rotor;

(f) a second outer rotor stacked on said shaft radially surrounding said second inner rotor and in face-to-face contact against said center plate;

(g) a manifold supportingly receiving said shaft and being in fluidic communication with said second inner rotor and said second outer rotor;

(h) a can mounted fast on said manifold and enclosing said first and second inner and outer rotors, said eccentric plate and said center plate; and

(i) a flexible seal interposed between said can and said manifold.

24. An hydraulic motor system according to claim 23 wherein all areas of said face-to-face contact are substantially resistant to fluid flow in a radial direction, said hydraulic motor system being provided with passageways interiorly connecting said flexible seal to a source of relief at atmospheric pressure.

25. The system according to claim 24 wherein said relatively light load is less than about 10 newton meters.

26. A method of assembling an hydraulic motor system comprising the steps of:

mounting a first inner rotor upon a shaft;

mounting a first outer rotor on said shaft radially surrounding said first inner rotor;

mounting an eccentric ring on said shaft radially surrounding said first outer rotor;

stacking a center plate on said shaft in face-to-face contact with said first inner rotor; said first outer rotor and said eccentric ring;

stacking a second inner rotor stacked on said shaft in face-to-face contact against said center plate, opposite said first inner rotor;

stacking a second outer rotor stacked on said shaft radially surrounding said second inner rotor and in face-to-face contact against said center plate;

positioning a manifold supportingly about said shaft and in fluidic communication with said second inner rotor and said second outer rotor;

mounting a can enclosingly about said first and second inner and outer rotors, said eccentric plate and said center plate;

establishing a sealing perimeter by interposing a generally circular flexible seal between said can and said manifold;

positioning a resilient cover plate against said can opposite said manifold;

securing said cover plate axially against said manifold by placing a plurality of clamping bolts along a clamp load circle having a diameter extending beyond said sealing perimeter;

seating said cover plate in a starting position by applying a relatively light torque load to each of said clamping bolts; and

applying a predetermined clamping pressure to said areas of face-to-face contact by turning said bolts predetermined amounts and causing said cover plate to transfer clamping pressure from a region inside said clamping circle to a region inside said sealing perimeter.

27. The method of claim 26 wherein said relatively light load is less than about 10 newton meters.

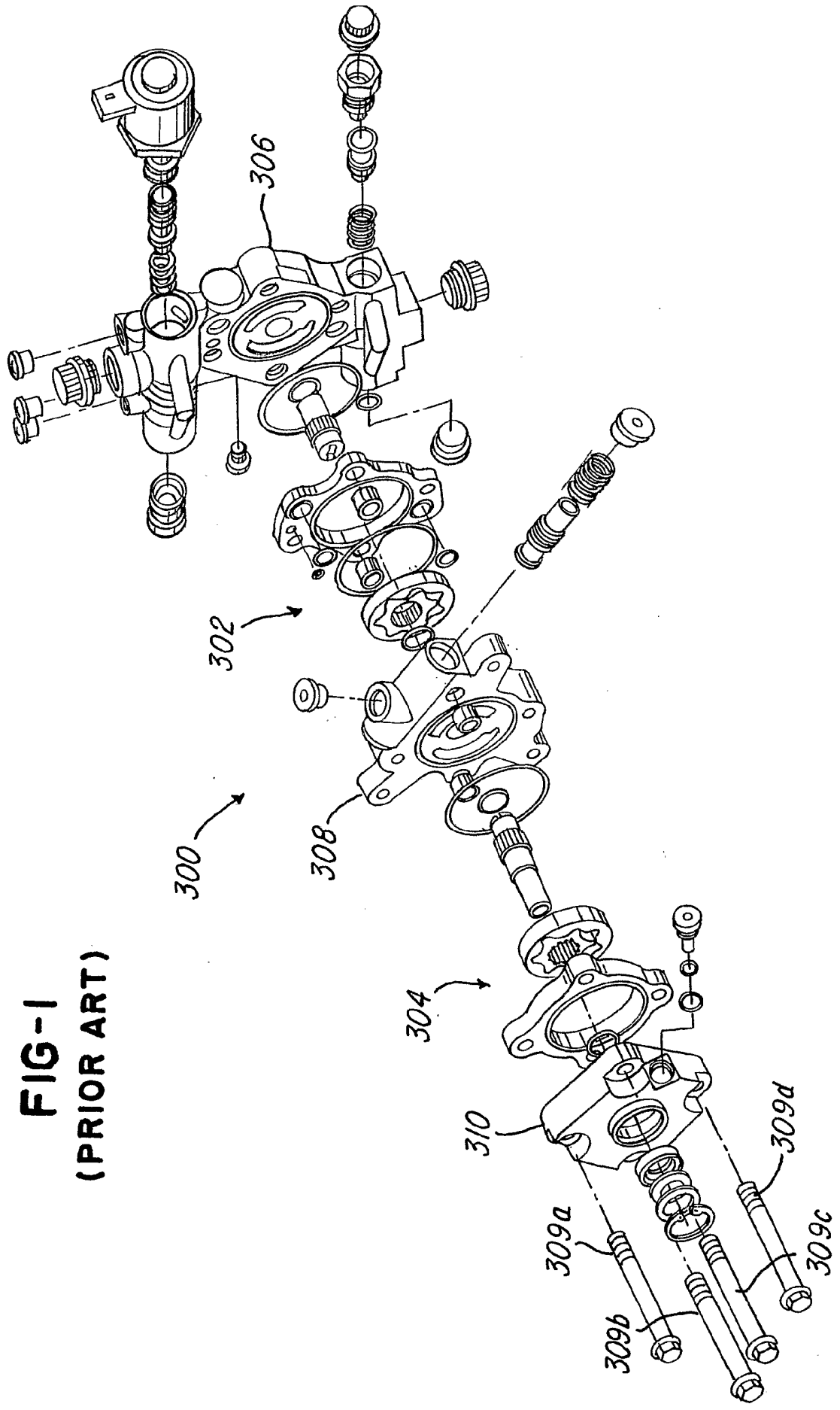


FIG-1
(PRIOR ART)

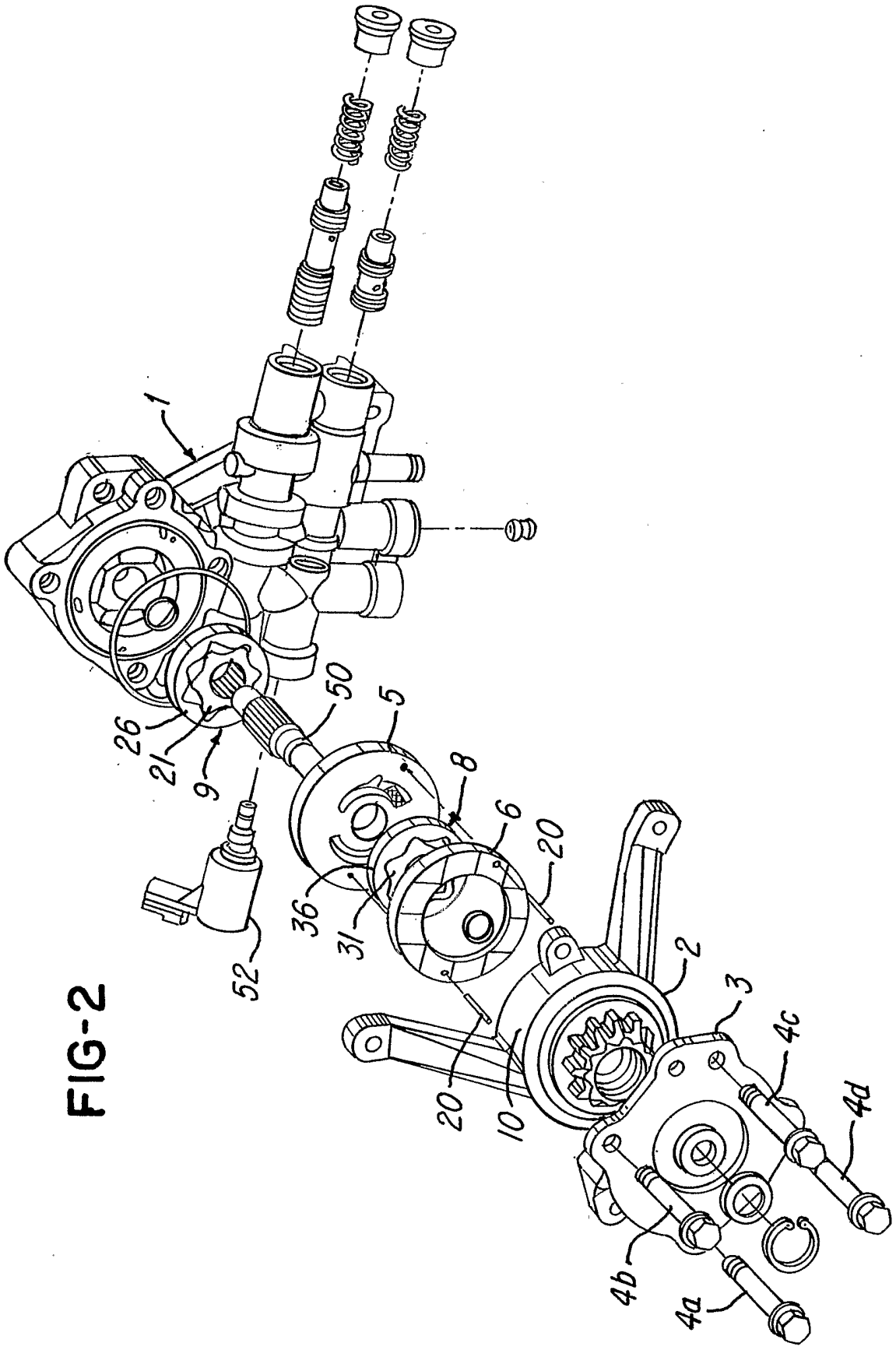


FIG-2

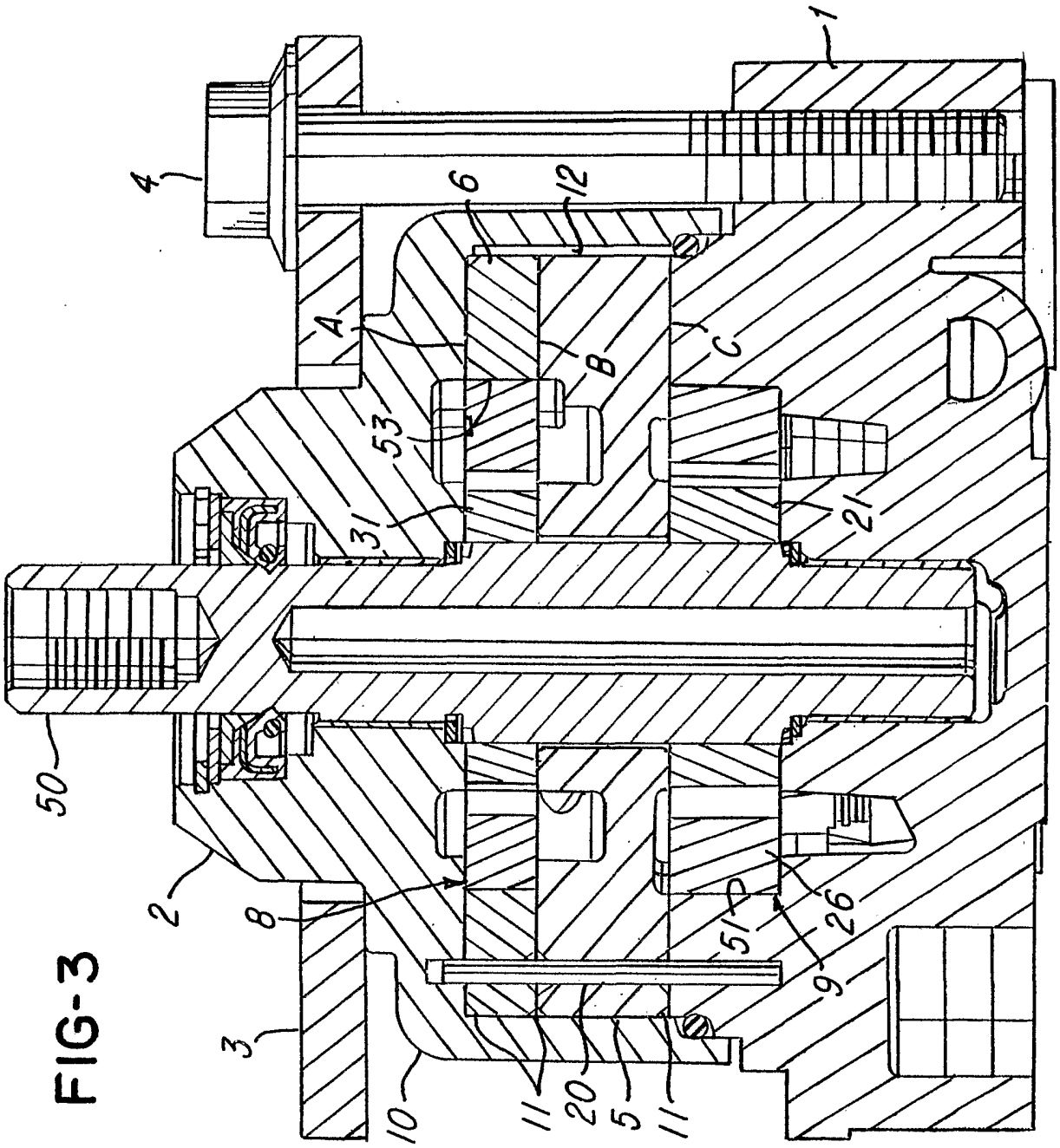


FIG-3

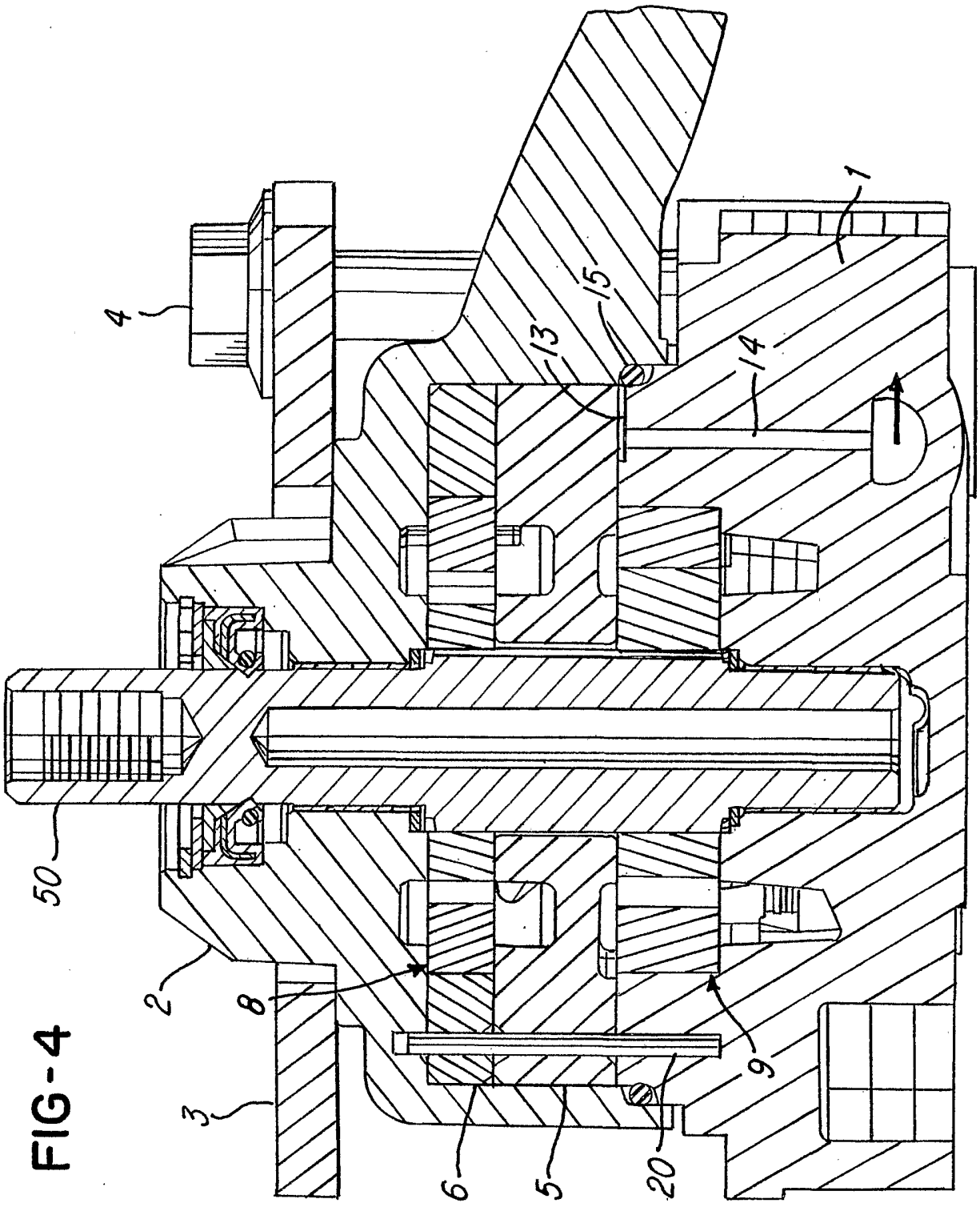


FIG-4

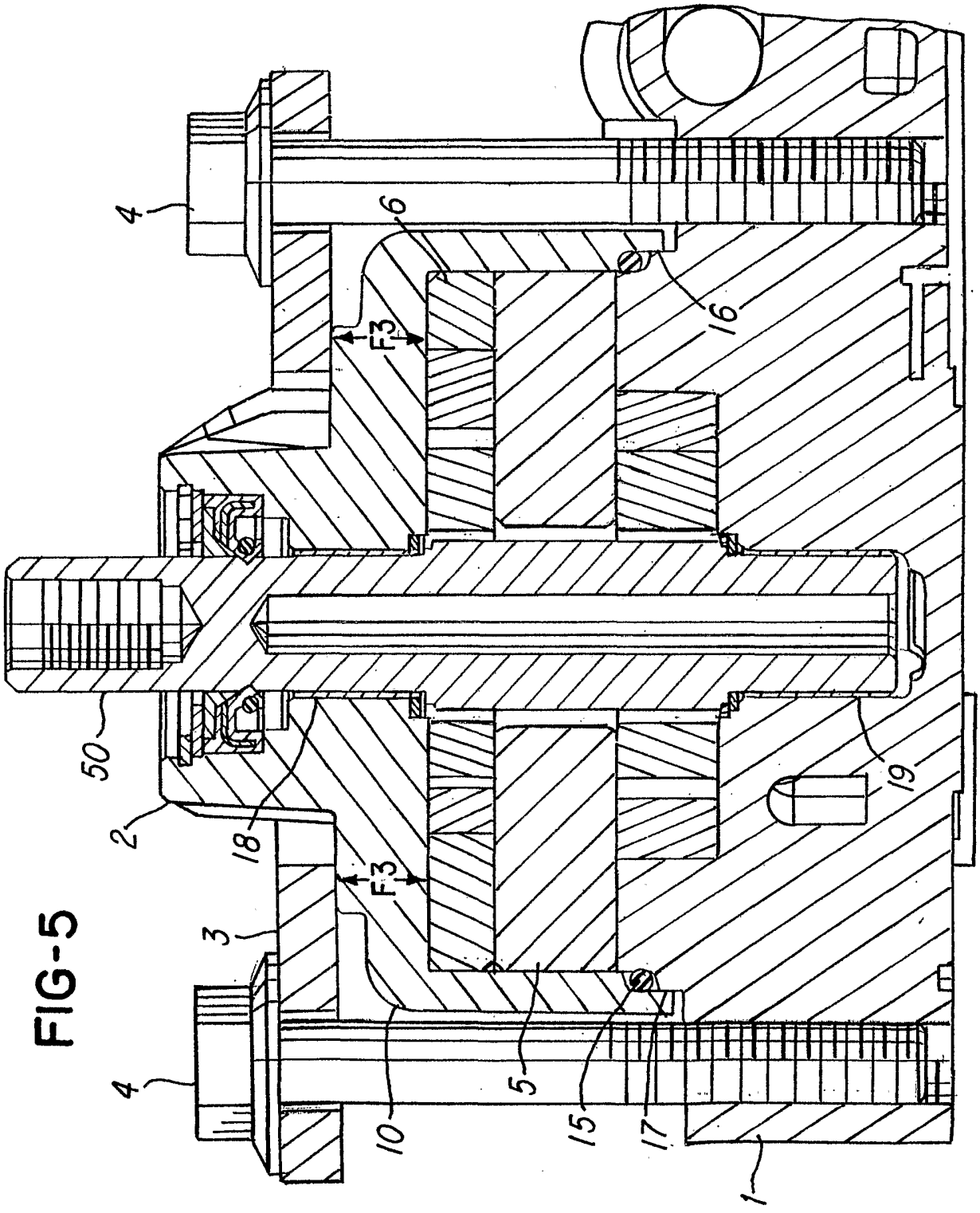


FIG-5

FIG-6

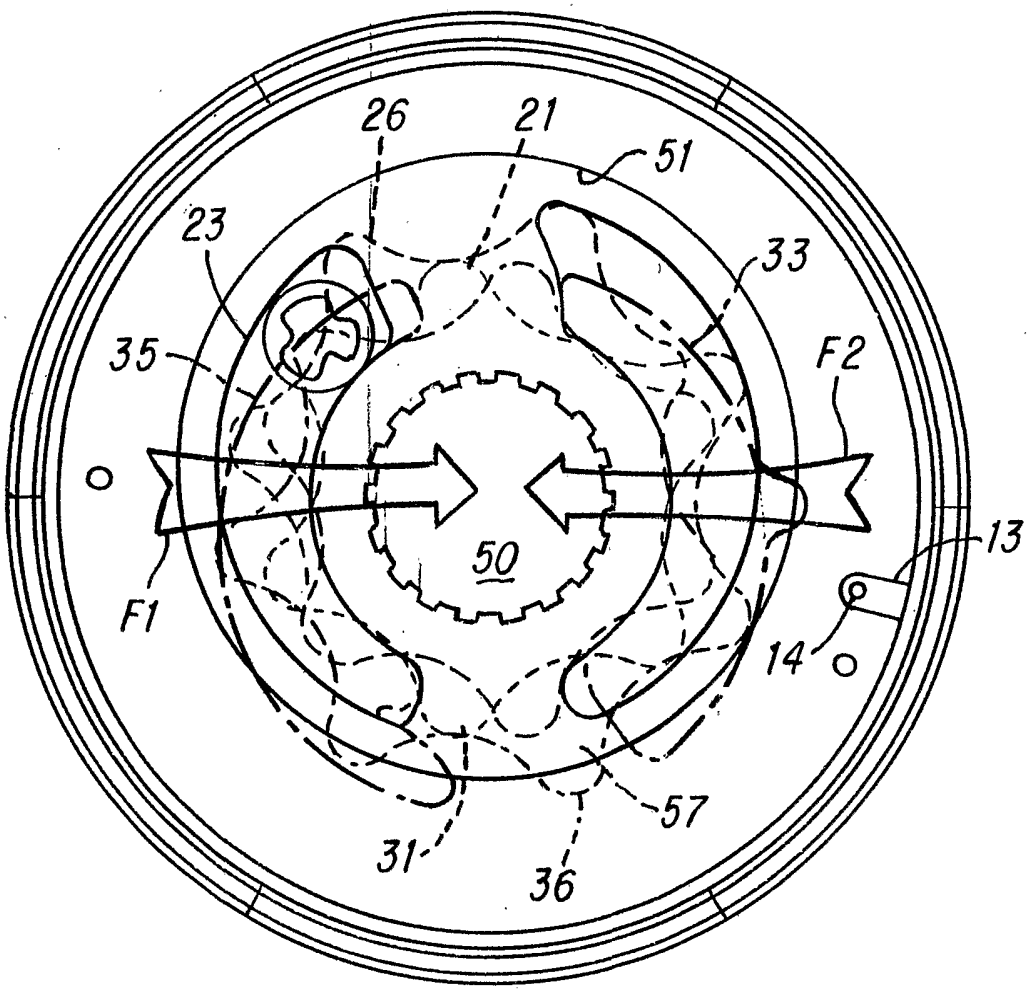


FIG-7

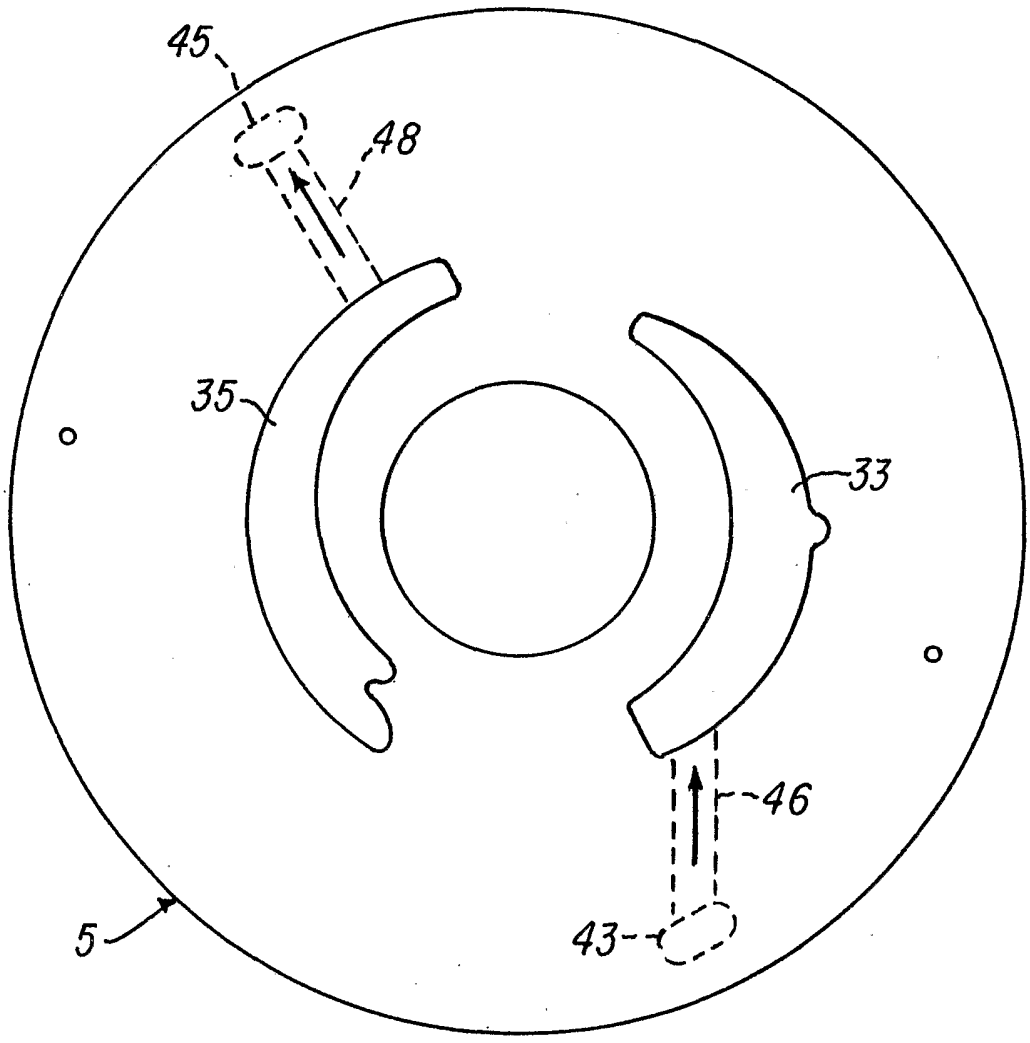
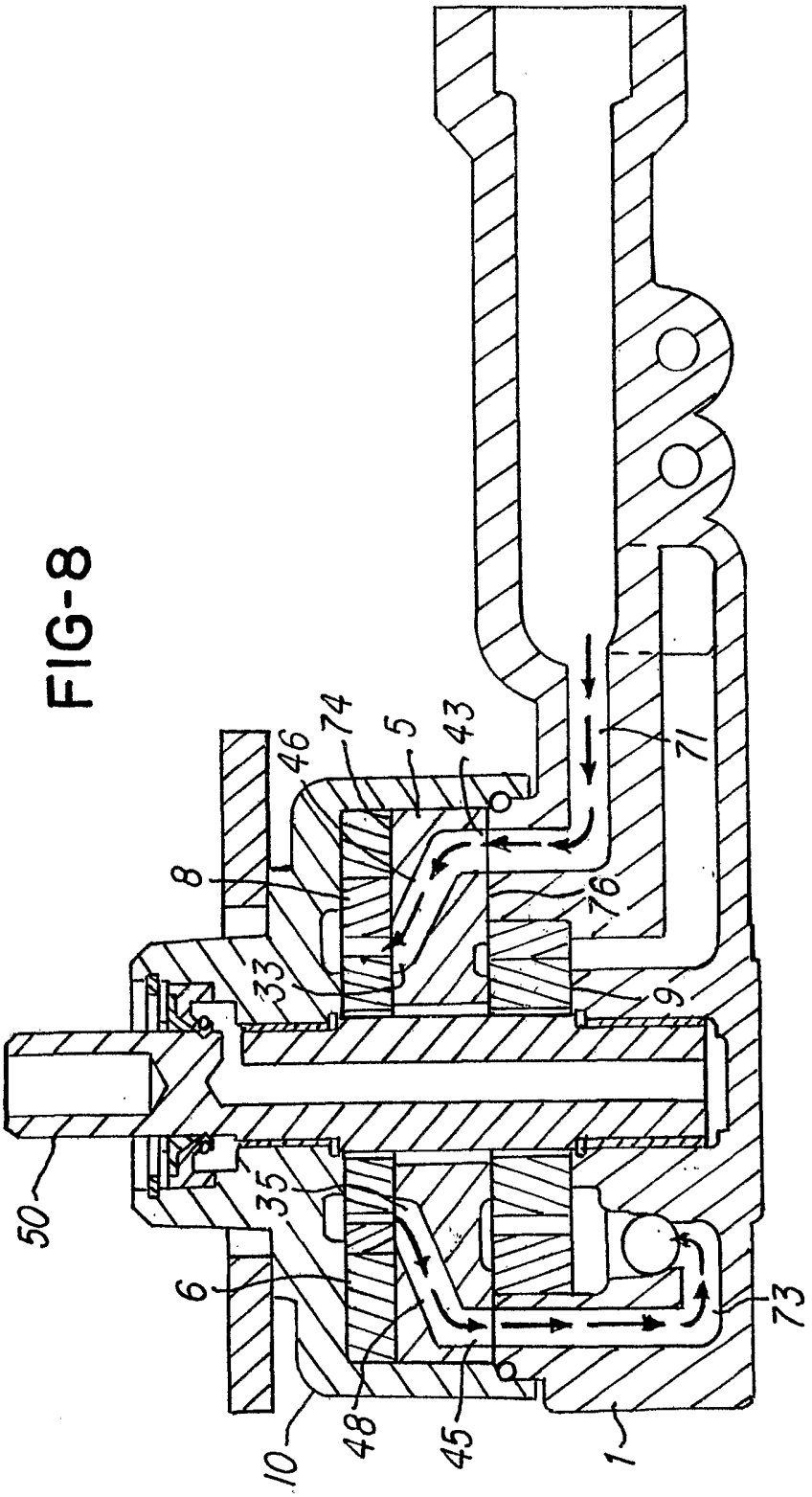


FIG-8



INTERNATIONAL SEARCH REPORT

tional Application No
PCT/US 02/21594

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F04C2/10 F04C11/00 F04C15/04 F04C2/08 F04C15/00

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)
IPC 7 F04C

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 5 216 983 A (NILSON CARL A) 8 June 1993 (1993-06-08) column 4, line 35 - line 68; figure 6	1-4 10,18, 19,23,26
X	US 6 195 990 B1 (MACHESNEY KERRY A ET AL) 6 March 2001 (2001-03-06) column 3, line 1 - line 10; figure 19	1,2,10, 11
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 05, 30 May 1997 (1997-05-30) -& JP 09 025882 A (MAYEKAWA MFG CO LTD), 28 January 1997 (1997-01-28) abstract	22

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

[X] Patent family members are listed in annex.

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"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 October 2002	05/11/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dimitroulas, P

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/21594

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 01, 31 January 1996 (1996-01-31) -& JP 07 247964 A (MATSUSHITA ELECTRIC IND CO LTD), 26 September 1995 (1995-09-26) abstract	22
X	US 3 551 081 A (BRUNDAGE ROBERT WESLEY) 29 December 1970 (1970-12-29)	1-5, 9-13, 15-18, 22,23
A	claim 1; figure 1	19,26
A	US 3 244 111 A (SHELHART ROBERT E) 5 April 1966 (1966-04-05)	1-5, 10-13, 16,18, 19,23,26
	claim 1; figures 1,2	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 02/21594

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 2 of first sheet)

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

see additional sheet

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.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-21

   A hydraulic motor system with a cover

2. Claim : 22

   A hydraulic motor system with first and second gerotor - type motors in opposite angular directions

INTERNATIONAL SEARCH REPORT

Information on patent family members

I ational Application No
PCT/US 02/21594

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5216983 A	08-06-1993	NONE	
US 6195990 B1	06-03-2001	EP 1144868 A1	17-10-2001
		WO 0042321 A1	20-07-2000
JP 09025882 A	28-01-1997	NONE	
JP 07247964 A	26-09-1995	NONE	
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		DE 2000477 A1	10-12-1970
		GB 1279041 A	21-06-1972
US 3244111 A	05-04-1966	NONE	