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CLEANING METAL SURFACES

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This invention relates to improvements in the cleaning of metal surfaces. It relates more particularly to improvements in the removal of grease, oil and similar dirt of various kinds (herein designated by the inclusive term "greasy residues") from the surfaces of metal objects as a step in the fabrication of the metal into a finished product having a coating on the surface of the metal.

An object of the invention is to provide improvements in the cleansing of metal surfaces whereby economies in the cleansing process may be effected.

Additional objects of the invention are to provide improvements in alkaline cleansing baths for removing grease, oil and similar dirt from metal surfaces whereby the cleansing action of said alkaline baths may be increased; to provide improvements in such alkaline cleansing baths whereby the rapidity of cleansing metal surfaces by said baths may be increased; to provide improvements in such alkaline cleansing baths whereby the power of said baths to retain removed oil, grease and dirt without impairment of the effectiveness of said baths as cleansing agents for metal may be increased; and to provide improvements in such alkaline cleansing baths whereby increased effectiveness of said baths as cleansing agents for metal surfaces may be obtained in connection with the use of said baths in cleansing processes involving electrolytic action.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

Many processes for the fabrication of metal products involve an operation in which a coating is applied to the surface of metal, either for protective or decorative purposes. Thus, metal objects of various sources and fabricated from ferrous or non-ferrous metals, are electroplated, painted, enameled, lacquered or otherwise treated to provide a finished article comprising a metal surface having a coating of another metal or of other coating material applied thereto. In connection with the fabrication of such coated metal articles, it is essential that the surface of the metal subjected to the application of the coating be free from grease, oil, scale and dirt of all kinds which would tend to interfere with the uniform adherence of the coating to the surface of the metal.

One method heretofore proposed for cleaning metal surfaces to prepare them for subsequent treatment, and particularly coating thereof, involves immersing the metal objects in baths containing non-aqueous solvents for greases; as for example, trichloroethylene, petroleum distillates, coal tar distillate, etc. Such non-aqueous solvents have many disadvantages, however; for example, many of them are inflammable; the vapors of many of them are toxic to workmen; and they usually require expensive systems for the recovery and purification of the soiled solvents for reuse. Further, in connection with the cleansing of many steel surfaces, a form of dirt known as "smut" (usually finely divided carbon) is left adhering to the metal after the cleaning treatment, especially when the steel has been subjected to a previous acid treatment.

With a view to overcoming these disadvantages, processes have been devised for cleansing metal surfaces, and particularly ferrous metal surfaces, wherein the metal objects to be cleaned are immersed in an aqueous alkaline bath which is heated to a relatively high temperature, in some cases after subjecting the metal objects to a preliminary treatment with an organic solvent. When the metal is removed from the treatment bath it is washed with water to remove adhering alkaline aqueous liquor. It is then in a clean condition ready for further aqueous treatments or drying prior to further treatment.

Sometimes the treatment in the aqueous alkaline bath is carried out in conjunction with the passage of an electric current through the bath, the metal objects being made the anode or the cathode, whereby the electrolytic action, together with such additional mechanical action as may result from the passage of the electric current (e. g., formation of bubbles and agitation by the gases liberated at the surface of the metal) aids in the removal of undesired impurities from the metal surface. The action of the hot alkali on the soil adhering to the metal surface in some cases effects a saponification of the oil or grease, or in other cases produces an emulsification of the dirt, according to the chemical nature of the constituents of the soil. When the treatment is supplemented by the passage of an electric current through the aqueous alkaline bath serving as the electrolyte of an electrolytic cell in which the metal to be cleaned is made the anode or cathode, the gases generated on the surface of the metal detach adhering foreign substances, and in some cases the metal surface itself may be modified by formation of a film of oxide, or by reduction of oxides which may be on the surface of the metal to the metal itself, according as the metal to be cleaned is made the anode or the cathode of the cell.

The aqueous alkaline solutions resulting from the cleansing of the metal surfaces is employed for the treatment of additional soiled metal until the concentration of dirt, grease, saponification products, and/or other soil in the bath becomes so great as to interfere with the efficient action of the bath.

According to the present invention improvements in the cleansing of metal surfaces by the use of aqueous alkaline baths are effected by incorporating into the aqueous alkaline baths higher alkyl aromatic sulfonates of the type hereinafter more fully described. I have found, in accordance with the present invention, that the presence of higher alkyl aromatic sulfonates of said type in alkaline solutions employed for cleaning metal surfaces increases the cleansing power of said solutions, as a result of which the said solutions are enabled to degrease and cleanse the metals more speedily and more effectively. I have further found, in accordance with the present invention, that the presence of higher alkyl aromatic sulfonates of said type in the alkaline solutions employed for cleaning metal surfaces increases the ability of said alkaline solutions to disperse, emulsify and/or absorb soil removed from the metal surfaces, as a result of which the effective period of usefulness of said alkaline cleaning solutions is greatly increased.

The amounts of said higher alkyl aromatic sulfonates necessary to effect the improvements are small and are usually only a fraction of the amount (on a weight basis) of the alkaline substances present in alkaline aqueous cleansing solutions.

I have also found, as a further feature of the present invention, that by reason of the emulsifying action of said higher alkyl aromatic sulfonates toward organic substances which are solvents for grease and oil and which are normally insoluble in water, such organic solvents can be emulsified in alkaline aqueous solutions, and accordingly alkaline aqueous cleansing solutions can be prepared containing both organic solvents and alkali; thereby making it possible to secure the cleansing action of both types of cleansing agents in a single aqueous cleansing bath. The following organic compounds exemplify some of the types of organic solvents which can be used in the metal cleaning processes and compositions of this invention:

Tetrahydronaphthalene
Hexahydronaphthalene
Decahydronaphthalene
Butyl acetate
Diethylene glycol monoethyl ether
Diethylene glycol monomethyl ether
Diethylene glycol monobutyl ether
Ethylene glycol monoethyl ether
Ethylene glycol monomethyl ether
Ethylene glycol monobutyl ether
Dibutyl phthalate
Dichlorethyl ether
Ethylene dichloride
Isopropyl alcohol
N-hexyl alcohol
Methyl amyl alcohol
Octyl alcohol
Methyl amyl acetate
Ethylene glycol monomethyl ether acetate
Ethylene glycol monoethyl ether acetate
Perchlorethylene (tetrachlorethylene)
Stoddard solvent

The higher alkyl aromatic sulfonates which may be employed in the practice of the present invention are the alkyl derivatives of aromatic mono- and polysulfonic acids and their salts, containing at least one nuclear alkyl radical of 7 or more carbons. (The term "nuclear" as employed herein refers to substituents for hydrogen atoms in the aromatic nucleus.)

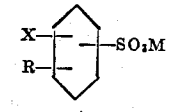
The aromatic nuclei of said higher alkyl aromatic sulfonates may be mononuclear (i. e., a member of the benzene series) or polynuclear, whether condensed polynuclear (e. g., of the naphthalene series, etc.) or uncondensed polynuclear (e. g., of the diphenyl series). They may contain 1 or more nuclear alkyl radicals of 7 or more carbon atoms, and 1 or more nuclear sulfonate groups (sulfonic acid groups or salts thereof). They may be free from further substituents or they may contain 1 or more additional nuclear substituents. Examples of such additional nuclear substituents are halogen, and hydroxyl, lower alkyl, alkoxy, carboxyl (in the free acid or salt form), aryloxy, amino and alkylamino groups.

The higher nuclear alkyl radical is preferably an aliphatic hydrocarbon radical containing at least 10 carbon atoms. It may be an open chain hydrocarbon radical containing a straight or branched carbon chain, or it may be a cyclo aliphatic radical.

Examples of such higher alkyl aromatic sulfonates are:

Potassium heptyl naphthol sulfonate
Sodium methyl-cyclohexyl naphthalene sulfonate
Sodium lauryl naphthalene sulfonate
Sodium cetyl benzene sulfonate
Ammonium dodecyl phenetol sulfonate

The higher alkyl aromatic sulfonates which are especially effective and useful for improving the cleansing power of various alkaline solutions for cleaning metal surfaces, applied with or without the aid of an electric current, are those which are aromatic monosulfonates of the benzene series containing 10 or more, and preferably 10 to 19, carbon atoms in a single alkyl radical and which correspond with the formula



in which X represents hydrogen, halogen, or one of the groups hydroxyl-, alkyl-, alkoxy-, (e. g., methoxy-, ethoxy-, benzyloxy-, etc.) aryloxy (e. g., phenoxy, etc.), carboxy-, amino- and alkylamino-; R represents an alkyl hydrocarbon radical, saturated or unsaturated, containing ten or more, and preferably ten to nineteen carbon atoms; and M represents hydrogen, or a metal or an ammonium or organic ammonium radical. For convenience, they are hereinafter referred to as "monoalkyl aromatic sulfonates of the benzene series," which term generically includes said sulfonates, whether in the form of the free sulfonic acids or their salts.

Preferred compounds employed in accordance with the present invention are the mixed monoalkyl aromatic sulfonates of the benzene series in which the higher alkyl radicals correspond with the aliphatic hydrocarbons of petroleum distillates, and similar products, boiling above 170° C., and which are obtainable by halogenation of a petroleum distillate or similar

product, and especially of an aliphatic hydrocarbon mixture of the Pennsylvania petroleum kerosene type of which at least 80 per cent boils above 170° C., followed by condensation of resulting mixed alkyl halides with an aromatic compounds (e. g., benzene, phenol, cresols, phenetol, etc.), preferably with the aid of a metal halide condensing agent, and sulfonation of resulting mixed alkyl derivatives of the aromatic compound.

This invention includes the use of the free sulfonic acids and various salts of the said sulfonic acids in which the hydrogen of the sulfo or other acidic groups is replaced by an inorganic or organic salt-forming radical. Among the more easily procured salts are the ammonium, alkali-metal, alkaline earth metal salts, and the salts in which the acidic groups are neutralized by the more common organic bases, such as mono-, di-, or triethanolamine, pyridine, ethylene diamine, amylamines, triethylene tetramine, etc. If the salt-forming basic component is polybasic, it may be neutralized in part with the above defined sulfonic acids and in part by other suitable acidic materials.

The following example illustrates a method of preparing alkyl aromatic sulfonates useful in connection with the present invention. It will be evident from a consideration of the disclosure herein that the invention is not limited to the use of products prepared in this manner but includes products of the type referred to herein when prepared in other ways. The parts are by weight and temperatures are in degrees centigrade.

Example 1

A hydrocarbon fraction boiling from 180° to 300° and obtained from a Pennsylvania crude oil was chlorinated in the presence of catalytic amounts of iodine at a temperature below 60°. The chlorination was continued until the specific gravity of the chlorinated hydrocarbon reached 0.92. This corresponds to an average of one and one-quarter atoms of chlorine per molecule of hydrocarbon. 2035 parts of this chlorinated hydrocarbon were rapidly added to a mixture of 1320 parts of benzene and 132 parts of anhydrous aluminum chloride. The mixture was agitated for 5 hours and then allowed to stand overnight. The oil was decanted from the aluminum chloride sludge and washed with an equal volume of water. The unreacted benzene and a part of the unreacted petroleum distillate were removed by distilling up to 100° at 25 mm. pressure. The remaining oil was mainly a mixture of alkyl derivatives of benzene. 400 parts of the resulting mixed alkyl derivatives of benzene were sulfonated with 330 parts of 26 per cent oleum by adding the oleum to the oil at 10°, and then agitating at room temperature for two and one-half hours. The mixture was then allowed to stand for about a half hour and the upper layer of unsulfonated material was drawn off. The lower sulfonate layer was then added to 110 parts of ice keeping the temperature below 35° and allowed to stand for about 2 hours, or until residual sulfuric acid separated from the alkyl benzene sulfonic acids. The residual sulfuric acid was drawn off and the mixed alkyl benzene sulfonic acids were recovered in the form of sodium salts by neutralizing with sodium hydroxide (for example, by treatment with a 50 per cent aqueous solution of caustic soda in an amount sufficient to render the resulting solution neutral to Brilliant Yellow and Congo Red papers) and evaporating the neutralized solution to dryness. In a similar manner, other salts of the mixed alkyl benzene sulfonic acids can be obtained.

Other examples of methods of preparing alkyl aromatic sulfonates useful in connection with the present invention are disclosed in United States Patents Nos. 2,195,409, 2,196,985, 2,249,757 and 2,283,199.

The following examples illustrate the use of the products herein described. It will be understood, however, that these examples are merely illustrative and that any of the other monoalkyl aromatic sulfonates herein disclosed may be similarly employed.

Example 2

An alkaline metal-cleaning solution was prepared by dissolving caustic soda and alkaline salts in water. The ingredients employed consisted of the following, in parts by weight:

Caustic soda ($NaOH$)	10
Trisodium phosphate ($Na_3PO_4.12H_2O$)	30
Sodium meta silicate ($Na_2SiO_3.5H_2O$)	20
Soda ash (Na_2CO_3)	40
	100

The proportions of ingredients employed were in the ratio of 6 ounces of the resulting mixture per U. S. gallon of water. To the resulting solution, one-third ounce was added of the product of Example 33 of United States Patent No. 2,196,985 (comprising about 45 per cent of sodium higher alkyl phenol sulfonates and about 55 per cent of inert salts, mainly sodium sulfate), equivalent to about one-sixth ounce on a salt-free basis, and the resulting solution was heated to between 160° F. and the boiling point of the solution.

Greasy iron plate was immersed in the resulting hot alkaline solution for 2 to 6 minutes, then removed and rinsed in water. The resulting iron plate was free from grease and dirt and was ready for further processing. When subjected to electroplating with nickel, uniformly adherent nickel coatings were obtained.

The alkaline solution was repeatedly used for the cleansing of greasy iron plates for a total period of three and one-half weeks before it had to be discarded because of accumulated impurities. Under the same conditions of treatment a solution to which the said alkyl phenol sulfonate product was not added, but which was otherwise the same, had to be discarded after a total period of only two weeks.

Example 3

A similar alkaline metal-cleaning solution was prepared by employing one-third ounce of the product of Example 1 in preparing the alkaline metal-cleaning solution of Example 2. The resulting solution had similar advantageously rapid and effective cleansing action on greasy iron plate, and emulsifying and dispersing action on the removed soil.

Example 4

A similar alkaline metal-cleaning solution was prepared by employing one-third ounce of the product of Example 9 of United States Patent No. 2,249,757 in preparing the alkaline metal-cleaning solution of Example 2. The resulting solution had similar advantageously rapid and effective cleansing action on greasy iron plate,

and emulsifying and dispersing action on the removed soil.

Example 5

A similar alkaline metal-cleaning solution was prepared by employing one-third ounce of the product of Example 2 of United States Patent No. 2,195,409 in preparing the alkaline metal-cleaning solution of Example 2. The resulting solution had similar advantageously rapid and effective cleansing action on greasy iron plate, and emulsifying and dispersing action on the removed soil.

Example 6

Alkaline metal-cleaning solutions were prepared by employing the same components as outlined in Examples 2, 3, 4 and 5 in the same amount, and mixing with these solutions 1 to 10 ounces of any one of the organic solvents listed at bottom of p. 2, col. 1, for each U. S. gallon of water therein; for example, 2 ounces of diethylene glycol monoethyl ether (per U. S. gallon of water) to the solution of Example 2. The resulting mixtures or emulsions possessed the advantages of having more pronounced, rapid, effective cleansing action on greasy iron plate and emulsifying and dispersing action on the removed soil. Instead of a single organic solvent, a mixture of two or more of said organic solvents may be employed. The amount of particular organic solvent or solvent mixture employed depends on the ease with which it can be emulsified with the alkaline cleaning solution employed.

It will be realized by those skilled in the art that changes may be made in the processes and compositions hereinbefore described without departing from the scope of the invention.

Thus the ingredients and proportions thereof employed in the preparation of the alkaline compositions may be varied. For example, any of the following mixtures of alkalies may be employed instead of those employed in above Examples 2, 3, 4, 5 and 6:

Alkaline mixture No.	Caustic soda	Trisodium phosphate	Sodium meta silicate	Soda ash
1	10	55	----------	35
2	10	----------	50	40
3	10	50	30	10

The proportions of the above alkaline constituents and those employed in Examples 2, 3, 4, 5 and 6 may vary from 3 ounces to 10 ounces of the alkaline mixture per U. S. gallon of water.

The higher alkyl aromatic sulfonates employed in accordance with the present invention have the advantage of being stable even in hot alkaline solutions and of forming salts with a number of heavy metals, which salts are soluble in the alkaline cleaning baths. They may therefore be used in a wide variety of alkaline metal cleaning processes under a variety of conditions. The amount of higher alkyl aromatic sulfonate employed in Examples 2, 3, 4, 5 and 6 may vary from ⅛ to 1 ounce of higher alkyl aromatic sulfonate (on a salt-free basis) per U. S. gallon of water.

The compositions of Examples 2, 3, 4, 5 and 6 and their equivalents can be used as electrolytic baths for the cleansing of metals by an electrolytic process in which the metal to be cleansed is made the anode or cathode. When employed for this purpose, the current density is preferably maintained between 10 amperes and 40 amperes per square foot of surface being cleaned and the temperature of the bath is preferably adjusted to between 160° F. and 212° F. The presence of the higher alkyl aromatic sulfonates in such electrolytic baths increases the rapidity and effectiveness of the cleaning.

I claim:

1. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises carrying out the metal cleaning with the aid of an alkaline aqueous solution containing a small amount of an alkyl aromatic sulfonate having at least 7 carbon atoms in an alkyl radical, as a cleansing assistant and as an emulsifying agent for the residues.

2. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises subjecting the metal to be cleaned to the cleansing action of a hot aqueous alkaline solution containing a small amount of an alkyl aromatic sulfonate having 10 to 19 carbon atoms in an alkyl radical, as a cleansing assistant and as an emulsifying agent for the residues.

3. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing a monoalkyl aromatic sulfonate of the benzene series having at least 7 carbon atoms in an alkyl radical in an amount not exceeding one ounce of said sulfonate per gallon of water, as a cleansing assistant and as an emulsifying agent for the residues.

4. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing caustic alkali and alkaline salts in a small amount and a lesser amount of a monoalkyl aromatic sulfonate of the benzene series having 10 to 19 carbon atoms in an aliphatic hydrocarbon radical, as a cleansing assistant and as an emulsifying agent for the residues.

5. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing caustic alkali and alkaline salts in a small amount and a lesser amount of a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have at least 10 carbon atoms and correspond with the aliphatic hydrocarbons of petroleum distillates, as a cleansing assistant and as an emulsifying agent for the residues, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water.

6. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing caustic alkali and alkaline salts in a small amount and a lesser amount of a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have 10 to 19 carbon atoms and correspond with the aliphatic hydrocarbons

of petroleum distillates, as a cleansing assistant and as an emulsifying agent for the residues, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water.

7. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing per gallon of water one-eighth to one ounce of an alkyl aromatic sulfonate having at least 7 carbon atoms in an alkyl radical, as a cleansing assistant and as an emulsifying agent for the residues, while passing an electric current through said bath and through said metal as an electrode.

8. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises immersing the metal to be cleaned in a hot aqueous alkaline cleansing bath containing caustic alkali and alkaline salts in a small amount and a lesser amount of a monoalkyl aromatic sulfonate of the benzene series having 10 to 19 carbon atoms in an aliphatic hydrocarbon radical, as a cleansing assistant and as an emulsifying agent for the residues, the amount of the sulfonate not exceeding one ounce per gallon of water, while passing an electric current through said bath and through said metal as an electrode.

9. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises carrying out the metal cleaning with the aid of an alkaline aqueous solution containing a small amount of an alkyl aromatic sulfonate having at least 7 carbon atoms in an alkyl radical, as a cleansing assistant and as an emulsifying agent for the residues, and containing an organic liquid which is a solvent for grease and oil and which is insoluble in water, emulsified in said solution by means of said alkyl aromatic sulfonate.

10. In the process of cleaning metal surfaces involving removal of greasy residues by treatment with an alkaline aqueous cleansing composition, the improvement which comprises subjecting the metal to be cleaned to the cleansing action of a hot aqueous alkaline solution containing a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have 10 to 19 carbon atoms and correspond with the aliphatic hydrocarbons of petroleum distillates, as a cleansing assistant and as an emulsifying agent for the residues, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water, and containing a small amount of an organic liquid which is a solvent for grease and oil and which is insoluble in water, emulsified in said solution by means of said mixture of sulfonates.

11. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts and an alkyl aromatic sulfonate having at least 7 carbon atoms in an alkyl radical, the amount of the sulfonate not exceeding one ounce per gallon of water.

12. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts and an alkyl aromatic sulfonate having 10 to 19 carbon atoms in an alkyl radical. the amount of the sulfonate not exceeding one ounce per gallon of water.

13. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts in a small amount and a lesser amount of a monoalkyl aromatic sulfonate of the benzene series having at least 10 carbon atoms in an alkyl radical, the amount of the sulfonate not exceeding one ounce per gallon of water.

14. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts in a small amount and a lesser amount of a monoalkyl aromatic sulfonate of the benzene series having 10 to 19 carbon atoms in an aliphatic hydrocarbon radical, the amount of the sulfonate not exceeding one ounce per gallon of water.

15. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts in a small amount and a lesser amount of a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have at least 10 carbon atoms and correspond with the aliphatic hydrocarbons of petroleum distillates, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water.

16. A metal-cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts in a small amount and a lesser amount of a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have 10 to 19 carbon atoms and correspond with the aliphatic hydrocarbons of petroleum distillates, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water.

17. A metal-cleaning composition comprising an aqueous alkaline solution containing in admixture therewith a small amount of an organic liquid which is a solvent for grease and oil and which is insoluble in water, and an alkyl aromatic sulfonate having at least 7 carbon atoms in an alkyl radical in an amount not exceeding one ounce of said sulfonate per gallon of water.

18. A metal cleaning composition comprising an aqueous alkaline solution containing caustic alkali and alkaline salts and a small amount of an organic liquid which is a solvent for grease and oil and which is insoluble in water, emulsified in said solution by means of a mixture of monoalkyl aromatic sulfonates of the benzene series in which the alkyl radicals have 10 to 19 carbon atoms and correspond with the aliphatic hydrocarbons of petroleum distillates, the amount of the mixture of sulfonates not exceeding one ounce per gallon of water.

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