United States Patent

[11] 3,597,668

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a part interest
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[31] 43/75262

[54] **ELECTROSTATIC CHARGER FOR LIQUID FUEL BY FRICTION**
9 Claims, 7 Drawing Figs.

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[51] Int. Cl. H01g 1/00
[50] Field of Search .... 55/2, 4, 14, 101, 103, 250, 259; 210/487, 500, 315; 317/2, 3, 4, 262, 6, 7, 1; 261/72, 1; 123/119, 30, 32; 204/168; 310/5—6

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ABSTRACT: A static charger for electrostatically charging liquid fuel comprises a friction element adapted to be installed within a fuel feed pipe adjacent the carburetor of an internal combustion engine. The friction element comprises a metal sheet or mesh rolled into a roll around a core and frictionally contacts the liquid fuel thereby electrostatically charging the liquid fuel.

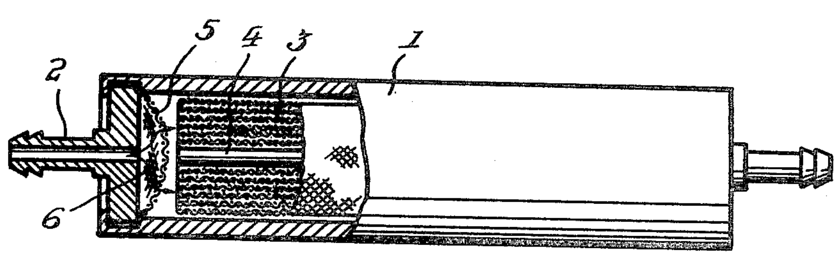


Fig. 1.

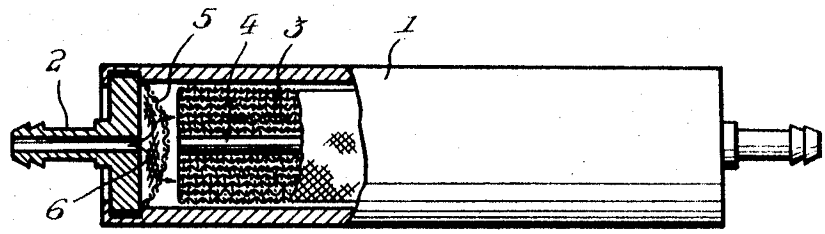


Fig. 2.

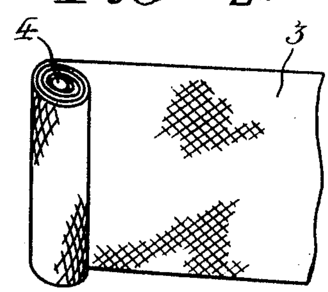


Fig. 3.

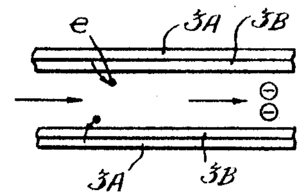


Fig. 4.

Fig. 5.

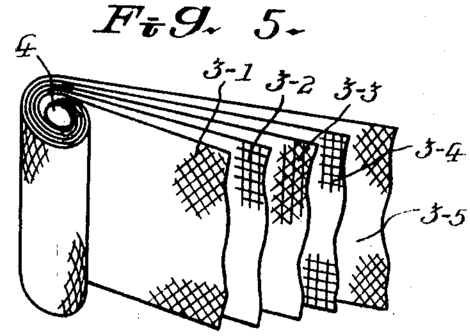


Fig. 6

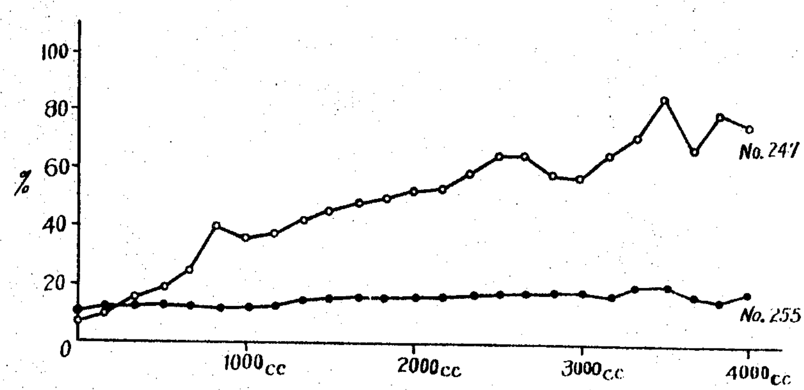
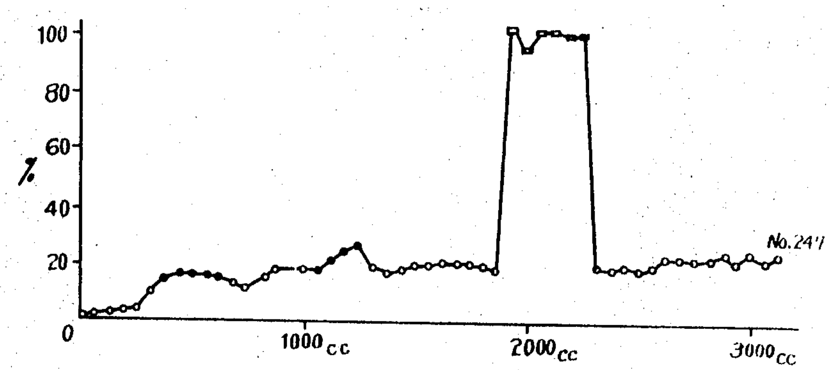

100
80
60
40
20
0
%
1000cc
2000cc
3000cc
4000cc
No. 247
No. 255

Fig. 7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ELECTROSTATIC CHARGER FOR LIQUID FUEL BY FRICTION

The combustion in internal combustion engine can be promoted with resulting improvement in the combustion efficiency by electrostatic charging the fuel and also the antiknock characteristic of gasoline engine can be increased, which facts are already known. As a result of various experiments carried out by inventors of the present invention, it was confirmed that an electrochemical change of combustion of fuel is promoted by a strong negative charge on the fuel and that the carbon monoxide contained in the exhaust gas can be also decreased remarkably as compared with the fuel which does not have such charge and that the antiknock characteristic can be increased in the case of positive charge of the fuel.

Such phenomena, above explained, may be simply understood as attributable to the fact that when the charged fuel evaporates the electric charged parts having the same polarity are electrically repulsed from each other, thus increasing the rate of vaporization and at the same time the vaporization becomes more perfect by more increased atomization of particulated fuel. Considering from various experimented results carried out by the inventors, however, some facts which are not satisfied by the foregoing explanations have been experienced by the inventors, therefore, the perfect and theoretical background in the physics and in the chemistry may be clarified after doing many repeated experiments in the future and by the analyzed results. It is a fact that the above explained phenomena exist in the practical circumstance, and standpoint of the present invention is based on this face.

Therefore, the purpose of this invention is to provide an electrostatic charge device for liquid fuel in order to promote the combustion by providing desired charge for the liquid fuel.

Another purpose of the invention is to provide an electrostatic charger which gives the desired charge onto the liquid fuel by the installation of said device in the midst of piping way, near the carburetor, leading to the carburetor of liquid fuel.

A further purpose of this invention is to provide a static charger by friction of the liquid fuel which provides electrostatic charge for the liquid fuel by means of friction with the fuel which flows in the liquid fuel pipe by the installation of the device in the midst of the fuel piping way.

Another object of this invention is to provide a static charger by friction of the liquid fuel, using a metal body which surface is coated with a semiconductor film which is the material providing the liquid fuel with a static charge caused by friction.

Another object of this invention is to provide a static charge device by the use of fiber comprising inorganic material or organic material.

Another object of this invention is to provide a static charge device by friction of the liquid fuel which device employs a combination of fibers made of inorganic material or organic material and a metal body, a semiconductor film being formed on the body surface.

Another object of this invention is to provide various semiconductor films suitable for formation of the friction part material, and the combination thereof.

As for the local charging method of liquid fuel, there are suggested various methods including such as to make a local and high electric field and etc., however, such means make complicate the apparatus and are difficult to maintain and with expensive costs, and for such reasons the general applications of said devices are a minimum.

According to one aspect of this invention there is provided, in association with or for a combustion engine, a static charger for electrostatic charging of liquid fuel by friction which comprises a friction element located inside a cylindrical casing through which liquid fuel can flow such that in use of the static charger the liquid fuel contacts the friction element and is thereby electrostatically charged.

Preferably, the friction element is in the form of a roll which is wound around a metal or wooden core and desirably the element is in the form of a metal sheet or mesh, or alternatively of a plurality of such metal sheets or meshes in several layers, each coated with a semiconductor film which desirably comprises any one of the following materials: a cuprous oxide film; a film prepared on the surface of copper or copper alloy, by treatment with chromic acid or phosphate; a crystalline film of selenium; an electrolytic film mainly composed of aluminum oxalate or of chromate or phosphate; a film of iron tetroxide prepared from iron with steam at an appropriate temperature; a black iron oxide film by treatment with materials belonging to alkaline system; an oxide film by treatment with phosphoric treating agents belonging to zinc phosphate system or manganese phosphate system or iron phosphate system.

Thus, this invention enables provision of a simple, inexpensive and reliable device for electrostatically charging liquid fuel, as a result of frictional contact between the fuel and a friction element.

The phenomenon of a liquid fuel becoming electrostatically charged as a result of frictional contact with a substance is attributed to the movement of electrons between the fuel and the substance. If many electrons move into liquid fuel, by any means, the electric resistance of the fuel decreases. This phenomenon in which the electric resistance decreases is called "minus-charge". On the contrary, when the electric resistance of fuel increases by the transfer of electrons from fuel to the paired friction substances, this is called "plus-charge". Inasmuch as such studies related to electrostatic charge phenomena and to utilization thereof are not so advanced yet, and accordingly, the measurement method for the static charge conditions is not established yet, there is no standard for such measurements. In this specification, therefore, the index used for measuring the quantity of electrostatic charge in the fuel is defined such that when the resistance across negatively charged gold plated electrodes, spaced 2 mm. apart and each having a surface area of 20 sq. cm. and each being immersed in the fuel, is 10,000 MΩ the fuel has 1 unit of static charge. Accordingly, a 1,000 MΩ resistance reading is equivalent to 10 units of static charge and if the resistance between the electrodes is 100,000 MΩ the fuel has 0.1 unit of static charge. The resistance of the fuel is greatly influenced by the temperature of the fuel and thus all resistance measurements were made at a fuel temperature of 20° C.

Also, in the measurement of static charge, the static charge is not always limited to one polarity, rather, locally different polarities appear often, accordingly, the balance of the total amount of the static charge is to be detected. Then, the polarity-wise measurement of the static charge is conducted by means of a Faraday gauge or similar method, namely; an electric field of another polarity is actuated to the fuel container to which charged fuel is poured in, then, the strength of electric field is increased so as to move the indicating needle of the detecting instrument to zero, followed by quick removal off of the electric field, then the indicating needle oscillates. By repeating the By of the polarity of the electric field to be actuated, the proportion of polarities can be cancelled out. By performing such procedures, it is possible to measure the amount of charge of each polarity.

The friction element within the static charger, to attain the static charge of liquid fuel by friction may be made of various kinds of materials, such as synthetic fiber or glass fiber, etc., but these materials being extremely insulative are apt to be saturated when used as a friction element according to this invention and considerable time may lapse before these being unsaturated. As a friction element which is saturated with charge does not operate efficiently, the use of the above-mentioned materials for the friction element is limited to cases in which there is an intermittent flow of fuel through the static charger for the reason mentioned above. One way of overcoming this difficulty is to use a material which ensures that electrons can be continuously supplied to, or transferred from, the material during the flow of fuel through the static charger. Thus a semiconductor film on a metal substrate may be used.

Now, exemplified embodiments desirable for the present invention will be explained with references to the drawings.

FIG. 1 is a vertical section of electrostatically charging liquid fuel by friction according to the present invention which gives charge to the fuel by friction-contact charging with liquid fuel;

FIG. 2 shows a perspective view of a friction element in the form of a roll for use in the static charger of FIG. 1;

FIG. 3 shows the condition of electron movement in the case of negative charge action;

FIG. 4 shows the condition of electron movement in the case of positive charge action;

FIG. 5 shows a perspective view of an alternative form of the friction element for use in the static charger of FIG. 1, and;

FIGS. 6 and 7 show graphs of plots of the change of electric resistance of the fuel against the quantity of fuel which has flowed through the static charger of FIG. 1.

In the graphs shown in FIGS. 6 and 7, the ordinates represent the electric resistance of the fuel, and electric resistance of 100 percent being equivalent to the electric resistance of fuel which has not been electrostatically charged in a static charger according to this invention. The abscissae of the graphs, shown in FIGS. 6 and 7, represent the total volume of fuel which has flowed through a static charger according to this invention.

Referring to FIG. 1, according to the present invention there is shown, a connecting piece 2, which connects a liquid fuel conveying pipe with this device, is fixed to a cylindrical casing 1 made of an appropriate material, and this device is to be connected to a fuel pipe at an appropriate position near the carburetor. Adjacent to this connecting piece, a metallic mesh or net 5 is installed, and which metallic mesh or net 5 gives some flow resistance to fuel flow and forms a sort of drain or space 6 which occupies a space between the connecting piece 2 and the metal mesh 5, thus the fuel following-out from the mesh is in contact and friction relationship with friction part or element material 3 creating a static charge. Thus the metal net 5 serves to keep the flowing fuel standing temporarily within the space 6 and then to direct the fuel onto the surface of the friction element 3. The friction element 3 for the charging is fabricated, as specified in FIG. 2, from a thin plate metal sheet or mesh on which oxide or other semiconductor film is deposited, and which plate is rolled up in a concentric circular form or in spiral form or roll. This friction element 3 is coiled around a core 4 made of metal or wood etc. and is secured thereto. This prevents the fluid from passing without making contact with friction element 3. The liquid fuel flows in the arrow direction as indicated in FIGS. 1 and 2, and is charged in minus or plus after contact with the friction element 3 of the charger.

In using the device according to this invention, electrons may be transferred from the semiconductor film 3B which originally is present on the metal substrate 3A to an arrow indicated by spot 3, that is, into the fuel as shown in FIG. 3. Thus, the fuel which flows to the carburetor is negatively charged. The semiconductor film should have positive "holes" after discharging electrons therefrom, but the "holes" are immediately supplied with electrons from the metal substrate (3A), and there is therefore no shortage of electrons on the semiconductor film, and a continuous charging action is performed. Alternatively, the electron transfer may be reversed as shown in FIG. 4, the fuel being supplied with positive charge. The metal substrate 3A may be made of various metals such as iron aluminum, copper and nickel, and it may comprise metal fibers or other fibrous materials. It should be noted, however, that the charging polarity may vary with the temperature at which each material is treated or with the process by which it is treated or with the kind of treating agents. The thickness of the semiconductor film (3B) is usually about one-tenth to some 4 or 5 microns and the charging polarity also varies depending on the thickness of the semiconductor film. It is found, by experiment, that an extremely thick semiconductor film lowers the function of electron exchange.

Referring to FIG. 5, which shows another form of the friction element for use in a preferred embodiment of a static charger according to this invention and comprises five sheets which are rolled around the central core 4. The sheet 3–2 comprises iron mesh the surface of which is covered with a zinc phosphate film coating, the sheet 3–3 comprises a mesh of iron fibers having a manganese phosphate film coating, the sheet 3–4 comprises a cloth made of organic or inorganic fibers and sheet 3–5 comprises iron mesh with a coating of ferroso ferric oxide. The use of the metal mesh beneath the semiconductor film is very important and effective in that it enables electrons to be continuously removed from or supplied to the semiconductor film and therefore prevents the latter from becoming highly saturated.

From the foregoing explanations, the effects by the utilization of the semiconductor film can be understood, while, the available semiconductor film for this purpose are mentioned below:

1. Cuprous oxide mesh.
2. Semiconductor film by the sulfide salt treatment or chromic acid treatment of copper and copper alloy.
3. Crystalline film of selenium.
4. Electrolytic film of aluminum whose electrolyte is oxalic acid, or film thereof from chromate salt or phosphate salt.
5. Phosphate salt film of zinc or chromate salt film thereof.
6. 4.3-iron oxide-film to be prepared from iron with steam at an appropriate temperature.
7. Black iron oxide-film by alkaline materials.
8. Oxide-film by the treating agents of phosphate salt type; including zinc phosphates, manganese phosphates, or iron phosphates. Among those, the one which is possible to be treated at comparatively high temperature is apt to be stabilized for long term operation, therefore, 6 through 8 of the above are applicable. In the following examples a combination of; iron material (fiber) containing manganese, thereon an oxide-film of phosphate type is applied; and with 4.3-iron oxide-film; is superior and which was exemplified in FIG. 5.

The following Examples further illustrate this invention. In the Examples the friction element of the static charger comprised materials substantially as hereinbefore described with reference to FIG. 5 of the drawings.

EXAMPLE 1

1. Model No. 243.

The charger had 372.2 cc. of the actuating part total internal volume with 49 mm. of the internal diameter and 198 mm. of the length. The friction element was made of steel mesh of 60 mesh, with 185 mm. width and 4.2 meter length, and having a phosphate salt-film of manganese type formed thereon, being spiral wound, and which weighed 800 g. The quantity of gasoline to be contained therein is 230 cc., and the effective cross-sectional area of the gasoline passage is 11.7 sq. cm. approximately; therefore, if the fuel moves by 1 mm. the volume becomes 1.17 cc., then, if the gasoline consumption is 3 liters per hour the flow becomes 0.83 cc. per second, which is equivalent to 0.7 mm. per second of the mean flow velocity.

EXAMPLE 2

2. Model No. 255-1.

Actuating internal volume of the static charger is 340 cc., with 49 mm. internal diameter and 180 mm. length. Friction part element is manganese-iron fiber weighting 80 g. A 298 cc. of the pourable gasoline volume. Effective cross-sectional area is 16.5 sq. cm. approximately, then, 1 mm. of the gasoline movement is equivalent to 1.65 cc., therefore, if the gasoline consumption is 3 liters per hour, the gasoline mean velocity flow is 0.5 mm. per second approximately.

Either cases of the above two were confirmed by experiments as the electrostatic charge effect can be maintained up to flow range of 7 times of the above-mentioned mean flow velocities. The above two type static chargers by friction for the liquid fuel will be explained as quoting FIGS. 6 and 7.

In the cases where Model No. 247 and No. 255 were used, and when premium-gasoline purchased from Nihon Sekiyu Company is used, the electric resistance of the electrodes dipped into the gasoline, as explained previously, was measured. The untreated gasoline exhibited approximately 200,000 MΩ, which was set at 100, and the relationship between the flow and the resistance was graphically presented. Of the Model No. 255, the electric resistance decreased by 20 percent, and it is recognized to have the negative charge. Also, with No. 247, the resistance tended to increase with the increase of flow, but was recognized to have negative charge. The abscissa of this graph indicates the amount of gasoline passing through the device (2.3 liters per hour), therefore, the change of this graph may be regarded as the change of charged amount against the time. FIG. 7 indicates the change of electric resistance of Model 247, in the case use of regular gasoline purchased from Nihon Sekiyu Company, and which basis is taken as 100 for 210,000 MΩ of the electric resistance of untreated gasoline. Therefore, the ordinate figures is given by the ratio of resistance, wherein *-o-o-o-* indicates the case of 2 liters per hour of the flow and -.-.-.- indicates the case of 10 liters per hour of the flow, and the line - - - - which was drawn at center of the graph is the resistance ratio of the original fuel which did not pass through the device. From FIGS. 6 and 7, the state in receiving the negative charge from the fuel from the friction charge device of the liquid fuel according to the present invention can be clearly understood from the graphical presentation.

In the following, the practical effects to be attained by the electrostatic charge of the fuel will be exemplified.

Table 1. Case of idling.

	r.p.m.	Percent concentration of carbon monoxide
Without the device	550	10
Minus charge by No. 232	680	3

Table 2. Concentration of carbon monoxide by car speed

Car speed	Percent concentration of carbon monoxide	
	Without the device	With No. 232 apparatus
ta Idling	0.2	trace
40 km./hr.	3.5	0.2
60 km./hr.	4.25	0.45

Tables 1 and 2 indicate the change of amount of carbon monoxide contained in the exhaust gas. Of the Table 1, an experiment by the use of 1200 cc. engine was exemplified, in which, the charging device is Model No. 232 and the friction element is a combination of brass mesh with nylon cloth which were doubled and rolled up, then, were inserted into casing of the device. In the case of idling of the engine, and when the gasoline was negative charged by means of the device, the carbon monoxide content decreased down to 3 percent, and the revolution of the engine increased up to 680 r.p.m. Table 2 indicates the experimented result in the case of practical automobile running, which car was equipped with a 1900 cc. engine, to which Model No. 223 device was attached. In either case, it can be recognized that the carbon monoxide concentration in the exhaust gas decreases down to one-tenth approximately than the case without use of the device.

From the foregoing explanations and from the measurement and the experimented results, it can be easily understood that the combustion efficiencies can be increased by the promotion of the combustion of fuel and at the same time the injurious component of the exhaust gas can be lessened by the charging of friction static charger of liquid fuel according to the present invention.

Explanations of the present invention were made by specified examples, however, the embodiment of the invention shall not be restricted by such examples, nor, various modifications and alterations are of course possible without overriding the principle and limitation of the present invention.

What we claim is:

1. A static charger for electrostatically charging liquid fuel, said charger comprising a conduit through which liquid fuel is adapted to flow, a metal friction element in said conduit in the path of flow of the fuel to contact the fuel frictionally, and a semiconductor film means on said friction element for producing static charge in said fuel to improve combustion efficiency thereof in an internal combustion engine.

2. A static charger as claimed in claim 1 wherein said friction element comprises at least a single metal sheet with said semiconductor film means on said metal sheet.

3. A static charger as claimed in claim 2 wherein said friction element includes a central core and said metal sheet is rolled around said central core.

4. A static charger as claimed in claim 3 wherein said central core has an axis, said axis being axially aligned with said conduit.

5. A static charger as claimed in claim 1 wherein said friction element comprises a metal mesh with said semiconductor film means on said metal mesh.

6. A static charger as claimed in claim 1 wherein said friction element comprises a plurality of metal sheets arranged in layers with said semiconductor film means on each of said plurality of metal sheets.

7. A static charger as claimed in claim 1 wherein said friction element comprises a plurality of sheets of metal mesh forming layers with said semiconductor film means on each of said plurality of meshes.

8. A static charger as claimed in claim 1 comprising a metal mesh disposed between said conduit and said friction element.

9. A static charger according to claim 1 wherein the semiconductor film comprises at least one of the following materials:

a. a cuprous oxide film;
b. a film prepared on the surface of copper, or copper alloy, by treatment with chromic acid or a sulfate;
c. a crystalline film of selenium;
d. an electrolytic film mainly composed of aluminum oxalate or of chromate or phosphate;
e. a film of iron tetroxide prepared from iron with steam at an appropriate temperature;
f. a black iron oxide film prepared by treatment with materials belonging to alkaline system; or
g. an oxide film prepared by treatment with phosphoric treating agents belonging to any one of zinc phosphate system, manganese phosphate system and iron phosphate system.