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CUTTING OIL

Louis A. Herrmann, Jersey City, N. J., and Theodore G. Roehner, Malverne, N. Y., assignors to Socony-Vacuum Oil Company, Incorporated, New York, N. Y., a corporation of New York

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This invention is directed to improvements in cutting oils, and particularly to improvements in the so-called soluble cutting oils.

Cutting oils are used in the lubrication of machine tool work, being applied at the point of contact of tool and work in such operations as lathe work, drilling, gear cutting, broaching and the like.

The functions of a cutting oil are to lubricate the point of contact of the tool and work, and of the tool and chip; also to carry away heat, to avoid the overheating of the tool or work. Failure of either function will give rise to consequent bad effects on the work, short useful life of tool between sharpening or reshaping and the like. The characteristics by which cutting oils are judged are such things as speed with which work may be performed with a given lubricant without serious overheating, etc., degree of cooling for a given speed of working, freedom from corrosion of finished surfaces of work, stability of lubricant ingredients, freedom from ingredients of an infectious nature or likely to carry infection, stability under repeated re-use, and the like.

For certain classes of lubrication in this art, there have been used what are known as soluble oils, or soluble cutting oils. These oils are hydrocarbon oils of mineral or animal origin, to which has been added a proportion of some compound capable of enabling the oil to be suspended as an oil-water emulsion, the emulsion being applied as the cutting lubricant and coolant. It is specifically with oils of this type that this invention has to do.

Oils of this type heretofore commonly used consist mainly of a hydrocarbon oil, together with an emulsifier. The oil may be all of mineral origin or may have a varying proportion of animal or vegetable oils, such as degras or castor oil.

We have found that by the addition to these oils of sulphur in an easily available form we are enabled to provide oils capable of giving exceptionally greater service than similar oils not containing available sulphur.

An object of this invention is to provide soluble cutting oils containing substantial and effective proportions of readily available sulphur. A further object is to provide such oils in which the sulphur is present in a stable form capable of withstanding storage and repeated re-use. Another object is to provide such oils with the property of emulsifying with water of any degree of hardness usually found. Further objects are the provision of oils of this type with varying percentages of available sulphur, freedom from offensive odor, freedom from infectious characteristics, and such further objects as may hereinafter appear.

As an example of one product embodying the invention, we may cite the following composition.

Formula I

	Weight per cent
Emulsifying base	20.0
Non-corrosive base	10.0
Paraffine oil	70.0

The physical properties of the resulting product are as follows:

Gravity, °A. P. I.	19.5
Flash, open °F.	350
Fire, °F.	400
Pour, °F.	20
Saybolt viscosity @ 100° F.	450''
Color, A. S. T. M.	Dark 8

The amounts of ingredients used in this formula may be varied between the following limits.

	Min.	Max.
Emulsifying base—weight per cent—	10	50
Non-corrosive base—weight per cent—	5	25
Paraffine oil—weight per cent—	85	25

In the above formula, the emulsifying base used is a sulphonated mineral oil plus soda soaps of oleic acid and rosin, containing some free oleic acid. For this emulsifying base there may be substituted any of the commonly used emulsifying bases, such as soaps of oleic acids, of other animal and/or vegetable acids, or the so-called "mahogany acids", which are sulphonates derived from the treating of petroleum oils with sulphuric acid.

The "non-corrosive base" is a compound formed by reacting together the following ingredients.

	Per cent
Flowers of sulphur	10
Crude corn oil	70
Common degras	20

Similar sulphur-bearing bases may be made by sulphurizing many animal, fish, vegetable, and other oils, such as sulphurized oleic and stearic acids, sulphurized whale oil, sulphurized soya bean oil, sulphurized hydrocarbon oils, sulphurized terpenes, and the like. These sulphurized oils are characterized by the presence of sulphur in dissolved form, as distinguished on the one

hand from compounds containing sulphur in particle form in suspension, and on the other hand from compounds containing sulphur in a closely bonded chemical combination from which the sulphur may not be separable and available under conditions of cutting oil use to lend an increased lubricating ability to the compound. These sulphurized bases are formed by heating together proper proportions of oil and sulphur and when properly made are homogeneous and do not deposit sulphur on standing. They are also stable against deposition of sulphur when placed in the form of highly dilute emulsions with water after the manner disclosed herein.

The paraffine oil is a light mineral oil of approximately 100 seconds viscosity, Saybolt Universal at 100° F. Lighter and heavier oils may be used, ranging from oils of 80 seconds viscosity (S. U. V.) at 100° F. upward, the heavier oils being used for services characterized by higher loading. This soluble sulphurized cutting oil is made by agitating the various ingredients together in a steam jacketed kettle at 100–150° F. until uniformly blended and then drawing into drums. An emulsion thereof made by stirring one volume of the finished oil into fifteen volumes of tap water should show only slight separation after standing 48 hours.

Similarly effective soluble lubricant oils may be made after the following formula.

Formula II

	Weight per cent
Emulsifying base	20.0
Sulphurized mineral oil	80.0

The physical properties of the resulting product are as follows:

Gravity, °A. P. I.	19.8
Flash, open °F.	360
Fire, °F.	420
Pour, °F.	25
Saybolt viscosity @ 100° F.	410''
Color, A. S. T. M.	Dark 7

In this formula, the base is the same as previously used, or any of the equivalents above noted. The sulphurized mineral oil is formed by dissolving about 1.5% of sulphur, by weight, in a light paraffine oil of approximately 150 seconds viscosity, (Saybolt Universal), at 100° F., by heating the oil and sulphur together until combination is effected. The oil used may be any light paraffine oil, less viscous or more viscous. The sulphur content of the oil may be varied from 0.5 per cent to 4.0 per cent.

In the above formula, the proportions of the ingredients may be varied from about 10% of emulsifying base as a minimum to about 50% of that base as a maximum.

The above formulae are capable of emulsification to a stable suspension in waters of the ordinarily neutral grade. In waters of extreme hardness emulsions made with soluble oils are frequently unstable and have relatively poorer lubricant value. In order to correct this, there may be added to these novel cutting oils, as for instance, those manufactured under Formula II, from about 8 per cent to about 30 per cent of a compound which we designate as a potash-rosin oil soap base. This ingredient is usually added in amounts of from 10 per cent to 17 per cent, this range being capable of handling waters of the usual range of hardness. A typical preferred percentage of this ingredient is 12.5 per cent. This ingredient consists of a rosin oil or rosin, saponified with an aqueous solution of caustic potash to such an extent that the final product comprises approximately 40 per cent of potash rosin soap, a maximum of 8 per cent of moisture, and a reaction approximately neutral. Other soaps may be used for this purpose, such as the equivalent soda soaps, or certain sodium-sulphonated soaps, but we prefer to use the potash or soda rosin soaps indicated, since other soaps usually must be present in large quantities to be effective and their use is not economical.

Similar results may be gotten by incorporating alcohols, and like mutual solvents, which may so modify surface tensions within the system or emulsion formed that the destructive effect of hard water is prevented. For example, methanol or diethylene glycol may be added in percentages ranging from 1.5 to 7.0 depending upon the hardness of the water and the acidity of the soluble oil.

These cutting oils are best evaluated by actual use, and comparative use of these novel products and the products heretofore available has indicated greatly enhanced properties in these novel cutting oils. For example, the oil set forth in Formula I when emulsified with water in the proportions of one part of oil to ten parts of water, and subjected to comparative tests with a good non-sulphurized cutting oil available on the market enabled the user to obtain about double the tool life obtained with the competitive oil. In a similar test, in which the oil of Formula II was emulsified one to four with water, it was found that tools lubricated with this emulsion yielded 900 pieces of work per tool grind while a good non-sulphurized competitive oil yielded only 150 pieces per grind.

Laboratory tests of such oils are of comparative value only as the best test is that of use. An indicative laboratory test does exist in the use of the Almen pin test machine, described by Moughey & Almen, (Proc. A. P. I. 1931 page 77), wherein a pin is rotated in bearings so designed that increasing pressures may be applied to the lubricated surface. This machine is widely used in such comparative evaluations. In the following tabulation, the results of test runs are given, wherein emulsions of the novel oils compounded according to the formulae above described are compared with emulsions prepared from competitive oils which do not embody the characteristic feature of available sulphur. In this tabulation, the right hand column indicates the degree of load which caused failure by seizing of the bearing and pin.

Soluble oil	Pounds per square inch load before failure
Formula I	+15000
Formula II	+15000
Competitive oil A	2000
Competitive oil B	3000
Competitive oil C	1500
Competitive oil D	5500
Competitive oil E	2500
Competitive oil F	2500

Competitive oils A to F inclusive are all compounds regularly supplied to the trade for the same purposes for which the novel oils of this invention are intended. No one of these oils contains an available sulphur ingredient. All of these oils were tested as emulsions containing

one part of the soluble oil and ten parts of water.

The method of compounding these oils is simply one of stirring in steam jacketed kettles fitted with paddles at a temperature of 100° F. to 150° F. until the product is uniform, after which it is drawn off directly into containers for sale.

Where used in the claims, the expression "sulphurized base" denotes a mineral oil or fatty oil, as described above, to which elementary sulphur has been added by a process of heat treating a mixture of sulphur and oil, the sulphur contained therein, either in solution or in loosely bound chemical combination, being available under conditions of cutting oil use to increase the load-bearing capacity of the lubricating compound.

We claim:

1. A lubricant of the class denoted as "soluble cutting oils", comprising a hydrocarbon oil, sufficient emulsifying base to bring about substantially immediate and permanent emulsion in water of ordinary neutral quality, and a "sulphurized base", said last-named ingredient being present to an extent sufficient to substantially increase the load-bearing capacity of the compound.

2. A lubricant of the class denoted as "soluble cutting oils", comprising a hydrocarbon oil, sufficient emulsifying base to bring about substantially immediate and permanent emulsion in water of ordinary neutral quality, and in the hydrocarbon oil, incorporated therein by heat treatment, sufficient sulphur to substantially increase the load-bearing capacity of the compound.

3. A lubricant of the class denoted as "soluble cutting oils", adapted for use as a permanently stable emulsion in hard water, comprising a hydrocarbon oil, sufficient emulsifying base to bring about substantially immediate and permanent emulsion in water of ordinary neutral quality and softness, sufficient "sulphurized base" to substantially increase the load-bearing capacity of the compound, and an additional amount of a water-hardness-correcting rosin soap of a strong alkali.

4. A lubricant of the class denoted as "soluble cutting oils", adapted to readily form permanently stable emulsions in water of ordinary neutral quality and containing sufficient sulphur to substantially increase the performance of the lubricant, comprising from 10 to 50 weight per cent of an emulsifying agent, from 5 to 25 weight per cent of a "sulphurized base", and from 85 to 25 weight per cent of a light hydrocarbon mineral oil.

5. A lubricant of the class denoted as "soluble cutting oils", adapted to readily form permanently stable emulsions in water of ordinary neutral quality and containing sufficient sulphur to substantially increase the performance of the lubricant, comprising from 10 to 50 weight per cent of an emulsifying base, and from 90 to 50 weight per cent of a light hydrocarbon lubricant oil in which there has been incorporated, by heating with sulphur, from 0.5 to 4% of its weight of sulphur.

6. A lubricant of the class denoted as "soluble cutting oils", adapted for use as a permanently stable emulsion in hard water and containing sufficient sulphur to substantially increase the performance of the lubricant, comprising the mixture set forth in claim 4 and in admixture therewith an additional amount of a rosin soap of a strong alkali, in the amount of from 10 to 30 weight per cent of the first mixture.

7. A soluble cutting oil lubricant having the following composition:

	Per cent by weight
Emulsifying base	20
"Sulphurized base"	10
Paraffine oil	70

8. A soluble cutting oil lubricant having the following composition:

	Per cent by weight
Emulsifying base	20
Mineral oil (containing 1.5% sulphur)	80

9. A soluble cutting oil lubricant having the following composition:

	Per cent by weight
Emulsifying base	17.5
"Sulphurized base"	8.7
Paraffine oil	62.3
Potash rosin soap	12.5

LOUIS A. HERRMANN.
THEODORE G. ROEHNER.