Sept. 12, 1961 J. H. LUNDY ET AL 2,999,485

PROCESS FOR PRECONDITIONING AIR FOR USE IN THE OXIDATION OF HYDROCARBON FUELS

Filed March 28, 1960 2 Sheets-Sheet 1

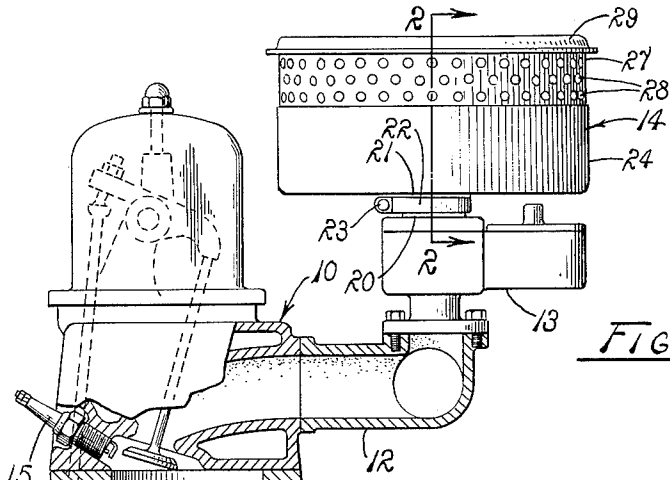


FIG. 1.

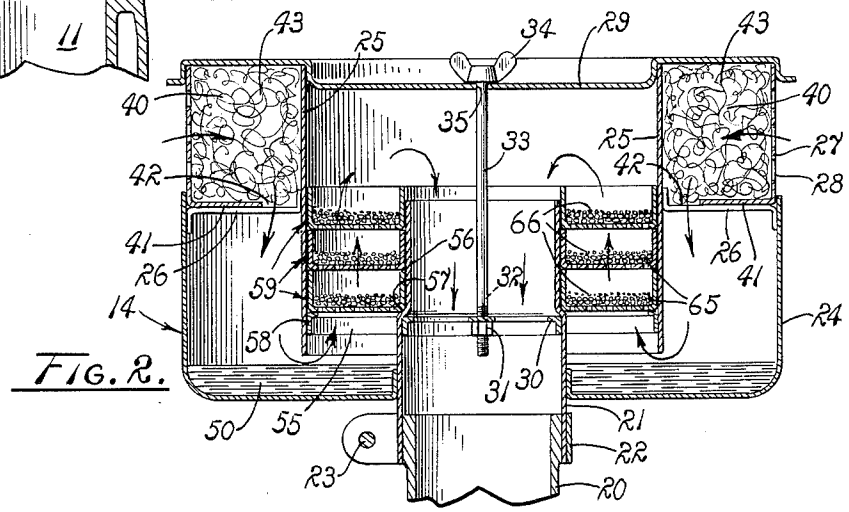


FIG. 2.

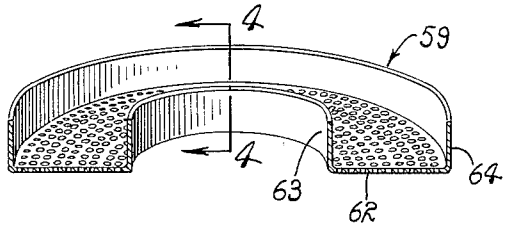


FIG. 3.

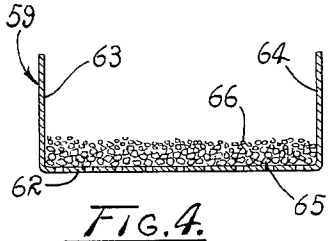


FIG. 4.

JAMES H. LUNDY
HERMAN G. REMPEL
RALPH SLAVICH
INVENTORS
HUEBNER & WORREL
ATTORNEYS
BY Richard M. Worrel

Sept. 12, 1961 J. H. LUNDY ET AL 2,999,485

PROCESS FOR PRECONDITIONING AIR FOR USE IN THE OXIDATION OF HYDROCARBON FUELS

Filed March 28, 1960 2 Sheets-Sheet 2

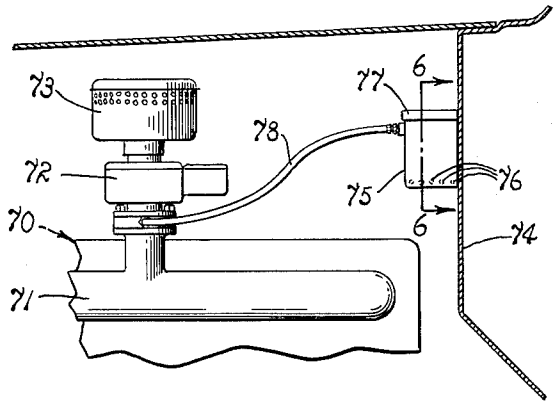


FIG. 5.

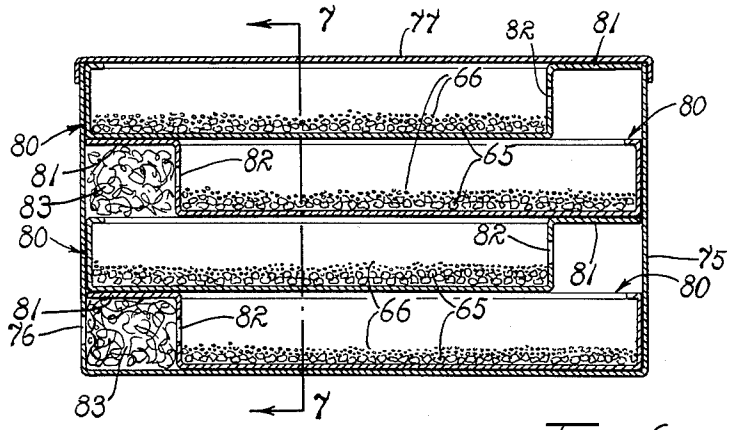


FIG. 6.

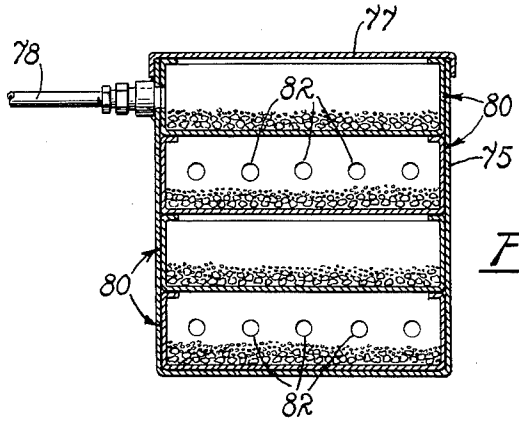


FIG. 7.

JAMES H. LUNDY
HERMAN G. REMPEL
RALPH SLAVICH
INVENTORS
HUEBNER & WORREL
ATTORNEYS
BY Richard M. Worrel

United States Patent Office 2,999,485 Patented Sept. 12, 1961

2,999,485

PROCESS FOR PRECONDITIONING AIR FOR USE IN THE OXIDATION OF HYDROCARBON FUELS

James H. Lundy, 2409 E. Belmont Ave., Herman G. Rempel, 4717 E. Nevada, and Ralph Slavich, 4363 N. Van Ness, all of Fresno, Calif.

Filed Mar. 28, 1960, Ser. No. 17,938
16 Claims. (Cl. 123—119)

The present invention relates to a process for preconditioning air for use in the oxidation of hydrocarbon fuels and more particularly to such a process having special application to the preconditioning of air for use in internal combustion engines.

The broad essence of the present invention resides in the discovery that copper oxide is an effective catalyst in the oxidation of hydrocarbon fuels and more particularly in the discovery that the combustion of hydrocarbon fuels in internal combustion engines can be facilitated by the admixture of minute quantities of cupric salts resulting from the interaction of solid acids or acid producing solid salts with copper in the air supply delivered to the combustion chambers of such engines.

The inefficiencies of internal combustion engines are well known and result in the three primarily objectionable results. The economy of operation is less than desired. The accumulation of partially burned and unburned fuel in such engines impairs operation and shortens useful engine life. The exhausts from such engines contain air polluting constituents which are believed to be a primary cause of the smog in areas of heavy traffic. The present invention is a further development of that disclosed in United States Patent No. 2,695,680 and is likewise directed to the improvement of the efficiency of combustion of hydrocarbon fuels in internal combustion engines.

Another object is to improve the overall efficiency of internal combustion engines.

Another object is to minimize the accumulation of hard carbon in the combustion chambers and associated parts of internal combustion engines.

Another object is to minimize creation or aggravation of smog by internal combustion engines.

Another object is to reduce the carbon monoxide in the exhaust from internal combustion engines.

Another object is to minimize the discharge of nitric oxide by internal combustion engines.

Further objects and advantages will become more fully apparent in the subsequent description in the specification.

In the drawings:

FIG. 1 is a fragmentary section of an internal combustion engine provided with a carburetor and intake air cleaner illustrative of structure suitable to the practice of the present invention.

FIG. 2 is a vertical section taken on line 2—2 of FIG. 1.

FIG. 3 is a perspective view of a diametrically sectioned material tray utilized in the air cleaner in the practice of the present invention.

FIG. 4 is a section taken on line 4—4 of FIG. 3 but showing air treating materials in the tray.

FIG. 5 is a fragmentary view of an internal combustion engine showing an intake manifold, air cleaner, and carburetor thereof as well as a fragmentary portion of an enclosing housing for the engine with a further form of air preconditioning apparatus suitable for the practice of the present invention.

FIG. 6 is a section taken on line 6—6 of FIG. 5 showing the internal structure of the air preconditioning apparatus of FIG. 5.

FIG. 7 is a section of the air preconditioning apparatus of FIG. 5 taken at a position represented by line 7—7 in FIG. 6.

Referring in greater detail to the drawings:

Referring to FIG. 1, an internal combustion engine is fragmentarily represented at 10 having a combustion chamber 11, an intake manifold 12, a carburetor 13, and an air cleaner 14. A spark plug 15 serves the usual purpose of igniting fuel in the presence of air while under compression in the combustion chamber 11. The elements as shown in FIG. 1 are conventional but, as illustrated in FIGS. 2 and 3, the internal construction of the air cleaner 14 is modified so as to practice the process of the present invention.

As fragmentarily shown in FIG. 2 the carburetor 13 provides an upwardly extended intake conduit 20. The air cleaner 14 has a sleeve 21 which slides downwardly over the upper end of the conduit 20 and is clamped thereon by a circumscribing collar 22 constricted by a bolt 23 in the well known manner. The cleaner 14 provides an annular housing 24 having a bottom wall welded or otherwise secured to the sleeve 21 in fluid-tight connection and an upwardly extended substantially cylindrical wall. An inner cylindrical wall 25 is supported concentrically on the outer wall of the housing 24 by brackets 26 inwardly extended from the outer wall of the housing in downwardly spaced relation to the upper edge thereof. As shown, the inner wall 25 extends upwardly an appreciable distance from the upper edge of the outer wall. A substantially cylindrical grill 27 is slidably fitted downwardly within the outer wall of the housing 24 and rests on the brackets 26. The grill has perforations 28 for the admission of air. A cover 29 is fitted downwardly against the upper edges of the grill 27 and inner wall 25 in substantially air-tight engagement therewith. To hold the cover in position, a spider 30 is provided in the sleeve 21 and has a nut 31 secured centrally thereof in alignment with an opening 32 therethrough. A bolt 33 having a wing nut 34 integral therewith is extended downwardly through an opening 35 in the cover and screw-threadably engaged in the nut 31. It will be readily understood that the cover can be tightened into place by tightening the bolt 33 or removed by first removing the bolt.

It will be observed in FIG. 2 that the grill 27, inner wall 25, and cover 29 define a filter compartment 40. To provide a floor for the compartment, an annular plate 41 is rested on the brackets 26 and fitted between the grill 27 and inner wall 25. In inwardly spaced relation to the grill, the floor plate is provided with air passages 42 downwardly disposed from the filter compartment. The compartment is filled with any suitable air filtering material 43, such as steel wool, fiber, or the like.

It will be noted that the inner wall 25 terminates short of the bottom of the housing 24 and that a pool of oil 50 is preferably provided in the bottom of the housing in downwardly adjacent spaced relation to the inner wall.

The spacing of the inner wall 25 from the sleeve 21 provides an air passage 55 therebetween. This passage is upwardly extended by a sleeve extension 56 of reduced diameter providing a shoulder 57. An annular bracket 58 is secured to the inner wall 25 in horizontal alignment with the shoulder 57. A series of trays 59 are rested in stacked relation on the shoulder 57 and bracket 58 in slidably fitted relation between the inner wall 25 and the sleeve extension 56.

The trays are conveniently of identical form and, as shown in FIG. 3, may be stamped from sheet metal or other sheet material to provide a perforate bottom 62 having concentric upstanding inner and outer walls 63 and 64, respectively. Although three trays are shown as utilized in FIG. 2, any desired number thereof may be em-

ployed. The bottom of each tray is covered with granular particles of copper **65** of a size such that they do not pass through the perforations in the bottom **62**. It is to be understood that when the term granular is employed it is intended to encompass shavings, threads, filaments, and other physical forms providing extensive surface area in relation to the total mass of copper utilized. The copper particles in each of the trays are intimately contacted with particles or powder of a solid material or materials selected from the solid acids and the acid forming solid salts. For example, solid acids such as tartaric, $C_4H_6O_6$; dextrotartaric; dihydroxysuccinic; citric, $C_6H_8O_7$; malic, $C_4H_6O_5$; succinic, $C_4H_6O_4$; sulfonic, —SO_2H or —SO_3H; and the like are excellently suited to the purpose. The acid forming salts of suitable solid form are typified by sodium bisulfite, $NaHSO_4$; potassium bisulfite $KHSO_4$; sodium sulfite, Na_2SO_3; potassium metabisulfite, $K_2S_2O_5$; ammonium nitrate, NH_4NO_3; chromic oxide, Cr_2O_3; ammonium chloride, NH_4Cl; aluminum chloride, $AlCl_3$; and the like. The solid acid material or acid forming solid salt material is indicated at **66** in FIGS. 2 and 4. The copper **65** and material **66** in the trays **59** must possess sufficient porosity for the passage of air therethrough and the material **66** should have a sufficient affinity for water that slight amounts of water vapor in the air will gradually ionize such material for interaction with the copper. In dry climates, the affinity of the materials for water may be enhanced by the addition of small amounts of sodium chloride, not shown, or other water attracting material. Although any one of the acids or salts described may be employed with the copper, greater accommodation to varied environmental conditions and moisture in the atmosphere can be attained by the use of several such materials. For example, the utilization of tartaric acid in the bottom tray, aluminum chloride in the second tray, and ammonium chloride in the third tray have been found excellently suited for the purpose. The copper reacts with the solid materials in proportion to their respective molecular weights and the quantities thereof are preferably employed in such proportion.

In FIG. 5, an internal combustion engine is fragmentarily indicated at **70** having an intake manifold **71** mounting a carburetor **72** having an air filter **73**. The housing for the engine includes a dash panel **74** which mounts a housing **75**. The housing is closed except for air intake openings **76** adjacent to the bottom of a side wall thereof. The housing **75** conveniently has a removable lid **77** for assembly and service convenience. An air duct **78** extends from the upper portion of the housing **75** and connects to the intake manifold **71**.

As best shown in FIGS. 6 and 7, a plurality of trays **80** are arranged in stacked relation in the housing. Each tray has a spacing flange **81** endwardly directed therefrom and air passages **82** in its end adjacent to, and below, the flange. Each tray is also open at the top. Filter material **83** is placed in the housing **75** over the intake opening **76**. The bottom tray is rested in the bottom of the housing with its flange **81** overlaying the filter material. A second tray **80** is rested on the lowermost tray and has its flange **81** oppositely disposed from that of the first tray. Successive superimposed trays have their flanges alternately extended so that the assembly provides an air conduit inwardly through the openings **76**, through the filter material **83**, longitudinally of the bottom tray, upwardly from the open top of the bottom tray, inwardly through the air passages **82** of the second tray, longitudinally of the second tray and upwardly and into the air passages **82** of the third tray and so on through each tray and subsequently out of the housing **75** through the duct **78** to the intake manifold **46**.

As described in connection with FIG. 4, a layer of copper particles **65** are provided in each of the trays and intimately contacted with a solid acid material or acid forming solid salt **66**.

Operation

The operation of the structures described in the practice of the process of the present invention is believed to be readily apparent and is briefly summarized at this point. As the engines **10** and **70** are operated in the usual manner, air is drawn in the intake manifolds **12** and **71** thereof. Referring to FIG. 2, air passes through the perforations **28**, is filtered by the material **43**, passes downwardly beneath the lower edge of the inner wall **25**, where heavy particles borne by the air stream are deposited in the oil **50**, and thence passes upwardly through the trays **59**, down through the sleeve **21**, through the carburetor **13**, and into the combustion chamber **11** through the manifold **12**.

Referring to FIGS. 6 and 7, the air passes through the intake openings **76**, is filtered by the material **83**, passes successively through the trays **80**, and thence outwardly through the duct **78** into the intake manifold **71** and from there into the combustion chamber, not shown, of the engine **70**. In passing through the trays **59** of the form of air preconditioning structure shown in FIGS. 1 through 4 and through the trays **80** of the form of the preconditioning apparatus shown in FIGS. 5 through 7, the air passes through the porous mixed masses consisting of the copper **65** and solid acid or acid producing solid salt material **66**. Moisture borne by the air gradually is accumulated by the material which in turn is slowly ionized and reacts with the copper. As a result, a fine powdered cupric salt is produced which is readily air borne in the air stream passing through such masses. For example, when tartaric acid is used at **66**, copper tartrate is formed.

$$Cu+H_2C_4H_4O_6 \rightarrow CuC_4H_4O_6+H_2\uparrow$$

When the copper tartrate burns in the combustion chamber of the engine, copper oxide is formed.

$$2CuC_4H_4O_6+5O_2 \rightarrow 2CuO+8CO_2+2H_2O$$

When aluminum chloride is utilized, it disassociates in the presence of moisture to form hydrochloric acid.

$$ClCl_3+H_2O \rightarrow 2HCl+AlOCl$$

The hydrochloric acid reacts with the copper to produce copper chloride. $Cu+2HCl \rightarrow CuCl_2$

When ammonium chloride is employed, copper chloride is similarly formed after the disassociation of the ammonium chloride to make hydrochloric acid available.

$$NH_4Cl \rightarrow NH_3+HCl$$
$$Cu+2HCl \rightarrow CuCl_2+H2\uparrow$$

The chemical interaction of the other solid acids and acid producing solid salts with copper will be readily apparent and are not further described.

The air borne cupric salts ($CuC_4H_4O_6$, $CuCl_2$, etc.) are then drawn into the combustion chamber of the engine with which the devices are associated, with the usual hydrocarbon fuel and air. The mixture, now being accompanied by the cupric salt, is compressed in the combustion chamber and the mixture ignited. As a result the cupric salt is oxidized to provide the copper oxide which in turn acts as an effective catalyst for combustion of the hydrocarbon fuel. Only minute quantities of copper oxide need be present to attain the described catalytic action.

The copper oxide introduced in the manner described tends to deposit on the electrodes of the spark plugs employed and to continue its effect. For example, the eight spark plugs of a 1959 automobile of popular make driven for 4,560 miles under the practice of the present invention as described, had an aggregate deposit of 37.0 micrograms of copper oxide. Similarly, laboratory tests of the copper oxide deposits on the spark plugs of three other automotive engines operated under the process of the present invention for various periods showed deposits of copper oxide on the eight spark plugs of each engine of 3.0 micrograms, 2.3 micrograms, and 4.8 micrograms,

respectively. The presence of the copper oxide attains a more thorough combustion of the fuel and is even effective in insuring combustion of the olefins and higher hydrocarbons. Further, its presence is conductive to the reduction of the nitric oxide, normally found in the exhaust of internal combustion engines, to nitrogen and oxygen so as to avoid the smog producing effect of nitric oxide.

In a test conducted by an independent scientific laboratory, the structure shown in FIGS. 5, 6, and 7 was connected, also as shown, to the internal combustion engine of a 1959 automobile of popular make. The trays contained particles of copper intimately contacted by tartaric acid, aluminum chloride, and ammonium chloride respectively. The engine was operated at 1,000 r.p.m. and tests conducted after the engine had reached operating temperature. The exhaust gases were then tested by infrared spectroscopy.

With a substantial portion of the air of combustion being drawn through the housing **75** and the chemicals **65** and **66**, the exhaust was analyzed and the results recorded below as condition "A." The duct **78** was then disconnected from the engine and its point of connection closed. The engine was then operated precisely as before but with all of the air of the combustion passing through the filter **73** and none passing through the chemicals **65** and **66**. The exhaust was again analyzed and the results are reported below as condition "B."

	Comparative values in mole percent				
	Total hydrocarbons (C_3 and higher)	Carbon monoxide	Ethylene	Acetylene	Methane
Condition A	0.009	0.67	0.03	0.05	
Condition B	0.024	6+	0.09	1.03	Present.

These results typify various test results attained by the process of the present invention and clearly reveal improved combustion and virtual elimination of carbon monoxide.

In many instances the process of the present invention has been found to reduce the carbon monoxide content of exhaust gases of internal combustion engines by as much as 90% and unburned constituents by as much as 60%. The process is effective in facilitating the combustion of olefins and the higher hydrocarbons contained in hydrocarbon fuel as well as in the minimizing of the exhaust of nitric oxide.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred method and embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent methods, devices and apparatus.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In the operation of an internal combustion engine having a combustion chamber, the steps of introducing a powdered cupric salt into the combustion chamber with hydrocarbon fuel and air of combustion, and oxidizing the fuel and the cupric salt in the combustion chamber whereby the latter forms copper oxide which acts as a catalyst in the oxidation of the fuel.

2. A process for improving the combustion of hydrocarbon fuels containing olefins and higher hydrocarbons in internal combustion engines having combustion chambers comprising introducing a powdered cupric tartrate in air stream with said fuel into the combustion chamber, and igniting the fuel in the combustion chamber in the presence of the cupric tartrate whereby copper oxide is formed by decomposition of the cupric tartrate and acts as a catalyst in the oxidation of the olefins and higher hydrocarbons.

3. A process for improving the combustion of hydrocarbon fuels containing olefins and higher hydrocarbons in internal combustion engines having combustion chambers comprising introducing a powdered cupric chloride in air stream with said fuel into the combustion chamber, and igniting the fuel in the combustion chamber in the presence of the cupric chloride whereby copper oxide is formed by oxidation of the cupric chloride and said copper oxide acts as a catalyst in the oxidation of the olefins and higher hydrocarbons.

4. In the operation of an internal combustion engine having a combustion chamber, a carburetor having an intake, and an intake manifold interconnecting the carburetor and the combustion chamber and through which hydrocarbon fuels are drawn from the carburetor into the combustion chamber; the step of introducing a powdered cupric tartrate in air stream into the intake of the carburetor for passage through the manifold with the fuel into the combustion chamber.

5. In the operation of an internal combustion engine having a combustion chamber, a carburetor having an intake, and an intake manifold interconnecting the carburetor and the combustion chamber and through which hydrocarbon fuels are drawn from the carburetor into the combustion chamber and through which air is drawn through the intake of the carburetor; a process for enhancing the combustion of the fuel and minimizing the presence of nitric oxide and carbon monoxide in the end product following combustion of the fuel comprising passing atmospheric air over copper in the presence of a solid material having an acid reaction in the presence of moisture gradually ionizing the solid material with moisture from the air to interact with the copper to form a powdered copper salt, directing said air and the copper salt into the intake of the carburetor where it is mixed with the fuel, and burning the fuel in the combustion chamber in the presence of the copper salt whereby the copper salt is transformed into copper oxide which acts as a catalyst in the oxidation of the fuels and carbon monoxide as well as in the reduction of the nitric oxide.

6. A process for preconditioning air for use in internal combustion engines having combustion chambers comprising passing a stream of air over granular copper particles which are contacted by a solid material having an acid reaction in the presence of moisture, gradually ionizing said solid material by the application of air borne moisture thereto whereby said solid material and the copper particles react to form a copper salt, directing the copper salt in the air stream passed over the copper particles into the combustion chamber of an internal combustion engine, and oxidizing the copper salt in the combustion chamber to copper oxide for use as a catalyst for combustion of hydrocarbon fuels in the combustion chamber.

7. The process of claim 6 in which said solid material is solid acid material in granular form.

8. The process of claim 6 in which said solid material is a solid acid forming salt in granular form.

9. The process of claim 6 in which said solid material is tartaric acid in granular form.

10. The process of claim 6 in which said solid material is ammonium chloride in granular form.

11. The process of claim 6 in which the solid material is aluminum chloride in granular form.

12. A process for preconditioning atmospheric air for use in internal combustion engines comprising passing an air stream successively through a mixture of granular copper particles and tartaric acid, granular copper particles and ammonium chloride, and granular copper particles and aluminum chloride, said air stream containing sufficient moisture gradually to ionize the tartaric acid, the ammonium chloride and the aluminum chloride for interaction with the copper particles of their respective mixtures to produce powdered cupric tartrate and powdered cupric chloride; and carrying said powdered cupric

tartrate and cupric chloride in air stream from their respective mixtures for use in internal combustion engines.

13. In an internal combustion engine having an inlet air supply, means for improving combustion in the engine comprising granular copper particles, a solid salt material in intimate contact with the copper particles, said copper particles and salt being of a character adapted to interact in the presence of moisture to form a cupric tartrate compound, and means for positioning said compound in the inlet air supply of the engine.

14. In an internal combustion engine having an inlet air supply, means for improving combustion in the engine comprising granular copper particles, a solid salt material in intimate contact with the copper particles, said copper particles and salt being adapted to interact in the presence of moisture to form a cupric tartrate compound, and an air pervious tray positioning said compound in the inlet air supply of the engine whereby the inlet air supply carries particles of said compound into the engine.

15. In an internal combustion engine having an intake manifold, an intake conduit upwardly extended from the manifold, and filtering means having inlet and outlet openings releasably mounted on said conduit in circumscribing relation thereto; a plurality of air pervious members disposed within said filtering means between the inlet and outlet openings, and a cupric tartrate compound disposed in said air pervious members whereby air moving through the filtering means passes through said compound.

16. In an internal combustion engine having an intake manifold, an intake conduit upwardly extended from the manifold and providing an opening for the entrance of air into said manifold, an air filter having inlet and outlet openings, a hollow tube forming said outer opening having opposite ends, one of said ends being releasably fitted about said intake conduit, and the other end terminating within the filter, a plurality of circular air pervious trays secured to said end of the tube within the filter in circumscribing relation thereto, and a granular cupric tartrate compound disposed in said trays and through which air passing from the inlet of the filter to the outlet is directed during engine operation whereby particles of said compound are carried into the engine for improving combustion.

References Cited in the file of this patent

UNITED STATES PATENTS

2,086,775	Lyons et al.	July 13, 1937
2,197,498	Guthmann	Apr. 16, 1940
2,460,700	Lyons	Feb. 1, 1949
2,477,098	Taylor et al.	July 26, 1949
2,552,555	Houdry	May 15, 1951
2,839,037	McKeever	June 17, 1958