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(54) **CARTRIDGE VANE PUMP HAVING
ENHANCED COLD START PERFORMANCE**

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(57) **ABSTRACT**

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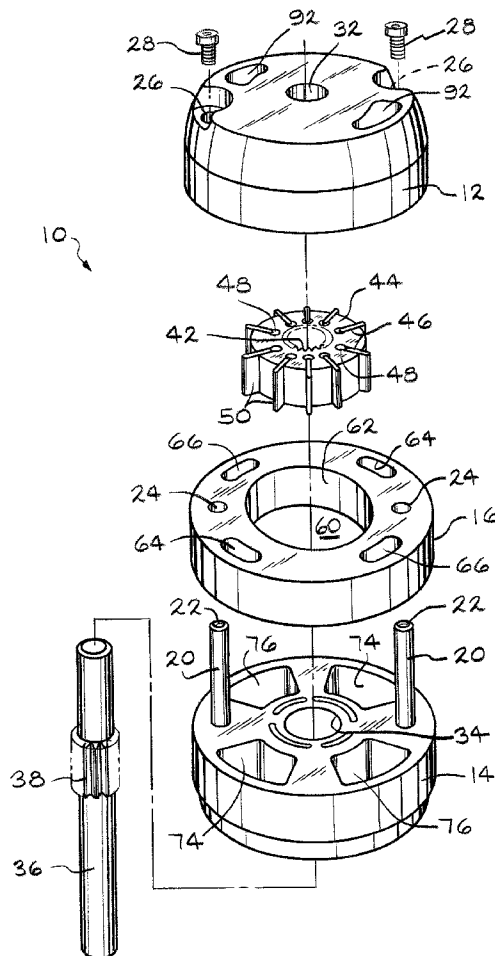
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A cartridge vane pump for a motor vehicle power steering system exhibits improved cold start performance. The pump includes a plurality of radially disposed vanes which are received within a rotor which is rotatably supported within a cylindrical cam ring defining two diametrically opposed pumping lobes. An inlet (upper) section and an outlet (lower) section engage the ends of the cam ring and define suitable passageways which provide fluid into and out of the pumping lobes. Under vane porting in the inlet section provides high pressure fluid to the inner edges of the vanes received within the rotor as they traverse the intake portions of the pumping lobes urging the vanes into contact with the cam ring surface.



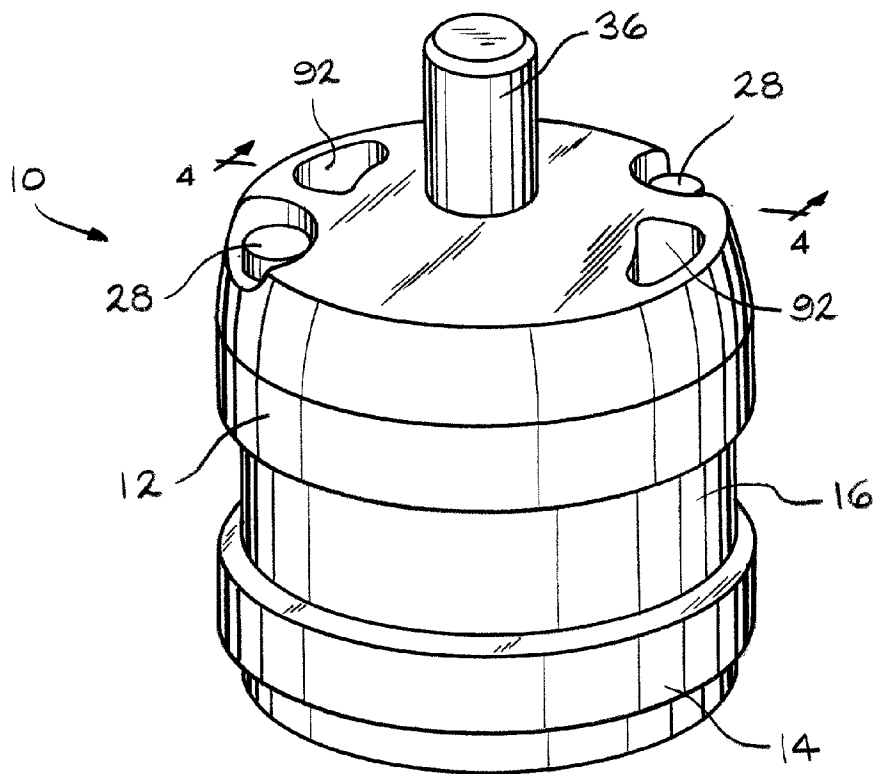


FIG. 1

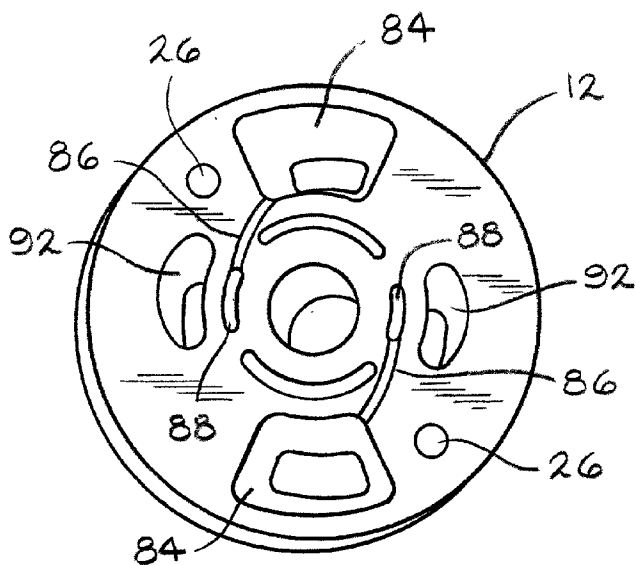
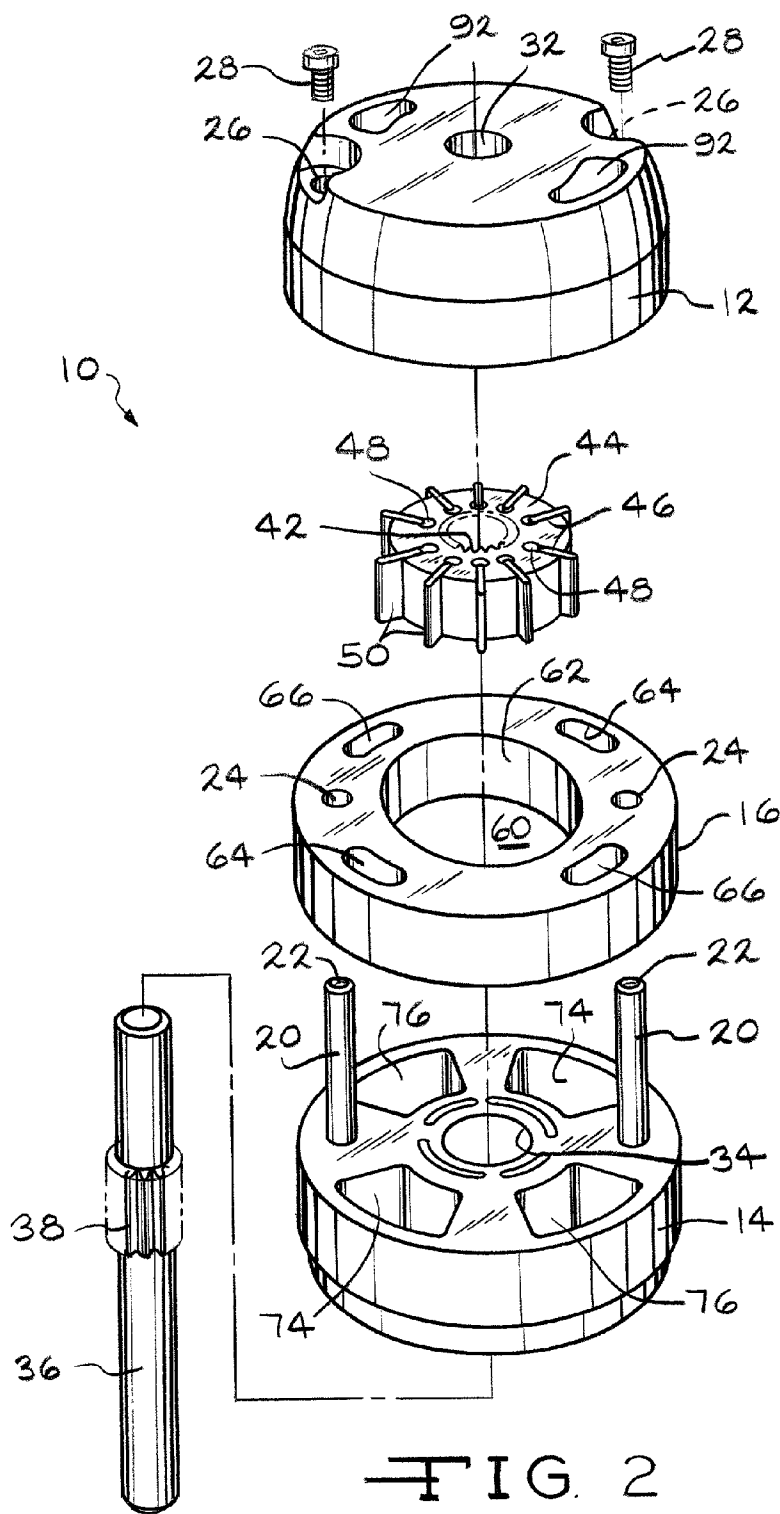


FIG. 3



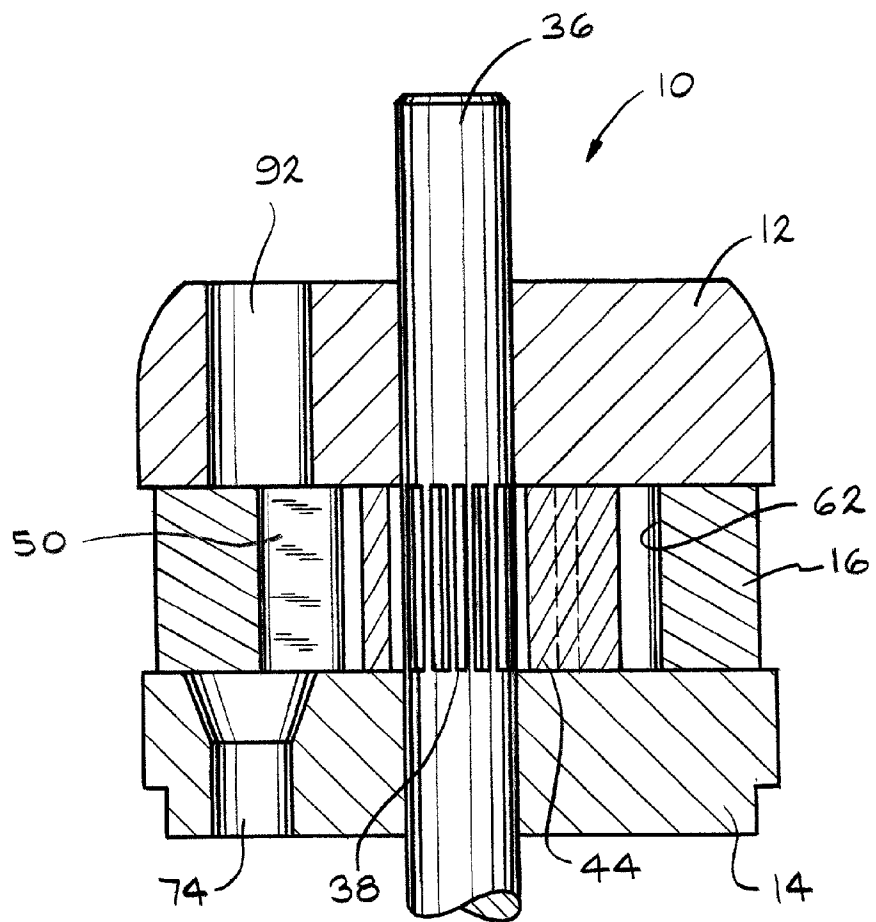


FIG. 4

CARTRIDGE VANE PUMP HAVING ENHANCED COLD START PERFORMANCE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates generally to rotary vane pumps for motor vehicle power steering systems and more particularly to a cartridge type rotary vane pump exhibiting enhanced cold start performance.

[0003] 2. Description of Related Art

[0004] Motor vehicle power steering systems typically rely upon rotary vane pumps to provide pressurized fluid utilized therein. Such pumps typically are driven by the vehicle engine and are thus oriented for rotation on a horizontal axis. When operating under typical service conditions, rotation creates centrifugal force which drives the vanes outwardly into intimate contact with the lobed, interior surface of the pumping chamber, thereby providing a fluid tight seal and good pumping efficiency.

[0005] During cold starts of the vehicle, especially those at 0° F. (-18° C.) and below, two factors conspire to reduce the output and efficiency of such pumps. First of all, due to their horizontal orientation, upon cessation of rotation, the sole force operating on the vanes is gravity and all those vanes disposed above the horizontal center plane of the rotor retract into the rotor, to the bottom of the rotor vane slots, causing a loss of contact with the pumping chamber surface. Without contact and seal at the tips of the vanes, pump output is reduced. Furthermore, because the viscosity of power steering fluid increases significantly at lower temperatures, centrifugal forces generated by rotation of the rotor and vanes may be insufficient to overcome the viscous frictional drag between the vanes and rotor slots caused by the cold power steering fluid. Once again, pumping efficiency may be reduced.

[0006] Such cold starting issues have been recognized and addressed. For example, U.S. Pat. No. 5,147,183 teaches a rotary vane pump having enhanced cold start priming. Appropriate porting disposed in the pressure plate abutting the rotor and cam ring directs power steering fluid from vane slots pumped by the action of retracting vanes in the direction of rotation across the rotor, through a hole at the base of the extending vane slots, to the outlet ports. Pressure developed at the base of retracting vanes forces extending vanes radially outwardly into contact with the chamber surface.

[0007] A recent improvement in power steering systems is electro-hydraulic power steering systems (EHPAS). In these systems, a variable speed electric motor directly drives a cartridge vane pump. A cartridge vane pump includes a top section, a cam ring having an interior lobed chamber which receives the rotor and vanes as well as axial passageways and a bottom section. The top section and bottom section engage opposite faces of the cam ring and these three components are secured together. Such a device is disclosed in U.S. Pat. No. 6,149,409.

[0008] Cartridge vane pumps are also susceptible to cold start inefficiencies as described above and the present invention addresses such inefficiencies.

SUMMARY OF THE INVENTION

[0009] A cartridge vane pump for a motor vehicle power steering system exhibits improved cold start performance. The pump includes a plurality of radially disposed vanes which are received within a rotor which is rotatably supported within a cam ring defining a pumping chamber having two diametrically opposed pumping lobes. An inlet (upper) section and an outlet (lower) section engage the end faces of the cam ring and define suitable passageways which provide fluid into and remove fluid from the pumping lobes. Under vane porting in the inlet section provides high pressure fluid to the inner edges of the vanes received within the rotor as they rotate through angular regions corresponding to the intake portions of the pumping lobes, urging the vanes into contact with the cam ring surface.

[0010] Thus it is an object of the present invention to provide a cartridge type rotary vane power steering pump having enhanced cold start performance.

[0011] It is a further object of the present invention to provide a cartridge type rotary vane pump for use with electro-hydraulic power steering systems having improved cold start performance.

[0012] It is a still further object of the present invention to provide a cartridge type rotary vane pump having passageways and arcuate slots adjacent an end of the rotor which provide high pressure fluid to the inner edges of the rotor vanes during the intake portion of rotor rotation to drive the vanes into contact with the inner surface of the cam ring.

[0013] It is a still further object of the present invention to provide a cartridge type rotary vane pump having under vane porting which is provided with high pressure fluid from the pump outlet.

[0014] Further objects and advantages of the present invention will become apparent by reference to the following description of the preferred embodiment and appended drawings wherein like reference numbers refer to the same component, element or feature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a schematic view of a cartridge type rotary vane pump according to the present invention;

[0016] **FIG. 2** is an exploded perspective view of a cartridge type rotary vane pump according to the present invention;

[0017] **FIG. 3** is a perspective view of the underside of the top section of a cartridge type rotary vane pump according to the present invention; and

[0018] **FIG. 4** is a full, sectional view of a cartridge type rotary vane pump according to the present invention taken along line 4-4 of **FIG. 1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Referring now to **FIGS. 1 and 2**, a cartridge type rotary vane pump having improved cold start performance is illustrated and generally designated by the reference number **10**. The rotary vane pump **10** includes a first or upper end section **12**, a second or lower end section **14** and a middle or cam ring section **16**. The three sections **12**, **14** and **16** are

coupled together through the agency of a pair of parallel spaced apart stanchions **20** which are secured to the second end section **14**. The stanchions **20** preferably include end threaded adjacent axial passageways **22**. The stanchions **20** extend through aligned spaced apart parallel apertures **24** in the cam ring section **16** and likewise extend through spaced apart parallel apertures **26** in the first end section **12**. A pair of threaded fasteners **28** such as machine bolts or screws may be secured in the threaded passageways **22** to retain the sections **12**, **14** and **16** of the pump **10** together as illustrated in FIG. 1.

[0020] The first end section **12** includes a centered, circular axial passageway **32** which aligns with a centered, circular axial passageway **34** in the second end section **14**. The axial passageways **32** and **34** receive and support for free rotation therein a shaft **36**. The shaft **36** include a central region of male splines **38** which engage and drive female splines **42** on a rotor **44**. The rotor **44** defines a plurality, preferably ten, radially disposed slots **46** defining an enlarged generally circular region **48** at their inner termini. Each of the radial slots **46** receives a radially slideable vane **50**. The rotor **44** with the vanes **50** is received upon the splines **38** of the shaft **36** within a generally oval pumping chamber **60** defined by an inner cam surface **62** within the cam ring **16**.

[0021] In addition to the axial parallel apertures **24**, the cam ring **16** defines a first pair of diametrically opposed high pressure outlet passageways **64**. Additionally, the cam ring **16** defines a pair of diametrically opposed low pressure inlet passageways **66**.

[0022] The second or lower end section **14** also defines a pair of diametrically opposed fluid outlet chambers **74** which collect and deliver high pressure power steering fluid to fluid passageways (not illustrated) exterior to the pump **10**. A pair of blind, i.e., closed, fluid pockets **76** may also reside in the second or lower end section **14**.

[0023] The high pressure fluid chambers **74** communicate with the high pressure fluid passageways **64** in the cam ring **16**. Similarly, the pockets **76** communicate with the low pressure inlet passageways **66** in the cam ring **16**.

[0024] Turning now to FIGS. 1 and 3, the first or upper end section **12** includes a pair of blind, i.e., closed, pockets **84** which align with the high pressure passageways **64** in the cam ring **16**. A pair of symmetrically disposed and identically configured channels **86** lead from the high pressure pockets **84** to a pair of diametrically opposed arcuate under vane ports **88**. The under vane ports **88** radially align with, i.e., reside at an equal distance from the axis of rotation of the rotor **44**, the generally circular regions **48** at the inner termini of the slots **46** in the rotor **44** illustrated in FIG. 2. The under vane ports **88** are aligned angularly, i.e., at positions around the axis of rotation of the rotor **44**, with the intake regions of the cam ring **16**, that is, those regions of increasing diameter. The end section **12** also defines a pair of diametrically opposed inlet ports **92** which communicate both with the low pressure passageways **66** in the cam ring **16** and the appropriate regions of the pumping chamber **60**, i.e., those regions having increasing diameter, to provide fluid to the inlet sides of the rotor **44**.

[0025] At start up, under cold conditions, at least one half of the vanes **50** will be retracted into the rotor **44** by gravity. The remaining vanes **50** will be driven into the rotor **44** as it rotates through the pumping (exhaust) portion of rotation, i.e., reducing diameter of the inner cam surface **62**. Under such cold start conditions, the drag created by the viscous hydraulic or power steering fluid on the vanes **50** tends to inhibit extension of the vanes **50** by centrifugal force. However, the rotor **44** does pump some fluid and the pressure of this fluid is transmitted through the high pressure fluid chambers **74**, through the high pressure fluid passageways **64**, through the pockets **84** in the end section **12**, through the channels **86**, through the under vane ports **88** and into the generally circular regions **48** at the inner edges of the vanes **50**. The pressurized fluid drives the vanes **50** radially outwardly during the intake portions of rotation of the rotor **44**. As fluid pressure increases additional pressure is applied to the inner edges of the vanes **50** and the output flow, pressure and efficiency of the pump **10** rises quickly.

[0026] The foregoing disclosure is the best mode devised by the inventors for practicing this invention. It is apparent, however, that apparatus incorporating modifications and variations will be obvious to one skilled in the art of hydraulic vane pumps. 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.

We claim:

1. A cartridge vane pump comprising, in combination,
 - a housing including a first end section, a second end section and a middle cam ring section disposed between said end sections and defining a pump chamber, said pump chamber defining intake regions of increasing diameter,
 - a rotor defining a plurality of axially and radially extending slots having inner ends and vanes disposed in respective said slots,
 - a shaft extending into said chamber for driving said rotor, and
 - one of said end sections defining arcuate passageways communicating with said inner ends of said vane slots and aligned with said intake regions of said pump chamber in fluid communication with a high pressure outlet of said pump.
2. The cartridge vane pump of claim 1 wherein said rotor includes a splined opening and said shaft includes splines disposed in said splined opening.
3. The cartridge vane pump of claim 1 further including a pair of alignment pins extending from said first end section, through said cam ring section and into said second end section.
4. The cartridge vane pump of claim 1 wherein said pump chamber of said cam ring section defines two lobes and said rotor defines ten slots.
5. The cartridge vane pump of claim 1 wherein said first end section defines inlet passageways and said second end section defines outlet passageways.

6. The cartridge vane pump of claim 1 wherein said shaft is received within passageways defined by both end sections.

7. The cartridge vane pump of claim 1 wherein both of said end sections define arcuate passageways aligned with said intake regions of said pump chamber and communicate with said inner ends of said vane slots.

8. A cartridge vane pump comprising, in combination,

a housing including a first end section, a second end section and a middle cam ring section disposed between said end sections and defining a pump chamber, said pump chamber defining intake regions of increasing diameter,

a rotor defining a plurality of axially and radially extending slots having inner ends and vanes disposed in respective said slots,

a shaft extending through one of said end sections and into said chamber for driving said rotor, and

one of said end sections defining arcuate passageways communicating with said inner ends of said vane slots and angularly aligned with said intake regions of said

pump chamber in fluid communication with high pressure outlets of said pump whereby fluid under pressure is provided to inner edges of said vanes.

9. The cartridge vane pump of claim 8 wherein said rotor includes a splined opening and said shaft includes splines disposed in said splined opening.

10. The cartridge vane pump of claim 8 further including a pair of alignment pins extending from said first end section, through said cam ring section and into said second end section

11. The cartridge vane pump of claim 8 wherein said pump chamber of said cam ring section defines two lobes and said rotor defines ten slots.

12. The cartridge vane pump of claim 8 wherein said first end section defines inlet passageways and said second end section defines outlet passageways.

13. The cartridge vane pump of claim 8 wherein both of said end sections define arcuate passageways aligned with said intake regions of said pump chamber and communicate with said inner ends of said vane slots.

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