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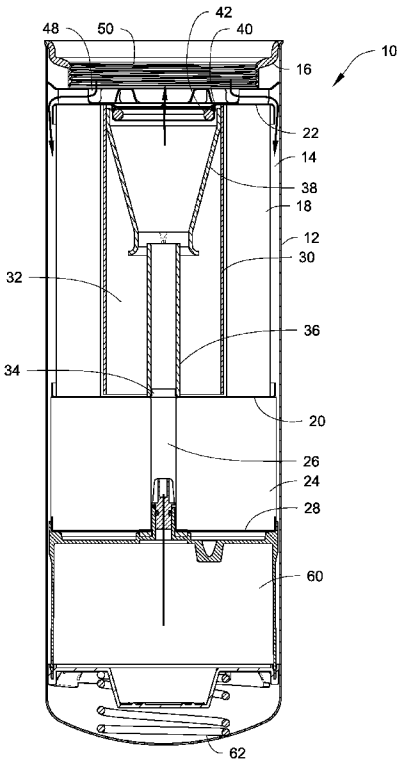
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(54) Title: LUBRICANT OIL FILTER WITH CONTINUOUS RELEASE ADDITIVE VESSEL

Fig. 1



(57) Abstract: An oil filter that includes an additive vessel to introduce additive material into oil flowing through the filter. The additive material includes an over-based detergent and optionally one or more of: a weak base additive, an anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

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LUBRICANT OIL FILTER WITH CONTINUOUS RELEASE ADDITIVE VESSEL

Field

An oil filter containing a continuous release additive vessel that releases an additive into the oil to extend oil drain intervals.

Background

Current lubricating oils do not meet the engine manufacturer's desired oil drain intervals because of limits in ash content placed upon the latest oil category. The inability of the oil to remain useful for extended service intervals is due to multiple changes in both the oil and the engine over the past few years. For example, many modern diesel engines are now equipped with exhaust gas recirculation (EGR) systems and diesel particulate filters (DPF), have reduced oil sump volumes, use lower viscosity oils, and use ultra low sulfur diesel (ULSD) and alternative fuels or coolants (including non-aqueous), all of which change the operating conditions of the engine and the rate of oil degradation.

The latest oil category, CJ-4, CI-4, limits the ash and sulfur content of new oil to 1.0% and 1.5%, respectively, which in turn limits the amount of high performance anti-wear additives (for example zinc dialkyldithiophosphates (ZDDP)) and over-based detergents (for example magnesium or calcium sulfonate or salicylate) because of the metal present in the chemical composition. It is expected that these limits will continue to decrease or at least remain the same as future oil categories are launched, continuing to limit the oil manufacturer's abilities to extend the oil's useful life.

The need for additional additives is driven by the reactions occurring in the crankcase of a diesel engine. The primary limiting factor of oil life that is most commonly seen is the inability for the total base number (TBN) to remain above the condemning limit of 2.5 mgKOH/g or alternatively at a level higher than that of the total acid number (TAN). This can be due to a variety of chemical reactions that occur in the crankcase including oxidation of the oil from high temperature and pressure environments, and the formation of both strong and weak acids in the oil from fuel blow-

by (including biodiesel), coolant leaks, moisture and other contamination, sludge or soot formation and a variety of other mechanism.

Weak acids (such as acetic acid, methyl acetate, ethyl acetate, carboxylic acids, etc.) are formed due to the blow-by of combustion products of biodiesel based fuels. These acids are best neutralized by weak bases (such as metal oxide or methyl amine). Strong acids are also formed and are best neutralized by strong base material in the oil thus depleting the initial TBN value.

Other reasons preventing the oil from reaching the desired drain intervals include thickening or thinning of the oil viscosity (e.g. maximum excursion equals ± one grade), the inability to disperse soot and particulates in the oil, and excessive nitration. With the past oil category, CI-4, ash content of up to 1.5% was acceptable with no limit on the sulfur content. This allowed an additive to include higher levels of over-based detergent and other additives and reach longer service intervals. Because additives are depleted continuously over time in the oil in part due to acid neutralization and by reacting with peroxides (a product of oxidation) generated in the engine oil, an improved technique of continually metering additives into the oil to extend the oil's useful life would be useful.

Summary

An engine oil filter is described that will continually release highly concentrated additives into the engine oil to reduce maintenance costs by reducing oil usage through extended oil drain intervals. The additives may include, but are not limited to, overbased detergents, weak base materials, anti-oxidants, anti-wear additives, friction modifiers, dispersants, viscosity modifiers, anti-foam additives, nano additives, or other additives beneficial to engine oil, individually or in various combinations.

In one embodiment, the oil filter includes a housing defining an interior chamber and having a first end and a second end, an oil inlet and an oil outlet at the first end of the housing, and oil flow pathway between the inlet and the outlet for oil flowing through the interior chamber. Filter media is disposed within the interior chamber in the oil flow pathway between the inlet and the outlet, and the filter media configured to filter oil flowing through the interior chamber. An additive vessel is disposed in the interior

chamber and is configured to introduce additive material contained therein into oil flowing through the interior chamber.

In one embodiment, the additive material includes an over-based detergent and optionally one or more of: a weak base additive, an anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive. For example, in one example, the additive material comprises the over-based detergent for example in an amount ranging from about 10% to about 90% by weight of the additive material, a friction modifier additive for example in an amount ranging from about 0.2 % to about 3% by weight, an anti-oxidant additive for example in an amount ranging from about 0.5% to about 3% by weight, an anti-wear additive for example in an amount ranging from about 1.0% to about 5% by weight, and an inert solvent for example in an amount ranging from about 0 to about 88.3% by weight.

Other additives and additive amounts can be used depending upon factors including, but not limited to, the type of oil, the oil category, the properties of the oil that one wants to improve, and the effectiveness of the additive(s). The additives can be used singly by themselves or in a multi-component mixture at any desired ratio. The additives may be combined with an inert solvent, such as base oil, for viscosity adjustment.

In one embodiment, the oil filter includes a full flow pleated filter media, a by-pass media, a venturi nozzle, and the additive vessel which continuously releases an oil additive into the oil flowing through the oil filter. However, other combinations of elements are contemplated including, but not limited to: a) an oil filter containing the full flow pleated media, a venturi, and the additive vessel; b) by-pass media and the additive vessel; and c) a full flow pleated filter media, a by-pass media, and the additive vessel.

Drawings

Figure 1 illustrates an example of an oil filter with an additive vessel as described herein.

Figure 2 illustrates the operation of the additive vessel of the oil filter in Figure 1.

Figure 3 is a cross-sectional view of another example of an oil filter with an additive vessel.

Description

With reference to Figure 1, a lubricating oil filter 10 is depicted that incorporates the concepts described herein. The filter 10 is a spin-on oil filter that includes a housing 12 having an open first end and a dome-shaped, closed second end defining an interior chamber 14 along with a nut plate 16 that is secured to an open first end of the housing 12. A filter element 18, for example a fibrous, pleated, full flow filter media, is disposed within the chamber 14 for filtering contaminants from the oil. The filter element 18 includes a hollow interior, a lower endplate 20, and an upper endplate 22. The two endplates are sealed across their corresponding filter element ends in order to prevent fluid flow out through the ends of the filter element 18.

Next to the filter element 18 is a by-pass filter media section 24. The by-pass filter media 24 can comprise, for example, an assembly of stacked, ring-shaped discs made of, for example, cellulose material. The by-pass filter media 24 is configured to filter the oil as the oil flows through the by-pass media toward a central oil passageway 26 thereof. The by-pass filter media 24 abuts up against the lower endplate 20 and includes an enclosing base endplate 28. The filter 10 may include any ratio of full flow filter media 18 to by-pass filter media 24.

The filter element 18 includes an inner sleeve 30 that supports the interior surface of the filter media and defines an interior space 32. The lower endplate 20 is open at its center and is formed with a short, cylindrical conduit 34 that extends upwardly into the interior space 32. A tube 36 fits around the conduit 34 and provides fluid flow communication from the central oil passageway 26 of the by-pass filter media 24 into a venturi nozzle 38 disposed within the interior space 32.

The upper endplate 22 is formed with an inner annular lip 40 which provides an anchor for an inner seal 42. The venturi nozzle 38 includes an outwardly flared end that fits around the inner annular lip. When the filter 10 is mounted during use, an inside annular surface of the inner seal 42 fits up against a stem of a filter head as described in US 5,906,736. The nut plate 16, which may be stamped, molded, or machined, is internally threaded and is assembled to an externally-threaded portion of the filter head.

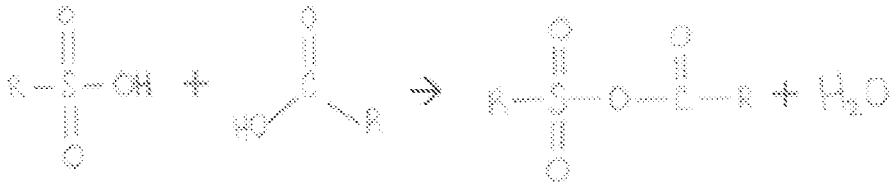
The housing 12 is metal and has a substantially cylindrical sidewall which includes a formed upper lip which is shaped with an inverted receiving channel. Tightly and securely anchored into the channel is an annular upper, outer lip of the nut plate 16.

The nut plate 16 is provided with at least one oil inlet opening 48 to allow oil to be filtered to enter the filter. The nut plate 16 also defines a central, threaded outlet opening 50 by which the filter is threaded onto a corresponding threaded mounting post on the filter head and through which oil exits the filter. Further details on the general construction and operation of this type of filter can be found in US 5,906,736 which is incorporated herein by reference in its entirety.

An additive vessel 60 is disposed within the chamber 14 next to the by-pass filter media 24 between the by-pass filter media and the second end of the housing 12. The additive vessel 60 contains one or more additive materials and is configured to continuously release the additive into the oil at a controlled rate.

A coil spring 62 within the housing 12 pushes directly or indirectly against the bottom of the additive vessel 60 which forces the additive vessel 60 into engagement with the endplate 28.

The additive(s) released into the oil are intended to improve oil quality in some manner including, but not limited to, replenishing reserve alkalinity (RA), reducing oxidation and wear, stabilizing oil viscosity, and/or neutralizing acids in the oil. One example by which an additive may improve an oil's useful life is illustrated through the reaction of a sulfonate and carboxylate acid to create a neutral salt and water as shown below, thus preventing the TAN of the oil from increasing.



The additive may include, but is not limited to, any of the following additives which may be combined with a base oil or solvent for viscosity adjustment:

Table 1: Potential Oil Additives – Example A

Additive	Benefit	Example Chemical Structure	min %	max %
Over-Based Detergent	Boost Base Number Neutralizes Acids	Metal Sulfonates (Such as Mg, Ca, Na,Li, K, Zn, Ba , etc)	0	100
		Phenols		
		Metal Salicylates (such as Ca, Mg, Li, Zn, K, Ba, etc)		
		Metal Olenates (Such as Mg, Ca, Na,Li, K, Zn, Ba , etc)		
Weak Base	Neutralizes weak acids	Metal oxides (such as MgO, CaO, ZnO, etc)	0	100
		Methyl Amine		
		Calcium or Magnesium Carbonate		
Anti-Oxidant	Reduces the rate of oxidation or thermal degredation	Zinc Dithiophosphates (ZDDP)	0	10
		Dialkyl di phenyl amine		
		N-phenyl-a napthylamine		
		Molybdenum Dithiocarbamate		
		Hindered phenols		
		Alkylated di phenol amines		
		Aromatic amines		
Anti-Wear / Extreme Pressure Agents	Produces a boundary film on metal surfaces for protection	ZDDP	0	10
		Sulfurized Olefins		
		borate esters		
		Tri-cresyl phosphate (TCP		
		sulfurized fats		
		sulfides and disulfides		
Friction Modifier	Reduces friction between surfaces and reduces parasitic loses	oleic acid	0	40
		dioleyl phosphite		
		glycerol dioleate		
		molybemun disulphide		
		Parafin Waxes & oxidized waxes		
		Fatty amines, acids,amides,esters		
		Fatty Phosphates		
		Nano Friction modifier eg tungstan nano particles		
		poly tetrafluoride		
Dispersant / Viscosity Modifier	Suspends particles in the lubricant and boost high temperature viscosity	Succimides	0	10
		Manniches		
		Amides		
		Olefin copolymers		
		Polyisobutylsuccinimide (PIBSA)		
		Polyvinylimidizole		
		Polymethacrylates		
		Styrene Butadiene Copolylmer (star Polymer)		
Anti-Foam	Prevents excessive foaming in the oil	Polysiloxane	0	5
		Poly ethylene glycol		
		Poly propylene glycol		
		Ethylene-propylene copolymers		
Nano Additives	Improved performance due to increased surface area	Over-based nano detergents (calcites, etc)	0	100
Corrosion Inhibitors	Prevents corrosion and protects surfaces	Succinates	0	5
		Imidazoline		
		Phosphate		
		Sulfonate		
		Borate esters		
		Thiadiazoles		
		Calcinates		
		Borate esters		
		Terephthalic acid		
Pour Point Depressants	Lowers the pour point of the lubricant for cold weather operation	Polyalkyl Methacrylate	0	10
		Styrene ester		
		Poly Vinyl acetate - alky fumarate		
		Alkylene coupled Naphthalene		
		Coupled Alkyphenols		
		Poly Ethylene Vinyla acetate		
Surfactants	Disperses water in the lubricant	Sodium dodecyl sulfate	0	10
		Sodium lauryl sulfate		

Potential Oil Additives – Example B

Additive	Benefit	Example Chemical Structure	Min %	Max %
Over-Based Detergent	Boost base number and neutralizes acids	Metal sulfonates	0	100
		Phenols		
		Metal salicylates		
		Metal olenates		
Weak Base	Neutralizes weak acids	Metal oxides	0	100
		Methyl amine / primary amine		
		Primary, secondary and tertiary amines		
		Hindered secondary and tertiary amines		
		Calcium or magnesium carbonate		
Anti-Oxidant	Reduces the rate of oxidation or thermal degredation	Zinc dithiophosphates (ZDDP)	0	10
		Dialkyl di phenyl amine		
		N-phenyl-a napthylamine		
		Molybdenum dithiocarbamate		
		Hindered phenols		
		Alkylated di phenol amines		
		Aromatic amines		
Anti-Wear / Extreme Pressure Agents	Produces a boundary film on metal surfaces for protection	ZDDP	0	10
		Sulfurized Olefins		
		Borate esters		
		Tri-cresyl phosphate		
		Sulfurized fats		
		Sulfides and disulfides		
Friction Modifier	Reduces friction between surfaces and reduces parasitic losses	Oleic acid	0	40
		Dioleyl phosphite		
		Glycerol dioleate		
		Molybdenum disulphide		
		Parafin waxes and oxidized waxes		
		Fatty amines, acides, amides, esters		
		Fatty phosphates		
		Nano friction modifier (i.e. tungstan nano particles)		
		Poly tetrafluoride		
Dispersant / Viscosity Modifier	Suspends particles in the lubricant and boost high temperature viscosity	Succimides	0	10
		Manniches		
		Amides		
		Olefin copolymers		
		Polyisobutly succinimide (PIBSA)		
		Polyvinylimidizole		
		Polymethacrylates		
		Styrene butadiene copolymer (Star Polymer)		
Anti-Foam	Prevents excessive foaming in the oil	Polysiloxane	0	5
		Poly ethylene glycol		
		Poly propylene glycol		
		Ethylene-propylene copolymers		
Nano Additives	Improved performance due to increased surface area	Over-based nano detergents (calcites, etc)	0	100
Corrosion Inhibitors	prevents corrosion and protects surfaces	Succinates	0	5
		Imidazoline		
		Phosphate		
		Sulfonate		
		Borate esters		
		Thiadiazoles		
		Calcinates		
		Borate esters		
		Terephthalic acid		
Pour Point Depressants	Lowers the pour point of the lubricant for cold weather operation	Polyalkyl methacrylate	0	10
		Styrene ester		
		Poly vinyl acetate - alky fumarate		
		Alkylene coupled napthalene		
		Coupled alkyphenols		
		Poly ethylene vinyl acetate		
Surfactants	Disperses water in the lubricant	Sodium dodecyl sulfate	0	10
		Sodium lauryl sulfate		

The percentages in Table 1 are by volume or by weight. One or more of the listed additives may be blended with an inert solvent, such as base oil, to reach 100% composition. The listed additives can be used individually as one pure additive or in any combinations to form a multi-component mixture at any ratio.

One exemplary embodiment of a multi-component additive mixture that is believed to be useful is listed in Table 2 (by volume % or by weight %), which may or may not be mixed with an inert solvent such as a base oil to adjust viscosity.

Table 2

Example A

Additive	Composition (%)	
	Minimum	Maximum
Over-based detergent	10	90
Multi functional Anti-Wear & Friction Modifier	0.2	3
Anti-oxidant	0.5	3
Anti-wear	1	5
Inert solvent	0	88.3

Example B

Additive	Composition (%)	
	Minimum	Maximum
Over-based detergent	20	90
Hindered Amines	0	90
Multi functional Anti-Wear & Friction Modifier	0.5	30
Anti-oxidant	1	30
Anti-wear	1	30
Inert solvent	0	77.5

Tables 3-6 shown below indicate possible additive compositions for the additive vessel. All compositions and treat rates (TR) are in % by volume or % by weight (both are applicable). The mixtures below may also be blended with an inert solvent, such as base oil, to reach 100% composition.

Table 3 (Overbased detergents/Strong bases)

A highly concentrated base with a TBN of 10-500mgKOH/g should be present with a concentration range of approximately 80% to 90% of the fully formulated additive.

Example A

Chemical Name	Minimum Treat Rate	Maximum Treat Rate
Calcium Sulfonate	10	90
Calcium Salicylate	10	90
Calcium Oleate	10	90
Calcium Phenate	10	90
Magnesium Sulfonate	10	90
Magnesium Salicylate	10	90
Magnesium Oleate	10	90
Magnesium Phenate	10	90

Example B

Chemical Name	Minimum Treat Rate (% undiluted)	Maximum Treat Rate (% undiluted)
Calcium Sulfonate	20	90
Calcium Salicylate	20	90
Calcium Oleate	20	90
Calcium Phenate	20	90
Magnesium Sulfonate	20	90
Magnesium Salicylate	20	90
Magnesium oleate	20	90
Magnesium Phenate	20	90
Primary, Secondary and Tertiary Amines	20	90
Hindered secondary and Tertiary amines	20	90
tertiary Hinder Amines)	20	90
1,2,2,6,6-Pentamethyl-4-piperidinol	20	90
4-Amino-2,2,6,6-tetramethylpiperidine	20	90

Table 4 (antioxidants)

The function of the antioxidant is to reduce the rate of oxidation in the oil, which will in turn help reduce acid formation, increase oil life and control viscosity.

Example A

Chemical Name	Minimum Treat Rate%	Maximum Treat Rate%
Aminic Antioxidant	0.5	3
Phenolic Antioxidants	0.5	3
Aminic & H. Mo. Wt. Phenolic antioxidants	0.5	3
H. Mo. Wt. Phenolic antioxidants	0.5	3
Aromatic Amines	0.5	3

Example B

Chemical Name	Minimum Treat Rate (% undiluted)	Maximum Treat Rate (% undiluted)
Aminic Anti oxidant	1	40
Phenolic Antioxidants	1	40
Aminic & High mo wt phenolic	1	40
Aminic & High mo wt phenolic	1	40
high molecular weight Phenolic	1	40

Table 5 (multi-functional friction modifiers)

The multi-functional friction modifier can be present to reduce engine wear and friction, leading to fuel economy improvements.

Example A

Chemical Name	Minimum Treat rate	Maximum Treat Rate
Oleamide (Alkyamide)	**0.2**	**3.0**
Polymer (Polyol Partial Ester)	**0.2**	**3.0**
Fatty Amides	**0.2**	**3.0**
Alkanolamine	**0.2**	**3.0**
H. Mo. Wt. Phenol polymer	**0.2**	**3.0**
Borated Ester	**0.2**	**3.0**
Amino Functionalized Acrylic polymer	**0.2**	**3.0**
Molybdenum Trimer	**0.2**	**3.0**
Molbdenum Dithio Carbamates	**0.2**	**3.0**

Example B

Chemical Name	Minimum Treat Rate (% undiluted)	Maximum Treat Rate (% undiluted)
Oleamide (Crodamide)	1	40
Polymer (Perfad 3000)	1	40
Fatty Amides	1	40
Alkanolamine	1	40
Irrgalbube F20	1	40
Borated Ester	1	40
Amino Functionalized Acrylic polymer	1	40
Molybdenum Trimer	1	40
Molbdenum Dithio Carbamates	1	40

Table 6 (anti-wear additives)

An anti-wear additive can be present to help reduce engine wear during extended oil drain intervals.

Example A

Chemical Name	Min Treat Rate	Max Treat Rate
Liquid ashless Butylated Triphenyl Phosphorothionate	1	5
Liquid ashless dithiophosphate	1	5
Liquid Mixture of amine phosphates	1	5
Alkyl Zinc Dialkyldithiophosphates	1	5
2 Ethyl hexyl zinc Dialkyl thiophospates	1	5
2 Ethyl hexyl Molydenum Dialkyl thiophospates	1	5
Ashles Amine Dialkyl dithiophosphate	1	5
Zinc Dialkyldithiocarbamate	1	5
Atimony Dialkydithiocarbamate	1	5
Methylene bis dialkyldithiocarbamate	1	5
Molybdeum Phosphorodithioate	1	5
Molybdeum Dithiocarbamate	1	5

Example B

Chemical Name	Minimum Treat Rate (% undiluted)	Maximum Treat Rate (% undiluted)
Liquid ashless Butylated Triphenyl Phosphorothionate	1	40
Liquid ashless dithiophosphate	1	40
Liquid Mixture of amine phosphates	1	40
Alkyl Zinc Dialkyldithiophosphates	1	40
2 Ethyl hexyl zinc Dialkyl thiophospates	1	40
2 Ethyl hexyl Molydenum Dialkyl thiophospates	1	40
Ashles Amine Dialkyl dithiophosphate	1	40
Zinc Dialkyldithiocarbamate	1	40
Atimony Dialkydithiocarbamate	1	40
Methylene bis dialkyldithiocarbamate	1	40
Molybdeum Phosphorodithioate	1	40
Molybdeum Dithiocarbamate	1	40

With reference to Figure 2, the additive vessel 60 includes a one-way valve 70 and a capillary tube 72 to effect release of the additive from the interior of the additive vessel. The capillary tube includes an inlet end 74 disposed inside the additive vessel and an outlet end 76 disposed within the center oil passageway 26 of the by-pass media. A hollow sleeve 78 is formed on and extends upwardly from the vessel 60, and a removable plug 80 fits into and seals with the sleeve 78 to close off the sleeve 78. The capillary tube 72 extends through the sleeve 78 and the plug 80. As shown in Figure 1, when the vessel 60 is in place in the filter, the plug 80 and the sleeve 78 extend into the center oil passageway 26 through the bottom of the by-pass filter media 24 so that the outlet end 76 of the capillary tube is disposed in and discharges into the passageway 26. In addition, the plug 80 is removable from the sleeve 78 to permit filling and refilling of the vessel 60.

Figure 3 illustrates a variation of a filter 10' that is similar to the filter 10. The filter 10' includes an additive vessel 60' with a one-way valve 70' and a capillary tube 72'. However, in the filter 10', the by-pass filter 24' is shorter in axial length than the

by-pass filter 24. In addition, the end of the capillary tube 72' is disposed adjacent to the bottom of the vessel 60'. The tube 36' is also provided with a flow restriction. The filter 10' in Figure 3 operates in much the same way as the filter 10 operation discussed below.

The vessel 60 utilizes the pressure gradient across the filter element in addition to the vacuum effect created by the venturi 38 on the clean side of the pleated filter media 18 to drive the additive up the capillary tube 72 and into the oil. The release rate of the additive is controlled by careful selection of the capillary inner diameter (release rate goes with fourth power of inner diameter ID) and capillary length (release rate goes with inverse proportion of length) according to the well-known Hagen-Poiseuille equation for laminar flow in capillary tubes:

$$\Delta P = \frac{128 \mu L Q}{\pi d^4}$$

where:

ΔP is the pressure drop
L is the length of pipe
μ is the dynamic viscosity
Q is the volumetric flow rate
r is the radius
d is the diameter

With reference to Figures 1 and 2, dirty oil passes through the one way valve 70 into the additive vessel 60. The pressure in region 1 will be referred to as P1. The oil mixes with additive in the vessel (region 2). The oil/additive mixture then flows through the capillary tube 72 (region 3) into the passageway 26 in the center of the by-pass media (region 4). The oil/additive mixture then combines with the clean oil and is dispensed from the filter. The pressure in region 4 will be referred to as P2.

The difference between P_1 and P_2 changes over the life of the filter 10 as the filter media becomes more plugged. However, P_1 will always be greater than P_2. As P_1-P_2 increases, the additive release rate will also increase, thus compensating for the dilution of the additive.

Approximately 85-95% of the oil flows through the filter media 18, and most of the remainder flows through the by-pass media 24 except for the small amount that flows into the additive vessel.

The very small inner diameter of the capillary tube 72 makes it intolerant of particulates which may plug or damage the tube. Therefore, the additive(s) in the vessel 60 is in liquid form.

The venturi 38 helps to drive flow through the capillary tube 72. In addition, it is beneficial if the by-pass filter media not include additive material intended to be introduced into the oil. The use of a stationary additive material in the by-pass filter media section can lead to a decrease in media capacity due to reduced porosity. Therefore, eliminating an additive material from the by-pass media would allow for equivalent capacity using a reduced by-pass media area, thus allowing for a larger chemical vessel. In addition, using a liquid additive in the vessel 60 will have improved reactivity when compared to use of a stationary additive in the by-pass media due to the fact that the active sites of an additive chemical contained in the by-pass media become coated with soot, sludge, and other contaminants and therefore have a reduced ability to neutralize acids. Nonetheless, if one finds it advantageous to do so, the by-pass media or the full flow filter media may include an optional stationary additive material, for example a strong or weak base additive material in particulate form, intended to be introduced into the oil.

Also, the central oil passageway 26 in the by-pass media is advantageous. Without this open flow path, the pressure across the capillary tube will be very similar on the dirty side and clean side, so there will be no force to drive liquid flow through the capillary. The lack of such a central passageway 26 also minimizes the effect of the venturi tube 38 on the additive vessel, further hindering the driving force of the flow.

While the filter 10 has been described with the additive vessel at the bottom of the filter, the filter 10 can include other configurations such as with the additive vessel in other locations in the filter, for example located between the by-pass media 24 and the full flow media 18.

In addition, although the filter 10 has been described as having a combination of the full flow filter media 18, the venturi 38, the by-pass media 24, and the additive vessel

60, other configurations are possible. For example, the filter can include the full flow pleated media 18, the venturi 38, and the additive vessel 60, without the by-pass media. In another example, the filter can include the by-pass media 24 and the additive vessel 60 without the pleated media 18. In another example, the filter can include the full flow pleated filter media 18, the by-pass media 24, and the additive vessel 60, without the venturi nozzle 38 and the sleeve 30. Other configurations and combinations of elements are possible.

The invention may be embodied in other forms without departing from the spirit or novel characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limitative. The scope of the invention is indicated by the appended claims rather than by the foregoing description; and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Claims

1. An oil filter, comprising:

a housing defining an interior chamber and having a first end and a second end, an oil inlet and an oil outlet at the first end of the housing, and an oil flow pathway between the inlet and the outlet for oil flowing through the interior chamber;

filter media disposed within the interior chamber in the oil flow pathway between the inlet and the outlet, the filter media configured to filter oil flowing through the interior chamber;

an additive vessel in the interior chamber, the additive vessel configured to introduce additive material contained therein into oil flowing through the interior chamber, the additive material includes an over-based detergent and optionally one or more of: a weak base additive, an anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

2. The oil filter of claim 1, wherein the filter media comprises a pleated filter media and a by-pass media disposed between the pleated filter media and the second end, the by-pass media includes a center oil passageway extending therethrough that is in communication with an interior of the pleated filter media, and the by-pass media does not include additive material intended to be introduced into the oil;

a venturi disposed within the interior of the pleated filter media;

the additive vessel includes a capillary tube with an inlet end disposed inside the additive vessel and an outlet end disposed within the center oil passageway of the by-pass media, and a one-way oil inlet that communicates the interior chamber of the housing with the inside of the additive vessel.

3. The oil filter of claim 1, wherein the filter media comprises a pleated filter media and a by-pass media disposed between the pleated filter media and the second end; the additive vessel is disposed between the by-pass media and the second end; the by-pass media includes a center oil passageway extending therethrough that is in communication with an interior of the pleated filter media; and

the additive vessel includes a capillary tube with an inlet end disposed inside the additive vessel and an outlet end disposed within the center oil passageway of the by-pass media, and a one-way oil inlet that communicates the interior chamber of the housing with the inside of the additive vessel.

4. The oil filter of any preceding claim, wherein the additive material comprises the over-based detergent in an amount ranging from about 10% to about 90% by weight of the additive material, about 0.2 % to about 3% by weight of the friction modifier additive, about 0.5% to about 3% by weight of the anti-oxidant additive, about 1.0% to about 5% by weight of the anti-wear additive, and about 0 to about 88.3% by weight of an inert solvent.

5. The oil filter of any one of claims 1-3, wherein the additive material comprises the over-based detergent in an amount ranging from about 20% to about 90% by weight of the additive material, about 0% to about 90% by weight of hindered amines, about 0.5 % to about 30% by weight of the friction modifier additive, about 1.0% to about 30% by weight of the anti-oxidant additive, about 1.0% to about 30% by weight of the anti-wear additive, and about 0 to about 77.5% by weight of an inert solvent.

6. The oil filter of any one of claims 1-3, wherein the additive material comprises the over-based detergent and one or more of: a weak base additive, the anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

7. The oil filter of claim 6, wherein the additive material comprises the over-based detergent and two or more of: a weak base additive, the anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

8. The oil filter of claim 1, wherein the filter media comprises a pleated filter media.

9. The oil filter of claim 1, wherein the filter media comprises stacked ring-shaped discs having a center passageway.

10. The oil filter of claim 1, wherein the additive vessel includes an inlet located at a region exposed to a first pressure and an outlet located at a region exposed to a second pressure, and the first pressure is greater than the second pressure.

11. An additive vessel configured to introduce an additive into oil in an oil filter, the additive vessel comprising:

a housing defining an interior space, a one-way oil inlet into the interior space located at a region that in use is exposed to a first pressure, and a capillary tube having an inlet end disposed within the interior space and an outlet end disposed outside the interior space at a region that in use is exposed to a second pressure; the first pressure is greater than the second pressure; and

additive material contained within the interior space, the additive material includes an over-based detergent and optionally one or more of: a weak base additive, an anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

12. The additive vessel of claim 11, wherein the additive material comprises the over-based detergent in an amount ranging from about 10% to about 90% by weight of the additive material, about 0.2 % to about 3% by weight of the friction modifier additive, about 0.5% to about 3% by weight of the anti-oxidant additive, about 1.0% to about 5% by weight of the anti-wear additive, and about 0 to about 88.3% by weight of an inert solvent.

13. The additive vessel of claim 11, wherein the additive material comprises the over-based detergent in an amount ranging from about 20% to about 90% by weight of the

additive material, about 0% to about 90% by weight of hindered amines, about 0.5 % to about 30% by weight of the friction modifier additive, about 1.0% to about 30% by weight of the anti-oxidant additive, about 1.0% to about 30% by weight of the anti-wear additive, and about 0 to about 77.5% by weight of an inert solvent.

14. The additive vessel of claim 11, wherein the additive material comprises the over-based detergent and one or more of: a weak base additive, the anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

15. The additive vessel of claim 14, wherein the additive material comprises the over-based detergent and two or more of: a weak base additive, the anti-oxidant additive, an anti-wear additive, a friction modifier additive, a dispersant additive, an anti-foam additive, a nano-additive, a corrosion inhibitor additive, a pour point depressant additive and a surfactant additive.

16. The additive vessel of claim 11, wherein the capillary tube is disposed along a central axis of the housing, and the oil inlet is located radially outward of the capillary tube.

Fig. 1

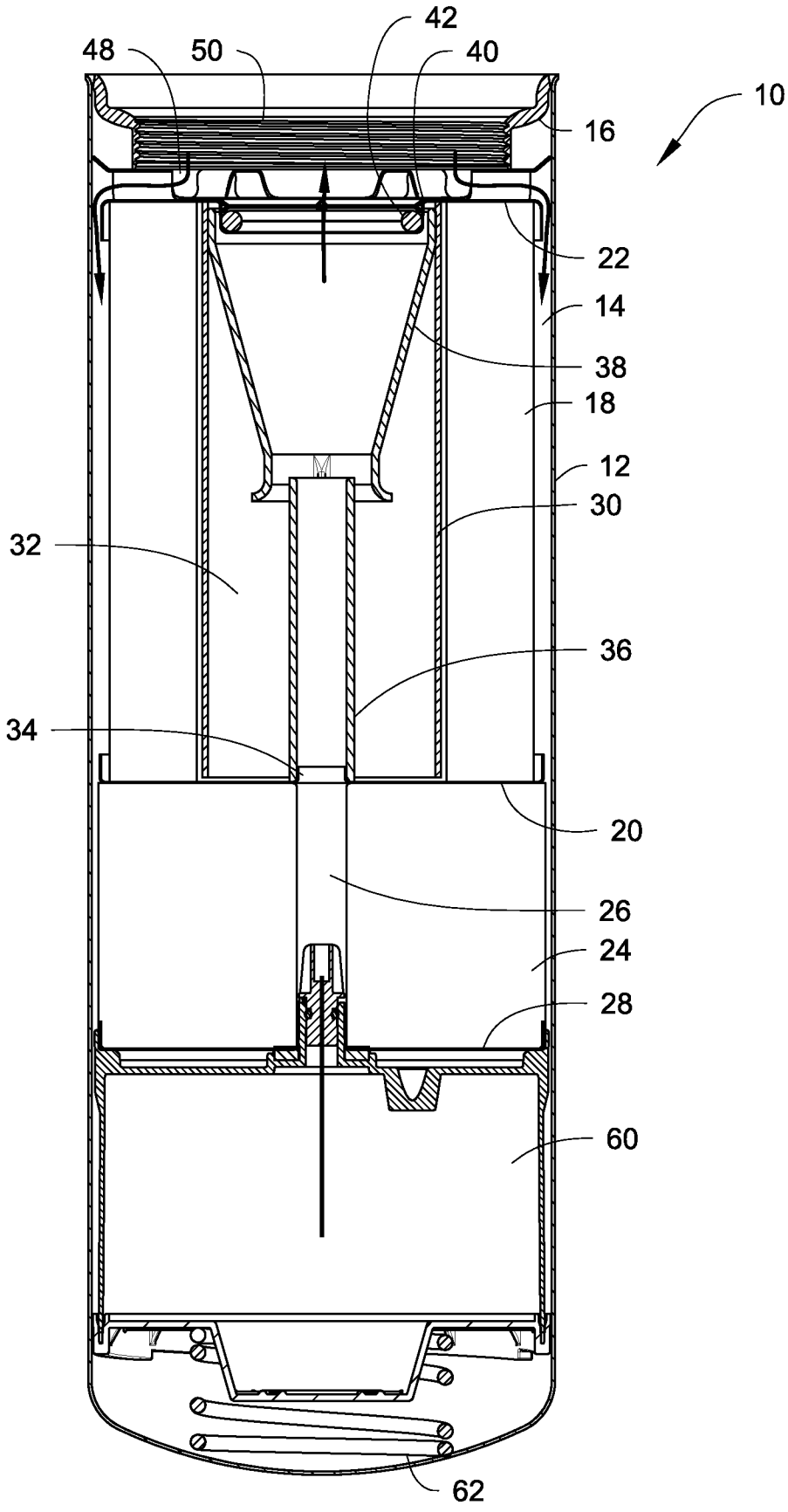


Fig. 2

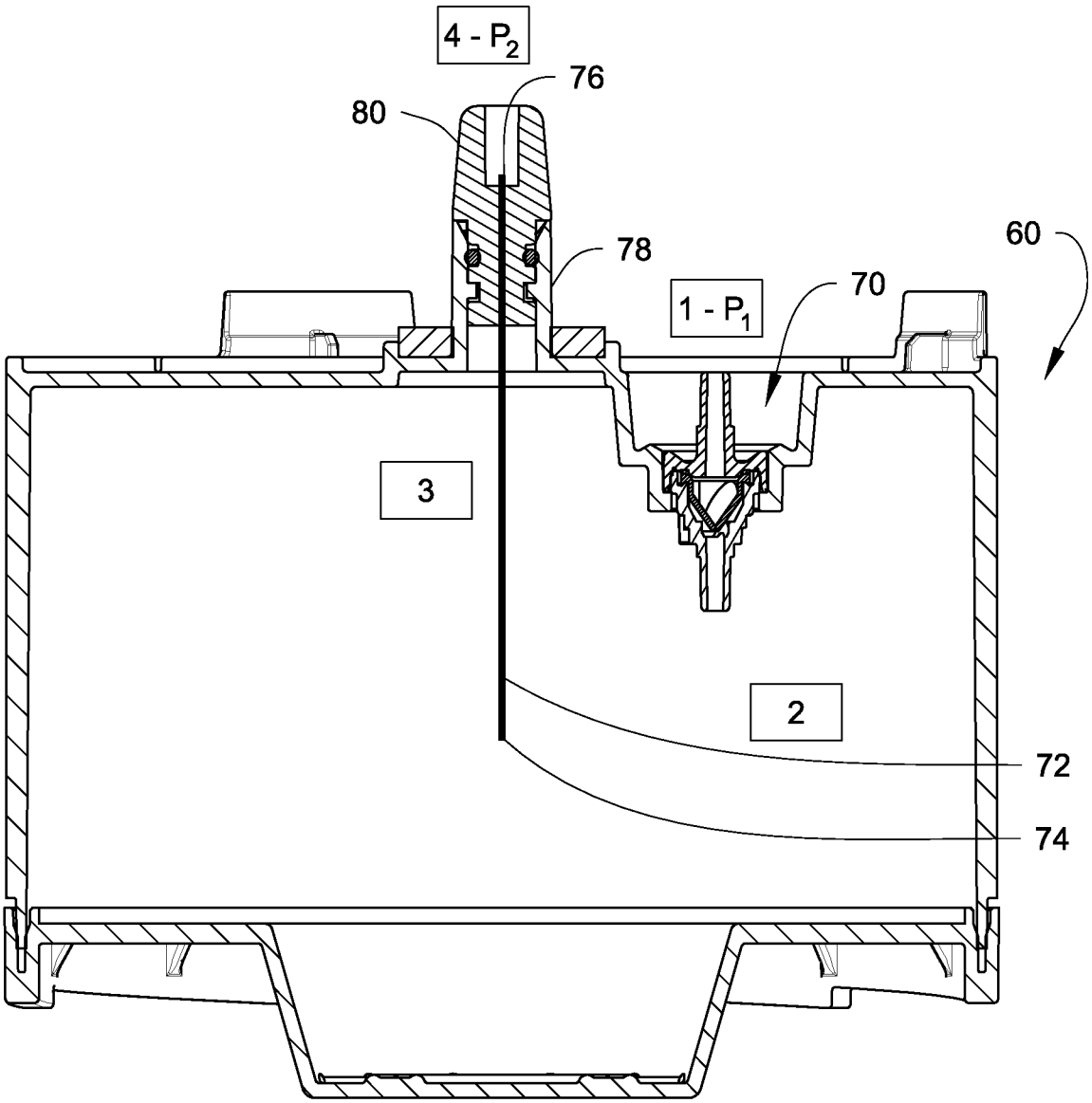
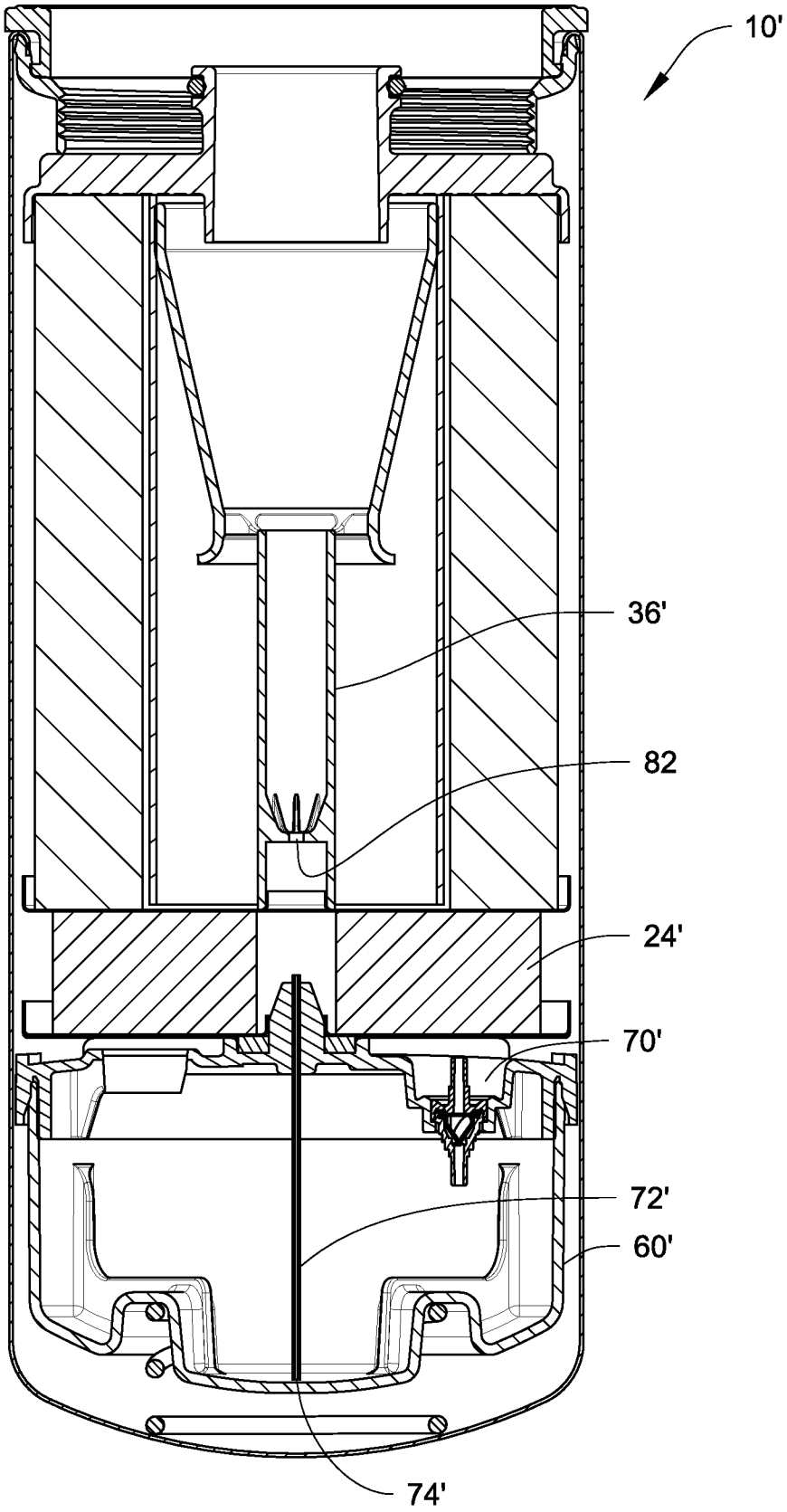


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/024883

A. CLASSIFICATION OF SUBJECT MATTER

F01M 11/03(2006.01)i, B01D 35/30(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F01M 11/03; B01D 27/14; C10M 169/06; C10M 163/00; B01D 35/00; C10M 159/24; B01D 29/07; B01D 29/11

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: oil, lubricant, filter, additive, over based detergent, capillary

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7,510,653 B2 (MARTIN et al.) 31 March 2009 See column 3 lines 24-63, column 4 lines 24-64, column 5 lines 18-53;	1-3,6-11,14-16
A	figure 2.	4,5,12,13
Y	US 7,417,012 B2 (BURRINGTON et al.) 26 August 2008	1-3,6-11,14-16
A	See column 2 lines 41-65; claims 1-6 and figure 2.	4,5,12,13
A	US 7,928,043 B2 (MAYHEW et al.) 19 April 2011 See claims 1,2.	1-16
A	US 7,481,923 B2 (GERWIN et al.) 27 January 2009 See colum 3 line 57-column 4 line 38; figures 1,2.	1-16
A	JP 2005-262203 A (FLEETGUARD INC.) 29 September 2005 See paragraphs [0024]-[0026],[0030],[0031]; figure 1.	1-16

☐ Further documents are listed in the continuation of Box C.

☒ 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
13 May 2013 (13.05.2013)	**14 May 2013 (14.05.2013)**

Name and mailing address of the ISA/KR

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Information on patent family members

International application No.

PCT/US2013/024883

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