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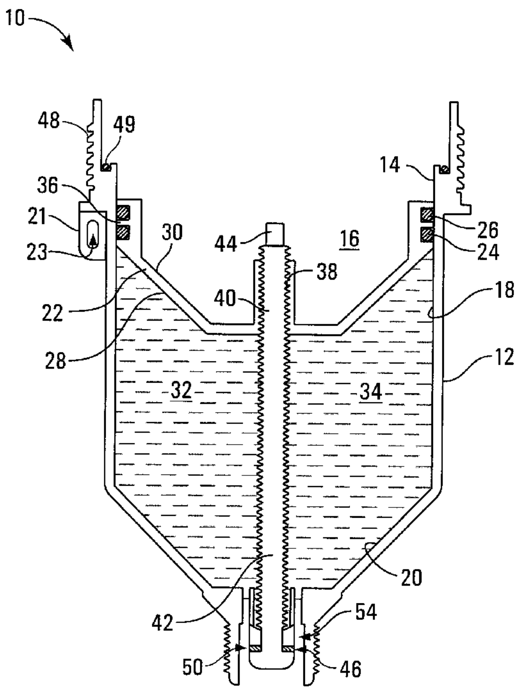

FIG. 1

(57) Abstract: A fluid holder includes: a housing having an inner surface and at least one fluid outlet; a piston in slidable engagement with the inner surface and having first and second opposed surfaces with a threaded opening extending therebetween, the first surface of the piston and the inner surface of the housing defining a fluid chamber in communication with the at least one fluid outlet; and a threaded member engageable with the threaded opening, a first portion of the threaded member extending from the first surface of the piston, the threaded member being rotatably coupled to the housing on the first portion of the threaded member for rotation in the threaded opening of the piston such that rotation of the threaded member causes a force to be exerted by the threaded member on the housing and on the piston to expand or contract the fluid chamber.

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FLUID HOLDER AND ELECTROMECHANICAL LUBRICATOR EMPLOYING SAME

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention relates generally to lubrication, and more particularly to a fluid holder and an electromechanical lubricator employing the same.

2. Description of Related Art

Known electromechanical lubricators include fluid holders that are detachably coupled to drive assemblies. In known electromechanical lubricators, the drive assembly causes rotation of a threaded member that is threaded through a threaded piston, urging the threaded piston in a direction that tends to expel fluid out of a fluid chamber through a fluid outlet. However, particularly with viscous fluids, rotation of the threaded member tends to cause pressure to accumulate in the fluid chamber, which results in a thrust force along the threaded member against the drive assembly. The thrust force exerted by the threaded member against the drive assembly can cause increased friction in the drive assembly. This increased friction may accelerate wear of the drive assembly, for example by causing misalignment of gears in the drive assembly, which may result in reduced life span for the drive assembly. The increased friction also requires delivery of more power by the drive assembly, thereby shortening the life span of batteries or other power sources for the drive assembly. The increased friction from the thrust force on the drive assembly may also limit the pressure that the drive assembly can exert on the fluid, and may limit the temperature range in which the lubricator can operate. Also, an accumulation of thrust force on the threaded member can cause the drive assembly of the lubricator to separate from the lubricator, and this potential for a significant accumulation of thrust force on the threaded member can cause disassembly of the lubricator to be difficult or unsafe.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, there is provided a fluid holder. The fluid holder includes a housing having an inner surface defining a cavity, the housing defining at least one fluid outlet in communication with the cavity. The fluid holder also includes a piston in slidable engagement with the inner surface, the piston having first and second opposed surfaces with a threaded opening extending between the first and second surfaces, the first surface of the piston and the inner surface of the housing defining a fluid chamber in the cavity in communication with the at least one fluid outlet, and the piston being movable to expand or contract the fluid chamber. The fluid holder also includes a threaded member engageable with the threaded opening of the piston, a first portion of the threaded member extending from the first surface of the piston and a second portion of the threaded member extending out of the second surface of the piston, the threaded member being rotatably coupled to the housing on the first portion of the threaded member for rotation in the threaded opening of the piston such that rotation of the threaded member causes a force to be exerted by the threaded member on the housing and on the piston to move the piston in the cavity to expand or contract the fluid chamber.

The inner surface may include a cylindrically shaped sliding portion, and the piston may be in slidable engagement with the cylindrically shaped sliding portion.

The inner surface may also include a frustoconical terminating portion.

The first surface of the piston may be shaped complementarily to the frustoconical terminating portion.

The fluid holder may further include a mixer in communication with the first portion of the threaded member, the mixer configured to mix fluid urged out said at least one fluid outlet.

The mixer may include an auger configured to urge a fluid in a direction into the fluid chamber when the threaded member is rotated in a direction that causes the fluid chamber to contract.

The mixer may include an auger configured to urge a fluid in a direction out of the fluid chamber when the threaded member is rotated in a direction that causes the fluid chamber to contract.

The mixer may include a plurality of radial projections.

The piston may be in sealed engagement with the inner surface, and the fluid chamber may be open only at the at least one fluid outlet.

The second portion of the threaded member may be configured to be detachably coupled to a drive member for applying a torque to the threaded member.

The fluid holder may further include a drive assembly configured to be detachably coupled to the fluid holder, the drive assembly having a motor and a drive member coupled to the motor and configured to be detachably coupled to the second portion of the threaded member of the fluid holder for applying a torque to the threaded member.

The fluid holder may further include a processor circuit in communication with the motor for controlling the motor, the processor circuit operably configured to respond to signals received from a temperature sensor sensing a temperature of an object to be lubricated, to cause the motor to deliver more fluid from the fluid chamber when the object to be lubricated is at a higher temperature

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the invention are illustrated, merely by way of example, in the accompanying drawings, in which

Figure **1** is a front cross sectional view of a fluid holder according to a first embodiment of the invention,

Figure **2** is a bottom view of the fluid holder of Figure **1**,

Figure **3** is a front cross sectional view of a fluid holder according to a second embodiment of the invention,

Figure **4** is a perspective view of an alternative mixer in the fluid holder of Figure **3**, and

Figure **5** is a front cross sectional view of an electromechanical lubricator including the fluid holder of Figure **1**.

DETAILED DESCRIPTION

Referring to Figure **1**, a fluid holder according to a first embodiment of the invention is shown generally at **10**. The fluid holder **10** includes a housing **12** having an inner surface **14** that defines a cavity **16**. In the illustrated embodiment, the inner surface **14** includes a cylindrically shaped sliding portion **18** and a generally frustoconical terminating portion **20**. Alternatively, the terminating portion of inner surface **14** may be conical, for example. Housing **12** preferably includes a tie-down **21** defining an eyelet **23**, and the eyelet **23** may receive a cord to facilitate attaching fluid holder **10** to an object (not shown), for example. However, it will be appreciated that equivalent results can be achieved with other configurations of the housing **12**.

A piston **22** is positioned in cavity **16** in slidable engagement with sliding portion **18** of the inner surface **14**. Piston **22** preferably includes sealing members such as O-rings **24** and **26** to facilitate slidable and sealed engagement with the inner surface **14**. Piston **22** includes a first surface **28** and an opposed second surface **30**, and is positioned in cavity **16** such that first surface **28** and inner surface **14** of housing **12** define a fluid chamber **32** in cavity **16**. In the illustrated example, the fluid chamber **32** holds a fluid, such as a lubricant **34**. Also, in the illustrated example, piston **22** has a circular outer flange **36** to engage cylindrical sliding portion **18** of inner surface **14**, and first surface **28** of piston **22** is generally frustoconically shaped to complement terminating portion **20** of inner surface **14**. Advantageously, this complementary configuration may enable first surface **28** of piston **22** to abut terminating portion **20** of inner surface **14** to force substantially all of lubricant **34** out of fluid chamber **32**. Piston **22** further defines a threaded opening **38** extending between the first surface **28** and the second surface **30** of the piston **22**.

Housing **12** defines at least one fluid outlet **50** in communication with fluid chamber **32**, and preferably fluid chamber **32** is open only at the at least one fluid outlet **50**. Referring to Figure **2**, the illustrated embodiment includes four fluid outlets **50**, **52**, **54**, and **56**, although it will be appreciated that other embodiments may include any number of fluid outlets. Returning to Figure **1**, when piston **22** slides along sliding portion **18** of the inner surface **14**, first surface **28** of the piston **22** exerts a force on lubricant **34** in the fluid chamber **32**, urging lubricant **34** out fluid outlets **50**, **52**, **54**, and **56**.

Fluid holder **10** further includes a threaded shaft **40** (which may also be referred to as a “threaded member”) which is in sealed threaded engagement with threaded opening **38** of piston **22**. Threaded shaft **40** includes a first portion **42** extending out of first surface **28** of piston **22**, and a second portion **44** extending out of second surface **30** of piston **22**. Second portion **44** of threaded shaft **40** may be configured to be detachably coupled to a drive member for applying a torque, for example by having a recess for receiving a tool bit or by any other known configuration. The first portion **42** of the threaded shaft **40** is rotatably coupled to the housing **12** for rotation in the threaded opening **38** of the piston **22**. In the illustrated example, a thrust bearing **46** positioned between the fluid outlets **50**, **52**, **54**, and **56** is supported by the housing **12**, and supports the threaded shaft **40** for rotation.

Thrust bearing **46** may be a washer manufactured from Delrin™, which is available from Dupont™, for example.

Therefore, in operation, rotation of threaded shaft **40** may cause a force to be exerted by threaded shaft **40** on housing **12** and on piston **22** to urge piston **22** towards terminating portion **20** of inner surface **14**, urging lubricant **34** out of fluid chamber **32** through the at least one fluid outlet **50**. Pressure exerted by lubricant **34** on first surface **28** of piston **22** results in a thrust force on threaded shaft **40**. Advantageously, the thrust force on threaded shaft **40** is accommodated in the illustrated embodiment by thrust bearing **46**, and therefore a thrust force will not be exerted on a drive assembly that is applying a torque to the second portion **44** of the threaded shaft **40**.

In the illustrated embodiment, housing **12** includes an external threaded surface **48** for engagement with a drive assembly (illustrated in Figure **5**, for example), and a sealing member such as an O-ring **49** for sealing the cavity **16** from the outside when the fluid holder **10** is coupled to a drive assembly.

Referring to Figure **3**, a fluid holder according to a second embodiment of the invention is shown generally at **90**. Fluid holder **90** includes a housing **92** having an inner surface **94** that defines a cavity **96**. In the illustrated embodiment, the inner surface **94** includes a cylindrically shaped sliding portion **98** and a frustoconically shaped terminating portion **100** that includes a generally flat surface **102**. Housing **92** preferably includes a tie-down **91** defining an eyelet **93**, and the eyelet **93** may receive a cord to facilitate attaching fluid holder **90** to an object (not shown), for example.

The fluid holder **90** further includes a piston **104** positioned in cavity **96** in slidable engagement with sliding portion **98** of inner surface **94**. Piston **104** includes a first surface **106** and a second opposite surface **108**, and is positioned in cavity **96** such that first surface **106** and inner surface **94** define a fluid chamber **110** in cavity **96** for holding a fluid such as a lubricant **112**, for example. First surface **106** of piston **104** is preferably frustoconically shaped to complement terminating portion **100** of inner surface **94**, which may advantageously enable first surface **106** to abut terminating portion **100** to force substantially all of lubricant **112** out of fluid chamber **110**. Piston **104** also preferably includes a circular outer flange **116** having sealing members such as O-rings **114** to facilitate slidable and sealed engagement with sliding portion **98** of inner surface **94**. Piston **104** further defines a threaded opening **118** extending between the first surface **106** and the second surface **108**.

Housing **92** defines at least one fluid outlet **120** in communication with the fluid chamber **110** such that when piston **104** slides along sliding portion **98**, first surface **106** exerts a force on lubricant **112** to urge lubricant **112** out of the at least one fluid outlet **120**.

Fluid holder **90** further includes a threaded shaft **122** (which may also be referred to as a "threaded member"), which is in threaded engagement with threaded opening **118** of piston **104**. Threaded shaft **122** includes a first portion **124** extending out of first surface **106**, and a second portion **126** extending out of second surface **108**. The first portion **124** is rotatably coupled to housing **92** at a thrust bearing **128** for rotation in threaded opening **118**. Thrust bearing **128** may be a washer manufactured from Delrin™, which is available from Dupont™, for example. Therefore, rotation of threaded shaft **122** may cause a force to be exerted by threaded shaft **122** on housing **92** and on piston **104** to urge piston **104** towards terminating portion **100**, urging lubricant **112** out of fluid chamber **110** through the at least one fluid outlet **120**. Pressure exerted by lubricant **112** on first surface **106** results in a thrust force that is accommodated by thrust bearing **128**. Advantageously, thrust force on threaded shaft **122** will not be exerted on a drive assembly that is applying a torque to second portion **126** of threaded shaft **122**. Second portion **126** may be configured to be detachably coupled to a drive member for applying a torque to threaded shaft **122**.

Housing **92** also preferably includes an external threaded surface **134** for engagement with a drive assembly (illustrated in Figure **5**, for example), and a sealing member such as an O-ring **136** for sealing cavity **96** from the outside when fluid holder **90** is coupled to a drive assembly.

In the illustrated embodiment, an auger **130** (which may also be referred to as a "helix blender") is in communication with first portion **124** of threaded shaft **122**, and is positioned outside of fluid chamber **110**. Auger **130** is preferably coupled to first portion **124** of threaded shaft **122** by a friction fit, although alternatively auger **130** may be integrally formed with threaded shaft **122**, for example.

In some embodiments, auger **130** is includes threads that are in a same direction as the threads of threaded shaft **122**, and thus auger **130** is configured in these embodiments to urge a fluid such as lubricant **112** in a direction out of fluid chamber **110** when threaded shaft **122** is rotated in a direction that causes fluid chamber **110** to contract, and thus causes lubricant **112** to be urged out of fluid chamber **110**.

In some other embodiments, auger **130** is includes threads that are in an opposite direction to the threads of threaded shaft **122**, and thus auger **130** is configured in these embodiments to urge a fluid such as lubricant **112** in a direction into fluid chamber **110** when threaded shaft **122** is rotated in a direction that causes fluid chamber **110** to contract. Thus, in these embodiments, auger **130** urges fluid contrary to its direction of travel, imparting a more aggressive mixing action.

Whether the threads of auger **130** are in a same direction or opposite direction to the threads of threaded shaft **122**, auger **130** may function as a mixer (or as a blender) to mix or blend lubricant **112** when lubricant **112** is urged out of the at least one fluid outlet **120**. This mixing (or blending) function may be advantageous when lubricant **112** has become separated during prolonged storage, for example. This mixing (or blending) function may be accomplished by numerous alternative mixers. In the illustrated embodiment, auger **130** is positioned outside of the at least one fluid outlet **120**, but auger **130** may alternatively be positioned inside of the at least one fluid outlet **120**.

For example, referring to Figure **4**, an alternative mixer (which may also be referred to as a "blender" or as a "paddle blender"), is shown generally at **140**. Mixer **140** may be substituted for auger **130** shown in Figure **3**. Mixer **140** is also preferably coupled to first portion **124** of threaded shaft **122** by a friction fit, but may also alternatively be integrally formed with threaded shaft **122**, for example. Mixer **140** includes a projection **142** for being received in a recess of first portion **124** in a friction fit, and includes radial projections **144**, **146**, **148**, **150**, **152**, and **154** for mixing or blending lubricant **112** when lubricant **112** is urged out of the at least one fluid outlet **120**.

Referring to Figure **5**, an embodiment of an electromechanical lubricator (which may also be referred to more generally as a "fluid holder") is shown generally at **60**. The electromechanical lubricator **60** includes a drive assembly **62** detachably couplable to fluid holder **10** of Figures **1** and **2**. Although the electromechanical lubricator **60** is, for simplicity, illustrated and described with drive assembly **62** detachably couplable to fluid holder **10**, it will be appreciated that drive assembly **62** may also be detachably couplable to fluid holder **90** illustrated in Figure **3**, for example. In the illustrated embodiment, drive assembly **62** includes a ring **64** having an internal threaded surface **66** for threadably engaging external threaded surface **48** of housing **12**. In the illustrated embodiment, external threaded surface **48** engages internal threaded surface **66** of ring **64** to urge O-ring **49** against a lower surface **68** of drive assembly **62** to seal cavity **16** from the outside.

In the illustrated embodiment, drive assembly **62** includes a drive motor **70** powered by a battery pack **72** and controlled by a processor circuit **74**. The processor circuit **74** receives inputs from a dip switch assembly **76**, which may be used to configure parameters for automatic scheduled delivery of the lubricant **34**. The delivery of lubricant **34** may, for example, be programmed in cycles wherein a predetermined volume of lubricant is delivered periodically in delivery cycles separated by predetermined intervals of time. The drive motor **70** is preferably geared to apply a torque to a cam coupling **78** that is detachably coupled to the second portion **44** of the threaded shaft **40**. The cam coupling **78** preferably includes a trigger **80** for triggering a limit switch (not shown) to count revolutions of cam coupling **78**. It will be appreciated that by counting revolutions of cam coupling **78**, an estimate may be calculated of the distance through which piston **22** has traveled along the sliding portion **18** of the inner surface **14** of the housing **12**, such that an estimate may be calculated of a volume of lubricant **34** that has been urged out of fluid chamber **32** through the at least one fluid outlet **50**. However, alternatively, processor circuit **74** may employ a timing function to estimate a volume of lubricant **34** that has been expelled from fluid chamber **32**. The drive assembly **62** also includes a threaded cap member **82** threadably engaged with drive assembly **62** for covering the internal components of the drive assembly **62**. However, it will be appreciated that in other embodiments, other configurations of drive assembly **62** may be used to apply a torque to the second portion **44** of the threaded shaft **40**.

Preferably, drive assembly **62** further includes a temperature sensor interface **84** for interfacing with a temperature sensor (not shown) operable to sense a temperature of an object to be lubricated (not shown). The temperature sensor may be a conventional temperature sensor that is well-known in the art. Preferably, processor circuit **74** responds to signals received from the temperature sensor (not shown) at temperature sensor interface **84**, and causes drive assembly **62** to deliver more lubricant **34** to the object to be lubricated (not shown) when the object to be lubricated is at a higher temperature. For example, when a signal received at temperature sensor interface **84** indicates that the object to be lubricated (not shown) exceeds one or more predefined thresholds, the interval of time between delivery cycles may be reduced, or the volume of lubricant delivered in delivery cycles may be increased, or the rate of lubricant delivery during delivery cycles may be increased, for example.

Preferably, the housing of the drive assembly **62** defines one or more openings illustrated generally at **86** for permitting air circulation in and through the inside of drive assembly **62**. The one or more openings **86** may be covered with a breathable material **89**, such as Tyvek™ available from Dupont™, for example, in order to permit air to enter the inside of the drive assembly **62** while preventing dust and other particles from entering the inside of drive assembly **62**. The housing of drive assembly **62** also preferably includes one or more openings shown generally at **88** to permit air from the inside of drive assembly **62** to circulate in and out of cavity **16**. Advantageously, when piston **22** is moved in a direction to expel lubricant **34** from fluid chamber **32**, air will enter cavity **16** through openings **86** and **88** in order to prevent a vacuum from forming in cavity **16**.

In operation, drive assembly **62** applies a torque to the second portion **44** of threaded shaft **40** to rotate the shaft and displace piston **22** along the length of the shaft to urge lubricant **34** out of fluid chamber **32**. Once substantially all of lubricant **34** has been expelled from fluid chamber **32**, the fluid holder **10** may be removed, and either refilled with lubricant **34** or discarded. The drive assembly **62** may be coupled to a new or refilled fluid holder **10** and reused.

Advantageously, thrust forces resulting from pressure of lubricant **34**, rotation of threaded shaft **40**, and displacement of piston **22** are accommodated by thrust bearing **46** of the fluid holder **10**, that is, the disposable component. Drive assembly **62**, which is desirably reused for numerous fluid holders **10**, tends not to experience a thrust force from the threaded shaft **40** in the configuration of the present invention, thus reducing wear and prolonging the useful life of the reusable drive assembly **62**.

Furthermore, reducing wear on the drive assembly **62** permits more efficient operation of drive assembly **62**, thereby reducing current drawn from battery pack **72**, and enabling operation of electromechanical lubricator **60** throughout a greater range of temperatures. It has also been found that electromechanical lubricator **60** can generate higher pressures of lubricant **34** as compared to some known electromechanical lubricators because of the reduced wear on the drive assembly **62**. For example, pressures in the lubricant **34** of over **200**psi have been achieved in electromechanical lubricators similar to the illustrated example, compared to approximately **70**psi for some known electromechanical lubricators.

In addition, absorption of thrust forces at thrust bearing **46**, rather than on drive assembly **62**, has been found to reduce the likelihood that fluid holder **10** will separate from drive assembly **62** as a result of accumulated thrust force on threaded shaft **40**. Accommodation and relief of thrust forces at thrust bearing **46** may also simplify the process of separating fluid holder **10** from drive assembly **62**, because there is less concern about an accumulated thrust force therebetween.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention. It will be apparent that certain changes and modifications may be practised within the scope of the appended claims.

I claim:

1. A fluid holder comprising:

a housing having an inner surface defining a cavity, the housing defining at least one fluid outlet in communication with the cavity;

a piston in slidable engagement with the inner surface, the piston having first and second opposed surfaces with a threaded opening extending between the first and second surfaces, the first surface of the piston and the inner surface of the housing defining a fluid chamber in the cavity in communication with the at least one fluid outlet, and the piston being movable to expand or contract the fluid chamber; and

a threaded member engageable with the threaded opening of the piston, a first portion of the threaded member extending from the first surface of the piston and a second portion of the threaded member extending from the second surface of the piston, the threaded member being rotatably coupled to the housing on the first portion of the threaded member for rotation in the threaded opening of the piston such that rotation of the threaded member causes a force to be exerted by the threaded member on the housing and on the piston to move the piston in the cavity to expand or contract the fluid chamber.

2. The fluid holder of claim **1** wherein the inner surface comprises a cylindrically shaped sliding portion, and wherein the piston is in slidable engagement with the cylindrically shaped sliding portion.

3. The fluid holder of claim **1** wherein the inner surface comprises a frustoconical terminating portion.

4. The fluid holder of claim **3** wherein the first surface of the piston is shaped complementarily to the frustoconical terminating portion.

5. The fluid holder of claim **1** further comprising a mixer in communication with the first portion of the threaded member, the mixer configured to mix fluid urged out said at least one fluid outlet.

6. The fluid holder of claim **5** wherein the mixer includes an auger configured to urge a fluid in a direction into the fluid chamber when the threaded member is rotated in a direction that causes the fluid chamber to contract.

7. The fluid holder of claim **5** wherein the mixer includes an auger configured to urge a fluid in a direction out of the fluid chamber when the threaded member is rotated in a direction that causes the fluid chamber to contract.

8. The fluid holder of claim **5** wherein the mixer includes a plurality of radial projections.

9. The fluid holder of claim **1** wherein the piston is in sealed engagement with the inner surface, and wherein the fluid chamber is open only at the at least one fluid outlet.

10. The fluid holder of claim **1** wherein the second portion of the threaded member is configured to be detachably coupled to a drive member for applying a torque to the threaded member.

11. The fluid holder of claim **10** further comprising a drive assembly configured to be detachably coupled to the fluid holder, the drive assembly having a motor and a drive member coupled to the motor and configured to be detachably coupled to the second portion of the threaded member of the fluid holder for applying a torque to the threaded member.

12. The fluid holder of claim **11** further comprising a processor circuit in communication with the motor for controlling the motor, the processor circuit operably configured to respond to signals received from a temperature sensor sensing a temperature of an object to be lubricated, to cause the motor to deliver more fluid from the fluid chamber when the object to be lubricated is at a higher temperature.

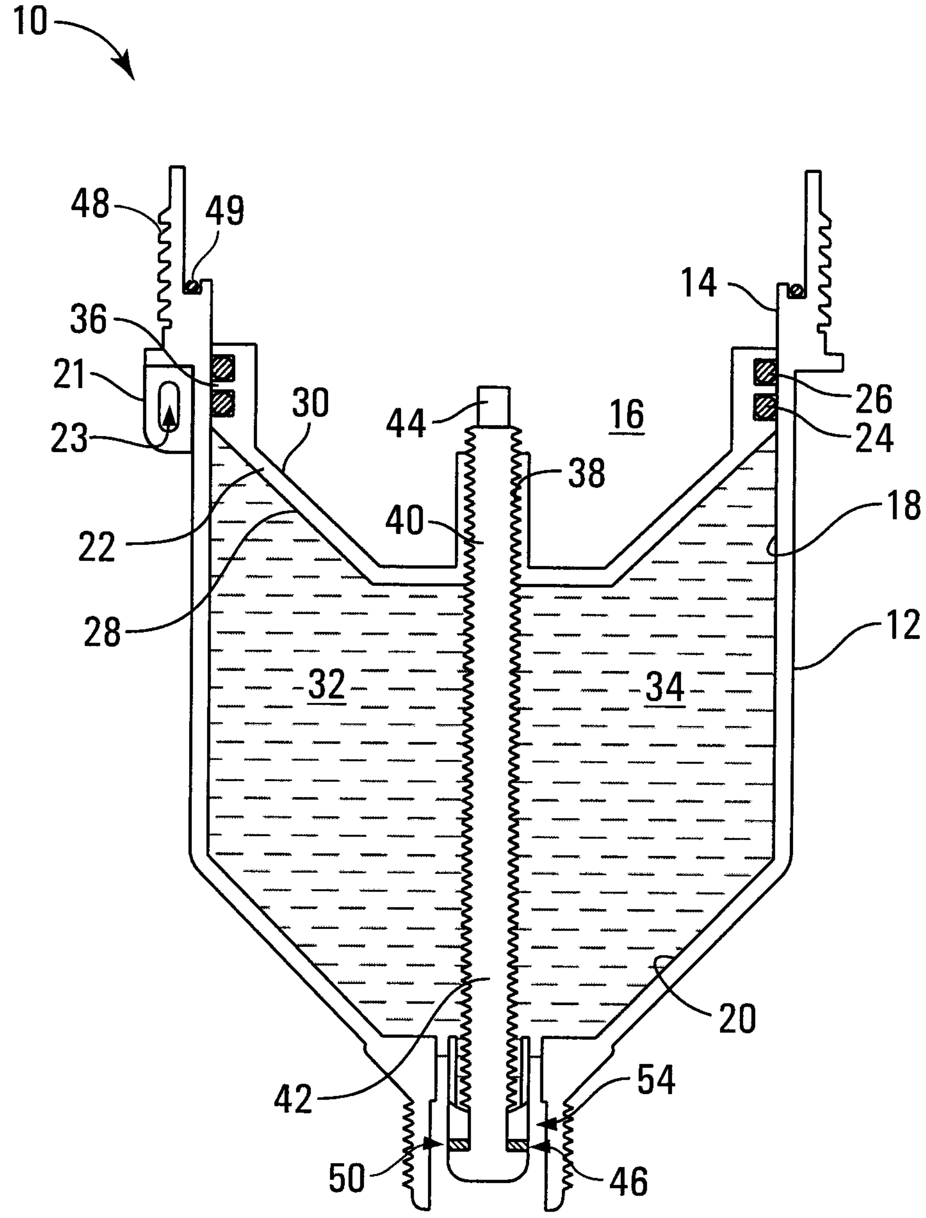
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FIG. 1

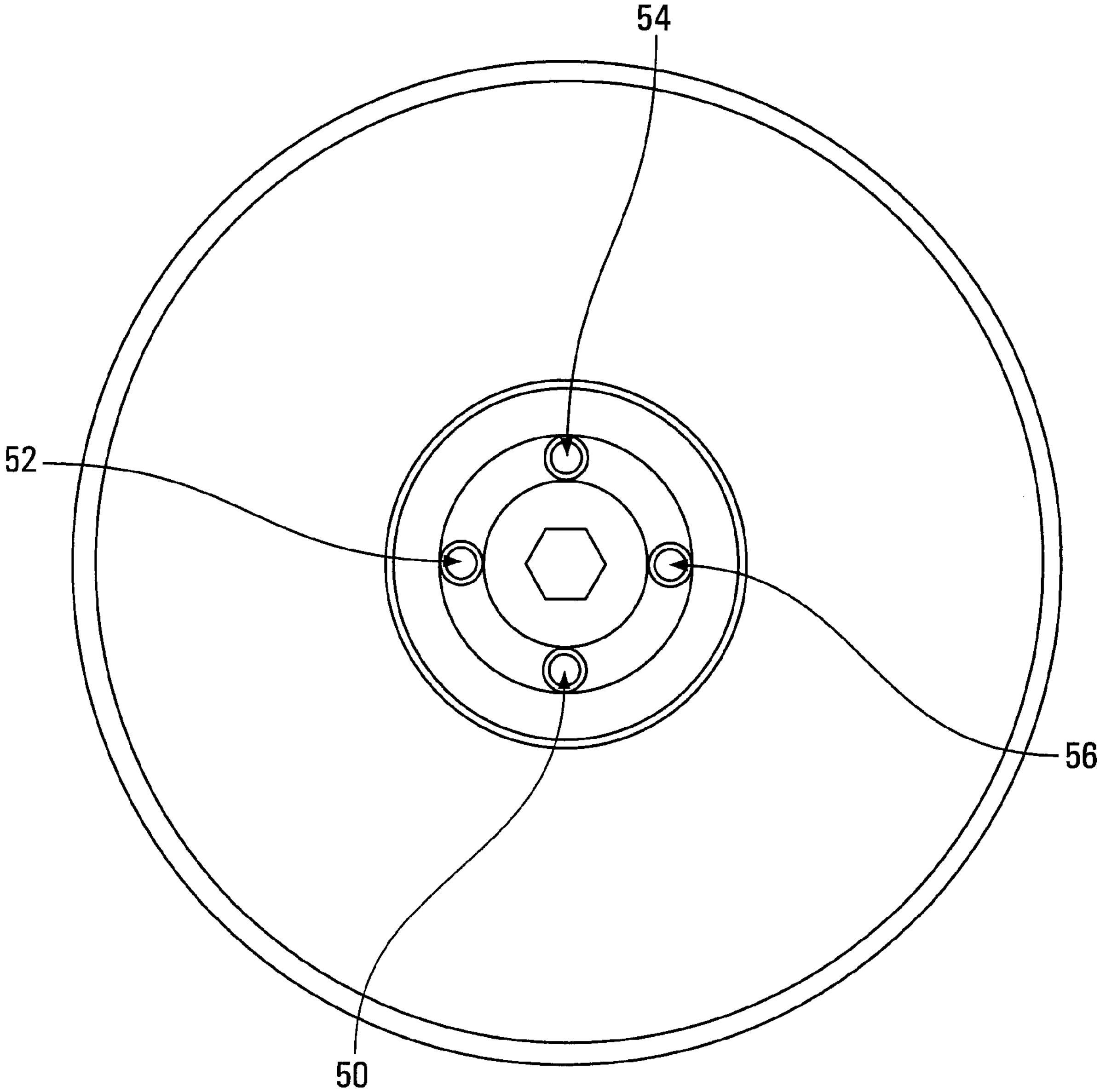

FIG. 2

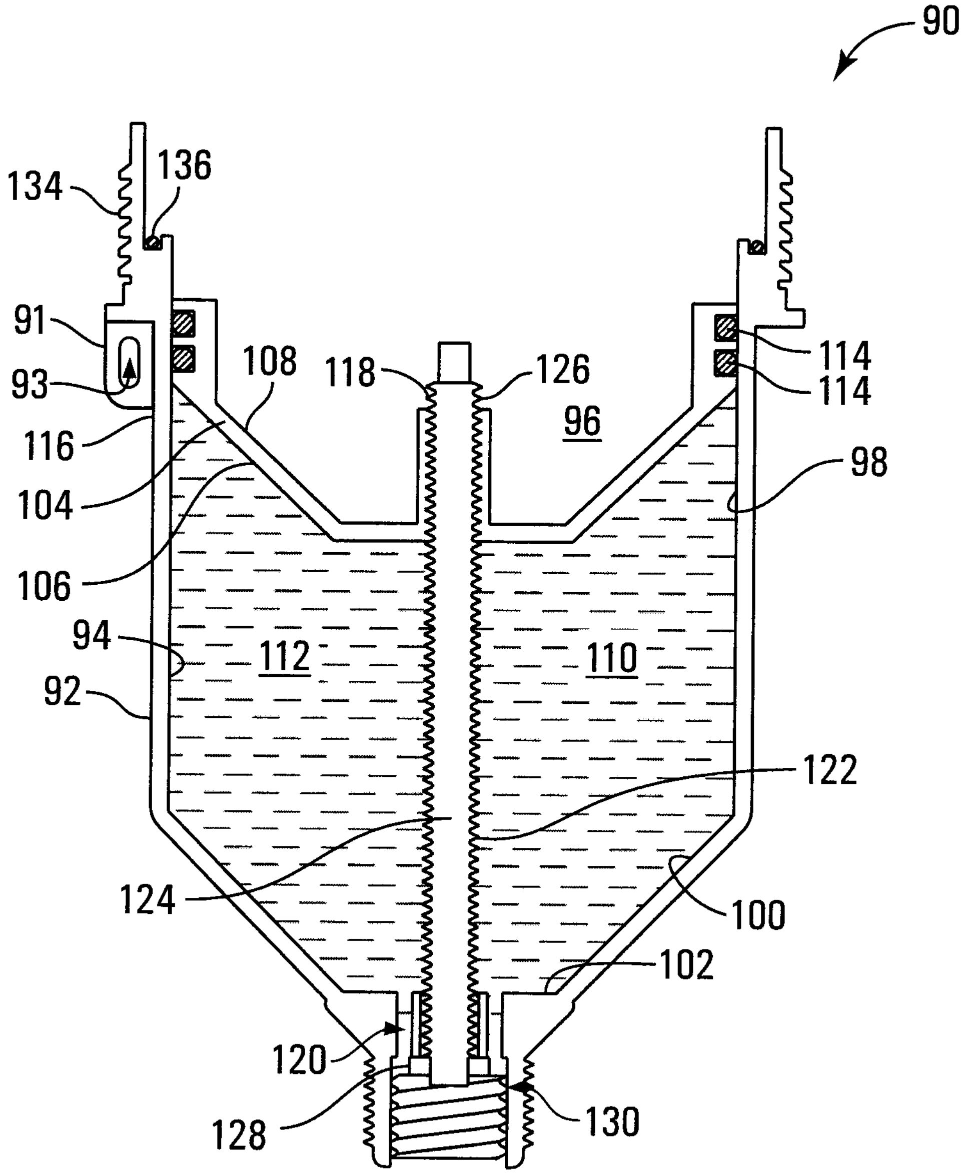
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FIG. 3

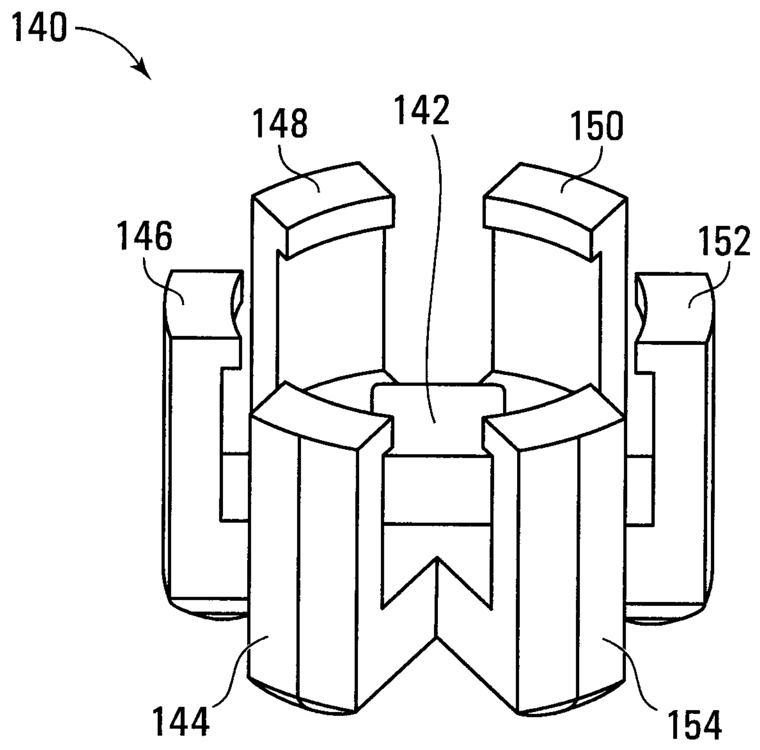

FIG. 4

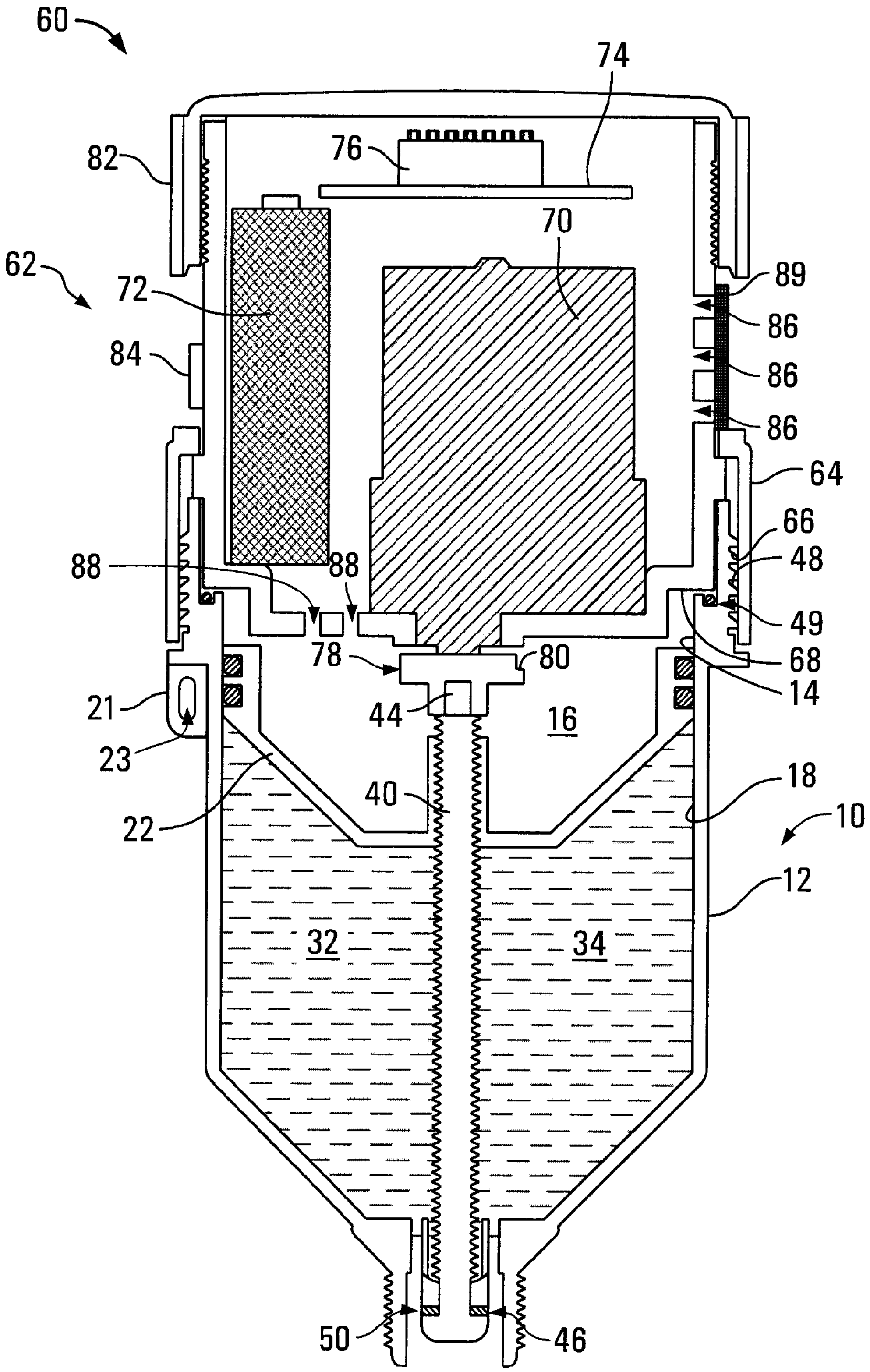
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FIG. 5

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F16N 19/00 (2006.01)*** , ***B05C 17/01 (2006.01)*** , ***F16N 11/08 (2006.01)*** , ***F16N 13/10 (2006.01)*** , ***F16N 7/38 (2006.01)***
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: ***F16N 19/00 (2006.01)*** , ***B05C 17/01 (2006.01)*** , ***F16N 11/08 (2006.01)*** , ***F16N 13/10 (2006.01)*** , ***F16N 7/38 (2006.01)***
USPC: 184/ , 222/

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

Canadian Patent Database

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

Epoque (Epodoc), Delphion, TotalPatent; keywords: lubrica*, fluid, chamber, piston, thrust

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,675,992 B2 (SCHUMANN, A) 13 January 2004 (13-01-2004) *see entire document*	1-4 and 9-12
A	US 6,802,394 B2 (PATTERSON, D. ET AL.) 12 October 2004 (12-10-2004) *see entire document*	1-12
A	US 7,228,941 B2 (WEIGLAND, M. ET AL.) 12 June 2007 (12-06-2007) *see entire document*	1-12
A	US 5,971,229 A (MAY, A. ET AL.) 26 October 1999 (26-10-1999) *see entire document*	1-12
A	US 5,271,528 A (CHIEN, H) 21 December 1993 (21-12-1993) *see entire document*	1-12

[ ] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :
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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
30 April 2010 (30-04-2010)	6 May 2010 (06-05-2010)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476	Robert Gruber (819) 953-1889

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