

## UNITED STATES PATENT OFFICE

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CARBON REMOVER AND METAL SURFACE  
CLEANING COMPOSITION

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This invention relates to the removal of undesirable foreign deposits from metal surfaces. More particularly this invention pertains to the removal of hard carbonaceous materials, resins, varnish, lacquers, rust, abrasives, welded metal particles, and the like, from engines, turbines, industrial equipment and the like by applying thereto a novel chemical composition, each component thereof being within rather specific proportions, said composition having the ability of penetrating through the deposit, loosening it and facilitating in removing it from the metal surface, leaving the engine or other metal surfaces clean and undamaged.

The development of high power engines operating at relatively very high temperatures and heavy loads, such as internal combustion engines, Diesel engines, gasoline aircraft engines, jet engines, form, during their operation, carbon and sludge deposits which cause sticking, clogging, and wear of movable parts. This results in wear and corrosion of engine parts, and generally reduces the operating efficiency of the engine. Present developments in gas turbine engines which operate at such elevated temperatures as from 1100° F. to 1800° F. greatly accentuate this problem. Thus, gas turbine engine parts such as the compressor blades and turbo-jet units such as turbo-super charged engines as well as other industrial units such as heat exchange elements, torque converter transmissions, air and gas compressor valves, etc., become coated within relatively short periods of time with thick layers of carbonaceous and other foreign deposits which must be removed. These deposits adhere so tenaciously to the surface that the only way to remove them at present is by hand scraping or by soaking in chemical solutions for long periods of time. Such drastic treatment usually results in damage caused by corrosion or pitting of the treated metal surface due to the chemical nature of the material used to remove the deposits, swelling or destruction of insulating and non-metallic parts, and chipping or cracking of metal surface due to hand scrubbing and cleaning. In addition present known deposit removers are highly toxic due to their high content of

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phenolic and/or halogen-containing materials which are a hazard and are detrimental to the health of the user. Known deposit removers also introduce a fire hazard problem due to the fact that such materials have low flash points but are only effective at elevated temperatures.

It is an object of this invention to provide a cleaning and deposit-removing composition which can be easily and readily applied to heavily carbon-coated metal surfaces at room or at slightly elevated temperatures and leave the surface clean and rust proofed. It is another object of this invention to provide a cleaning composition which is non-corrosive to the metal being cleaned and which is non-reactive with non-metallic parts with which it might come in contact. Still another object of this invention is to provide a cleaning composition which is safe to use within a relatively wide temperature range, and is non-toxic.

The above and other objects may be attained in accordance with the present invention by admixing, with a suitable hydrocarbon base, certain chemically active ingredients in rather specific proportions, each of which exerts a specific function and a co-ordinating one with the composition taken as a whole which results in a potent cleaning composition. The active ingredients of this invention comprise a hydrocarbon base admixed with specific types of detergent, wetting and coupling agents, a penetrant and water, all of which are essential. A criteria of compositions of this invention is that all ingredients which comprise it must be present at all times and in relatively specific proportional relationship to each other.

The base comprises essentially a hydrocarbon having a boiling point above that of room temperature and up to boiling temperatures of mineral lubricating oil fractions. The selection of the type of hydrocarbon base to be used depends primarily upon the intended use of the composition. Thus, if the composition is to be used mainly as a carbon remover, a relatively light petroleum hydrocarbon fraction, such as kerosene, is preferred, although mineral seal oil, gas oil, various petroleum naphtha cuts, mineral

spirits, kerosene  $\text{SO}_2$  extracts, aromatic solvents, petroleum ether, aromatic hydrocarbons such as benzene, p-xylene, o-xylene, m-xylene, cumene, butylbenzenes; paraffinic hydrocarbons, e. g. normal hexane, dimethyl pentane, octane, isooctane, undecane, dodecane; cycloparaffins, e. g. cyclohexane, methylcyclohexane, isopropylcyclohexane, can be used. In cases where compositions of this invention are to be used as flushing oils in addition to functioning as carbon and engine deposit removers, a petroleum hydrocarbon having some lubricating properties such as a mineral lubricating oil should be used. The amount of base used can vary from between about 12% to about 50% by weight, and preferably between about 12% and 20% by weight of the composition.

Detergents of this invention function both in a chemical and physical manner. Primarily they help to keep finely divided carbon and resinous particles formed during operation of internal combustion engines, turbines and the like or deposits already formed but loosened from a surface by suitable means, in a state of suspension thereby preventing their adherence to or build-up on a surface. This is due to the adsorptive action of the detergents, making the carbon particles and other deleterious matter with which they come in contact large enough and light enough so that their settling rate is greatly retarded and therefore they tend to remain in suspension. In addition the detergents co-act with other constituent materials of this invention so as to aid in loosening and removing deposits from surfaces and at the same time not interfere with the activity of other additives present. They are also thermally stable, resist oxidation and attack by active corrosive materials.

It has been found that only a limited number of detergents have the above properties when employed in conjunction with other additives of this invention. Broadly they include the amine and ammonium salts of organic and inorganic acids, as well as the alkali metal salts thereof. They can best be formed by combining salts of primary, secondary and tertiary amines containing from about 8 to about 20 carbon atoms, e. g. octyl, nonyl, undecyl, stearyl, dibutyl, diamyl, dioctyl, didecyl, triethyl, tributyl amines; alkylolamines, e. g. mono-, di- and triethanolamine, diethylethanolamine, dimethylethanolamine, monoethylethanolamine, phenylethanolamine, phenyldiethanolamine, ethylphenylethanolamine, mono-, di- and triisopropanolamine; heterocyclic amines, e. g. morpholine, methyl morpholine, ethyl morpholine, phenyl morpholine; cyclic amines, e. g. cyclohexylamine, dicyclohexylamine; and ammonium and alkali metals, e. g. sodium, potassium, lithium, with the following acidic materials: saturated and unsaturated fatty acids containing up to about 20 carbon atoms, terpene acid derivatives such as abietic and rosin acids, naphthenic and sulfonic acids as well as inorganic acids such as phosphoric acid and the like. The following detergents are particularly suitable for use in this invention: diethylethanolamine oleate, diethylethanolamine stearate, laurylamine acetate, laurylamine stearate, laurylamine abietate, laurylamine naphthenate, laurylamine ricinoleate and laurylamine phosphate; morpholine oleate, ethyl morpholine oleate, morpholine stearate, morpholine naphthenate; cyclohexylamine ricinoleate, cyclohexylamine phosphate; ammonium ricinoleate; sodium petroleum sulfonate, etc. The detergent is used in

amounts varying from 2 to 15% and generally is kept between about 4 to 8% by weight.

The function of a good penetrant is to penetrate through interfering layers of deleterious materials and loosen them from the surface to which they adhere. To accomplish this a penetrant must possess low degree of volatility, low surface tension and high capillary or creeping properties so that once having penetrated through the foul matter adhering to a surface it can displace it therefrom and leave on said surface a protective oiliness film which if desired can be easily removed by flushing, for example, with steam and the like. The protective film acts as a boundary separator between contacting surfaces thereby protecting them from wear and the like. Penetrants which are particularly suitable due to their co-ordinate action with other constituents of this invention so as to produce a product having maximum efficiency in removing foul matter from surfaces are halogenated aliphatic and aromatic compounds, e. g. trichloroethylene, 2,2-dichloroethylether, O-dichlorobenzene, dichloroisopropylether, etc.; ketones, e. g. mesityl oxide, isophorone; and mixture of the above halogenated compounds and ketones. The penetrant generally comprises approximately 20% to 40% by weight of the composition.

To activate and improve the general properties of compositions under consideration a wetting agent is employed which co-acts with the above penetrants and wets the surface which has been rendered free of the deleterious materials by the active ingredients of this composition. The surface thus wetted is protected and foul matter is prevented from re-adhering to the cleaned surface. Wetting agents which are suitable for this purpose are alkyl and alkyl substituted alkylol amines; cyclic amines; heterocyclic amines; alicyclic alcohols, etc. These types of compounds can best be illustrated by such specific compounds as diethylethanolamine, laurylamine, morpholine, ethyl morpholine, cyclohexylamine, cyclohexanol, trimethylcyclohexanol and the like. The amines are particularly preferred, for in addition to acting as wetting agents, they react with acidic materials thereby continuously replenishing the detergent agent. The amount of wetting agent used ranges between about 2% and about 25% and preferably is kept within 8% to 20% by weight of the total composition.

Water is an essential component of the present composition. The exact function or mechanism of it is not understood, but in cases where water was eliminated as a component of the present composition the efficiency of the latter as a deposit remover was reduced to such a degree as to render it almost useless. It is noted that the wetting power of the composition is increased and the foreign matter is kept in a more permanent dispersion due to the presence of water. It therefore appears that water exerts a synergistic effect and also acts as a carrier for foreign deposits loosened from a surface. The amount of water used varies from between about 10% to about 20%, and preferably is kept between about 12% and 15% by weight.

In order to stabilize compositions under consideration so as to prevent separation and break down, a coupling agent is added. The preferable coupling agents are polyhydric organic derivatives such as alkylene glycols; diglycols, e. g. dipropylene glycol, dibutylene glycol, diamylene glycol; triglycol, e. g. tripropylene glycol; ether

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alcohols containing up to 20 carbon atoms and more particularly glycol mono-alkyl ethers, e. g. the cellosolves, e. g. ethylene glycol mono-ethyl ether, ethylene glycol mono-propyl ether, ethylene glycol mono-n-butyl ether, ethylene glycol mono-isobutyl ether, ethylene glycol mono-tert-butyl ether, ethylene glycol mono-hexyl ether, propylene glycol mono-ethyl ether, propylene glycol mono-isobutyl ether, etc.; diglycol mono-alkyl ethers such as the carbitols, e. g. diethylene glycol mono-methyl ethyl, normal and isopropyl ethers, diethylene glycol mono-butyl ether, diethylene glycol mono-decyl ether, etc.; also dipropylene glycol mono-isopropyl ether, dipropylene glycol mono-ethyl ether, dipropylene glycol mono-isooamyl ether, dipropylene glycol mono-heptyl ether, diisobutylene glycol mono-isopropyl ether, ethylene-propylene glycol mono-ethyl ether, ethylene-isobutylene glycol mono-isopropyl ether, etc.; also, glycerine mono or di-ethers of 6 or more carbon atoms such as glycerine mono- or dipropyl, butyl, amyl, etc. ethers; mono-esters of glycol or glycerine, etc. The amount of coupling agent used generally does not exceed

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To test the effectiveness of compositions of this invention as removers of carbon and other deleterious materials from various surfaces the following tests were performed and results compared with the best known commercial materials used for the same purpose.

*Example I*

Steel panels were sprayed with a solution of oil sludge in carbon tetrachloride and baked at 220° C. in a forced draft oven. The steel panels were then removed from the oven, cooled and some were immersed in deposit remover compositions of this invention while others were immersed in commercial deposit remover X reported to contain chlorinated aromatic, water, butyl cellosolve and ethanolamineoleate. The time of initial deposit removal as well as time of complete removal were noted at room temperatures and at approximately 185° F. In cases where complete removal of the deposit was not effected in 10 minutes, the test was stopped and the percent of deposit removed was estimated as well as the effect of flushing the test piece with water noted.

|   | Composition          | Temperature | Time of Initial Removal | Time of Complete Removal | Appearance after water flush                        |
|---|----------------------|-------------|-------------------------|--------------------------|-----------------------------------------------------|
| 1 | Commercial Product X | 185° F.     | None after 1 hr.        | None after 2 hrs.        | No effect, Panel still corroded with heavy deposit. |
| 2 | Composition of Ex. 1 | 185         | 2:30 min.               | 6:00 min.                | Panel absolutely clean.                             |
| 3 | Composition of Ex. 2 | 185         | 2:15 min.               | 6:00 min.                | Do.                                                 |
| 4 | Composition of Ex. 3 | 185         | 2:00 min.               | 6:10 min.                | Do.                                                 |
| 5 | Composition of Ex. 4 | 185         | 1:45 min.               | 4:30 min.                | Do.                                                 |

20% and is preferably kept in the range of 15 to 20%.

The above classes of additives which constitute the essential component parts of compositions of this invention have not been selected at random but have been selected after careful and painstaking research and because of their coordinating action in aiding to remove deleterious engine deposits as well as removal of undersirable foreign deposits from various surfaces in general.

To more fully illustrate the present invention the following are a few compositions which have been compounded, tested and found extremely

*Example II*

The effectiveness of the present deposit removers was tested on pancake valves from a catalytic cracker hydrocarbon compressor having an accumulated hard carbon deposit of over one-half inch in thickness. A set of such valves were immersed in test compositions at room temperature and after an interval of time as indicated in the table the temperature was maintained at about 120° F. The time for removal of the deposits was observed after the valves were steam flushed.

|   | Composition          | Temperature           | Time of carbon removal                           | Appearance of valves after flush treatment        |
|---|----------------------|-----------------------|--------------------------------------------------|---------------------------------------------------|
| 1 | Commercial Product X | Room Temp.<br>120° F. | Very little carbon removed after 1 hr.           | No effect.                                        |
| 2 | Product of Ex. 1     | Room Temp.<br>120° F. | 1/4 hr. for substantial complete carbon removal. | Do.<br>Valves were clean except for a few specks. |
| 3 | Hand scraping        | 120° F.               | 1/4 hr. for complete carbon removal.             | Valves were perfectly clean.                      |
|   |                      |                       | 2 valves required 1 day                          |                                                   |

efficient for removing deposits from metal surfaces and the like.

*Example III*

After a 500 hour test run of a GM-71 single cylinder Diesel engine the piston rings were covered with heavy fouled deposits. The piston rings were immersed at room temperature in a composition of this invention and in a commercial product X and the time required for loosening and removing the fouled deposits noted.

| Composition Components <sup>1</sup> | 1  | 2  | 3  | 4  | 5    | 6  | 7  | 8  | 9  | 10 |
|-------------------------------------|----|----|----|----|------|----|----|----|----|----|
| Kerosene                            | 12 | 12 | 12 | 12 | 16   | 12 | 15 | 18 | 12 | 12 |
| o-dichlorobenzene                   | 40 |    |    | 30 |      |    |    | 30 | 31 | 40 |
| ethylene glycol mono butyl ether    | 10 | 10 | 10 | 20 | 20   | 20 | 20 | 10 | 10 | 10 |
| oleo acid                           | 4  | 4  | 4  |    |      |    |    |    |    | 4  |
| diethylethanol amine                | 22 | 22 | 22 | 22 |      |    |    |    | 22 | 22 |
| stearic acid                        |    |    |    | 4  |      |    |    |    |    |    |
| isophorone                          |    |    |    | 40 |      |    |    |    |    |    |
| ethyl morpholine stearate           |    |    |    |    | 5.5  |    |    |    |    |    |
| dichloroisopropyl ether             |    | 40 |    |    | 25   |    | 25 |    |    |    |
| ethyl morpholine mesityl oxide      |    |    |    |    | 18.5 |    | 33 | 25 |    |    |
| trimethyl cyclohexanol              |    |    |    |    |      | 20 | 5  | 20 |    |    |
| naphthene sulfonate                 |    |    |    |    |      | 5  | 5  |    | 5  |    |
| ammonium ricinoleate water          | 12 | 12 | 12 | 12 | 15   | 10 | 10 | 10 | 20 |    |

<sup>1</sup> All figures in table are parts by weight.

| Composition          | Time for loosening or Removal of Deposit | Remarks                                                                                    |
|----------------------|------------------------------------------|--------------------------------------------------------------------------------------------|
| Commercial Product X | 4 hours                                  | After 4 hours the deposit was loosened but still difficult to remove.                      |
| Product of Example I | 15 minutes                               | Deposit loosened and after 1 hr. completely removed by cleaning with water or a waste rag. |

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## Example IV

The effectiveness of deposit removers of this invention was tested on hydrocarbon compressors, the cylinder walls, suction and discharge valves, pistons, bearings, etc. being heavily coated with foul material. Previous method of cleaning such equipment was by sanding with fine emery cloth and required approximately 8 hours of sanding by one man to clean the cylinder walls alone and  $\frac{3}{4}$  of an hour to scrape a valve clean. The time which was required to clean five cylinders with a composition of Example 1 was only 10 to 12 minutes and valves and pistons were perfectly clean after a 10 minute soaking in a composition of Example 1 at room temperature and a one minute steam flush.

## Example V

A gas turbine engine was run for a number of days until heavy fouling of the axial flow compressor was noted. The engine was cut down to about half speed and sprayed at room temperature into the air intake of the compressor during a  $4\frac{1}{2}$  minute interval with 10 gallons of a composition of this invention referred to in the table as Example 1. This was followed by steam flushing the engine and it was observed that the compressor was absolutely clean. In addition the overall engine efficiency of the clean engine increased by about 5.8% for a two hour performance test. Previous methods of cleaning such engines necessitated tearing it down which took about 24 to 32 hours and required approximately 32 hours to clean.

## Example VI

Compositions referred to in the table as 1, 2, 3, and 4 were tested as paint and varnish removers. Painted steel panels were immersed in these compositions at room temperature and 185° F. and compared with a commercial paint and varnish remover. After 10 minutes compositions of this invention at both room temperature and 185° F. stripped the paint off the steel panel leaving it perfectly clean. The commercial product was still ineffective at the end of the test period.

Compositions of this invention are excellent for removing scales, rust and corrosive deposits from metal surfaces such as boiler tubes, evaporators, pipes, machines and the like. They are excellent degreasing compositions and also are effective in removing dirt and grease from industrial equipment. They are non-corrosive, non-toxic and are not a fire hazard. They have no

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harmful effect when in contact with the skin, rubber, plastic surfaces and the like and can be applied by any known means such as spraying, immersing, dipping, swabbing, and the like.

It is to be understood that while the features of the invention have been described and illustrated in connection with certain specific examples, the invention, however, is not to be limited thereto or otherwise restricted, except by the prior art and the scope of the appended claims.

I claim as my invention:

1. A cleaning composition comprising a mixture of:

|                                 | Per cent by weight |
|---------------------------------|--------------------|
| 15 Kerosene                     | 12                 |
| o-Dichlorobenzene               | 40                 |
| Diethylethanolamine oleate      | 6                  |
| Diethylethanolamine             | 20                 |
| Ethylene glycol monobutyl ether | 10                 |
| 20 Water                        | 12                 |

2. A cleaning composition comprising a mixture of about 12% to about 50% of kerosene, about 2% to about 15% of diethylethanolamine oleate, about 20% to about 40% of o-dichlorobenzene, about 2% to about 25% of diethylethanolamine, about 10% to about 20% of ethylene glycol monobutyl ether, and about 10% to about 20% of water.

3. A cleaning composition comprising a mixture of about 12 to 50% kerosene, about 2 to 15% of diethylethanolamine oleate, about 20 to 40% of a chlorinated organic compound selected from the class consisting of o-dichlorobenzene, trichloroethylene, dichloroethyl ether and dichloroisopropyl ether, about 2 to 25% of a diethylethanolamine, about 10 to 20% of ethylene glycol monobutyl ether and about 10 to 20% water.

BEN BORUS.

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