OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

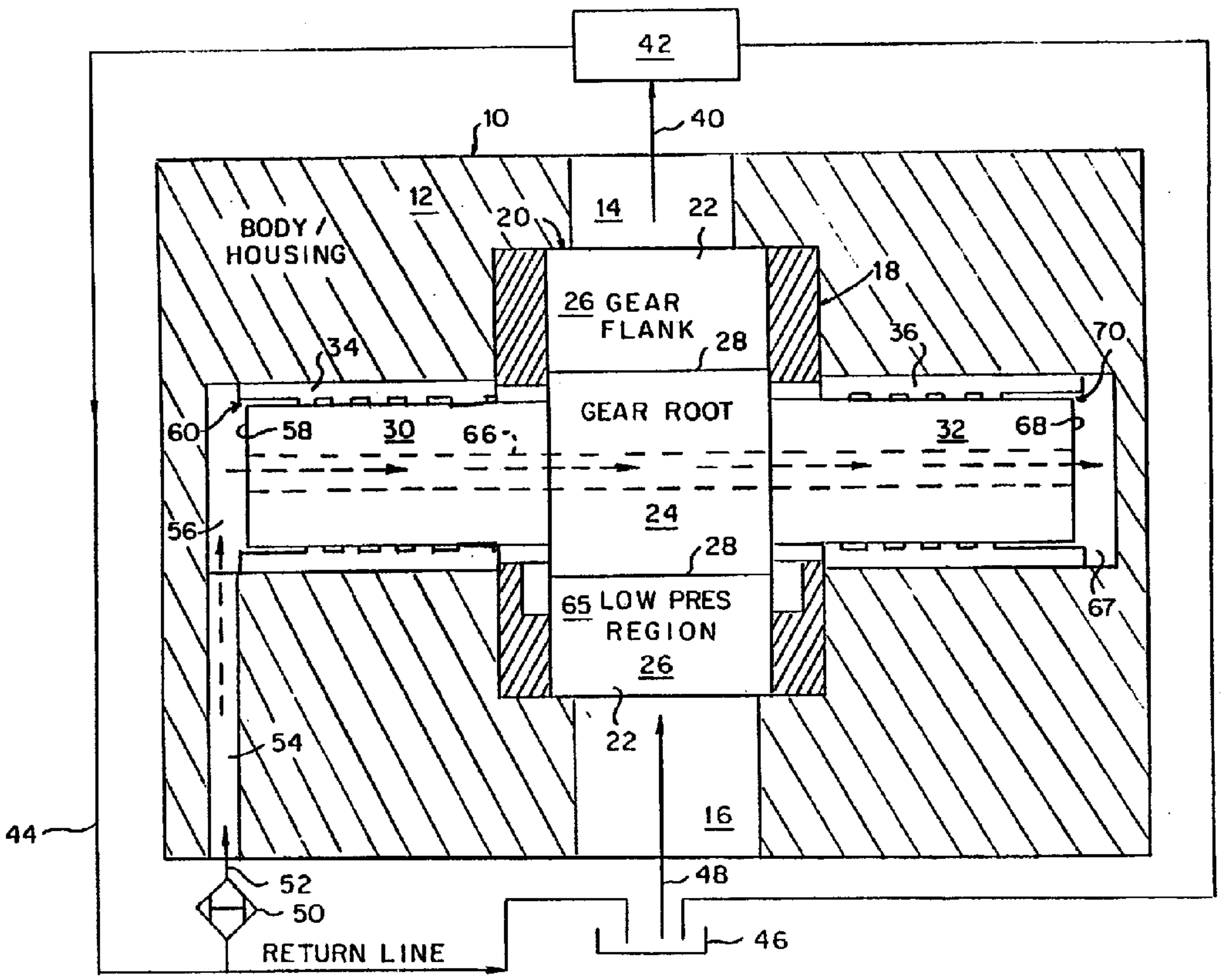
(12) (19) (CA) **Demande-Application**

(21) (A1) **2,309,458**
(86) 1999/09/28
(87) 2000/04/06

(72) MCBURNETT, JAMES R., US
(71) DANA CORPORATION, US

(51) Int.Cl.^{7} F04B 53/18, F04B 53/08
(30) 1998/09/28 (09/161,289) US

(54) **SYSTEME DE GRAISSAGE POUR POMPES HYDRAULIQUES**
(54) **LUBRICATION SYSTEM FOR HYDRAULIC PUMPS**



(57) Pour protéger les coussinets qui soutiennent les tourillons d'engrenages de pompage, des paramètres opérationnels restreints sur la base de la température sont fixés pour des pompes hydrauliques à engrenages. En général, de telles pompes ne fonctionnent pas à des températures supérieures à environ 210 °F. Il est

(57) In order to protect bearings which support the journals of pumping gears, hydraulic gear pumps have operating parameters restricted by temperature. Typically, these pumps do not operate at temperatures above about 210 °F. There is, however, a need for hydraulic gear pumps which can pump hydraulic fluid

OPIC
Office de la propriété intellectuelle du Canada

CIPO
Canadian Intellectual Property Office

(21) (A1) **2,309,458**
(86) 1999/09/28
(87) 2000/04/06

toutefois nécessaire d'obtenir des pompes hydrauliques à engrenages capables de pomper un fluide hydraulique à des températures pouvant atteindre environ 250 °F sans endommager les coussinets. Pour pomper un fluide hydraulique à ces températures, le procédé de l'invention raccorde la canalisation de retour du système dans lequel fonctionne la pompe à une chambre de graissage à une extrémité d'un tourillon soutenant un des engrenages de pompage. Le fluide hydraulique refroidi par l'échangeur de chaleur est ensuite aspiré à basse pression dans une zone de dépression d'un orifice d'admission de la pompe, à travers une interface située entre les coussinets qui soutiennent les tourillons de l'engrenage et les tourillons de l'engrenage eux-mêmes. Ainsi, les coussinets et les tourillons de l'engrenage sont graissés avec un fluide hydraulique dont la température est sensiblement inférieure à celle d'un fluide hydraulique contenu dans une canalisation de retour ou dans un réservoir.

having a temperature which may be as high as about 250 °F without adversely affecting the bearings. In order to pump hydraulic fluid at these temperaturers, the present invention connects the return line of the system in which the pump is used to a lubrication chamber at one end of a journal supporting one of the pumping gears. The hydraulic fluid which has been cooled by the heat exchanger is then drawn by low pressure in a low pressure region of a pump inlet opening, through an interface between bearings supporting the gear journals and the gear journals themselves. In this way, bearings and gear journals are lubricated with hydraulic fluid having a temperature substantially lower than hydraulic fluid in a return line or tank.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : F01M

A2

(11) International Publication Number: WO 00/19067

(43) International Publication Date: 6 April 2000 (06.04.00)

(21) International Application Number: PCT/US99/22316

(22) International Filing Date: 28 September 1999 (28.09.99)

(30) Priority Data:
09/161,289 28 September 1998 (28.09.98) US

(71) Applicant: DANA CORPORATION [US/US]; P.O. Box 1000, Toledo, OH 43697 (US).

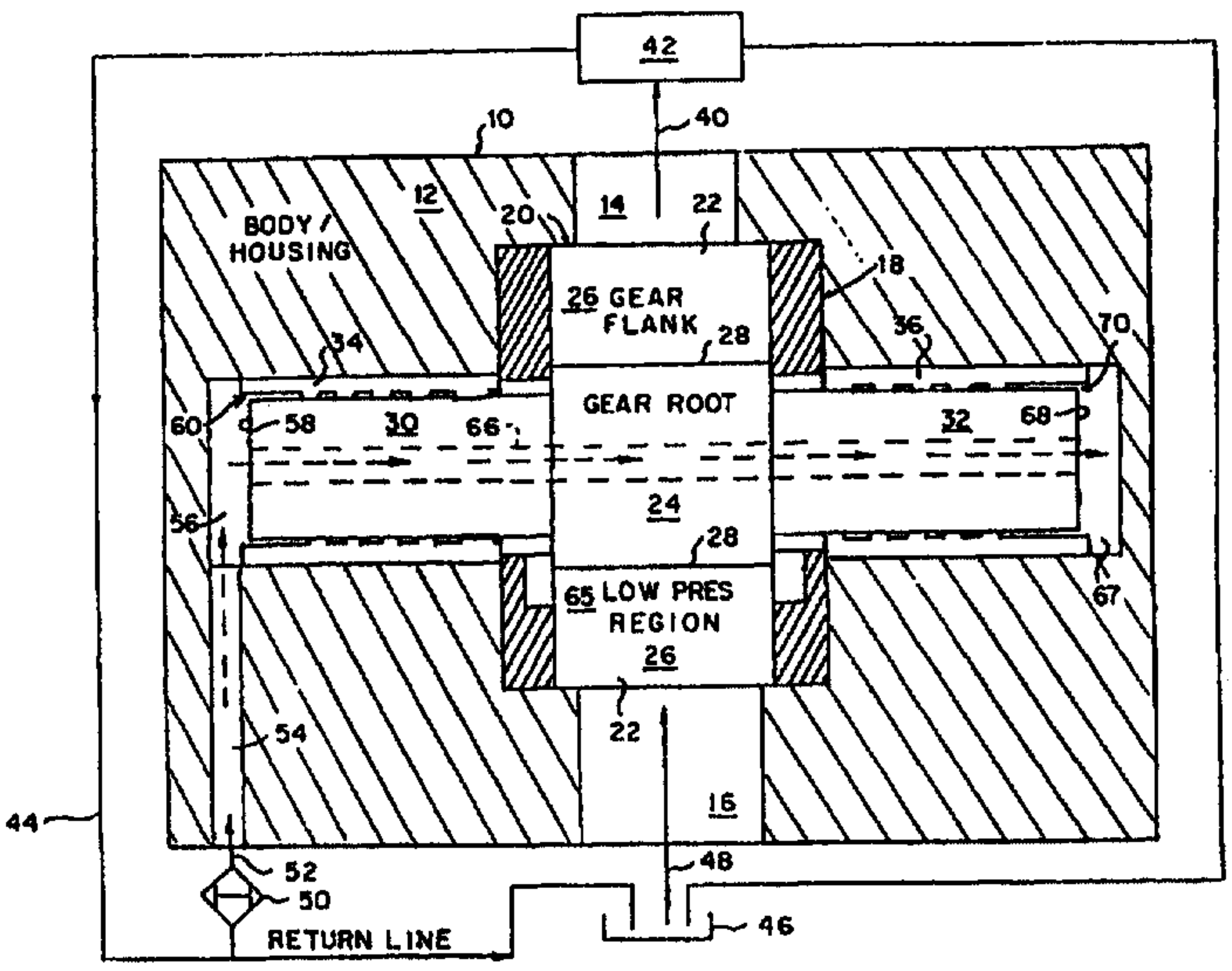
(72) Inventor: MCBURNETT, James, Robert; 513 Crestmont Way, Greenville, SC 29615 (US).

(74) Agents: MOSES, John, R. et al.; Millen, White, Zelano & Branigan, Arlington Courthouse Plaza 1, Suite 1400, 2200 Clarendon Boulevard, Arlington, VA 22201 (US).

(81) Designated States: CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: LUBRICATION SYSTEM FOR HYDRAULIC PUMPS



(57) Abstract

In order to protect bearings which support the journals of pumping gears, hydraulic gear pumps have operating parameters restricted by temperature. Typically, these pumps do not operate at temperatures above about 210 °F. There is, however, a need for hydraulic gear pumps which can pump hydraulic fluid having a temperature which may be as high as about 250 °F without adversely affecting the bearings. In order to pump hydraulic fluid at these temperaturers, the present invention connects the return line of the system in which the pump is used to a lubrication chamber at one end of a journal supporting one of the pumping gears. The hydraulic fluid which has been cooled by the heat exchanger is then drawn by low pressure in a low pressure region of a pump inlet opening, through an interface between bearings supporting the gear journals and the gear journals themselves. In this way, bearings and gear journals are lubricated with hydraulic fluid having a temperature substantially lower than hydraulic fluid in a return line or tank.

LUBRICATION SYSTEM FOR HYDRAULIC PUMPS

Field of the Invention

This invention relates to lubrication systems for hydraulic pumps, and more particularly, to lubricating systems for bearings in external gear pumps.

Background of the Invention

Use of fluid being pumped by a gear pump to lubricate the journals and bearings of the pump is accomplished by various lubrication systems which usually include at least one groove along each bearing, the groove or grooves connecting hydraulic fluid non-cumulations at different pressures. The different fluid pressures may be created by, for example, outlet discharge pressure or inlet pressure drops when gear teeth separate. By having a continuous flow, the fluid serves to cool the bearings.

One approach is high pressure bearing lubrication, in which high pressure hydraulic fluid, that leaks past the pressure plate surface of the pump near the roots of the gear teeth, flows down the lengths of the journals and bearings supporting the gear and is collected at the outer ends of the journals. Fluid then flows through bearing drain passages in the pump housing and back to the inlet of the pump. The pressure plates may also incorporate lubrication grooves to ensure adequate flow rates from the discharge side of the pump to the journals and bearings.

Another approach is low pressure bearing lubrication where lubrication is drawn into a low pressure region where the meshing gears separate. This low pressure region draws oil from chambers at the ends of the gear journals which have been charged with lubricant withdrawn from the inlet by passages connecting the inlet to those chambers.

While these approaches are sufficient for many applications, they impose a 210°F operating limit on gear pumps because temperatures in excess of 210°F have been found to damage the bearings of gear pumps. There is, however, a need for gear pumps which can pump hydraulic fluid having temperatures up to about 250°F.

Summary of the Invention

It is a feature of the present invention to provide a new and improved arrangement for lubricating hydraulic fluid pumps, wherein such pumps may operate to pump hydraulic fluids at elevated temperatures such as, for example, temperatures higher than about 210°F.

In view of this feature and other features, the present invention is directed to a system for pumping hydraulic fluid to drive a hydraulic device, wherein the system comprises at least one rotary pump element having at least a first journal extending therefrom. The rotary pump element is positioned in a pumping chamber of a housing, wherein the housing has an inlet opening and a discharge opening connected to the pumping chamber. The housing includes at least a first bearing for supporting the journal of the pump element. Hydraulic fluid pumped by the pump is returned to the inlet opening by a return line after having driven the hydraulic device. A heat exchanger is connected between the return line and the bearing for the gear journal by a lubrication line to cool returning hydraulic fluid prior to using the fluid for lubrication of the bearing journal. In accordance with a more specific aspect of the invention, the pump element is a gear and the lubrication line communicates with a chamber at an end of the journal distal from the gear.

In a still more specific aspect of the invention, the pump element includes a second journal extending in a direction opposite the first journal and the housing includes a second bearing for supporting the second journal, the second journal and second bearing being connected receive lubrication fluid from the lubrication line.

Still a further aspect of the invention, the second journal is connected to the lubrication line by a bore which extends through the first and second journals, as well as the pump element.

Brief Description of the Drawings

Various other features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood when considered in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the several views, and wherein:

Figure 1 is a schematic view of a lubrication system in accordance with the present invention in combination with one gear of a gear pump;

Figure 2 is a side elevation of one embodiment of a gear pump employing the hydraulic pump lubrication system in accordance with the present invention; and

Figure 3 is an elevation taken along lines 3-3 of Figure 2.

Detailed Description

Referring now to Figure 1, there is shown gear pump 10 having a housing 12 with a discharge opening 14 and an inlet opening 16, both in communication with pumping chamber 18. The pumping chamber 18 has two gears therein, only one of which is shown, gear 20. As is well known, one of the gears of the gear pump is driven gear (not shown) and the other gear is an idler gear (such as the gear 20) arranged, for example, like the gears in U.S. Patent 4,553,915 to Eley, incorporated herein by reference. The gear 20 includes gear teeth 22 which are mounted on the hub 24 and include flank portions 26 and root portions 28. The hub 24 of the gear 20 has a first gear journal 30 projecting from one side and a second gear journal 32 projecting from the other side. The gear journals 30 and 32 rotationally support the gear 20 in bearings 34 and 36, respectively, seated in the housing 12.

Hydraulic fluid illustrated by the arrow 40 is pumped from the discharge opening 14 to a driven device 42, such as a motor or hydraulic cylinder and is returned via a return line 44 to tank 46. From tank 46, the fluid is returned by line 48 through the inlet opening 16 of the housing 12. If the temperature of the hydraulic fluid in the tank 46 exceeds the rated temperature level of pump 10, for example, 210°F, it should not be returned to the pump because, since it is used to lubricate the pump, it can damage the bearings 34 and 36 of the pump by overheating the bearings. For at least some operations, hydraulic fluid is at an elevated temperature of, for example, 250°F.

In accordance with the present invention, a heat exchanger 50 is connected between the return line 44 and a lubrication line 52. The lubrication line 52 is in turn connected to a lubrication passage 54 in the housing 12 which is in turn connected to a lubrication cavity 56 disposed at the free end 58 of the gear journal 30. Accordingly, a small portion of the return fluid in return line 44 is cooled by the heat exchanger 50 and placed in proximity with the gear journal 30 and the bearing 34.

The interface 60 between the gear journal and bearing 34 includes interstices, such as spaces between roller bearing elements, which allow the cool hydraulic fluid to flow from the lubrication cavity 56, between the gear journal 30 and bearing 34 and back to the pumping chamber 18. This flow through the interface 60 is due to a low pressure region 65 communicating with the interface 60 in the gear pump chamber 18 at the location where the gear 20 demeshes from the drive gear (not shown in Figure 1). The hydraulic fluid flowing into the low pressure region 65 joins the hydraulic fluid entering the inlet opening 16 from the inlet line 48 for pumping out through the discharge opening 14.

In the embodiment of Figure 1, gear journal 32, which projects opposite the gear journal 30 from the hub 24, is lubricated with cool lubricant which flows through a bore 66 that extends through the gear journal 30, the hub 24 and the gear journal 32 into a second lubrication cavity 67 at the free end 68 of the second gear journal 32. Cool lubricant then flows from the lubrication cavity 67 back through the interstices of the interface 70 between the second gear journal 32 and the second bearing 36. Again, the lubricant in the interface 70 flows into the low pressure region 65 of the pumping chamber 18 because the pressure in space 67 is higher than the pressure in the low pressure region. The hydraulic fluid that has lubricated gear journal 32 and bearing 36 then joins the hydraulic fluid in inlet opening 16 and is discharged through discharge opening 14.

Referring now to Figures 2 and 3, there is shown an embodiment of the invention in which a pair of gear pumps 80 and 82, driven by a single input shaft 83, pump hydraulic fluid in a parallel arrangement. The pump 80 has a drive gear 84 and an idler gear 85, while the pump 82 has a drive gear 86 and an idler gear 87. The drive gear 84 is coupled to the drive gear 86 with a coupling 88. The gears 84-86 have teeth 90 which mesh at areas 91 so that the driving gears 84 and 86 both drive the idler gears 85 and 87 and accomplish a pumping function by carrying the fluid from an inlet 92 (only one of which is shown in Figure 3) to an outlet 93.

In the arrangement of Figure 2, like the arrangement of Figure 1, a heat exchanger 100 is placed in a return line 102. The return line 102 is connected to a coupling cavity 104 which includes the coupling 88 between the drive gears 84 and 86. To facilitate understanding, in the embodiment of Figure 2 first gear journals 30a, 30b, 30c and 30d, correspond to the gear journal 30 of Figure 1, while the second gear journals 32a, 32b, 32c and 32d correspond to the second gear journal 32 of Figure 1. From the coupling cavity 104, hydraulic fluid flows through interfaces 60a and 70a, 60b and 70b, and 60c and 70c, and 60d and 70d, to the inlet region 92 via bleed grooves 94 (see Figure 3), which provides the low pressure regions 65a and 65b for drawing the hydraulic fluid along the interfaces 60 and 70.

In order to transport the hydraulic fluid from the coupling cavity 104, the idler gears 85 and 87 have bores 66b and 66d which extend through the hubs 24b and 24b thereof (as well as through the journals 30b and 32b and 30d and 32d) in order to take the fluid to outside lubrication chambers 67b and 67d. Lubrication chambers 67b and 67d communicate with lubrication chambers 67a and 67c to convey the cooled lubricant to the drive gears 84 and 86. If it is necessary to supplement cooling of the hydraulic fluid in the return line 102 after it has been cooled by the heat exchanger 100, a second heat exchanger 110 is disposed in the lubrication line 104.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

*rB

<u>WHAT IS CLAIMED IS:</u>

1. A system for pumping hydraulic fluid to drive a hydraulic device comprising:

at least one rotary pump element having at least a first journal extending therefrom;

a housing defining a pumping chamber that receives the pump element, the housing having an inlet opening and a discharge opening connected to the chamber;

a first bearing in the housing for supporting the journal of the pump element;

a return line connected to the inlet for returning hydraulic fluid to the chamber after the fluid has driven the hydraulic device; and

a heat exchanger connected between the return line and the bearing and journal by a lubrication line for cooling hydraulic fluid prior to using the fluid for lubrication of the bearing and journal.

2. The system of claim 1, wherein the pump element is a gear.

3. The system of claim 1, wherein the lubrication line communicates with an end of the journal, the end being distal from the pump element.

4. The system of claim 3, wherein the pump element is a gear.

5. The system of claim 4, wherein the pump element includes a second journal extending from the pump element in a direction opposite the first journal and a second bearing in the housing supporting the second journal, the second journal and second bearing being connected to receive the lubrication fluid from the lubrication line.

6. The system of claim 3, wherein the channel is a bore through the first and second journals that are connected by a bore through the pump element.

7. The system of claim 6 comprising lubrication chambers adjacent the ends of the first and second channels for receiving the lubricating fluid, the lubrication chambers being in communication with interfaces between the journals and bearings, which interfaces communicate with the pumping chamber, whereby the lubricating fluid flows from the lubricated chambers, through the interfaces into the pumping chamber and back out of the discharge opening.

8. The system of claim 7 wherein there are at least two rotary pump elements both of which are gears meshed with one another within the pumping chamber of the housing.

9. A system for pumping hydraulic fluid to drive a hydraulic device comprising:

at least a pair of meshing gears each first and second journals extending from hubs thereof;

at least one housing defining a pumping chamber that receives the pair of meshing gears, the housing having an inlet opening and a discharge opening connected to the pumping chamber;

first bearings in the housing for supporting the first journals of the meshing gears; second bearings in the housing for supporting the second journals of the meshing gears;

a return line connected to the inlet for returning hydraulic fluid to the chamber after the fluid has driven the hydraulic device; and

a heat exchanger connected between the return line and the bearings and journals by a lubrication line for cooling hydraulic fluid prior to using the fluid for lubrication of the bearings and journals.

10. The system of claim 9, wherein the lubrication line communicates with lubrication chambers at ends of the journals, the ends being distal from the meshing gears.

11. The system of claim 10, wherein the lubrication chambers at the ends of at least one pair of the first and second journals are connected by a bore extending through hubs of the meshing gears and through the first and second journals.

12. The system of claim 11 wherein the lubrication chambers are in communication with interfaces between the journals and bearings, which interfaces communicate with the pumping chamber, whereby the lubricating fluid flows from the lubricated chambers, through the interfaces into the pumping chamber, and back out of the discharge opening.

13. The system of claim 12 wherein one gear in the pair of gears is an idler gear and the other gear is a drive gear and wherein the bore extends through only one gear and the first and second journals thereof.

14. The system of claim 13 wherein the bore extends through only the idler gear.

15. The system of claim 14 wherein there are two pairs of meshing gears each pair being within a pumping housing and wherein at least one of the lubrication chambers is disposed adjacent an opposed pair of journal ends.

16. The system of claim 13 wherein there are two pairs of meshing gears, each pair being within a pumping housing and wherein the bore extends through only one gear and the first and second journals thereof.

17. The system of claim 9 wherein there are two pairs of meshing gears, each pear being within a pumping housing and wherein a heat exchanger is connected between the return line and the bearings and journals by a lubrication line for cooling hydraulic fluid prior to using the fluid for lubrication of the bearings and journals.

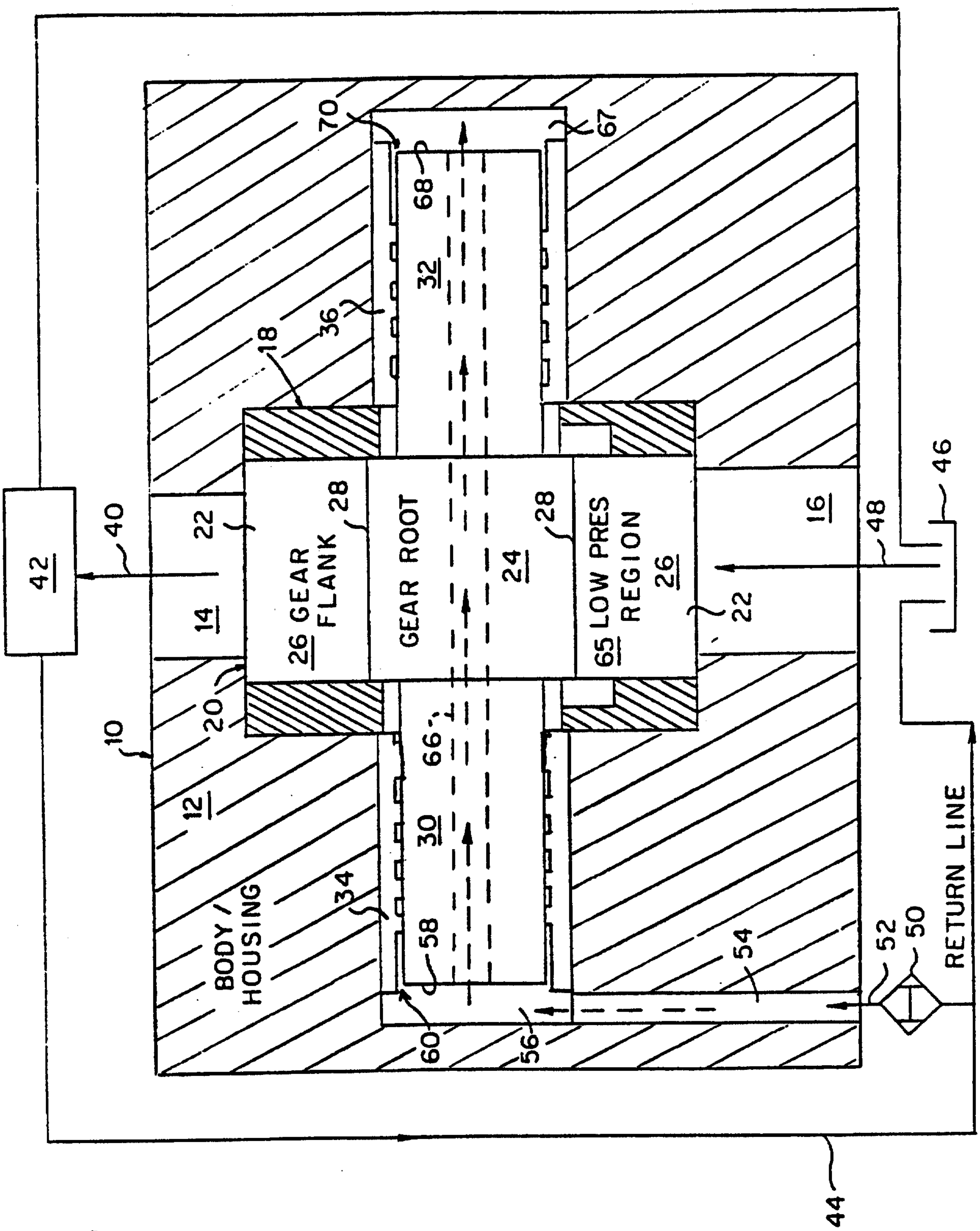
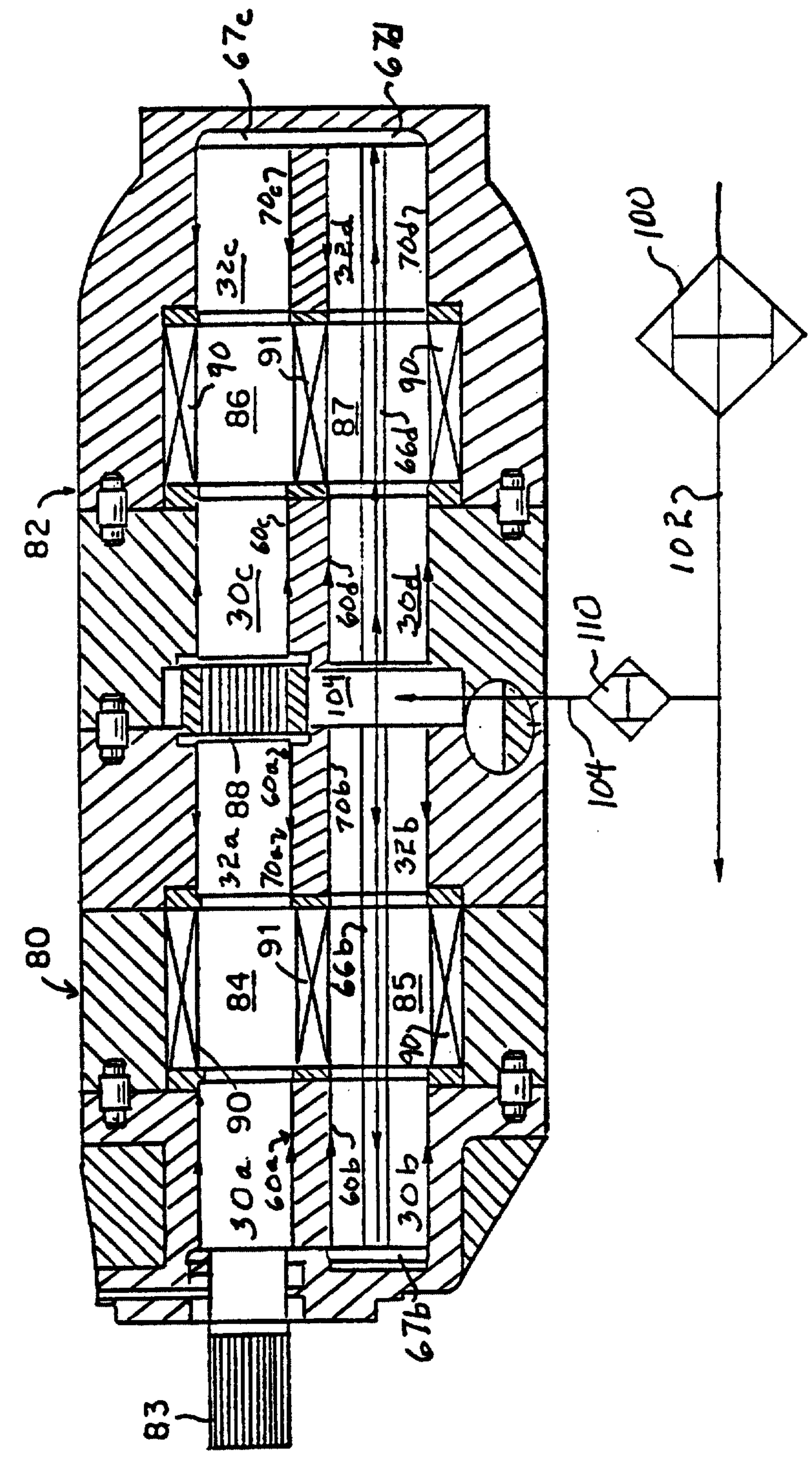

10
12
14
16
18
20
22
24
26 GEAR FLANK
28
GEAR ROOT
65 LOW PRES REGION 26
30
32
34
36
40
42
44
46
48
50
52
54
56
58
60
66
67
68
70
BODY / HOUSING
RETURN LINE

FIG.1

*rB

FIG. 2


67c
67d
70c
32d
70d
100
32c
90
86
91
87
66d
82
102
30c
60c
60d
30d
110
104
104
88
32a
70a
60a
70b
32b
80
84
91
66b
85
30a
60b
30b
67b
83

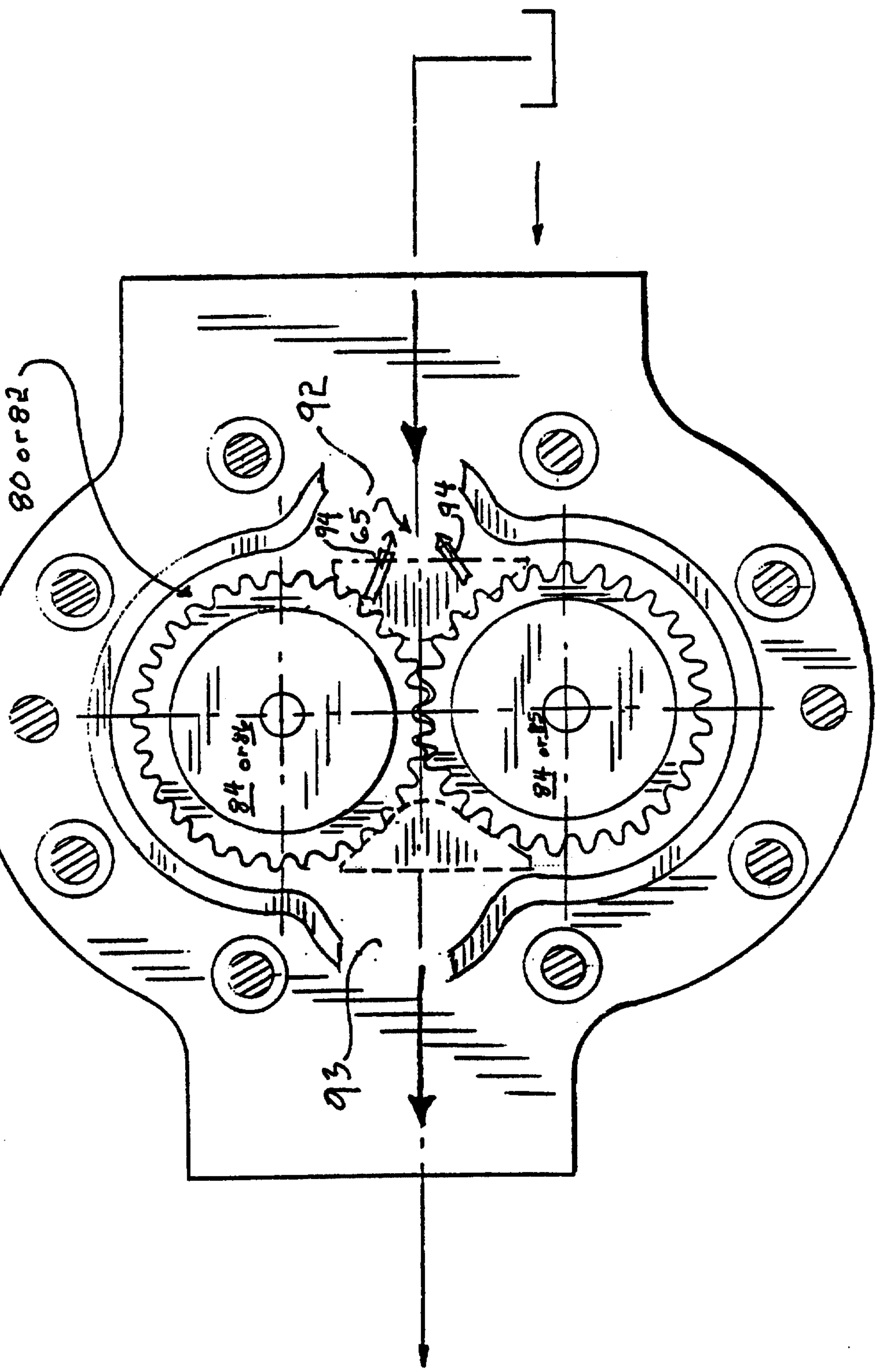


FIG. 3