

Oct. 31, 1950

V. N. BORSOFF ET AL
FOAM INHIBITED OILS

2,528,465

Filed Sept. 18, 1947

2 Sheets-Sheet 1

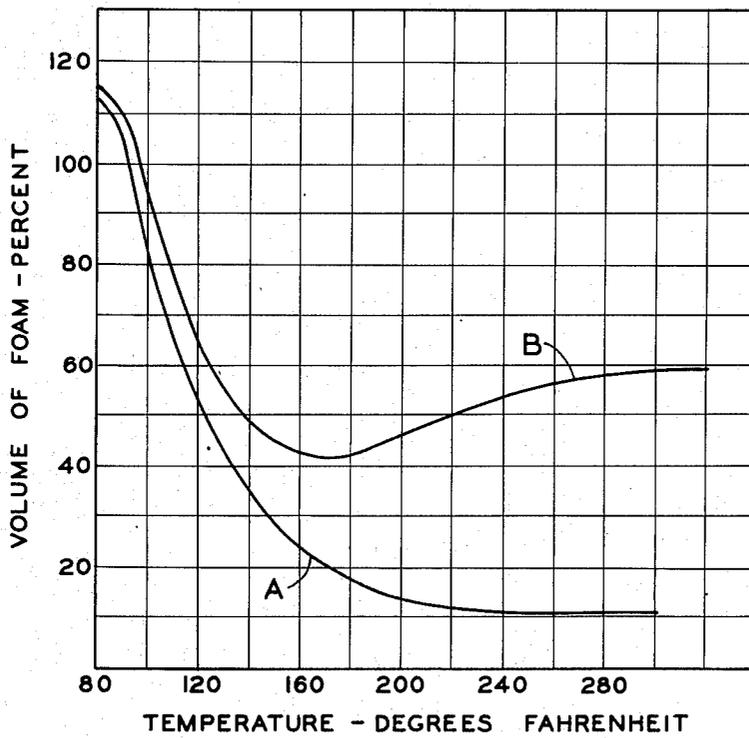


Fig. 1

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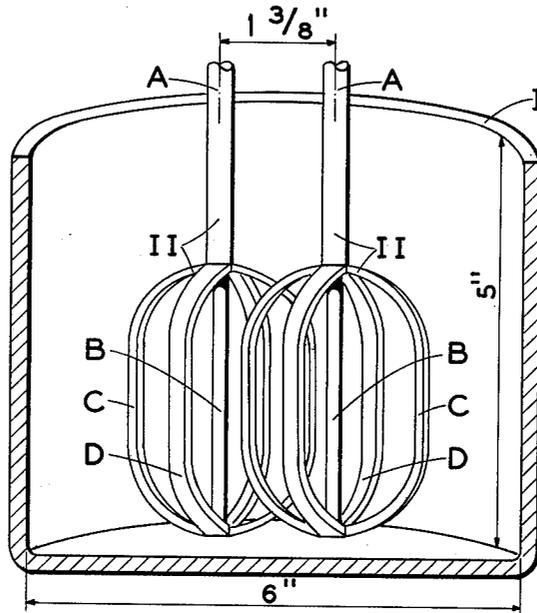


Fig. 2

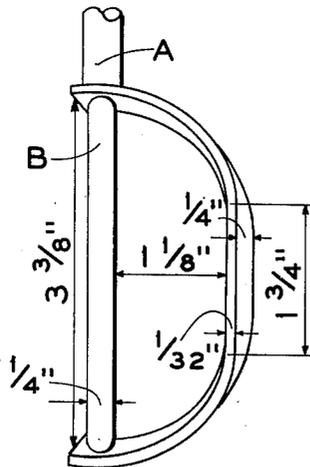


Fig. 3

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2,528,465

FOAM INHIBITED OILS

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Application September 18, 1947, Serial No. 774,743

7 Claims. (Cl. 252—32.5)

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This invention relates to oils inhibited against the formation of a stable bubble foam and to a method of inhibiting the foam formation tendency of oils.

This application is a continuation-in-part of our copending application Serial No. 450,886, filed July 14, 1942 now Patent No. 2,430,857, issued November 18, 1947.

On mixing oil with air, a certain amount of foam may be created. The amount of foam will depend, among other things, upon the character of the oil and the type of service in which it is employed. Thus most base mineral oils, that is, mineral oils uncompounded with a chemical additive, do not readily form foam, at least under ordinary service conditions. Many compounded oils tend to produce a more stable foam than the base oils from which they are compounded. Thus petroleum lubricating oils compounded with metal naphthenates, higher metal alcoholates, higher metal alkyl phenates and metal salts of higher fatty acids foam more than the corresponding base oils. Many other additives cause more foam to be produced by oils to which they are added, than is formed by the base oils.

Oil foaming, even with compounded oils which display the greatest tendency to foam, is not always troublesome. Under conditions of little or no agitation, for example, trouble due to foaming is encountered, if at all, only in very exceptional cases. On the other hand, certain drastic types of service, involving extremely violent intermixture of oil and air or combustion gases, may produce an objectionable amount of foam with many oils. Between the extremes, however, of service causing little foaming of any oil and service causing much foaming of many oils, there are types of service and certain oils which, when used in combination, cause considerable difficulty. As stated, certain compounded oils exhibit a greater tendency to foam than the base oils, and when these compounded oils are used in certain types of lubricating systems, involving greater agitation of the oil and greater intermixture with gases than the ordinary crankcase lubrication of automobiles, the greatest practical difficulty is encountered.

Illustrative of the type of lubrication system which, when used with compounded lubricating oils having a strong tendency to foam, causes practical difficulty, is the dry sump lubrication system employed in many aircraft engines. In this system, oil from the moving parts of the motor is collected in the crankcase and pumped from there to an external tank or sump by a

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scavenging pump. Oil from this sump is pumped back to the motor in the usual manner by an oil pump. The foaming difficulty arises from the fact that the scavenging pump operates at excess capacity; it pumps faster than required to pump all of the available oil in the crank-case. It therefore pumps a great deal of air along with the oil, and this at a rapid rate, and the result is entrainment of air in the oil and the formation of foam. As a consequence, excessive foaming occurs when oils such as the aforementioned compounded oils are used and oil is lost through the breather pipes, insufficient lubrication results because of the presence of air in the oil supplied to the motor, and other disadvantages result.

Oil also forms a more persistent foam if it contains water (as in solution) and is then heated and suddenly subjected to a very low pressure, as for instance, in an airplane engine climbing from a low altitude to 40,000 feet at a high speed.

In other instances, as in the lubrication of gears with heavy oils, foaming difficulties may also be encountered.

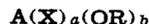
It is an object achieved by the present invention to inhibit the foaming of oils.

It is a further object achieved by the present invention to inhibit the foaming of compounded mineral lubricating oils.

It is a still further and a particular object achieved by the present invention to obviate the problem of excessive foaming of compounded mineral lubricating oils when used in types of lubrication service involving severe conditions of intermixture of oil and gases.

Other objects achieved by the invention will be apparent from the following description and from the claims.

We have discovered that foaming of oils can be inhibited by incorporating therein a small amount of a compound containing not less than about 15% by weight of oxygen and represented by the formula—



wherein A is an aromatic nucleus, X is an oxygen-containing substituent, R is a substituent selected from the group consisting of hydrogen, alkyl, aryl, aralkyl and cyclo-alkyl radicals, a is a whole number at least equal to 1 and b is zero or a whole number. The aromatic nucleus A may contain other substituents in addition to X and OR.

We have found that such oxygen-containing substituted aromatic compounds are effective in reducing foaming even when used in very small

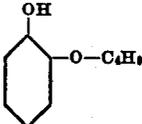
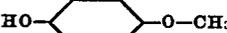
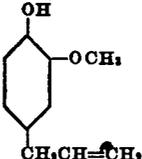
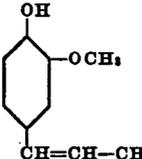
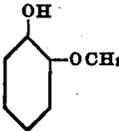
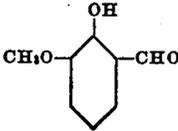
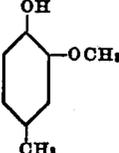
amounts, and that they are highly effective in inhibiting the foaming of compounded lubricating oils when subjected to extreme agitation and intermixture with gases. They are, however, not limited in their effectiveness to compounded oils but may be used to advantage wherever troublesome foaming of oils is encountered. Certain of the foam inhibitors of the invention are more effective than others for a given set of conditions, whereas for another set of conditions a different group of inhibitors will be found to be superior. Simple experiment will enable one to select the best inhibitor for the purpose at hand.

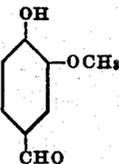
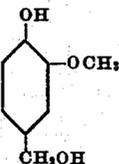
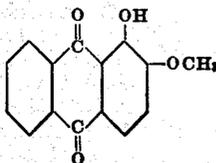
An especially effective and preferred class of compounds are alkoxy phenols, wherein the alkoxy group may be methoxy, ethoxy, propoxy, butoxy, hexoxy, cetoxy, etc., and wherein the phenol nucleus and/or alkoxy group may be further substituted with hydroxy groups. Illustrative compounds are o-butoxy phenol, hydroquinone monomethyl ether, eugenol, isoeugenol, guaiacol, 2-hydroxy-3-methoxy benzaldehyde, 2-methoxy-4-methyl phenol, vanillin, vanillyl

alcohol, 1-hydroxy-2-methoxy anthraquinone, resorcinol monomethyl ether, guaethol, resorcinol mono-ethyl ether, hydroquinone monoethyl ether, pyrocatechol monopropyl ether, resorcinol monopropyl ether, hydroquinone monopropyl ether, pyrocatechol monoamyl ether, resorcinol monoamyl ether, hydroquinone monoamyl ether, etc.

Preferably we use as foam inhibitors oxygen-containing aromatic compounds containing not less than about 15 per cent by weight of oxygen, and having a molecular weight not higher than about 270. We also prefer to use as inhibitors those compounds which are soluble in mineral oil to the extent used. Less soluble inhibitors are more likely to be removed by filtration or to settle out on standing. However, oil solubility is not essential to effectiveness in reducing foam and a solubility of the order of 0.001 per cent by weight based on the oil is adequate.

Specific examples typifying the class of inhibitors which we have found to be effective are the following:

Inhibitor	Molecular Structure	Molecular Weight	Per Cent by Weight of Oxygen
o-Butoxy phenol.....		168	20.2
Hydroquinone monomethyl ether.....		124	25.8
Eugenol.....		164	19.5
Isoeugenol.....		164	19.5
Guaiacol.....		124	25.8
2-Hydroxy-3-methoxy benzaldehyde.....		152	31.5
2-Methyl-4-methyl phenol.....		138	23.2

Inhibitor	Molecular Structure	Molecular Weight	Per Cent by Weight of Oxygen
Vanillin.....		152	31.5
Vanillyl alcohol.....		154	31.2
1-Hydroxy-2-methoxy anthraquinone.....		254	25.2

The inhibitors of our invention may be advantageously used in a wide variety of oils, including naphthenic base, paraffin base and mixed base mineral oils, and in oils of viscosity ranging from 40 S. S. U. or lower at 210° F. to 150 S. S. U. or higher at 210° F.

Preferably the foam inhibitors of the present invention are used in the finished oil in an amount equal to about 0.001% to 1 per cent by weight based on the oil. If the oil is a compounded oil containing 0.1 to 5.0 per cent by weight of an additive which promotes foaming, the foam inhibitor is preferably used in an amount equal to about 10 to 200 per cent by weight based on the additive.

Concentrated solutions of foam inhibitor in oil

tainable from the Office, Chief of Ordnance, War Department, Washington, D. C. In this test, a column of oil is aerated under controlled conditions, and the volume of foam is recorded after 5 minutes; then the introduction of air is stopped and the amount of foam recorded for regular intervals of time. This test was applied to a compounded oil consisting of an S. A. E. blend of 70% Western acid treated naphthenic base oil and 30% Western paraffinic base oil compounded with 0.55% by weight of a calcium alkyl phenate, 0.5% by weight of a calcium alkylphenyl thiophosphate and 0.17% by weight of an aliphatic polysulfide; and to the same oil containing 0.25% of the indicated anti-foaming agents. The results are shown in Table I below:

Table I

Oil Description	Temp.	cc. Foam after bubbling 5 minutes	cc. Foam uncollapsed after				
			5 min.	10 min.	15 min.	20 min.	30 min.
Compounded Oil.....	200° F.....	650	610	580	490	390	300
	Room.....	460	400	390	370	360	350
Compounded Oil+0.25% 2-Hydroxy-3-methoxy benzaldehyde.....	200° F.....	45	No foam after 1 min., 40 sec.				
	Room.....	430	100	25	10	Few bubbles	0
Compounded Oil+0.25% Vanillyl alcohol.....	200° F.....	30	No foam after 35 secs.				
	Room.....	20	Few bubbles at 4 mins.				

may be prepared. Such concentrates may also contain other compounding agents. By diluting the concentrate with more oil, a finished oil can be produced containing foam inhibitor, or foam inhibitor and other compounding agent or agents in the desired amount. Conveniently, concentrates containing from about 1.0 to 20 per cent by weight of foam inhibitor based on the total concentrate are thus prepared, in cases where the foam inhibitor is sufficiently oil soluble.

The following specific examples will serve to illustrate the advantages and effectiveness of the inhibitors of the invention in reducing foam formation:

Example I.—The effectiveness of the present anti-foaming agents may be shown by means of the ASTM Foaming Test, which is also known as the U. S. Army Specification 2-104B-Test AXS 1562, a detailed description of which is ob-

Example II.—The foaming qualities of various oils were observed. The base stock was a solvent treated, paraffinic base oil having a viscosity of 120 S. S. U. at 210° F., and a viscosity index of 86. The first oil tested consisted of this base stock alone and the second oil consisted of the base stock compounded with 0.25 per cent by weight of a 2:1 mixture of a calcium alkyl phenate and a calcium cetyl phosphate. The calcium alkyl phenate so used was the salt of an alkyl substituted phenol prepared by condensing butene polymers, having an average molecular weight of about 196, with phenol. The calcium cetyl phosphate so used was the salt prepared from a mixture of monocetyl- and dicetyl-phosphoric acids. The test conditions were as follows:

500 cc. of the oil were placed in a cylindrical metal container 6 inches in diameter by 5 inches high and a "Mixmaster" stirrer of the type used

in household kitchens was lowered into the oil. The oil was slowly heated by means of an electric hot plate and the amount of foam produced was measured at various temperatures up to 300° F. The speed of the stirrer was 1100 revolutions per minute. The test results at 275° F., under identical operating conditions except for variation of the oil composition, are set forth in Table II below:

Table II

	Percent increase in volume at 275° F.
Uncompounded oil.....	11
Compounded oil.....	57

The per cent increase in volume referred to in the above table, and again in Table III below, is arrived at by observing the increase in volume of the mixture of foam and oil over the original volume of oil, dividing the increase by the original volume of oil, and multiplying by 100. It is, therefore, the volume of foam produced reckoned as per cent of the original volume of oil.

Example III.—Oils were tested in an apparatus comprising a reservoir adapted to be heated by a hot plate, a sump situated below the reservoir, a drain provided with a regulating valve and leading from the bottom of the reservoir to the sump, and a return conduit connected with the bottom of the sump, provided with a pump, and extending into the reservoir under the surface of the oil therein. Oil, maintained at 200° F. in the reservoir, dropped from the reservoir through the drain to the sump at a rate controlled by the regulating valve. The pump in the return conduit was operated at a capacity three times the rate of flow of oil into the sump; therefore, both oil and air were pumped from the sump to the reservoir and foaming was caused in the reservoir. At the end of each 30 minutes of operation, the volume of foam and oil in the reservoir was observed. The amount of foam was calculated as the per cent increase in volume over the original volume of oil. Under identical operating conditions, various oils produced increases in volume as given in Table III below:

Table III

	Percent increase in volume
Uncompounded oil.....	30
Compounded oil.....	200+

Example IV.—A Wisconsin air-cooled engine equipped with an external sump was provided with a vacuum system attached to this sump in order to simulate various altitudes up to 62,000 feet. During the test, oil was continuously circulated at 135° F., the scavenging system causing 50 to 60 per cent air to be circulated with the oil. The foam height in the external sump was recorded at vacuum increments of 5 in. of mercury. Oils were assigned foam indices on the basis of this test. The foam index was calculated as the foam height at 25 in. of mercury vacuum, divided by the vacuum in inches of mercury at which foaming became universal throughout the liquid; this fraction was then multiplied by 100. This index is designated as *I_f*. The same compounded oil as described in Example I was employed, and the results of addition of the indicated amounts of additives are recorded in Table IV below:

Table IV

Additive	Percent in Oil	Wisconsin Engine
None.....		<i>I_f</i> 25
Vanillyl alcohol.....	0.25	1.7
2-Hydroxy-3-methoxy benzaldehyde.....	0.25	5.0
3-Ethoxy-4-hydroxy benzaldehyde.....	0.25	7.2
Vanillin.....	0.25	12.5

In addition to effectiveness in reducing foam formation, it is desirable that a foam inhibitor possess certain other desirable properties. Among such additional properties are lack of objectionable odor, at least a slight solubility in lubricating oil, stability at high and at low temperatures, non-corrosiveness to bearings, such as alloy bearings, and good engine performance (that is, the inhibitor should not increase ring sticking, should not increase gum or resin formation on pistons or other hot parts of the engine, and should not increase wear). Also, it is desirable that the inhibitor be not subject to removal on filtering. The best inhibitor is, therefore, one which is highly effective in reducing foaming and which also possesses, in high degree, the desirable properties listed above. Also, some of our inhibitors, in addition to their foam-inhibiting effect, have other desirable properties, from which oils containing them are generally improved as lubricating oils. They may impart properties of inhibiting oxidation, or enhance the effectiveness of other additives present, or serve as metal deactivators, corrosion inhibitors, etc.

We have observed that our inhibitors are more effective at elevated temperatures than at lower temperatures. At about the ordinary temperature, the reduction in foaming produced by the inhibitors of the invention is small, although substantial. At about 120° to 150° F. the reduction of foaming begins to be large, and above about 150° F. the reduction in foaming is very large.

The effect of temperature upon foaming of uninhibited and inhibited oils is shown by Fig. 1 of the accompanying drawings.

In Fig. 1, abscissae represent temperature in degrees Fahrenheit and ordinates represent the volume of foam calculated as percentage on the original volume of oil. Curve A represents the uncompounded oil of Example II, and curve B represents the same oil compounded with 0.25 per cent by weight of a 2:1 mixture of calcium alkyl phenate and calcium cetyl phosphate (the same as used in Example II). The test conditions were the same as in Example II, except that observations were made at a number of different temperatures.

It will be noted that foaming was great in the case of both oils at 80° F., though substantially less with Oil A (uncompounded oil) than with Oil B (compounded oil). As the temperature increased, the foaming of both oils decreased, but the foaming of Oil A decreased more rapidly than that of Oil B. At about 170° F., however, Oil B began to foam more with increase in temperature whereas Oil A continued to decrease in amount of foaming.

The phenate-phosphate mixture referred to above is effective in inhibiting oxidation of lubricating oils and in reducing ring sticking. It is given by way of example of the oil-soluble metal organic salts which are widely used in lubricating oils for such purposes. The tendency of such

compounding agents to promote foaming detracts somewhat from their utility, and the obviation of this defect, by the use of our foam inhibitors, is one of the principal objects accomplished by the invention.

It has been found that certain compounded oils which foam excessively also develop surfaces having the characteristics of plastic solids; that is, the surface is highly viscous, yields to and is deformed by a pressure in excess of a minimum yield value, but does not flow freely like a liquid under the force of gravity. This fact has been brought to light through the use of torsion pendulum. This apparatus and its use is described by R. E. Wilson and E. D. Ries in "Surface Films as Plastic Solids," Colloid Symposium Monograph, volume I, pages 145-173, published by the Department of Chemistry, University of Wisconsin 1923. The same apparatus and method were used to determine surface plasticity and viscosity of mineral oils.

Thus an S. A. E. 30 blend of 70% Western acid treated naphthenic base oil and 30% Western paraffinic base oil compounded with 0.25% by weight of a 2:1 mixture of a calcium alkyl phenate and a calcium cetyl phosphate (the same as Example II) was investigated by means of the torsion pendulum. The base oil is a non-foaming oil and the compounded oil exhibits a marked tendency to foam under the conditions of Example II. It was found that at room temperature the surface of the compounded oil, on ageing, became very viscous and similar to a plastic solid. However, when 0.1% of a foam inhibitor was dissolved in the compounded oil, a sharp initial rise in the viscosity of a freshly formed surface occurred and the surface became plastic, but after about 40 minutes the viscosity dropped off sharply and then more slowly. The surface became liquid again. The use of 0.2% of saligenin produced a similar result in less time.

A similar experiment at 200° F. revealed that the same compounded oil (lacking foam inhibitor) increased in surface viscosity during the first 2.5 minutes, remained constant for 1 minute and increased sharply between 3.5 and 4.0 minutes, and that after 4 minutes the surface was a plastic solid. On dissolving 0.1% of a foam inhibitor in the compounded oil, the surface viscosity-time curve was found to be anomalous for the first 7 minutes, exhibiting sharp drops and subsequent rises in viscosity. After about 9 minutes the surface began to set like a gel and become like a plastic solid, but a plastic solid having a very low yield point.

At both room temperature and 200° F., therefore, a correlation was found between surface viscosity and foaming tendency; the excessively foaming oil formed a surface, on ageing, similar to a plastic solid, but the foam inhibited oil formed a liquid surface on ageing at room temperature or a plastic solid surface of very low yield point on ageing at 200° F.

Therefore, those oils whose surfaces on ageing (a matter of minutes) exhibit the properties of plastic solids with high yield points are excessively foaming oils, while oils whose surfaces on ageing remain liquid or exhibit the properties of plastic solids with very low yield points are not excessively foaming oils. The most probable explanation of these observed phenomena seems to be as follows: All oils, when agitated with air produce foam, which consists of small portions of air each surrounded by a film of oil. In many cases this foam is unstable, probably due to the

instability of the film of oil. This film is so fluid that continued agitation and collisions of the foam bubbles with each other and the sides of the vessel and draining of the liquid from the film cause rupture of the film and destruction of the bubbles. In those cases, however, where the oil surface (hence the film of oil enclosing the air in the foam) is a plastic solid, the film is not as easily ruptured because the liquid cannot drain from the film due to capillary forces set up by the plastic solid surfaces, and the foam is stable. The plasticity and stability of the oil film clearly depend, in part at least, upon the nature and amount of solutes in the oil. Thus metal salts such as metal naphthenates, metal soaps of higher fatty acids, higher metal alkyl phenates, metal salts of phosphoric acid partly esterified by long chain alcohols, and higher metal alcohols are apparently adsorbed by the film of oil and render it more viscous, plastic and tough. We do not wish to infer that this is the only factor influencing foaming or that all foaming is due to the formation of a plastic solid film, but this is one of the principal contributing factors. The inhibitors of this invention apparently function by reducing the amount of adsorption of the foam-producing salts in the film, or are themselves adsorbed and counteract the adsorbed foam-producing salts.

Compounding agents, including oil-soluble polyvalent metal salts of organic and of organic-substituted inorganic acids, such as salts of organic substituted acids of phosphorus, which tend to cause foaming, are illustrated in Farrington et al. 2,228,659 (polyvalent metal salts of organic substituted acids of phosphorus), Rutherford et al. Reissue 22,829 (polyvalent metal salts of sulfur-containing acids of phosphorus having at least 24 carbon atoms), and Gardiner et al. 2,228,661 (alkaline earth metal alkyl phenates). Types of metal salts of organic acids are metal salts of higher fatty or aliphatic acids, metal salts of naphthenic salts, metal salts of oil-soluble substituted phenols, and metal salts of carboxylic acids containing an aryl substituent. A number of examples of these metal salts of organic acids are given in Denison et al. 2,346,155 (pp. 17-18); examples of various mixed and complex additives are given in Neely et al. 2,322,307.

Our invention, however, is not limited in its application to those oils which, because of certain salt-like compounding agents, form viscous, plastic surfaces. Our invention is applicable broadly to the inhibition of oil foaming wherever it occurs and comprises the addition of our foam inhibiting agents to any oil which foams excessively.

For the purpose of clarity, the terms "excessive foaming," "excessively foaming," and the like, as applied to oils herein and in the claims, refer to performance under the conditions of the following reproducible test, described with reference to Figs. 2 and 3 of the accompanying drawings. An oil which, when agitated under the conditions of this test at 275° F., increases in volume due to foaming by more than 20 per cent of its original volume, is an "excessively foaming" oil, and oils which foam less than this amount are not "excessively foaming" oils.

500 cc. of oil are placed in a cylindrical flat bottomed container 6" in diameter and 5" high (internal dimensions), the oil in the container is brought to and maintained at 275° F. by any suitable means such as a hot plate or a jacket, and the stirring elements of a "Mixmaster"

stirrer of the type used in household kitchens is lowered into the container. The "Mixmaster" stirrer is the product of and obtainable from the Chicago Flexible Shaft Co., 1124 South Central Avenue, Chicago, Ill. The stirring elements are similar in construction and action to the familiar household egg beater, consisting of two shafts oppositely rotated by a motor, and two elliptical loops attached to each shaft, one loop being at right angles to the other and the two loops having a common long axis. The dimensions and form of the vessel and stirring elements will be better understood, and can be duplicated, by reference to Figs. 2 and 3.

Fig. 2 shows, partly in cross section and partly in front elevation, the container and the stirring elements, while Fig. 3 shows in front elevation a detailed view of one-half of one loop of one stirring element.

Referring to Fig. 2 the apparatus comprises a cylindrical flat bottomed container I and two stirring elements II constructed exactly alike. The internal dimensions of the container, as shown, are a diameter of 6" and a height of 5". The stirring elements consist each of an upper shaft A geared at the top to a motor (not shown) and rigidly secured at the bottom to a lower shaft B and to two elliptical loops C and D which are disposed at right angles to each other and have each the shaft B as their long axis and as a supporting member. Shaft B is rigidly secured to the tops and bottoms of loops C and D. In the preferred construction, as shown, shaft A is sturdier than shaft B, but this is not necessary; for example, a single shaft of uniform diameter may take the place of shafts A and B, passing through the tops of loops C and D and being secured thereto at the top and bottom of the loops. The stirring elements II are so placed in vessel I that shafts A are parallel and $1\frac{1}{2}$ " apart (center to center) and they are placed in vessel I so that a line drawn half way between and in the plane of the shafts coincides with the axis of vessel I, and the distance from the bottom of loops C to the bottom of vessel I is $\frac{1}{4}$ inch. The shafts A are so geared to the motor that they rotate at equal speeds in opposite directions.

Referring to Fig. 3, shafts A and B and one-half of loop C are shown. The other half of loop C, and both halves of loop D are identically constructed.

Shaft B is cylindrical and has a diameter of $\frac{1}{4}$ " and a length of $3\frac{3}{8}$ ". Loop C consists of a flat strip of metal or equivalent material $\frac{1}{8}$ " thick and $\frac{1}{4}$ " wide. It is bent approximately in the shape of an ellipse with a short radius of $1\frac{1}{8}$ ". It has flat sides $1\frac{3}{4}$ " long, and the portions between the flat sides and shaft B have approximately the curvature of a circle.

Small variations of the structure of the loop and of the diameter of shaft B may be made without altering substantially the results obtained.

In operation, the oil in container I is maintained at 275° F. and stirring elements A are rotated in opposite directions each at the rate of 1100 revolutions per minute. The volume increase due to foaming is determined by measuring the height of the oil before foam formation and after foam formation.

We claim:

1. A compounded lubricating oil comprising a petroleum lubricating oil, containing an oil-soluble metal salt selected from the group consisting of polyvalent metal phenates and polyvalent metal salts of organo substituted acids of phosphorus, and in an amount sufficient substantially to increase the tendency of the lubricating oil to foam excessively at temperatures above about 150° F., and under conditions of severe oil agitation and intermixture with gas, and a small amount, sufficient to inhibit foaming of the oil, of an alkoxy phenol which contains not less than 15% by weight of oxygen and has a molecular weight not higher than 270.

2. The composition of claim 1, wherein said phenol is vanillyl alcohol.

3. The composition of claim 1, wherein said phenol is 2-hydroxy-3-methoxy benzaldehyde.

4. The oil of claim 1, wherein said alkoxy phenol is present in the oil in an amount of about 0.001 to 0.5 per cent by weight based on finished oil.

5. A compounded lubricating oil comprising a petroleum lubricating oil, an oil-soluble polyvalent metal phenate, and a small amount, sufficient to inhibit foaming of the oil, of an alkoxy phenol which contains not less than 15% by weight of oxygen and has a molecular weight not higher than about 270.

6. A compounded lubricating oil comprising a petroleum lubricating oil, an oil-soluble polyvalent metal salt of an organic substituted acid of phosphorus and a small amount, sufficient to inhibit foaming of the oil, of an alkoxy phenol which contains not less than 15% by weight of oxygen and has a molecular weight not higher than 270.

7. A compounded lubricating oil comprising a petroleum lubricating oil, a small amount each, sufficient to stabilize the oil and to inhibit piston discoloration and piston ring sticking in an internal combustion engine, of an oil-soluble polyvalent metal phenate and an oil-soluble polyvalent metal salt of an organic substituted acid of phosphorus, and a small amount, sufficient to inhibit foaming of the oil, of an alkoxy phenol which contains not less than 15% by weight of oxygen and has a molecular weight not higher than 270.

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JAMES O. CLAYTON.

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Certificate of Correction

Patent No. 2,528,465

October 31, 1950

VICTOR N. BORSOFF ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 12, line 3, after the word "soluble" insert *foam-promoting*; and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of January, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.