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METHOD OF CHARGE FORMING

Original Filed July 11, 1930

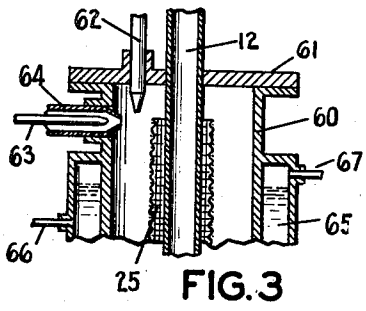


FIG. 3

FIG. 1

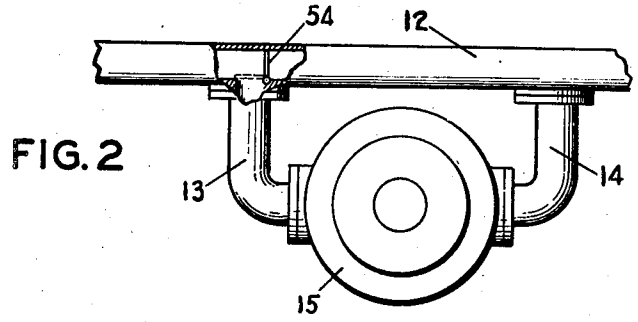


FIG. 2

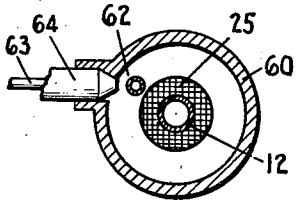


FIG. 4

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2,080,420

METHOD OF CHARGE FORMING

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Application July 11, 1930, Serial No. 467,212
Renewed May 15, 1936

13 Claims. (Cl. 123—133)

For more than a decade, three different and perplexing facts made it difficult for the oil refiner to effect a balance in his operations:

1. A rapidly swelling demand from the motoring public for more gasoline, this demand having multiplied nearly four times in the past decade;

2. Inability, with the existing processes, to derive more than 42% of gasoline from crude oil; and

3. Consequent overproduction of heavy fuel oil and other residues far and above the market demands.

In view of this rapidly swelling demand for gasoline and of the overproduction of crude oil, the importance of an invention, which offers relief in this situation by effecting the transformation of crude oil into gas for power purposes is, therefore, apparent.

This invention relates to the transformation of heavy fuel oil into a fuel of low boiling point, which is readily vaporized into a gas suitable for internal combustion engines, as, for instance, those used for running of industrial machinery as well as vehicles, such as automobiles, busses, trucks, boats, and other means of transportation.

It is known that heavy fuel oils, as a source for power, have the advantage over the fuel oil applied prior hereto for the operation of combustion engines in that they furnish a higher power effect at a lower cost owing to better thermal efficiency and the lower cost of the raw fuel oil.

If, notwithstanding such advantages obtainable by the use of heavy fuel oils, their application was not universally adopted, such failure was probably due to the fact that the heavy fuel oils were not changed into a suitable form and were, therefore, not burned up completely. Residues, such as carbon, soot and the like were formed, and would cover the spark plugs, and so forth, whereby considerable annoyances were caused.

Though we are aware that the problem of burning heavy fuel oils for power purposes is solved to some extent by the Diesel motor, other types of internal combustion engines, receiving a charge of an explosive gas mixture from an outside source, are, however, still restricted to the application of a relatively low boiling liquid, the vapors of which form with air an explosive gas mixture. Such liquids are chiefly the low boiling liquid hydrocarbons of the type, C_nH_{2n+2}, for instance, in the form of the well-known "gasoline" as supplied by the oil companies, while the application of heavy fuel oils, or heavy hydrocarbons, in such explosive engines, notwithstanding many efforts to solve the problem, have failed and have not furnished one practical solution which would be in use even on a moderate scale.

It is an object of this invention to provide ways and means by which heavy fuel oils may be transformed and applied to internal combustion engines in a manner similar to the utilization of gasoline so that the inherent energy may be developed as completely as possible in order that a high thermal effect similar to the effect given by the Diesel motor may be attained.

Under heavy fuel oils we understand all such hydrocarbons which are of higher specific gravity and boiling point than gasoline and, therefore, are not any more included in the class constituting what presently is sold as "gasoline" on the market.

It is a further object of the invention to provide means for applying heavy fuel oils in an internal combustion engine so that, without any material change of this type of machine, the cooperation with the aforesaid engine of a desired supply of operative fuel for the production of an explosive gas mixture may proceed according to demand.

It is also an object of the invention to provide means by which not only all the gas for the machine, but, if desired, more than the required amount can be produced.

With these and other objects in view, which will be more apparent as the description proceeds, reference is had to the accompanying drawing, illustrating by way of example how we may proceed in the operation of our invention in connection with an average type of an internal combustion engine.

On the drawing,

Figure 1 is a fragmentary front elevation of a combustion engine embodying the means for carrying our invention into effect, parts of the means, in relation to the cylinder of the combustion engine shown, being in somewhat larger proportion, and parts being shown in section so as more fully to disclose essential parts;

Figure 2 is a fragmentary plan view, showing a bypass of the exhaust pipe to provide a passage through a part of the device in which the transformation is effected;

Figure 3 is a fragmentary vertical sectional view of a modified form of the reaction chamber, and Figure 4 is a fragmentary sectional plan view showing the spaced relation of the inlets for oil, air and water vapor, or steam.

On the drawing, numeral 10 denotes the cylin-

der of a combustion engine of any of the usual types, 11 is the inlet pipe for the fuel gas, and 12 is the exhaust pipe for the burned gases. Two elbow pipes 13 and 14 branch off from this exhaust pipe 12 and are joined to a hollow cylindrical vessel 15 having centrally arranged therein a cylindrical wall 16 so as to form a chamber 17 communicating, by the elbow pipes 13 and 14, with the exhaust pipe 12.

The cylindrical wall 16 rises perpendicularly from the bottom of the chamber 17; its upper end is outwardly flared at its union with the roof of the same chamber. The cylindrical wall 16 thus forms a reaction chamber 18 which is open at its lower end, and is closed by a cap 19 at its upper wider end, closed. Through cap 19, the chamber may be connected with an oil feed pipe 20, an air admission pipe 21 with apertures 22 at its upper terminal regulated by means of a cap 23, and a pipe 24 for the admission of steam or water.

The pipes 20 and 24 are so positioned in relation to each other that a jet of oil from pipe 20 and a jet of steam or water from pipe 24 intersect with each other substantially at the middle, or on the axis, of the cylindrical reaction vessel 18, and closely above the catalyzer 25, which may be arranged within a tube 26 of fused quartz, porcelain, fire clay, or the like refractory material, tube 26 being in close contact with wall 16. The catalyzer 25 is made of asbestos covered with a metal oxide, as will be further explained below, or may consist of some metal wire netting, it being by no means necessary that the catalyzer 25 be arranged within tube 26, but, for matters of observing the work of the various catalyzers, we prefer to have it, at present, in the chamber so as to exclude any consideration of the contemporaneous action of the iron in the catalyzing reaction.

Pipe 20 is connected with a storage tank for oil (not shown), and may be controlled by valve 27. The pipe 24 is connected with any suitable water supply (not shown), and by the branch-pipes 28 and 29, is in communication with a steam or water vapor generator 30, here shown as operatively surrounding exhaust pipe 12. A valve 31 is interposed in pipe 24 between the connections thereto of pipes 28 and 29, the latter having valves 32 and 33, respectively, interposed therein.

The reaction chamber 18 has an extension chamber 34, arranged below and fully communicating with reaction chamber 18 to serve as a condensing chamber, for which purpose it is surrounded by a cooler 35 provided with inlet and outlet tubes 36 and 37, respectively, for the cooling water.

A vertically arranged S bend 38 connects at its upper end with the condensing chamber near the lower end of reaction chamber 18 where the products from the reaction chamber are still in the gaseous form. In about the middle of its vertical part the S bend communicates with inlet pipe 11 of cylinder 10, and its lower end co-operatively connects with a carburetor 39, which have a by-pass for air.

The condensing chamber 34 is provided at its lower end with a drainage pipe 40 which communicates by pipe 41 with a storage tank (not shown), from which, by pipe 42, carburetor 39 may be fed. The pipe 41 is provided with a check valve 43, and pipe 42, with a valve 44. Furthermore, pipes 40 and 42 may be put into communication by a connection piece 45, consisting of a valve and connecting nipples, so that, upon closing valve 44 and opening valve 45, carburetor 39 may be fed directly from condensing chamber 34.

The inlet pipe 11 is cut and provided at both its ends with perpendicularly disposed standards 46 so as to serve as journals for a vane 47 provided with a set of propellers 47^a rotarily arranged between the ends of the inlet pipe 11 and within a suitable housing 55 between and fixedly retaining the ends of pipe 11. The housing is connected with exhaust pipe 12 by a pipe 48 having a valve 49. Upon opening valve 49, the pressure of the exhaust gases acts on the turbine or driving blades 47^b of vane 47, to impart rotary motion thereto, the exhaust gases leaving through pipe 50 to be discharged again into exhaust pipe 12 near its exit.

Wire screens 51 are interposed in S bend 38 to arrest any back firing from engine 10.

A plate valve 52 is arranged in the lower end of bend 38, somewhat above carburetor 39, and another plate valve 53 is arranged in the vertical part of bend 38 slightly above the highest point of inlet pipe 11, both plate valves being spacedly related to each other and co-operatively engaged by a lever system 56 so that, when one of them is closed, the other is open, and vice versa.

A plate valve 54 is, furthermore, rotatably arranged within exhaust pipe 12 for the purpose of shutting off elbow pipe 13 from connection with exhaust pipe 12.

In view of the object of the invention to apply heavy fuel oils as a source of motive power for internal combustion engines, we assume, to simplify the description of how we proceed to operate such an internal combustion engine by our invention, that the engine has already run for some time, and that its exhaust pipe is at the maximum temperature to which it is ordinarily heated by the exhaust gases.

In the operation of our invention, we proceed about as follows:

We fill the storage tank (not shown) with a heavy fuel oil, as, for instance, Pennsylvania crude oil, which preferably has been deprived of its sediment by filtering or like operation, and further was de-sulfurized by any of the well known methods; then we adjust valve 27 so that a predetermined quantity of the heavy fuel oil, as, for instance, 2 gallons per hour, may pass through pipe 20 into the bell shaped funnel of the reaction zone, or chamber 18. When oil is started, air is delivered from pipe 21 by a vane propeller such as described above, the air entering through apertures 22 of cap 23; furthermore, we admit water, or water-vapor, or steam, through pipe 24 from generator 30.

The water-vapor or steam is generated by closing valve 31 and opening valve 33 so as to admit water into generator 30, wherein the heat of the exhaust gases, penetrating through the wall of exhaust pipe 12, evaporates the water, the vapor of which then escapes through open valve 32 and through pipe 24 into reaction chamber 18.

As already stated, the inner wall of reaction chamber 18 is lined by a fused quartz tube or other similar refractory material. By suitable supports, (not shown), catalyzer 25 is arranged in the tube.

This catalyzer 25 may consist of a metal in any suitable form, as, for instance, in the form of wire netting, clippings, balls, rods, or in the form of a fine precipitate coating of granulated refractory material; in fact, any form offering a considerable surface to gases, without substan-

tially reducing quantitatively the flow of the gases, may be applied.

As catalyzers, we may apply any of the so-called noble metals, such as platinum, palladium, gold, silver, and also the base metals, such as copper, nickel, aluminum, iron, cobalt, manganese, or any other metal, the oxide or oxides of which are known to burn up hydrogen at ordinary or elevated temperatures.

While we have stated above that we apply the catalyzers in the form of a metal having a great surface, we may apply the catalyzer directly in the form of an oxide of the metals specified above. Such an oxide catalyzer is formed, for instance, by first saturating asbestos fibres, preferably of long staple, or an asbestos fabric of very wide mesh, with a solution of a salt of the selected metal, as, for instance, copper sulfate, silver nitrate, or the like, then acting on the metal salt with an alkali metal hydroxide, thereby precipitating the metal in form of its hydroxide, and heating the washed hydroxide to remove the water therefrom and obtaining the metallic oxide thereby.

We prefer particularly as catalyzers the oxides of those metals which are known to burn up hydrogen at a low temperature, either below or approximately at the boiling point of water, that is, at approximately 100° C.; such metals, also preferred on account of their relatively low price, include silver, copper, and nickel.

Taking copper, for instance, as a catalyzer by way of example, we apply the same in the form of wire netting of relatively wide mesh, a strip of the netting being rolled up so as to form a twisted or spiral path and to give a swirling motion to the gaseous and liquid materials within the reaction chamber.

It is advantageous to form the mixture of air, water in liquid or vapor form, and oil in the upper bell of the reaction chamber over catalyzer **25**, which may be of copper or silver. This is heated by the hot exhaust gases, which pass from exhaust pipe **12** through elbow **13** into chamber **17** to heat inner wall **16** and thereby heat the catalyzer **25**.

This catalyzer **25** is preheated to a temperature sufficiently high to start the reaction before the mixture of oil, air and steam is passed over it.

When such temperature is reached, the above described mixture is started upon the catalyzer, the oxygen of the copper oxide attacks the oil in the presence of steam, which is admitted chiefly to avoid explosions in the reaction zone, and lighter hydrocarbons are formed; the oxygen of the air re-oxidizes the copper or other metal catalyzer and this alternate reduction of the metal oxide to metal and the re-oxidation of the same cause the process of transforming the heavy fuel oil. Through this reaction a minor fraction of the oil is destroyed.

During this operation, valve **53** may be closed so that the vapors of the newly formed light hydrocarbons cannot pass into the inlet pipe of the combustion engine, but must descend into condensation chamber **34** where the hydrocarbons are dephlegmated by a cooling agent, for instance, water in chamber **35***a*, acting upon the walls of chamber **34** and upon a coil **35***b* connected to chamber **35***a* so as to induce convection currents of the fluid. The discharge of uncondensable gases, such as the nitrogen of the air and carbon dioxide, is described below.

The temperature in the reaction chamber rises, and with the admission of oil, air and steam adjusted, the reaction becomes self-sustaining without further heating by the exhaust gases. The particular temperature at which this stage is reached may vary with various catalyzers, but may easily be ascertained by a thermometer and, with a copper catalyzer, lies at red glow heat.

If we now consider running the internal combustion engine with the reaction products, we have three different possibilities of operating it:

First, by condensing all the reaction products in chamber **34**, running the internal combustion engine with a gasoline mixture obtained from the reaction products discharged through pipe **40** and valve **45**, valve **44** being closed into carburetor **39** operatively connected with the inlet pipe **11**, through the S bend, valve **52** being open and upper valve **53** closed.

Secondly, lower valve **52** and valves **45** and **44** are closed, and upper valve **53** is fully open, so that the engine is run directly with the reaction products coming from reaction chamber **18**. In this case, however, the surplus of the reaction products condenses within condensation chamber **34** and pass through check valve **43** and pipe **41** to the storage tank, not shown.

Thirdly, valves **52** and **53** are so adjusted or regulated that both valves are partly open, and the internal combustion engine is operated partly with the gaseous reaction products and partly with the gasoline mixture obtained by draining into carburetor **39** the condensate of the reaction products from the storage tank (not shown) through the valve **44**, valve **45** being closed into the carburetor **39** and discharging the gasified mixture from the carburetor into the lower elbow of the S bend, where it combines with the aforesaid part of the reaction products and the whole mixture passes into the engine.

When the internal combustion engine is in full operation and constantly exhausts burned gases, these expanding gases may also be discharged through open valve **49** of pipe **48** upon the outer set of the turbine or driving blades **47***b* of vane **47**, and thus cause movement of air and the reaction products under some pressure into the combustion engine. After the impact of the expanding exhaust gases on driving blades **47***b*, the gases leave casing **55** around inlet pipe **11** through exhaust **50** and empty into conduit pipe **12** near its exit.

The diameter of the reaction chamber **18** will determine how much gaseous fuel is produced by converting the heavy fuel oils into light hydrocarbons; the reaction zone is always somewhat larger than necessary, and the unused part of the reaction products condenses in chamber **34**, to be stored in a tank (not shown).

Though we here describe vane **47** and its effect, we are aware that the same is not absolutely necessary and that its function may be effected by other devices, and in view of the suction by the piston of the combustion engine, it may even be entirely dispensed with.

As the decomposition of the oil in reaction chamber **18** is rendered self-maintaining and continuous, it is obvious that temporarily stopping the engine does not interfere with starting the apparatus again. There always is produced enough of the condensate, which can be accumulated either in condensing chamber **34**, or in the storage tank (not shown) connected therewith by pipe **41**, that by feeding the condensate into carburetor **39** to produce an explosive gas mixture for the engine, the engine can

again be placed in operation after an interruption. Furthermore, the transformation of the oil in reaction chamber **18** may be continued after stopping the engine by simply continuing the introduction of oil and water vapor into reaction chamber **18** and taking care that the admission of the air into the same continues as before.

We have described above the best mode of carrying out our invention as far as is known to us at the present state of its development. Various changes could obviously be made without deviating from the spirit, or sacrificing the advantages, of our invention; so, for instance, the reaction chamber could be arranged around the outside of the exhaust pipe. Furthermore, the steam, which is desired for the reaction of transforming the heavy fuel oil into the gaseous fuel, may be generated also in some other vessel than the steam chamber **30** shown in Figure 1; there are other possibilities to produce steam, as, for instance, the heat generated by the reaction between the oil and the air forming a part of our invention and from any source connected in some way or other with the combustion process within an internal combustion engine.

We wish to say, in connection with this supply of steam into the reaction chamber, that it is by no means necessary to introduce steam or water vapor into the reaction chamber; the chamber is always at a temperature sufficiently high to transform immediately such amounts of water into vapor as is necessary for the smooth operation of the reaction which is of exothermic character, and, therefore, can be so regulated as to take care of the immediate vaporization of water in the reaction chamber.

It is one of the desirable features of our method that the mixture of the oil spray, air and water vapor passes through the reaction chamber in a vertical direction and that at each area, or cross-section, of said reaction chamber the spaced reaction between the catalyzer and the original mixture of applied substances is uniform, that consequently also the spaced relation between the catalyzer and the gases, resulting from the contact of aforesaid mixture with said catalyzer, if uniform. It is evident, therefore, that the aforesaid mixture everywhere meets with the same equal resistance so as to guarantee an even distribution in each area with the result that the chemical reaction goes on evenly within each single area of the reaction chamber and that the generation of the gaseous products in the reaction chamber is thus confined to an area in which they are subject to a relatively minimum and uniform frictional resistance.

In the modified arrangement illustrated by Figures 3 and 4, exhaust pipe **12** is centrally disposed within reaction chamber **60**, and catalyzer **25** is arranged on the outer wall of exhaust pipe **12**. The reaction chamber **60** is covered with a plate **61** through which an oil feed **62** is tightly arranged and suitably perpendicularly disposed. The steam supply **63** is arranged coaxially within air pipe **64**, the outlets of both furthermore being in the same plane and slightly below the perpendicularly disposed oil feed **62** so that, when steam and air is blown into reaction chamber **60**, the incoming oil is dispersed into a fine spray. It is shown by Figure 4 that the position of pipes **63** and **64** relative to the inside wall of reaction chamber **60** is substantially parallel to the tangent on the peripheral circumference of the outside wall. The fine spray of oil, air and steam follows, therefore, a helical path in its travel through the reaction chamber.

A chamber **65** may surround the reaction chamber **60**, having an inlet **66** for water, and an outlet **67** for steam to be conducted by a suitable conduit **63** into reaction chamber **60**.

To discharge the nitrogen of the air and non-condensable gases, generated by the process from the condensing chamber, when the gaseous fuel supply to the internal combustion engine is furnished by the carburetor, an exit pipe from the condensing chamber is provided with a check valve **68** at its outer end so as to allow the discharge of these uncondensable gases and to prevent air from entering the condensing chamber.

What is claimed is:

1. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of fuel for a gasoline internal combustion engine, said method comprising: heating to a predetermined reaction temperature a reaction zone connected with the intake of said engine and containing a catalyzer; causing a mixture of oil, air and water to react in aforesaid zone; continuing the reaction by its own exothermic heat; producing gaseous reaction products in excess; condensing the excess of the gaseous reaction products; and feeding said condensate to the carburetor of said engine.

2. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of fuel for a gasoline engine, said method comprising: heating to a predetermined reaction temperature a reaction zone of the intake of said engine containing a catalyzer; causing a mixture of oil, air and water to react in aforesaid zone; continuing the reaction by its own exothermic heat; producing the gaseous reaction products in excess; condensing the excess of the gaseous reaction products; feeding some of said products directly to the engine; and storing the condensate in revaporizable relationship of reserve to said engine.

3. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of fuel for a gasoline internal combustion engine, said method comprising: heating a reaction zone to a predetermined reaction temperature by the heat set free in the operation of said engine; causing a mixture of oil, air and water catalytically to react in aforesaid zone; maintaining the reaction by its own exothermic heat; producing gaseous reaction products in excess; condensing the excess; storing the condensate; and complementarily feeding non-condensed reaction gases and revaporized condensate into the engine.

4. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of fuel for an internal combustion engine in combination with the operation of said engine, said method comprising: heating a reaction zone by the heat set free during operation of said engine to a predetermined reaction temperature; causing a mixture of oil, air and water catalytically to react in aforesaid zone; producing gaseous reaction products in excess; condensing substantially all the gaseous reaction products; storing the condensate; and feeding the revaporized condensate into the engine.

5. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of fuel for an internal combustion engine, said method comprising: heating a reaction zone, containing a catalyzer; to red glow heat; producing gaseous reaction products in excess by mix-

ing said oil, air and water in aforesaid zone; feeding part of said products directly into said engine; condensing part thereof for carburetion; and continuing the reaction by its own exothermic heat.

6. The method of producing from a high boiling fuel oil a fuel for operating a gasoline internal combustion engine, said method comprising: heating a reaction zone containing a catalyzer, to red glow heat; mixing said oil, air and water in aforesaid zone; continuing the reaction by its own exothermic heat; producing gaseous reaction products in excess; feeding some of said products directly to said engine; and condensing the excess of the gaseous products.

7. The method of producing from a high boiling fuel oil a fuel for operation of a gasoline internal combustion engine, said method comprising: heating a reaction zone, containing a catalyzer, to red glow heat; mixing said oil, air and water in aforesaid zone; continuing the reaction by its own exothermic heat; producing gaseous reaction products in excess; feeding such products into said engine; condensing the excess of the gaseous reaction products; and storing the condensate for fueling said engine.

8. The method of operating a gasoline internal combustion engine with a high boiling fuel, said method comprising: heating a reaction zone, containing a catalyzer, to red glow heat; mixing such oil, air and water to react in aforesaid zone; condensing some of the gaseous reaction products; storing the condensate; and directly feeding non-condensed gases into the engine with an admixture of the revaporized condensate.

9. The method of operating with a high boiling fuel oil and internal combustion engine for low boiling fuel oil, said method comprising: mixing said high boiling fuel oil, air and water in the presence of a catalyzer; heating said catalyzer by the exothermic heat of operating the engine with the reaction products; condensing substantially all the gaseous reaction products; storing the condensate; and feeding it into the engine.

10. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply of gasified fuel or fuel gasifiable at substantially atmospheric temperatures, said method comprising heating a reaction zone containing a catalyzer to a predetermined temperature, causing a mixture of oil, air and water to pass downwardly through the reaction zone and over the catalyzer, continuing the downward movement of the reacted mixture beyond the reaction zone and into a condensing zone, circulating a cooling medium through the condensing zone, and continuing the reaction at the reaction zone under the exothermic heat of the reaction while condensed products of the reaction are led away from the condensing zone.

11. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply for an internal combustion engine of gasified fuel or fuel gasifiable at substantially atmospheric temperatures, said method comprising heating to a predetermined temperature with the exhaust gases of the engine a reaction zone containing a catalyzer, causing a mixture of oil, air and water to pass downwardly through the reaction zone and over the catalyzer, continuing the downward movement of the reacted mixture beyond the reaction zone and into a condensing zone, circulating a cooling medium through the condensing zone, and continuing the reaction at the reaction zone under the exothermic heat of the reaction while condensed products of the reaction are led away from the condensing zone.

12. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply for an internal combustion engine of gasified fuel or fuel gasifiable at substantially atmospheric temperatures, said method comprising heating to a predetermined temperature with the exhaust gases of the engine a reaction zone containing a catalyzer, causing a mixture of oil, air and water to pass downwardly through the reaction zone and over the catalyzer, continuing the downward movement of the reacted mixture beyond the reaction zone and into a condensing zone, circulating a cooling medium upwardly through the condensing zone, and continuing the reaction at the reaction zone under the exothermic heat of the reaction while condensed products of the reaction are led away from the condensing zone.

13. The method of producing from a high boiling fuel oil a continuous and self-maintaining supply for an internal combustion engine of gasified fuel or fuel gasifiable at substantially atmospheric temperatures, said method comprising heating to a predetermined temperature with the exhaust gases of the engine a reaction zone containing a catalyzer, causing a mixture of oil, air and water to pass downwardly through the reaction zone and over the catalyzer, continuing the downward movement of the reacted mixture beyond the reaction zone and into a condensing zone, circulating a cooling medium through the condensing zone and the reacted mixture passing through the condensing zone and in a general direction opposite to that of the movement of the reacted mixture, and continuing the reaction at the reaction zone under the exothermic heat of the reaction while condensed products of the reaction are led away from the condensing zone.

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CERTIFICATE OF CORRECTION.

Patent No. 2,080,420. May 18, 1937.

JOHN T. HAVEKOST, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 45, after the reference numeral "16" insert a comma; line 46, strike out the reference numeral "25"; line 47, beginning with the words "This catalyzer" strike out all to and including the word and period "destroyed." in line 61 and insert instead the following paragraphs:

> This catalyzer, before the mixture of oil, air and steam is passed over it, is preheated to a temperature sufficiently high to start the reaction.
>
> When such temperature is reached, the above described mixture is directed upon the catalyzer. The oxygen of the copper oxide attacks the oil, in the presence of steam which is admitted chiefly to avoid explosions in the reaction zone, and lighter hydrocarbons are formed. The oxygen of the air then re-oxidizes the copper or other metal catalyzer. By this alternate reduction of the metal oxide to metal, and the re-oxidation of the same, the process of transforming the heavy fuel oil proceeds. Through this reaction, a minor fraction of the oil is destroyed.

and second column, line 14, after "closed" insert a comma; line 17, strike out the period after "closed" and insert instead a semicolon; line 24, for "pass" read passes; line 25, strike out the period after "shown" and insert instead a semicolon; line 33, strike out "the"; line 34, insert a comma after "closed"; line 38, strike out "and the whole mixture passes" and insert instead the words to then pass as one mixture; line 49, for "exhaust" read conduit and for "conduit" read exhaust; line 51, strike out "the"; line 64, for "decomposition" read transformation; page 4, first column, line 38, beginning with "It is one" strike out all to and including the word and period "resistance." in line 57, and insert the following paragraph:

It is one of the desirable features of our method that the mixture of the oil spray, air and water vapor passes through the reaction chamber in a vertical direction, that, at each area or cross-section of said reaction chamber, the spaced reaction between the catalyzer and the original mixture of applied substances is uniform and that consequently also the spaced relation between the catalyzer and the gases, resulting from the contact of aforesaid mixture with said catalyzer, is uniform. It is evident, therefore, that the aforesaid mixture everywhere meets with the same equal resistance so as to guarantee an even distribution in each area, with the result that the chemical reaction goes on evenly within each single area of the reaction chamber, and that the generation of the gaseous products in the reaction chamber is thus confined to an area in which they are subjected to a relatively minimum and uniform frictional resistance.

and second column, line 8, after "process" insert a comma; line 74, claim 5, strike out the semicolon after "catalyzer" and insert instead a comma; page 5, first column, line 37, claim 9, for "and" read an; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of October, A. D. 1937.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)