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(54) **LUBRICANT COMPOSITION WITH A COMBINATION OF PARTICLES**

(57) The present invention relates to a lubricant composition comprising at least one graphite particle (P1) and at least one polytetrafluoroethylene particle (P2).

It also relates to the use of said composition for the lubrication of gears, in particular of industrial gears.

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Description

[0001] The present invention concerns a lubricant composition, in particular for lubricating industrial gears, comprising a specific combination of particles.

[0002] Gears, especially industrial gears, see extreme operating conditions that can lead to damage, for example, wear to the internal components of the gears. This damage reduces the life of the industrial gears and can lead to costly and prolonged maintenance, repair costs, unscheduled downtime for the equipment that contains the industrial gears, and similar problems.

[0003] There is an on-going need for improved industrial gear lubricants that can provide better performance in and protection of industrial gears, thus extending the service life of the industrial gears and the equipment that contains them.

[0004] One means of protecting such gears is the use of soluble additives with active sulfur. However, such additives are not satisfying as they raise corrosion issues, as well as pitting corrosion, and an increase thermal sensitivity. Moreover, their performance is decreased because of the oxidation and temperature. Also, most soluble additives are activated by temperatures and are lost with time by exposure to temperature, oxygen or water contamination.

[0005] To this date, there is thus a need for a lubricant composition with satisfying properties concerning weld load and satisfying anti-wear properties at extreme pressure.

[0006] The aim of the invention is to provide a lubricant composition, with improved weld load, being used in particular for lubricating industrial gears.

[0007] The aim of the invention is also to provide a lubricant composition, with improved weld load, and also with satisfying anti-wear properties with extreme pressure (EP) performance.

[0008] Thus, the present invention relates to a lubricant composition comprising at least one graphite particle (P1) and at least one polytetrafluoroethylene particle (P2).

[0009] The lubricant composition according to the present invention is thus based on a combination of two kinds of particles, which are particles (P1) made of graphite and particles (P2) made of polytetrafluoroethylene (PTFE).

[0010] It has been surprisingly shown that this combination has a synergistic activity and has very satisfying anti-wear properties, even at very high pressure. This combination thus provides satisfying anti-wear properties together with extreme pressure (EP) performance.

[0011] The combination of particles (P1) and (P2) thus provides a synergistic improvement of the weld load, especially in industrial gears, and without any decrease of the wear properties.

[0012] In addition, the two particles are less prone to degradation with time than soluble additives and thus surprisingly give the lubricant long lasting properties.

[0013] According to an embodiment, the lubricant composition of the invention comprises at most 20% by weight of particles (P1) in relation to the total weight of said composition.

[0014] Preferably, the lubricant composition of the invention comprises from 1% to 15%, from 1% to 10%, from 1 to 5%, more preferably from 1% to 3%, by weight of particles (P1) in relation to the total weight of said composition.

[0015] According to an embodiment, the lubricant composition of the invention comprises at most 20% by weight of particles (P2) in relation to the total weight of said composition.

[0016] Preferably, the lubricant composition of the invention comprises from 1% to 15%, more preferably from 5% to 10%, by weight of particles (P2) in relation to the total weight of said composition.

[0017] According to an embodiment, the particles (P1) have a particle size comprised between 300 nm and 5 μm , preferably between 300 nm and 3 μm , and more preferably between 500 nm and 2 μm .

[0018] According to an embodiment, the particles (P2) have a particle size comprised between 50 nm and 400 nm, preferably between 50 nm and 300 nm, and more preferably between 200 nm and 300 nm.

[0019] According to an embodiment, the lubricant composition of the invention also comprises at least one oil of lubricating viscosity.

[0020] The oil of lubricating viscosity can be present in a major amount, for a lubricant composition, or in a concentrate forming amount, for a concentrate and/or additive composition. The industrial gear oil compositions of the invention may be either lubricant compositions or concentrate and/or additive compositions.

[0021] Suitable oils include natural and synthetic lubricating oils and mixtures thereof. In a fully formulated lubricant, the oil of lubricating viscosity is generally present in a major amount (i.e. an amount greater than 50% by weight). Typically, the oil of lubricating viscosity is present in an amount of 75% to 98% by weight, and often greater than 80% by weight of the overall composition.

[0022] The oil of lubricating viscosity may include natural and synthetic oils, oil derived from hydrocracking, hydrogenation, and hydrofinishing, unrefined, refined and re-refined oils or mixtures thereof. Unrefined oils are those obtained directly from a natural or synthetic source generally without (or with little) further purification treatment. Refined oils are similar to the unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Purification techniques are known in the art and include solvent extraction, secondary distillation, acid or base extraction, filtration, percolation and similar processes. Re-refined oils are also known as reclaimed or repro-

essed oils, and are obtained by processes similar to those used to obtain refined oils. Re-refined oils are often processed by techniques directed to removal of spent additives and oil breakdown products.

[0023] Natural oils useful as the oil of lubricating viscosity include animal oils and vegetable oils (e.g., castor oil, lard oil), mineral lubricating oils such as liquid petroleum oils and solvent-treated or acid-treated mineral lubricating oils of the paraffinic, naphthenic or mixed paraffinic naphthenic types and oils derived from coal or shale or mixtures thereof.

[0024] Synthetic oils of lubricating viscosity include hydrocarbon oils such as polymerized and interpolymerised olefins (e.g., polybutylenes, polypropylenes, propyleneisobutylene copolymers); poly(1-hexenes), poly(1-octenes), poly(1-decenes), and mixtures thereof; alkyl-benzenes (e.g., dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di-(2-ethylhexyl)-benzenes); polyphenyls (e.g., biphenyls, terphenyls, alkylated polyphenyls); alkylated biphenyl ethers and alkylated biphenyl sulfides and the derivatives, analogs and homologs thereof or mixtures thereof. In some embodiments the oil of lubricating viscosity used in the invention is a synthetic oil that includes polymerized polyisobutylene, and in some embodiments the oil of lubricating viscosity used in the invention is a synthetic oil that includes polymerized polyisobutylene and a polyalpha-olefin.

[0025] Another synthetic oil of lubricating viscosity includes polyol esters other than the hydrocarbyl-capped polyoxy-alkylene polyol as disclosed herein, dicarboxylic esters, liquid esters of phosphorus-containing acids (e.g., tricresyl phosphate, trioctyl phosphate, and the diethyl ester of decane phosphonic acid), or polymeric tetrahydrofurans. Synthetic conventional oil of lubricating viscosity also includes those produced by Fischer-Tropsch reactions and typically may be hydroisomerised Fischer-Tropsch hydrocarbons or waxes. In one embodiment, the oil of lubricating viscosity may be prepared by a Fischer-Tropsch gas-to-liquid synthetic procedure as well as other gas-to-liquid oils.

[0026] Oils of lubricating viscosity may further be defined as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines. The five base oil groups are as follows: Group I (sulfur content >0.03 percent by weight, and/or <90 percent by weight saturates, viscosity index 80-120); Group II (sulfur contents ≤ 0.03 percent by weight and ≥ 90 percent by weight saturates, viscosity index 80-120); Group III (sulfur content ≤ 0.03 percent by weight and ≥ 90 percent by weight saturates, viscosity index ≥ 120); Group IV (all polyalphaolefins, or PAO, such as PAO-2, PAO-4, PAO-5, PAO-6, PAO-7 or PAO-8); and Group V (which encompasses "all others"). The oil of lubricating viscosity includes API Group I, Group II, Group III, Group IV, Group V oil or mixtures thereof. In one embodiment, the oil of lubricating viscosity is an API Group I, Group II, Group III, Group IV oil or mixtures thereof. Alternatively, the oil of lubricating viscosity is often an API Group II, Group III or Group IV oil or mixtures thereof.

[0027] In some embodiments, the lubricating oil component of the present invention includes a Group II or Group III base oil, or a combination thereof. The oil can also be derived from the hydroisomerization of wax, such as slack wax or a Fischer-Tropsch synthesized wax. Such "Gas-to-Liquid" oils are typically characterized as Group III.

[0028] The compositions of the present invention may include some amount of Group I base oils, and even Group IV and Group V base oils. However, in some embodiments, the lubricating oil component of the invention contains no more than 20, 10, 5, or even 1 percent by weight Group I base oil. These limits may also apply to Group IV or Group V base oils. In other embodiments, the lubricating oil present in the compositions of the invention is at least 60, 70, 80, 90, or even 98 percent by weight Group II and/or Group III base oil. In some embodiments, the lubricating oil present in the compositions of the invention is essentially only Group II and/or Group III base oil, where small amounts of other types of base oils may be present but not in amounts that significantly impact the properties or performance of the overall composition.

[0029] In some embodiments, the compositions of the invention include some amount of Group I and/or Group II base oils. In other embodiments, the compositions of the invention are lubricating compositions where the oil of lubricating viscosity is primarily Group I and/or Group II base oils, or even essentially Group I and/or Group II base oils, or even exclusively Group I and/or Group II base oils.

[0030] In some embodiments the invention provides a Group II composition, that is the oil of lubricating viscosity includes Group II oil, and can even be primarily if not exclusively Group II oil.

[0031] The various described oils of lubricating viscosity may be used alone or in combinations. The oil of lubricating viscosity may be used in the described industrial gear lubricant compositions in the range of about 40 or 50 percent by weight to about 99 percent by weight, or from a minimum of 49.8, 70, 85, 93, 93.5 or even 97 up to a maximum of 99.8, 99, 98.5 or even 97 percent by weight. In other embodiments, the oil of lubricating viscosity may be used from a minimum of 40, 65, 73, 73.5, or even 81 up to a maximum of 99.8, 99.7, 98.8, 94.3, 88.5, or even 81 percent by weight.

[0032] In still other embodiments the oil of lubricating viscosity may be used from a minimum of 50, 70, 75, 86, 86.8, or even 92.05 up to a maximum of 99.6, 99.5, 98.5, 98.4, or even 98.2 percent by weight, or from a minimum of 80, 90, 95, 96, 96.8, or even 97.05 up to a maximum of 99.6, 99.5, 99.4, or even 99.2 percent by weight, or from 50 to 99.6, from 50 to 99.5, from 70 to 99.5, from 75 to 98.5, from 86 to 98.4, from 86.8 to 98.4, or even from 92.05 to 98.2, and instill further embodiments from 80 to 99.6, from 90 to 99.6, from 95 to 99.5, from 96 to 99.4, from 96.8 to 99.4, or even from 97.05 to 99.2.

[0033] According to an embodiment, the lubricant composition of the invention also comprises at least one additive.

[0034] The compositions of the invention may further include one or more additional additives, for example the com-

position of the invention may include an industrial gear additive package. In other words, the compositions of the invention are designed to be industrial gear lubricants, or additive packages for making the same. The present invention does not relate to automotive gear lubricants or other lubricating compositions.

[0035] Any combination of conventional additive packages designed for industrial gear application may be used. The invention inherently assumes such additive packages are essentially free of the phosphorus containing compounds and derivatives of hydroxy-carboxylic acids described above, or at least do not contain the type of the phosphorus containing compounds and derivatives of hydroxy-carboxylic acids specified by the particular embodiment of the invention.

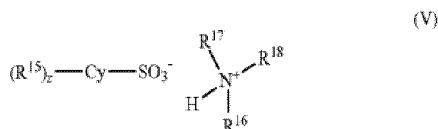
[0036] The additional additives which may be present in the industrial gear oil compositions of the invention include: a demulsifier, a pour point depressant, an antioxidant, a dispersant, a metal deactivator (such as a copper deactivator), an antiwear agent, an extreme pressure agent, a viscosity modifier, or some mixture thereof. In some embodiments the additives may each be present in the range from 50, 75, 100 or even 150 ppm up to 5, 4, 3, 2 or even 1.5 percent by weight, or from 75 ppm to 0.5 percent by weight, from 100 ppm to 0.4 percent by weight, or from 150 ppm to 0.3 percent by weight, where the percent by weight values are with regards to the overall lubricating oil composition. However it is noted that some additives, including viscosity modifying polymers, which may alternatively be considered as part of the base fluid, may be present in higher amounts including up to 30, 40, or even 50% by weight when considered separate from the base fluid. Each of the described additional additives may be used alone or as mixtures thereof.

[0037] Antifoams, also known as foam inhibitors, are known in the art and include but are not limited to organic silicones and non-silicon foam inhibitors. Examples of organic silicones include dimethyl silicone and polysiloxanes. Examples of non-silicon foam inhibitors include but are not limited to polyethers, polyacrylates and mixtures thereof as well as copolymers of ethyl acrylate, 2-ethylhexylacrylate, and optionally vinyl acetate. In some embodiments the antifoam is a polyacrylate. Antifoams may be present in the composition from 0.001 to 0.012 or 0.004 pbw or even 0.001 to 0.003 pbw.

[0038] Demulsifiers are known in the art and include but are not limited to derivatives of propylene oxide, ethylene oxide, polyoxyalkylene alcohols, alkyl amines, amino alcohols, diamines or polyamines reacted sequentially with ethylene oxide or substituted ethylene oxides or mixtures thereof. Examples of demulsifiers include polyethylene glycols, polyethylene oxides, polypropylene oxides, (ethylene oxide-propylene oxide) polymers and mixtures thereof. In some embodiments, the demulsifiers are polyethers. Demulsifiers may be present in the composition from 0.002 to 0.2 pbw.

[0039] Pour point depressants are known in the art and include but are not limited to esters of maleic anhydride-styrene copolymers, polymethacrylates; polyacrylates; poly-acrylamides; condensation products of haloparaffin waxes and aromatic compounds; vinyl carboxylate polymers; and terpolymers of dialkyl fumarates, vinyl esters of fatty acids, ethylene-vinyl acetate copolymers, alkyl phenol formaldehyde condensation resins, alkyl vinyl ethers and mixtures thereof.

[0040] The compositions of the invention may also include a rust inhibitor, other than some of the additives described above. Suitable rust inhibitors include hydrocarbyl amine salts of dialkyldithiophosphoric acid, hydrocarbyl amine salts of hydrocarbyl arenesulphonic acid, fatty carboxylic acids or esters thereof, an ester of a nitrogen-containing carboxylic acid, an ammonium sulfonate, an imidazoline, mono-thio phosphate salts or esters, or any combination thereof; or mixtures thereof. Examples of hydrocarbyl amine salts of dialkyldithiophosphoric acid of the invention include but are not limited to those described above, as well as the reaction product(s) of diheptyl or dioctyl or dinonyl dithiophosphoric acids with ethylenediamine, morpholine or PrimeneTM 81R or mixtures thereof. Suitable hydrocarbyl amine salts of hydrocarbyl arenesulphonic acids used in the rust inhibitor package of the invention are represented by the formula:



wherein Cy is a benzene or naphthalene ring. R¹⁵ is a hydrocarbyl group with about 4 to about 30, preferably about 6 to about 25, more preferably about 8 to about 20 carbon atoms. z is independently 1, 2, 3, or 4 and most preferably z is 1 or 2. R¹⁶, R¹⁷ and R¹⁸ are the same as described above. Examples of hydrocarbyl amine salts of hydrocarbyl arenesulphonic acid of the invention include but are not limited to the ethylenediamine salt of dinonylnaphthalene sulfonic acid. Examples of suitable fatty carboxylic acids or esters thereof include glycerol monooleate and oleic acid. An example of a suitable ester of a nitrogen-containing carboxylic acid includes oleyl sarcosine. The rust inhibitors may be present in the range from 0.02 to 0.2, from 0.03 to 0.15, from 0.04 to 0.12, or from 0.05 to 0.1 percent by weight of the lubricating oil composition. The rust inhibitors of the invention may be used alone or in mixtures thereof.

[0041] The compositions of the invention may also include a metal deactivator. Metal deactivators are used to neutralize the catalytic effect of metal for promoting oxidation in lubricating oil. Suitable metal deactivators include but are not limited to triazoles, tolyltriazoles, a thiadiazole, or combinations thereof, as well as derivatives thereof. Examples include derivatives of benzotriazoles other than those described above, benzimidazole, 2-alkyldithiobenzimidazoles, 2-alkyldithiobenzothiazoles, 2-(N,N'-dialkyldithio-carbamoyl)benzothiazoles, 2,5-bis(alkyl-dithio)-1,3,4-thiadiazoles, 2,5-

bis(N,N'-dialkyldithiocarbamoyl)-1,3,4-thiadiazoles, 2-alkyldithio-5-mercapto thiadiazoles or mixtures thereof. These additives may be used from 0.01 to 0.25 percent by weight in the overall composition. In some embodiments, the metal deactivator is a hydrocarbyl substituted benzotriazole compound. The benzotriazole compounds with hydrocarbyl substitutions include at least one of the following ring positions 1- or 2- or 4- or 5- or 6- or 7-benzotriazoles. The hydrocarbyl groups contain about 1 to about 30, preferably about 1 to about 15, more preferably about 1 to about 7 carbon atoms, and most preferably the metal deactivator is 5-methylbenzotriazole used alone or mixtures thereof. The metal deactivators may be present in the range from 0.001 to 0.5, from 0.01 to 0.04 or from 0.015 to 0.03 pbw of the lubricating oil composition. Metal deactivators may also be present in the composition from 0.002 or 0.004 to 0.02 pbw. The metal deactivator may be used alone or mixtures thereof.

[0042] Antioxidants may also be present including (i) an alkylated diphenylamine, and (ii) a substituted hydrocarbyl mono-sulfide. In some embodiments, the alkylated diphenylamines of the invention are bis-nonylated diphenylamine and bis-octylated diphenylamine. In some embodiments, the substituted hydrocarbyl monosulfides include n-dodecyl-2-hydroxyethyl sulfide, 1-(tert-dodecylthio)-2-propanol, or combinations thereof. In some embodiments, the substituted hydrocarbyl monosulfide is 1-(tert-dodecylthio)-2-propanol. The antioxidant package may also include sterically hindered phenols. Examples of suitable hydrocarbyl groups for the sterically hindered phenols include but are not limited to 2-ethylhexyl or n-butyl ester, dodecyl or mixtures thereof. Examples of methylene-bridged sterically hindered phenols include but are not limited to 4,4'-methylene-bis(6-tert-butyl o-cresol), 4,4'-methylene-bis(2-tert-amyl-o-cresol), 2,2-methylene-bis(4-methyl-6-tertbutylphenol), 4,4'-methylene-bis(2,6-di-tertbutylphenol) or mixtures thereof.

[0043] In some embodiments, the additional additives present include a nitrogen-containing dispersant, for example a hydrocarbyl substituted nitrogen containing additive. Suitable hydrocarbyl substituted nitrogen containing additives include ashless dispersants and polymeric dispersants. Ash- less dispersants are so-named because, as supplied, they do not contain metal and thus do not normally contribute to sulfated ash when added to a lubricant. However they may, of course, interact with ambient metals once they are added to a lubricant which includes metal-containing species. Ashless dispersants are characterized by a polar group attached to a relatively high molecular weight hydrocarbon chain.

Examples of such materials include succinimide dispersants, Mannich dispersants, and borated derivatives thereof.

[0044] In some embodiments, the additional additives present include a sulfur-containing compound. Such sulfur-containing compounds may include sulfurized olefins and polysulfides and/or sulfurized fatty esters. The sulfurized olefin or polysulfides may be derived from isobutylene, butylene, propylene, ethylene, or some combination thereof. The sulfurized fatty esters may include sulfurized olefins derived from any of the natural oils or synthetic oils described above, or even some combination thereof. For example the sulfurized fatty ester may be derived from vegetable oil.

[0045] In some embodiments, the invention includes a sulfurized fatty ester that includes a sulfurized natural oil. In some embodiments the sulfurized fatty ester includes a sulfurized animal and/or vegetable oil. In some embodiments, the sulfurized fatty ester includes a sulfurized vegetable oil. In some embodiments the sulfurized fatty ester includes a sulfurized unsaturated oil. In some embodiments the sulfurized fatty ester includes a sulfurized unsaturated natural oil. In some embodiments the sulfurized fatty ester includes a sulfurized unsaturated vegetable oil. In some embodiments the sulfurized fatty ester described above further includes one or more sulfurized olefins and/or polysulfides. In some embodiments, the sulfurized fatty ester includes a sulfurized rapeseed oil.

[0046] In some embodiments, the additional additives present include one or more phosphorous amine salts (different from the phosphorous containing compound described above), but in amounts such that the resulting industrial gear lubricant compositions, contains no more than 1.0 percent by weight of such materials, or even no more than 0.75 or 0.6 percent by weight. In other embodiments, the resulting industrial gear lubricant compositions, are essentially free of or even completely free of such phosphorous amine salts.

[0047] In some embodiments, the additional additive component includes one or more antiwear additives and/or extreme pressure agents, one or more rust and/or corrosion inhibitors, one or more foam inhibitors, one or more demulsifiers, or any combination thereof. In other embodiments the additional additives, and/or the resulting industrial gear lubricant compositions, are essentially free of or even completely free of phosphorous amine salts, dispersants, or both.

[0048] In some embodiments the additional additives, and/ or the resulting industrial gear lubricant compositions, include a demulsifier, a corrosion inhibitor, a friction modifier, or combination of two or more thereof. In some embodiments, the corrosion inhibitor includes a tolyltriazole. In still other embodiments, the additional additive component, and/or the resulting industrial gear lubricant compositions, include one or more sulfurized olefins or polysulfides; one or more phosphorus amine salts; one or more thiophosphate esters, one or more thiadiazoles, tolyltriazoles, polyethers, and/or alkenyl amines; one or more ester copolymers, one or more carboxylic esters; one or more succinimide dispersants, or any combination thereof.

[0049] In some embodiments, the compositions of the invention further include (d), one or more additional additives, that may include one or more sulfurized olefins, phosphoric acid esters, thiophosphates, thiophosphoric acid esters and/or amine salts thereof, thiadiazoles and/or substituted thiadiazole, tolyltriazoles and/or substituted triazoles, polyethers, alkyl and/or alkenyl amines and/or polyolefin amide alkenamines, ester copolymers, carboxylic esters, dispersants, hydrocarbon polymers, or any combination thereof.

[0050] Dispersants suitable for use in the compositions of the invention are not overly limited and may include borated dispersants, non-borated dispersants, succinimide dispersants (including borated and non-borated succinimide dispersants), Mannich dispersants, and the like.

[0051] In some embodiments, the compositions of the invention are free of antioxidants. In some embodiments, the compositions of the invention are free of fatty amines. In some embodiments, the compositions of the invention are free of high TBN overbased detergents (where high TBN can mean having a TBN of >100, >50, >20 or even >10). In some embodiments, the compositions of the invention are free of zinc dithiophosphates.

[0052] In some embodiments, the compositions of the invention, in addition to the components (a), (b), and (c), further comprise a sulfurized olefin, a dithiophosphate ester, a phosphate amine salt, a high TBN succinimide dispersant, a fatty amine, a tolyltriazole, an acrylate, a polyether, and a thiadiazole, which may be described as additional component (d).

[0053] In some embodiments, the compositions of the invention, in addition to the components (a), (b), and (c), further comprise an extreme pressure agent, a combination of antiwear agents, a rust inhibitor, a metal deactivator, a antifoam agent, a demulsifier, and a copper deactivator, which may be described as additional component (d).

[0054] The additional additives may be present in the overall industrial gear lubricant composition from 0.1 to 30 percent by weight, or from a minimum level of 0.1, 1 or even 2 percent by weight up to a maximum of 30, 20, 10, 5, or even 2 percent by weight, or from 0.1 to 30, from 0.1 to 20, from 1 to 20, from 1 to 10, from 1 to 5, or even about 2 percent by weight. These ranges and limits may be applied to each individual additional additive present in the composition, or to all of the additional additives present.

[0055] The present invention also relates to the use of the lubricant composition as defined above, for the lubrication of gears or transmissions, in particular of industrial gears. The lubricant composition may also be used in the marine field or for off-road applications (such as public works and agriculture vehicles).

[0056] The present invention also relates to a method for lubricating gears, in particular industrial gears, comprising a step of contacting at least one gear with the lubricant composition as defined above.

FIGURES

[0057]

Figure 1 represents the WSD on worn balls with and without the inclusion of graphite particles (KS4) in a commercial oil suitable for use in carter (CEP), at various loads.

The curve with squares corresponds to the use of CEP (lubricant alone) and the curve with triangles corresponds to the use of CEP together with 1% by weight of graphite particles (KS4).

Figure 2 represents the WSD on worn balls with and without the inclusion of graphite particles (KS4) and PTFE particles (NanoFlon, NF) in CEP, at various loads.

The curve in continuous line with squares corresponds to the use of CEP (lubricant alone); the curve in dotted line with circles corresponds to the use of CEP together with 10% by weight of NF particles; the curve in continuous line with triangles ▼ corresponds to the use of CEP together with 1% by weight of KS4 particles; and the curve in continuous line with triangles ▲ corresponds to the use of CEP together with 9% by weight of NF particles and 1% by weight of KS4 particles.

Figure 3 represents the weld load for CEP oil with different combinations of NF and KS4.

Figure 4 represents the WSD on worn balls with and without the inclusion of graphite particles (KS4) in a commercial oil suitable for use in carter (CSH), at various loads.

The curve with squares corresponds to the use of CSH (lubricant alone) and the curve with triangles corresponds to the use of CSH together with 1% by weight of KS4 particles.

Figure 5 represents the WSD on worn balls with and without the inclusion of KS4 particles and NF particles (individually and simultaneously) in CSH, at various loads.

The curve with squares corresponds to the use of CSH alone; the curve with triangles ▼ corresponds to the use of CSH together with 1% by weight of KS4 particles; the curve with circles corresponds to the use of CSH together with 10% by weight of NF particles; and the curve with triangles ▲ corresponds to the use of CSH together with 9% by weight of NF particles and 1% by weight of KS4 particles.

Figure 6 represents the weld load for CSH with different combinations of NF and KS4.

EXAMPLES**Materials**

- [0058] Graphite particles (P1) are TIMCAL TIMREX® KS4 Primary Synthetic Graphite.
 [0059] PTFE particles (P2) are Shamrock NanoFlon.
 [0060] The lubricant oils are either 2 commercially available oils suitable for use in carter CEP and CSH.

Example 1: Effect on AW and EP property of CEP oil due to addition of 1% KS4 particles**1.1. Effect on anti-wear property**

- [0061] Anti-wear tests were conducted as per CONOMO standards on 150, 200 and 250 kg respectively.
 [0062] Figure 1 delineates the WSD on worn balls with and without the inclusion of KS4 in carter oils, while Figure 2 compares these results with the inclusion of NanoFLon.
 [0063] The 4 ball test (CONOMO standard) is carried out (speed - 1500 rpm, at ambient temperature; Time -1min).

Results

a) It appears from Figure 1 that the minimum value of WSD is 1.26 mm.

- [0064] Figure 1 also shows that with an increase in load, the wear scar increased commensurately.
 [0065] Moreover, this figure shows that inclusion of KS4 deteriorated the performance at every load.
 [0066] The results may be summarized as shown in the below table.

Table 1: % increase in WSD due to addition of 1% KS4 in Carter EP 68

Load	150kg	200kg
% increase/deterioration in performance	44.4%	50.7%

b) It appears from Figure 2 that the minimum value of WSD is 0.53 mm.

- [0067] Figure 2 also shows that with an increase in load, the wear scar increased commensurately.
 [0068] Moreover, this figure shows that inclusion of KS4 deteriorated the performance at every load, whereas the inclusion of NanoFLon or NanoFLon + KS4 leads to improvement in performance.
 [0069] The percentage in improvement is shown below:

Load	150kg	200kg	250kg
CEP +10% NF	23%	18%	22%
CEP +9% NF+1% KS4	27%	18.65%	21.6%

1.2. Effect on weld load

- [0070] Figure 3 shows the effect on Weld load (WL) of oil due to addition of 1% KS4 in CEP.
 [0071] The 4 ball test is carried out according to the following parameters (IP 239): speed - 1,450 rpm, at ambient temperature; Time - 60 s).

Results

- [0072] It appears from Figure 3 that the range of WL is 2,453 to 9,810 N.
 [0073] Figure 3 also shows that the addition of 1% KS4 reduced WL by 37.5% compared to the oil alone.
 [0074] It also shows that addition of 10% NF lead to increase in weld load by 100% and that addition of KS4 with NanoFLon lead to further increase to a minimum load of 1000 kg in Weld load of oils.

Example 2: Effect on AW and EP property of CSH due to addition of 1% KS4 particles

2.1. Effect on anti-wear property

[0075] Figure 4 delineates the WSD on worn balls with and without the inclusion of KS4 in carter oils, while Figure 5 compares these results with the inclusion of NanoFLon.

[0076] The carried out test is the same as the one described in example 1.

Results

a) It appears from Figure 4 that the minimum value of WSD is 0.52 mm.

[0077] Figure 4 also shows that with an increase in load, the wear scar increased commensurately.

[0078] Moreover, this figure shows that inclusion of KS4 has no significant effect on WSD when compared to parent oil.

b) It appears from Figure 5 that the minimum value of WSD is 0.52 mm.

[0079] Figure 5 also shows that with an increase in load, the wear scar increased commensurately.

[0080] Moreover, this figure shows that inclusion of KS4 appears to have no significant effect on WSD, whereas the inclusion of 10% NF leads to improvement in performance at higher loads.

2.2. Effect on weld load

[0081] Figure 6 shows the effect on Weld load (WL) of oil due to addition of 1% KS4 in CSH.

[0082] The 4 ball test is carried out according to the following parameters (IP 239): speed - 1,450 rpm, at ambient temperature; Time - 60 s).

Results

[0083] It appears from Figure 6 that the range of WL is 2,747 to 6,082 N.

[0084] Figure 6 also shows that KS4 alone has no effect on EP performance of CSH.

[0085] It also shows that addition of 10% NF lead to increase in weld load by 98% and that addition of KS4 with NanoFLon lead to further increase to a minimum load of 1,000 kg in weld load of oils.

Claims

1. A lubricant composition comprising at least one graphite particle (P1) and at least one polytetrafluoroethylene particle (P2).

2. The lubricant composition of claim 1, comprising at most 20% by weight of particles (P1) in relation to the total weight of said composition.

3. The lubricant composition of claim 1 or 2, comprising at most 20% by weight of particles (P2) in relation to the total weight of said composition.

4. The lubricant composition of any of claims 1 to 3, wherein the particles (P1) have a particle size comprised between 300 nm and 5 μ m, preferably between 300 nm and 3 μ m, and more preferably between 500 nm and 2 μ m.

5. The lubricant composition of any of claims 1 to 4, wherein the particles (P2) have a particle size comprised between 50 nm and 400 nm, preferably between 50 nm and 300 nm, and more preferably between 200 nm and 300 nm.

6. The lubricant composition of any of claims 1 to 5, comprising at least one oil of lubricating viscosity.

7. The lubricant composition of any of claims 1 to 6, comprising at least one additive.

8. The use of the lubricant composition of any one of claims 1 to 7, for the lubrication of gears or transmissions, in particular of industrial gears.

9. A method for lubricating gears, in particular industrial gears, comprising a step of contacting at least one gear with the lubricant composition of any one of claims 1 to 8.

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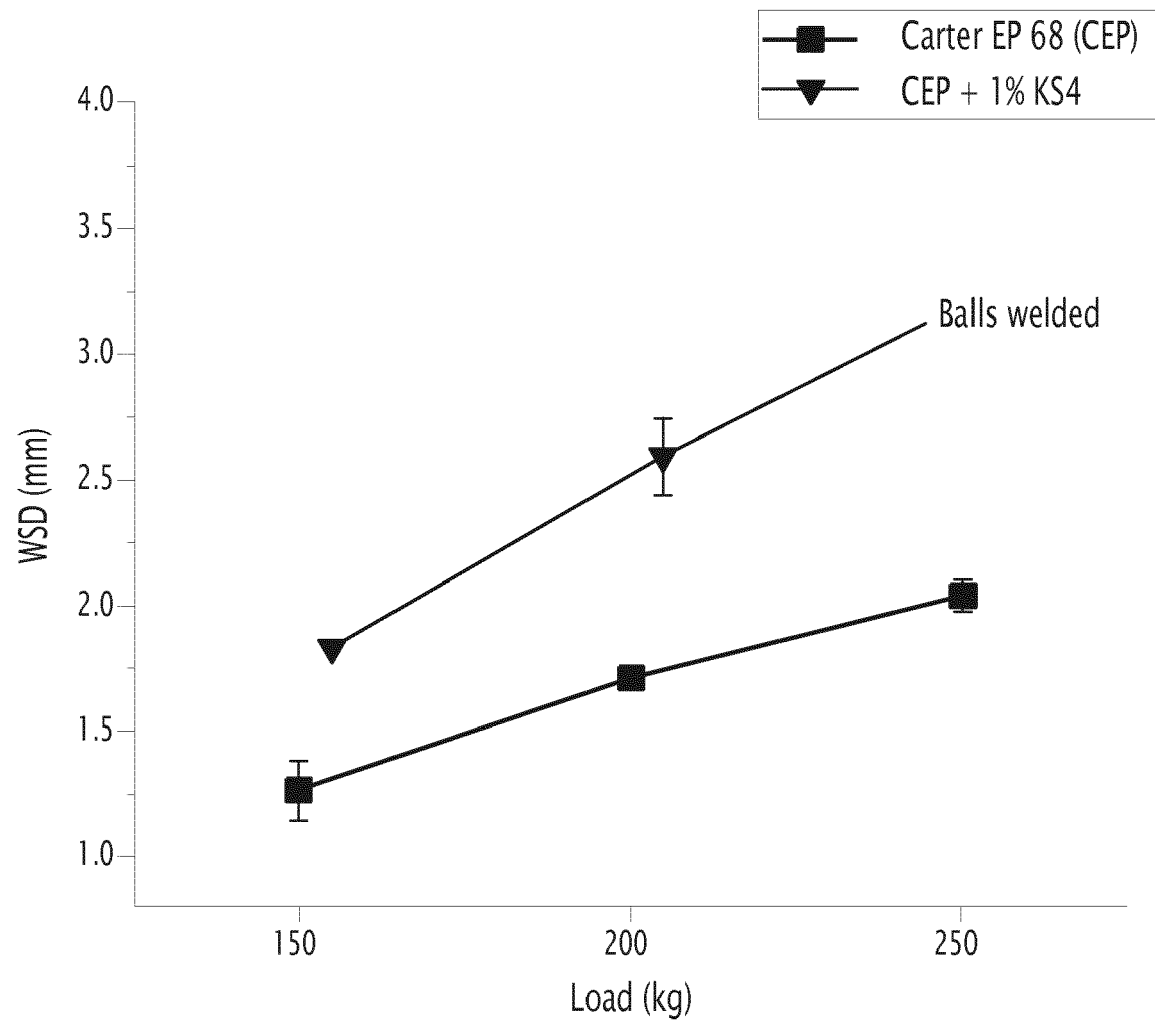


FIG.1

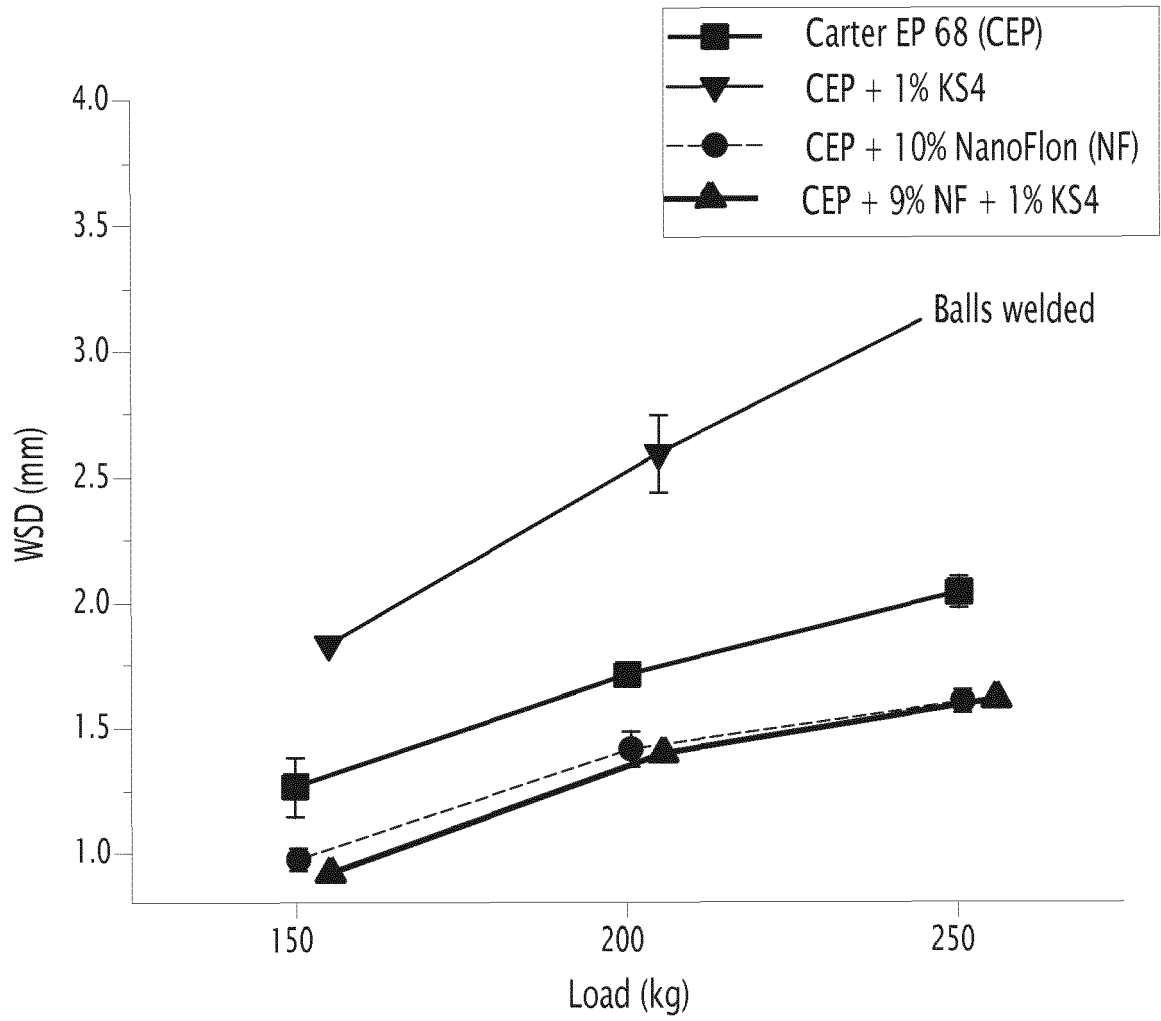


FIG.2

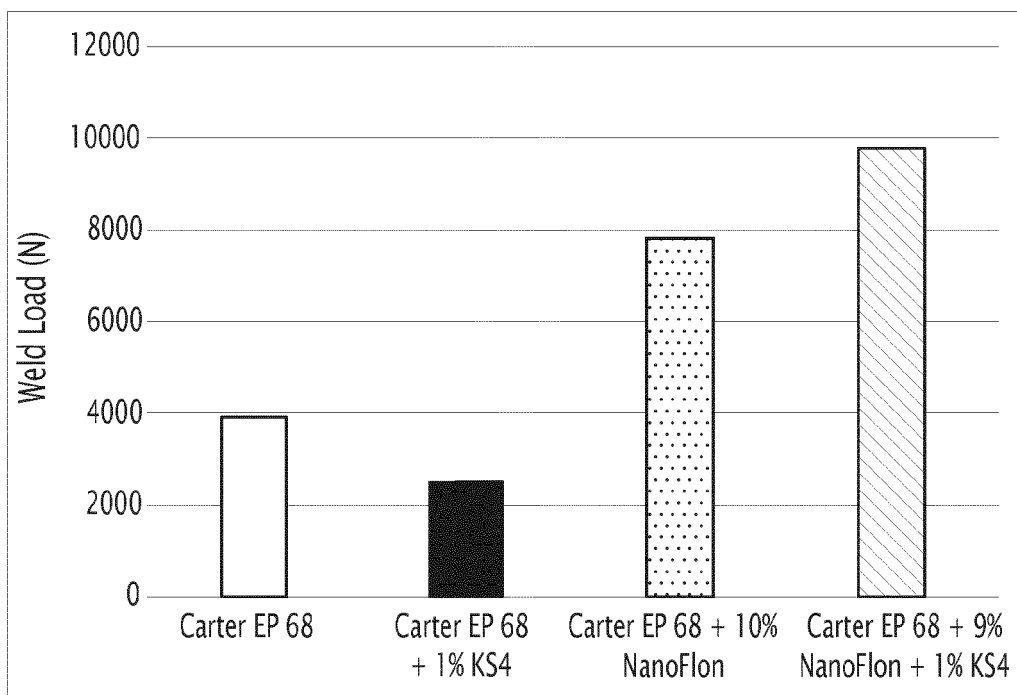


FIG.3

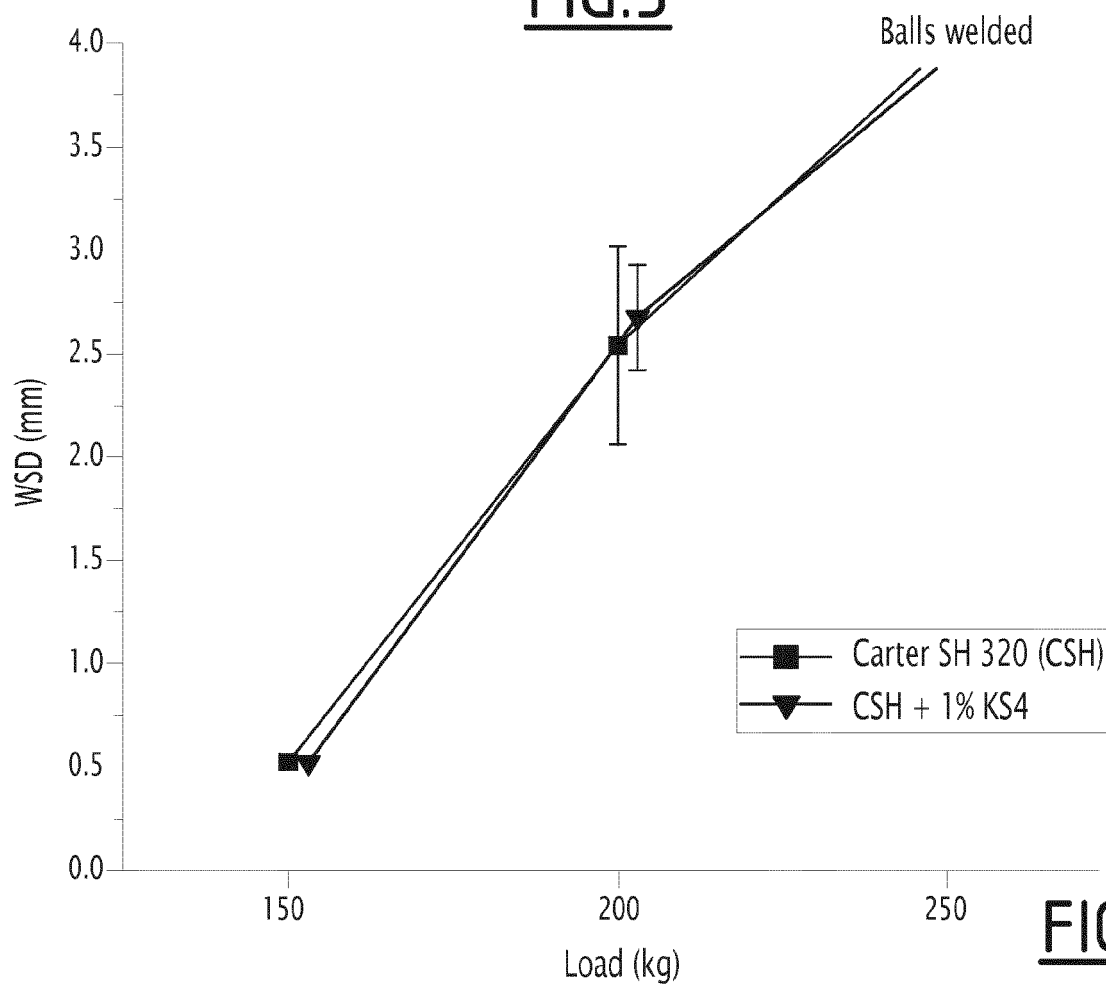


FIG.4

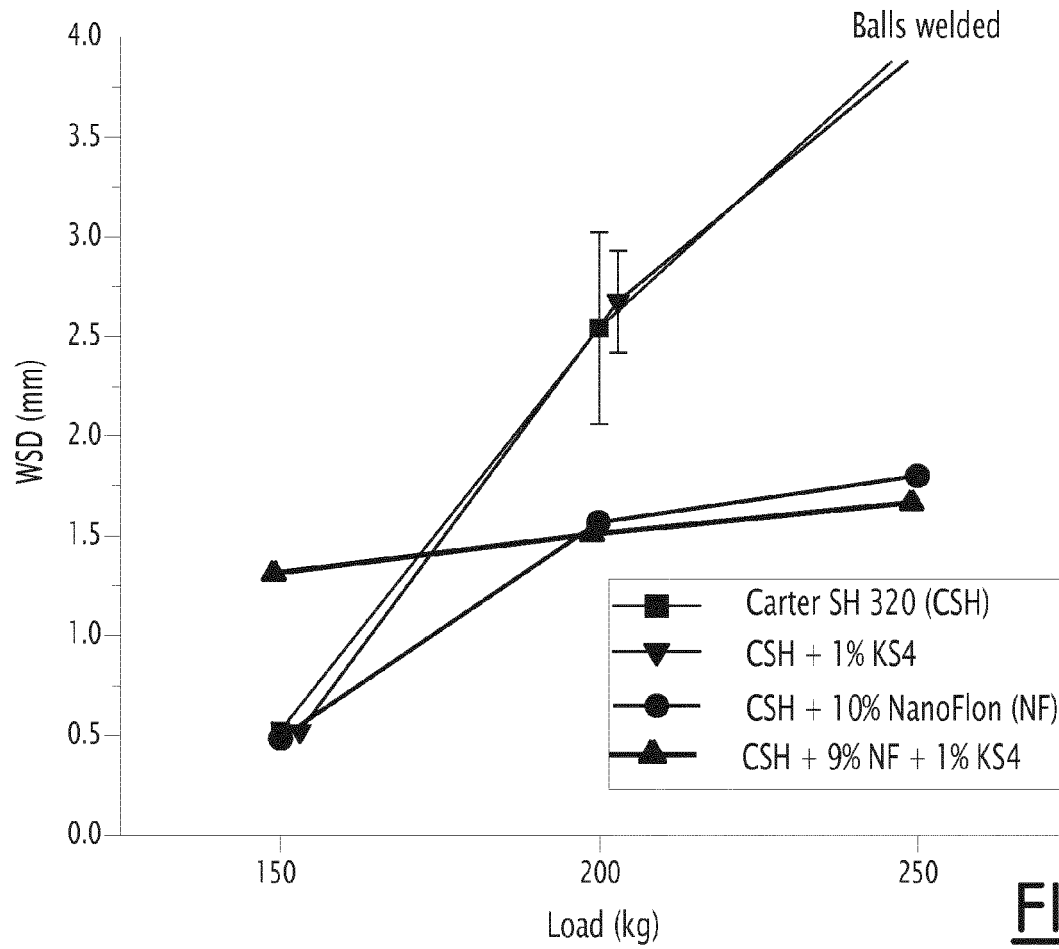


FIG.5

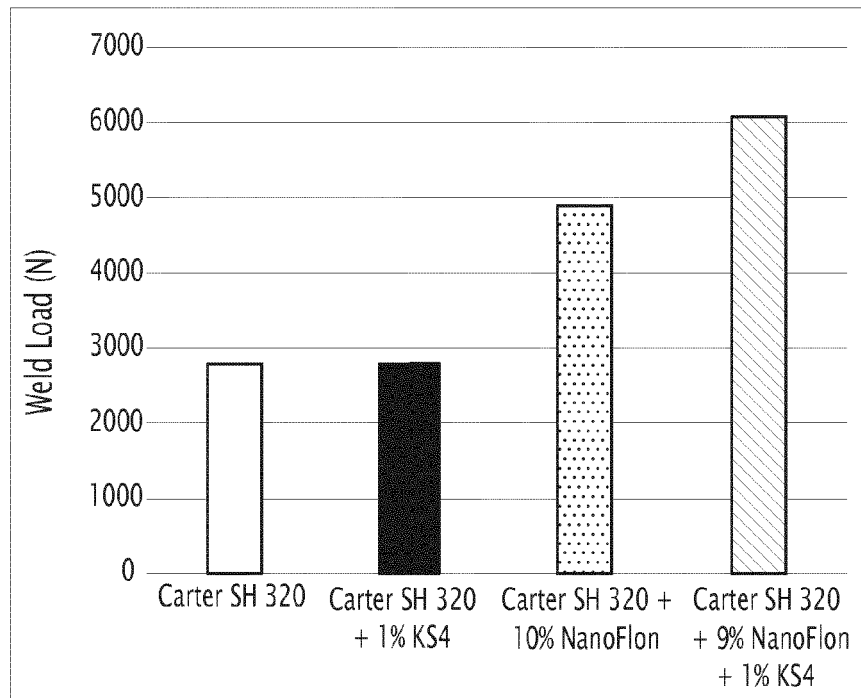


FIG.6



EUROPEAN SEARCH REPORT

Application Number
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