Feb. 11, 1941. W. G. STEPHENSON ET AL 2,231,605

FUEL CONDITIONING

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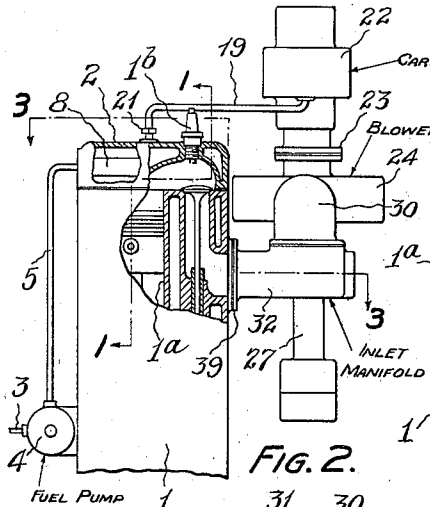


FIG. 2.

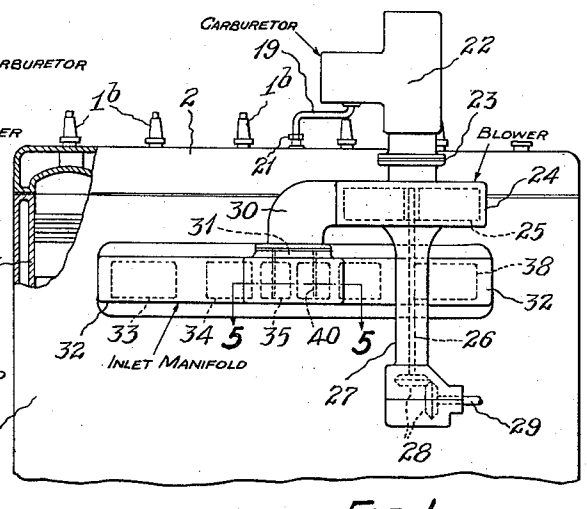


FIG. 1.

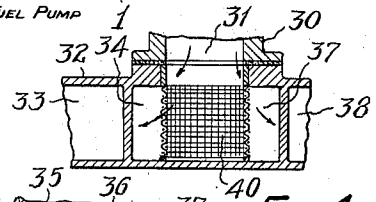


FIG. 4.

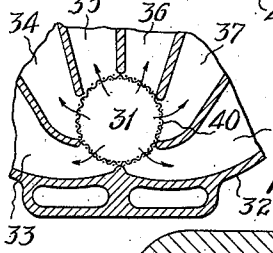


FIG. 5.

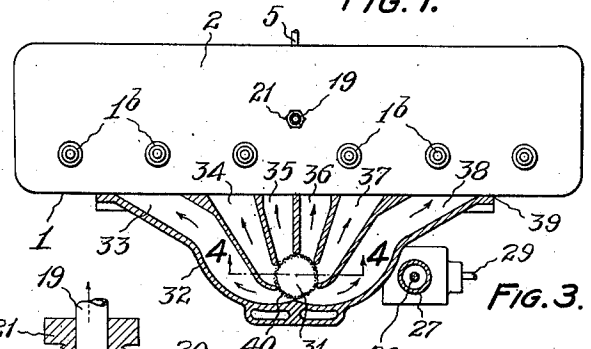


FIG. 3.

FIG. 11.

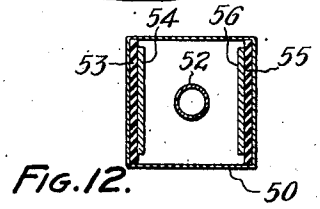


FIG. 12.

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FUEL CONDITIONING

Filed July 15, 1938 2 Sheets-Sheet 2

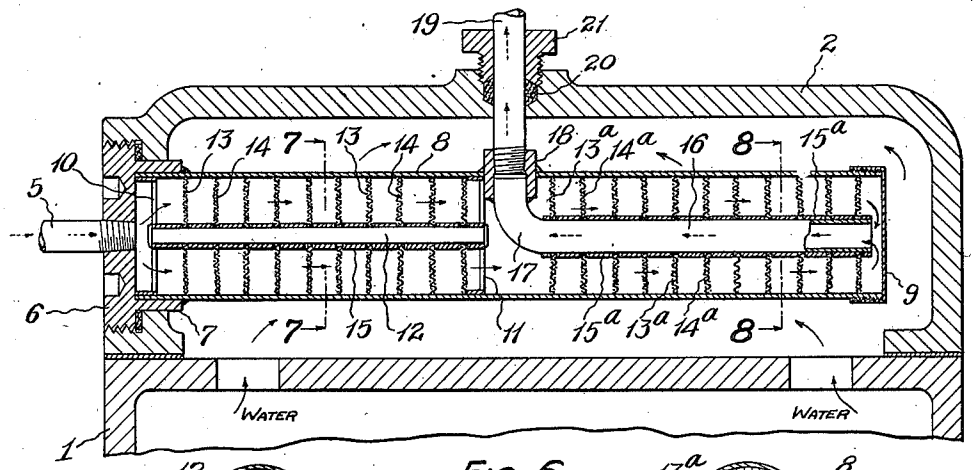


FIG. 6.

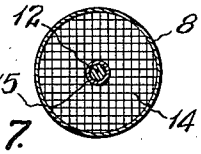


FIG. 7.

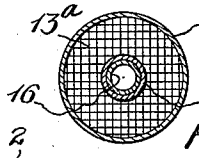


FIG. 8.

FIG. 9.

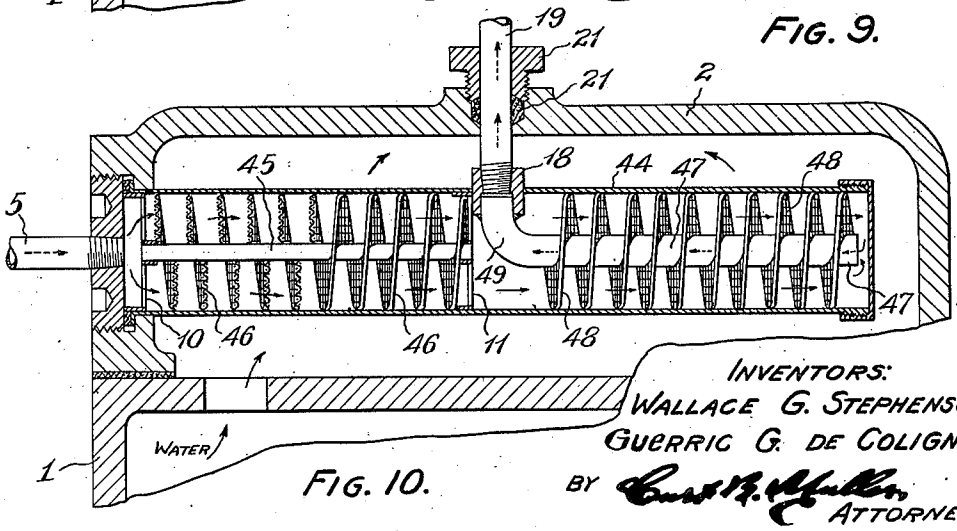


FIG. 10.

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UNITED STATES PATENT OFFICE

2,231,605

FUEL CONDITIONING

Wallace G. Stephenson and Guerric G. de Coligny, New Orleans, La., assignors to The White Motor Company, Cleveland, Ohio, a corporation of Ohio

Application July 15, 1938, Serial No. 219,466

6 Claims. (Cl. 123—122)

Our invention pertains to a modification and/or conversion of a liquid hydrocarbon fuel, to the process employed and to the structural assembly for performing the process to improve the fuel and its combustion.

For decades there has been an unattained goal in the automotive industry despite repeated, intensified striving by its engineers. That goal has been the redesign of a standard internal combustion engine, whether it be the Otto, Diesel or Hesselman type, to adapt it to the use of heavy hydrocarbon fuel or distillates with continuing commercial success. We have been unable to collect evidence that the problem or problems presented during all conditions of automotive use ever became satisfactorily solved either in this county or in any foreign country. Many proposals alleged to be successful have reached the market. None is known to have survived. Their failure to achieve continued commercial success under all kinds of necessitated operation of a vehicle is supposedly the reason. Many patents, both domestic and foreign, have been granted for methods of or an appliance for burning distillates with success. Some of the patentees have expounded the theory of the cracking principle in the presence not only of heat, but of a sub-atmospheric pressure. Others have further explained that only the attainment of a fixed gas could avoid condensation and lubricant dilution, especially if an over-rich mixture was subsequently to be cooled by introduction of auxiliary air calculated to transform to a combustible charge. Others have selectively or automatically (as by thermostatic control) regulated differing contributory agencies, for instance, the amount of fuel, the temperature of the fuel or the amount of pressure for some stage of the distribution. Some cause must have existed for lack of enduring success hitherto. The demand for a satisfactory adaptation of an internal combustion engine for using distillates has been so insistent and the reward for first commercial success so certain that no other conclusion is plausible, much less convincing. There appears to be no reason for discrediting the belief that all prior attempts were failures (within the imposed limitations of space and time and variant operating conditions) and that a determination of the necessary attendant physical and chemical influences has not been reached.

We have departed from earlier knowledge and understanding by recognizing that copper has a pro-oxidant property and exercises a catalytic function beneficial for preparing a distillate, indeed even a lighter hydrocarbon like gasoline, for promoting its oxidation or better combustion, whether with or without intervening atomization. Some of the copper, even if not in colloidal form, may be carried away in suspension with the fuel and some of it may be dissolved therein especially if a copper compound (soap or salt) or equivalent pro-oxidant-property-possessing or catalytic-function-exercising metallic compound be exposed to flowing fuel in the presence of adequate heat and preferably in the liquid stage while excluding air. While copper has long been known to be a pro-oxidant and even employed as a catalytic agent in refineries at very high temperatures or for production of aldehydes and our investigation has also brought us familiarity with the sweetening of sour (sulphur-containing) distillates by suitable admixtures and also made us familiar with the common copper dish method for detecting inadequately refined distillates, it is our well-considered opinion that copper has never herebefore been suitably employed for the treatment, modification or conversion (through catalytic or some electrical influence) of distillate fuel immediately before its ignition anywhere or likewise in liquid state before its atomization or in vapor phase beyond the carburetor or both before and after its admixture with air preparatory to ignition in an internal combustion engine. Employment of one or more activating agents, nickel and/or magnesium has been advantageously practised as an aid to exercise of the unique application of a pro-oxidant function.

The behavior of any apparatus employing heavy hydrocarbons as a fuel has long been judged by experts according to several determinants including these: (1) Ease of vaporization, (2) anti-knock or octane value, (3) lubricant dilution, (4) consumption rate, (5) temperatures generated and (6) coordinated performance. It has also long been recognized that one of the greatest disadvantages heretofore attending use of distillates as fuel in an internal combustion engine mounted on a travelling vehicle, with its wide range and constantly changing conditions of operation, has been the discouragingly bad perforance during light load service. We list the theories which we have entertained during our protracted experimentation and tests:

Catalytic action is so well known that it should suffice merely to state that it involves initiation or stimulation of the chemical reactions without its taking part therein. We are aware that copper has long been known to exercise the function of a catalyst and that the performance is favored

by heat and in the presence also of copper and copper oxides where the highest action seems to occur along the boundaries between clean and corroded copper. One novelty of our discovery is that temperatures not exceeding the boiling point of water and therefor only a third as high as the temperatures needed in a refinery process were required preparatory to immediate combustion of the fuel in an internal combustion engine. Moreover, our method of utilizing copper as a catalyst is promoted by the fact that there is considerable fluctuation in engine temperatures serving to contract and expand the area of deposition on the copper thereby breaking up the surface of the carbonaceous film or deposition and constantly presenting different copper areas to heated fuel exposure. Colloidal assistants such as gumarabic or starch and activating agents such as nickel and magnesium have been employed with beneficial effect.

A pro-oxidant is any element, material or compound which promotes oxidation or combustion. It operates in the same manner as a catalyst inasmuch as it promotes or encourages or establishes more weakening to oxidation without actually taking part in the chemical reaction itself.

Copper is known in the chemical industry as a pro-oxidant. Precisely how it functions is not any better known than how a catalytic agent functions. We have discovered that it can act as a pro-oxidant on hydrocarbons in the liquid state or phase as well as in a vapor state or phase. Pure metallic copper or copper oxides or salts of copper could all perform this function. The rapidity or intensity of the reaction is very often increased by an increase in pressure, particularly in connection with hydrocarbons in a vaporous state. Temperatures are also increased along with the pressure.

A number of copper salts could be used. The compounds generally known as copper soaps (stearate or oleate) would probably be the most soluble and for this reason the most effective as a pro-oxidant in hydrocarbons. Copper chromate also might turn out to be a pro-oxidant as nearly all the chromates of catalytic elements are also catalysts.

It is known in the chemical industry that several elements or compounds stimulate the pro-oxidizing properties of copper. Two of the best known assistants or activating agents are nickel and magnesium.

No information on what a resultant fine, black, smeary formation as a deposition or encrustation on the copper might be is now available. Copper is apparently not very easily poisoned as a catalyst or pro-oxidant and can stand considerable corrosion without being affected in its intensity either as a pro-oxidant or catalyst.

It is to be realized that the scope of our invention comprehends many equivalent structural variations, process performances and product compositions. The showing of the drawings and the particular description are merely specific exemplifications of a plurality of conceivable modifications and arrangements.

Adverting to the drawings:

Figure 1 is a broken side elevation of the upper portion of an internal combustion engine embodying all of the structural features of our invention.

Figure 2 is an end view of Figure 1 with a portion of the cylinder head broken away to reveal an interior structure.

Figure 3 is a plan section on zigzag line 3—3 of Figure 2.

Figure 4 is an enlarged vertical section on line 4—4 of Figure 3.

Figure 5 is a plan section, also on an enlarged scale, viewed on line 5—5 of Figure 1.

Figure 6 is a greatly enlarged vertical section through the detachable cylinder head showing some of the features of our invention.

Figure 7 is a vertical section on line 7—7 of Figure 6.

Figure 8 is a vertical section on line 8—8 of Figure 6.

Figure 9 is a view similar to Figure 6 but incorporating several modified elements.

Figure 10 is another view like Figures 6 and 9 illustrating a further modification.

Figure 11 is a view like Figure 6 of a further modification.

Figure 12 is a vertical section on line 12—12 of Figure 11.

While as just declared the drawings illustrate a series of exemplifications of our invention, though not all of our conceptions which are being intially claimed, we would have it clearly understood that the differing features or contributing factors might be variously combined and that it is purely optional, with consideration of commercial feasibility and economy, as to which elements, physical and chemical agencies and theoretical principles are to be combined in a marketed structure. For instance, one or more pro-oxidants or catalysts might be employed, one or more activating agents might be employed, both liquid phase and vapor phase treatment of the fuel singly or together might be adopted and the blower mechanism be either included or excluded—all depending on a multiplicity of factors to be reckoned with including characteristics of some particular fuel, climatic conditions, type of fuel burning equipment (furnace or engine) or general performance requirements.

Inviting attention first to the disclosures of Figures 1 to 5, an internal combustion engine comprises a water jacketed enclosing case 1, one or more explosion cylinders 1*a* therein and a corresponding number of spark plugs 1*b* each adapted to ignite the combustible charge reaching one of the cylinders and which plugs might be fitted in the detachable cylinder head 2. A pipe 3 to be considered as connected with a source of fuel (not shown) leads to a fuel pump 4 which discharges through a pipe 5 entering the cylinder head 2. Upon reference to Figures 6 and 7 there will be observed a detachable cylinder head plug 6 through which the pipe 5 leads. The plug carries an angular internal flange 7 in which is fitted one end of a tube 8 composed of copper and extending across the cylinder head water jacket with its opposite end closed in any suitable manner as by a cap 9. At the entry end of the tube 8 it is fitted around an open spider 10 and a similar spider 11 is located within the tube 8 just short of its middle. Extending between and secured in the spiders 10 and 11 is a rod 12 on which is mounted a plurality of annular screens 13 and 14 of different metal and in spaced relation, the spacing of the screens being maintained by spacers 15 which surround the rod and are located one between each pair of screens. In this exemplification some of the screens are composed of copper and some are composed of nickel and

in selectable alternative arrangement. Both the copper tube and the copper screens are to serve the functions of a pro-oxidant and a catalyst. The nickel screens are to serve the function of an activating agent. As shown, the first screen 13 at the left end of Figure 6 may be regarded as composed of copper, the second screen 14 composed of nickel and so on, every other one being of the same metal and adjacent ones of different metals.

Another series of screens 13^a and 14^a composed of copper and nickel respectively are similarly mounted within the rear end of the tube 8 beyond the middle line of the latter and while likewise held in spaced relation by means of spacer rings 15^a, that rearward series of rings and screens surround a return flow tube 16 having an open end appositioned to the cap 9 whereby to compel travel of the treated fuel through all of the screens. The tube 16 is bent upwardly at 17 and at the middle of the tube 8 is fitted into one side of a coupling 18 which also confines the inlet end of a pipe 19 which passes through a packing gland 20 and screw cap 21 which are fitted around a hole through the top of the head 2. The tubes 8 and 16 are sealed against the water in the cylinder head jacket.

The pipe 19 discharges into a carburetor 22 which being a part of the entire fuel conduit from its source of supply to the cylinders may be optionally lined with copper or a copper alloy or otherwise contain copper or a copper compound. The lower outlet of the carburetor is connected at 23 with a blower casing 24 within which is rotatable any suitable form of impeller 25 mounted on a downwardly extending shaft 26 which extends through a housing 27 and is driven by mitre gearing 28 one of the meshed units of which being connected by means of a shaft 29 with any rotating part of the engine.

The blower 25 discharges through a pipe 30 leading downwardly through a passage 31 which is clearly shown in Figures 3, 4 and 5. The passage 31 is a common distributing point to a manifold 32 composed of six branches 33, 34, 35, 36, 37 and 38 which diverge therefrom in a fan-shaped arrangement and each of which establishes substantially the shortest possible route or direct travel to one of the cylinders. This design of manifold, while it is not indispensable to the success of our invention, has shown improved results of distribution to and efficiency of the engine. The manifold 32 is appropriately secured at 39 to the side of the engine case 1.

The liquid phase treatment of the fuel within the tube 8 may be supplemented by a subsequent vapor phase treatment at the common distributing point 31 of the manifold by the location within that passage 31 of a cylindrical screen 40 which may be composed of copper or an alloy thereof or of composite metals one of which is to exercise the function of an activating agent for promoting the pro-oxidation or catalytic action of the copper.

The modification disclosed in Figure 9 comprises a tube 41 composed of nickel instead of copper and further comprises insertion in the entering end of the tube 41 of a reticulated or perforated cartridge casing 42 filled with a copper compound 43, for instance copper stearate or copper oleate. The separated units composing the copper "soap" contents 43 are, of course, a porous aggregate permeable by the incoming fuel and are therefore a further equivalent of the copper screens. The alternately arranged screens in Figure 9 are to be considered as composed, one set of copper and the other set of magnesium instead of nickel.

Figure 10 involves a modification by insertion within the forward end of a tube 44 of a rod 45 on which is wound a helical copper screen 46. A return pipe 47 within the rearward end of the tube 44 similarly supports a helical copper screen 48 and near its middle has a bent discharge end 49 similarly communicating with the pipe 19 leading to the carburetor.

Figures 11 and 12 illustrate the adaptation of a copper tube 50 receiving fuel from the pipe 5, closed at its rear end 51 and discharging through the pipe 52 into the pipe 19. The tube 50 is shown in Figure 12 to be square in cross section and interiorly has one of its side walls carrying insulation 53 which in turn carries a copper sheet 54. The opposite wall carries internally insulation 55 on which is mounted a sheet of magnesium 56.

We claim:

1. In a fuel conditioner the combination of a fuel conduit, a copper salt in said conduit and a water-circulating system for heating said conduit.

2. The process for improving combustion of a liquid hydrocarbon fuel in advance of its immediate introduction into an internal combustion enging including a fuel conduit, which comprises subjecting the fuel to a plurality of different catalytic agencies while in the liquid phase within said conduit and in the presence of heat less than 212° F.

3. In a fuel conditioner, the combination of a hot water compartment and an assembled fuel conduit passing through yet closed with respect to said compartment, said assembly comprising a copper tube, having its one end closed and a pipe having an inlet end appositioned to said closed tube end and extending away from it and out through one side of said tube.

4. In combination, a conduit for supplying fuel, a water-circulatory system for heating a portion of said conduit and differing metallic screens within said heated conduit portion, the constituent metals of said screens acting as conditioning agents for catalyzing the combustion of said fuel.

5. The process for improving the oxidation of a hydrocarbon distillate preparatory to its immediate introduction into a cylinder of an internal combustion engine, comprising the steps of flowing the liquid fuel in contact with a metallic catalyst in the presence of heat, adding air to said fuel, causing the air-fuel mixture to flow in contact with another and different metallic catalyst in the presence of heat, and thereupon introducing the air-fuel mixture into the engine cylinder.

6. In a fuel conditioner, the combination of a hot water compartment and an assembled fuel conduit passing through, yet closed, with respect to said compartment, said assembly comprising a tube, having its one end closed, a pipe having an inlet end appositioned to said closed tube end and extending away from it and out through one side of said tube, and a perforated cartridge casing located within the tube and containing a copper compound for fuel conditioning.

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