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METHOD AND APPARATUS FOR REMOVING LEAD CONTAINING INGREDIENTS FROM HYDROCARBON FUELS

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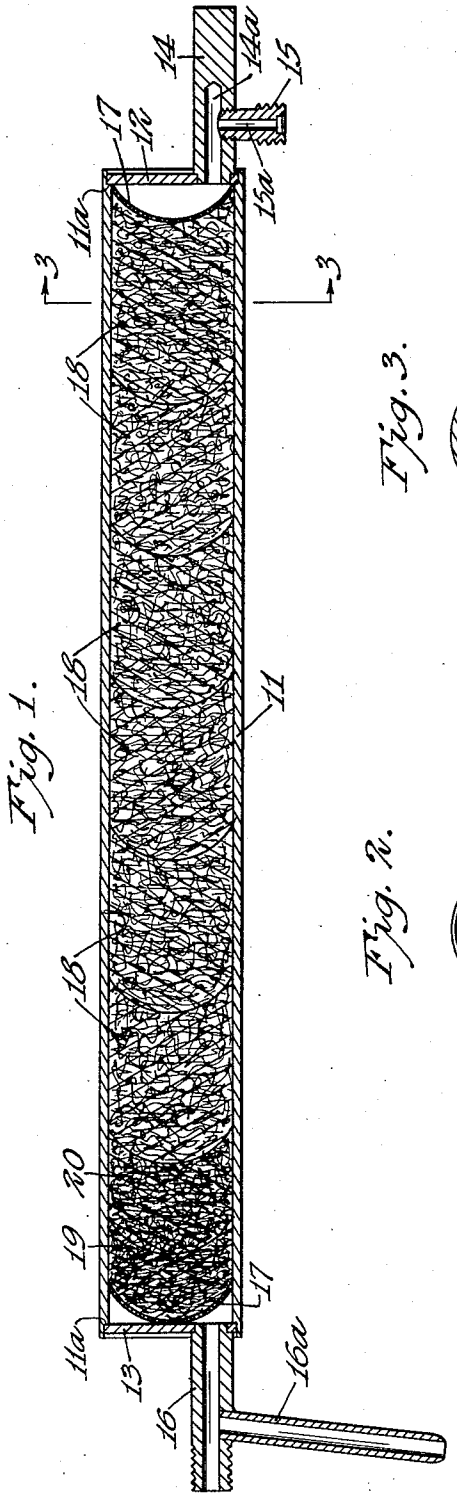


Fig. 1.

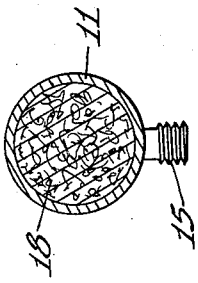


Fig. 3.

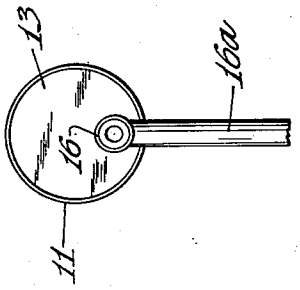


Fig. 2.



Fig. 4.

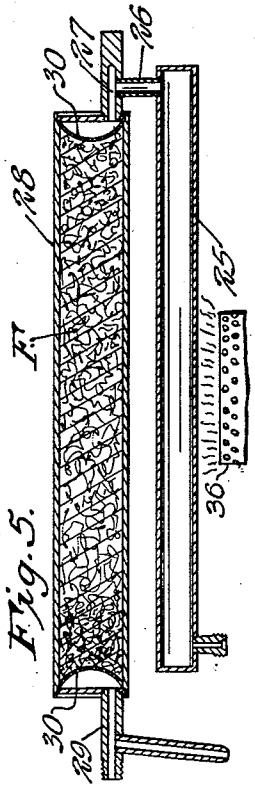


Fig. 5.

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METHOD AND APPARATUS FOR REMOVING LEAD CONTAINING INGREDIENTS FROM HYDROCARBON FUELS

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2 Claims. (Cl. 196—1)

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This invention relates to the generating and conditioning of hydrocarbon fuels containing tetra-ethyl lead, such as leaded gasoline, to enable such fuels to be burned successfully in pressure type systems for heating, cooking and illumination.

Heretofore, to applicant's knowledge, it has been impractical and commercially impossible to successfully utilize gasoline containing tetra-ethyl lead in gasoline burner systems of the pressure type. Such systems employ generators wherein the fuel is introduced, vaporized and passed on by pressure and they also contain small orifices, valves and other restricted passages which become easily clogged with accumulations of any deposits or sludge. In the vaporization of the leaded gasoline in the generator tube or other retort, the temperatures are such that a cracking or decomposition of the tetra-ethyl lead occurs resulting in production of atoms or extremely minute particles of the element lead as well as some small amount of lead oxide due to some presence of air in the generator. These atoms and particles, I have discovered, will deposit upon surfaces in small and restricted passages of the system or apparatus, clogging parts of the device ahead of the actual burner jets. The actual burning of the vaporized leaded fuel, of course, produces particles of lead oxide in the burner structure itself where air is admixed with the vaporized fuel, further clogging passages and ports and making such systems inoperative after leaded gasoline has been utilized for a relatively very short period of time.

Furthermore, the production of minute particles of lead oxide through the burning of gasoline vapor containing tetra-ethyl lead or constituents thereof is dangerous to human and animal life, such particles being toxic when breathed or swallowed. Various attempts have been made to solve the problems enumerated herein, both for the purpose of enabling pressure burner systems to be utilized to successfully burn leaded gasoline and for the further purpose of removing the grave danger to human life.

It is an object of my invention to provide a comparatively simple, but highly successful method whereby the toxic and solid or clogging constituents of tetra-ethyl lead and its oxides formed in vaporizing and burning of the fuel are substantially eliminated from the burner system as the fuel is being vaporized in the generator and prior to entrance of the vapors into the burner proper and, of course, prior to actual burning.

A further object is the provision of a simple and highly efficient apparatus for substantially eliminating the objectionable and dangerous constituents of leaded gasoline to enable such fuel to be burned successfully and safely in pressure systems.

These and other objects and advantages of my

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invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to the same parts throughout the views, and in which—

Figure 1 is a longitudinal, sectional view of a generator detached from a gasoline burner system constructed to carry out my improved method and embodying the principles of my improved apparatus;

Figure 2 is an end view of the same;

Figure 3 is a cross section taken on the line 3—3 of Figure 1;

Figure 4 is a side elevational view illustrating a bat of matted metal filaments, such as steel wool before the same is compressed or condensed; and

Figure 5 is a longitudinal elevation of a somewhat different form of my apparatus.

The tetra-ethyl lead contained in leaded gasoline or other analogous hydrocarbon fuels is held in suspension in the form of very minute globules and remains in such form until it is heated to such temperature either by vaporization of the fuel at high temperature or in the subsequent burning, to crack or otherwise decompose the tetra-ethyl lead thereupon liberating free lead atoms or minute particles which in the presence of air readily form particles of lead oxide.

After exhaustive testing of various chemicals, filters and methods for eliminating the constituents of tetra-ethyl lead both upon burning and prior to burning of the vaporized fuel, I have discovered a method and apparatus which by actual long recurrent tests have demonstrated an efficiency for removing as high as 95% of all lead constituents of the prepared leaded gasoline.

My method is preferably carried out within the generator or vaporizing tube itself as the leaded hydrocarbon fuel is heated at relatively high temperatures for producing a combustible vapor and gas. It can be carried out, although not as successfully, at points in the pressure burner system immediately after vaporization of the fuel and where the temperature of the mixture is such that the tetra-ethyl lead is still in cracked or decomposed state.

In the form of the apparatus illustrated in the drawings Figs. 1 and 3, there is shown a relatively large generator tube 11 which has circumferential rabbeted ends 11*a* wherein are secured as by welding closure discs 12 and 13 respectively, closure disc 12 at the fuel entrance of the generator tube being tapped to receive a straight-fitting or plug 14 having an axial passage 14*a* in the inner end thereof which communicates with a lateral port 15*a* of a nipple 15 which is connectable with the tank or other source of fuel supply.

At the discharge end of the generator tube 11, as shown, a short tubular fitting 16 is screw-

threaded into the closure disc 13 having a branch laterally extending discharge nipple 16a connected therewith and communicating with the axial port in tube 16. The tube 11 is filled with the exception of its ends with a densely compressed or related mass of metal fragments or particles preferably steel wool, the mass of steel wool as utilized being greatly compressed to provide a dense homogenous filler having a minute porosity sufficient, however, to permit passage of vapors and gases. The filler is very preferably compressed in such manner that its density adjacent the discharge end of the vaporizing tube is materially greater than it is at the entrance end.

As shown the cylindrical filler is disposed between two reticulated or relatively rigid concavo-convex screen partitions 17 disposed at the respective ends of the tube. The reticulated members may be shell members provided with a multiplicity of very closely spaced small perforations or may be in the form of rigid metal netting of small mesh.

It will be understood that while I prefer densely compressed steel wool for the filler of my tube, that other metal fibers matted together and densely compressed or other forms of metal particles, such as compressed metal granules preferably iron or steel having a dense porosity, may be utilized. It is essential that the character of the metal be such that it will have a relatively high melting point above the temperatures utilized in vaporizing the leaded fuel.

I prefer to construct the filler of my generating tube from a plurality of abutting plugs of compressed metallic fibers or particles. As shown eight of said plugs disposed end to end in tube 11 are utilized but, of course the number thereof and lengths of the same may be considerably varied. It is important, however, that the density of the right hand plug 18 be less than the extreme left hand plug 19 and I prefer to utilize a number of plugs 18 of similar compression and density and then utilize one or more intermediate plugs 20 of greater density than the plugs 18 but of less density than the plug 19 immediately adjacent the discharge of the tube.

In utilizing the preferred fibrous metal of relatively high melting point, such as steel wool, a proper density of the various plug members 18, 19 and 20 may be readily and accurately obtained by successively inserting uncompressed bats of the proper diameter to fit the fuel entrance end of tube 11 with disc 12 removed and the disc 13 applied and compressing the first bat of steel wool or fibrous metal to the desired determined position by a piston inserted through the open end of the tube and then applying a second bat of steel wool or fibrous metal and compressing this bat upon the compressed plug 19 by the same piston action, the inward movement of the piston indicating through predetermined means the compression and density desired and thereafter successively introducing uncompressed bats of fibrous metal and compressing by piston action to the extent gauged to obtain the plugs 18, thereafter the grating or reticulated discs 17 with its supporting clip may be inserted and the tube closed at the fuel entrance end by welding or otherwise, securing the disc 12 in the rabbeted end of the tube.

Referring now to Fig. 2, there is there shown a supply pipe 31, which will supply the fuel, such as gasoline containing tetra-ethyl lead, from a source of supply such as a fuel tank under air

pressure to the plug 14, a coupling 32 being employed for connecting the delivery end of the fuel supply pipe to the plug 14. The branch discharge nipple 16a has quite a small passage therethrough and it leads into a U-shaped mixing chamber 33, this chamber having an air opening 33a beyond the point where nipple 16a delivers into the same. The mixing chamber 33 connects with a manifold 34, which has connected thereto a burner 35 underlying the generator tube 11 and adapted to deliver heat thereto when in operation.

In carrying out my method and in the operation of the apparatus illustrated, when the apparatus is in full operation, leaded hydrocarbon fuel, such as gasoline containing tetra-ethyl lead, is introduced under pressure through the fuel supply pipe 31 and nipple 14 into the generator tube 11. The generator tube is heated by the burner 35 and the gasoline is generated into gas in the generator tube, the generator tube delivering through the nipple 16a into the mixing chamber 33 where the gas mixes with air admitted through the opening 33a and the mixed air and gas then pass through the manifold 34 to deliver from the burner 35 where it is burned. The heat delivered from the burner 35 intensely heats the generator tube 11 together with the steel wool plugs 18, 19, and 20 to maintain the metal particles or fibers at high temperatures.

The tube is of such diameter and length that actual passage of the fuel therethrough is slow, the globules of the tetra-ethyl lead passing through the less compressed and less dense pads 18 until cracking or decomposition of the tetra-ethyl lead takes place in the vaporizing of the gasoline. As decomposition or cracking of the tetra-ethyl lead commences, liberation of atoms or fine particles of the element lead, is thought to be produced within the tube with some small formation of lead oxide in minute particles because of the small amounts of air admixed with the leaded gasoline. These particles impinge against and some are restricted by the fine porosity of the plugs 18 but it is believed that the lead atoms or minute particles in molten state, unite with the particles of iron at high temperature usually incandescent to form minute quantities of lead-iron alloy. Certain metals have an affinity or ability to form alloys and this is true of metals, lead and iron. In any event, in the vaporization of the fuel and in the material decomposition of the tetra-ethyl lead as the mixture passes through the very finely porous plugs 18, the lead constituents of the tetra-ethyl lead are removed and this I am convinced is through action in addition to mechanical filtering. In the more volatile state and with greater decomposition of the tetra-ethyl lead near the discharge end of tube 11, the plugs 20 and 19 are successively denser thereby producing greater impingement of the remaining molten particles of free lead and serving to substantially eliminate all such particles before the vapors and volatile materials discharge into the tube 16.

The vaporized fuel then passes from the generator tube to the burner and burns without producing any substantial traces of lead oxide.

Careful tests have been made both upon the products of combustion of the fuel conditioned by my method and upon the vapors condensed before being burned to determine traces of lead constituents. Such tests have shown that from 90 to 95% of the lead constituents of gasoline containing tetra-ethyl lead have been eliminated

with the proper use of my method and apparatus.

Examination of filler plugs 18, 19 and 20 have been made by opening up a number of my generator tubes after many hours of actual operation of the burner system and have revealed what apears to be alloy coatings upon the particles or fibers of the steel wool.

It will, of course, be understood that the filler bats have to be occasionally renewed, or what is usually simpler, a new generator tube with my improvements therein, installed for replacement. In the apparatus herein described, with the tube and bats of suitable size for the requirements, several hundred hours of operating use may be obtained where leaded gasoline is burned before replacement is needed. This means that in most commercial devices the system may be operative from six months to over a year without replacement of the filler plugs or generator tube.

I realize that in the high temperature heating action of the leaded gasoline within the generator tube and in the heating of the metallic fibers or particles preferably of steel composition many complicated physical and chemical reactions occur. I cannot positively state what causes the unexpected elimination of substantially all of the lead ingredients during vaporization or immediately thereafter, but I believe there are several factors which may include reactions occurring through carbon in the steel particles; formation of small amounts of alloy with the lead and heated steel, or iron; some other attraction or affinity between the extremely minute lead atoms or particles and certainly decomposition or cracking in the generating tube of the tetra-ethyl lead globules. In any event, I am positive of the successful results produced by carrying out my method as disclosed herein and by the use of the simple apparatus described.

Where in the appended claims the term "particles" is used, it is used in its broad sense to indicate elements of very small cross sectional area whether in the shape of filaments, fibers or minute granules.

Where in the appended claims the term "separated off" is used, it is used in its broad sense to include within its meaning any action whether through attraction, surface tension, alloy affinity, or pure physical filtering to retain the lead ingredient.

In Figure 5 a satisfactory form of apparatus is illustrated wherein the medium for separating off the residue particles from decomposed tetra-ethyl lead is isolated from the generator tube but closely associated therewith. In this form of my invention the generator tube 25 is of conventional structure and may or may not have a filling therein to prevent pulsations or choking and has its discharge end connected by a short tube 26 with the intake 27 of a residue removing retort or tube 28. Tube 28 is preferably of considerably greater diameter than the vaporizing tube 25 and in general is constructed similarly to the tube 11 of the form first described, having a discharge tube 29 at one end thereof and being substantially filled throughout its cross sectional area with preferably densely compressed plugs or a plug of metallic fibrous material preferably steel wool or some other fibrous iron containing metal. In the tube 28 the heavy screens 30 are of similar construction to the retaining screens 17 shown in the form first described, but are related somewhat different as shown both having the concave portions disposed inwardly relatively to the respective ends of the tube. The filler F of

steel wool or the like is as in the form of the invention first described preferably constructed and compressed in such manner that the plug or portion of the filler at the discharge end of the tube is of greater compressed density than the portion of the filler at the intake end.

In operation the vaporized fuel with free particles of lead and particles of lead oxide mixed therewith at high temperature pass into the intake end of tube 28 and then are affected by the filler F in the same manner as in the preferred form previously described. The volatile material passes through the filler F whereas the lead atoms or particles and other residue particles impinge against the many matted fibers or particles of steel wool and react therewith and are separated off as described with reference to the form first described. It is, of course, essential that the temperature within the filler F be adequate to retain the fuel in vaporized state, and for this purpose there is shown a burner 36 underlying both tubes 25 and 28 and playing thereon.

What I claim is:

1. Apparatus for substantially removing the lead containing ingredients of hydrocarbon fuels containing tetra-ethyl lead, comprising a retort adapted to be subjected to high temperatures, said retort having a fuel entrance and a fuel discharge, a filler occupying at least a portion of the interior of said retort between said entrance and said discharge, said filler being composed of a mass of densely related iron containing particles, said particles adjacent the discharge portion of said retort being more densely related than said particles adjacent the fuel intake portion of said retort.

2. The method of generating hydrocarbon fuels containing tetra-ethyl lead to successfully burn the same in burners of the pressure type, which consists in heating the fuel to vaporize the hydrocarbons and decompose the tetra-ethyl lead and passing the fuel in such condition through a mass of successively more densely compressed and matted metal fibers, which, while permitting passage of the vaporized hydrocarbon elements for burning, will act to catch, retain, and substantially remove from the vaporized hydrocarbons the decomposed elements of the tetra-ethyl lead.

SOPHUS RASMUSSEN.

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