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FUEL METERING DEVICE

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Fig. 1.

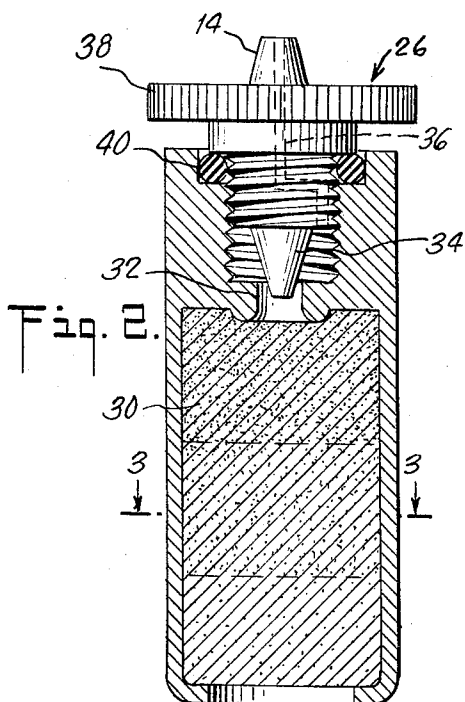
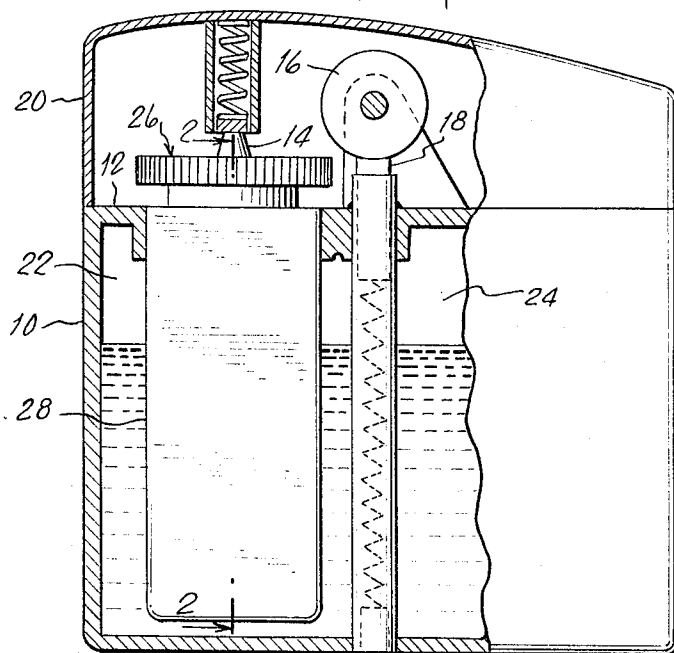
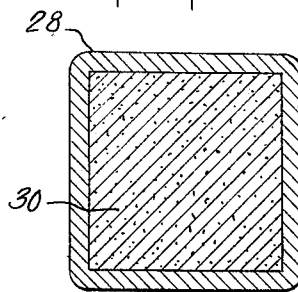


Fig. 3.



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FUEL METERING DEVICE

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7 Claims. (Cl. 67-7.1)

This invention relates to fuel metering devices of a type suitable for use with gas fueled cigar lighters.

In gas lighters, wherein highly volatile fuel is maintained in liquid form under pressure in the lighter fuel tank, it is necessary to provide a fuel metering means such that a controlled but complete evaporation of the fuel will take place prior to its being emitted from the burner nozzle of the lighter. This is done, in some cases, by means of a sintered pellet located in a passageway leading from the lighter fuel tank to the burner nozzle. The porosity of these pellets is such as to prevent the flow of liquid through them; but is sufficient to permit evaporated fuel in the gaseous state to pass out of the fuel container and through the burner nozzle. There is also generally provided a fibrous wick which extends downwardly from the pellet to a point below the liquid surface of the fuel contained within the lighter. The liquid fuel is transmitted through the wick by capillary action and wets the bottom of the pellet. This insures that evaporation of the fuel will take place within the pellet itself, thereby promoting a more even and controllable flow of fuel at the burner nozzle.

According to one feature of the present invention there is provided a porous type fuel metering device wherein evaporation takes place with a porous element and yet no wick is required to convey the liquid fuel to the element. Thus, in the present invention the problem of securing a wick in proper position relative to the fuel tank and the porous element, is eliminated. Also eliminated is the problem of insuring that the wick is maintained in intimate contact with the porous material comprising the element so as to permit transfer of the fuel therebetween.

According to a further feature of the present invention, the overall structure of a fuel metering assembly is considerably simplified. This has been accomplished through the provision of a porous element of a particular size, shape and porosity as well as the provision of a unique means for supporting the porous element within the fuel container. More specifically, in the present invention an elongated porous element extends between the lighter burner nozzle and a point near the bottom of the fuel container. The porosity of this element is such as to permit a highly restricted but nevertheless, positive flow of fuel in its liquid state through the element. Means are also provided for preventing any fluid flow, either liquid or gas, through the sides of the metering element. Thus, all fuel flowing through the element must proceed along its entire length. Means may additionally be provided above the porous element for adjusting the volume rate of flow of gaseous fuel or for closing off the flow of fuel entirely.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several pur-

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poses of the invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the spirit and scope of the invention.

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification, wherein:

FIG. 1 is a side elevation, partially in section of a lighter embodying the present invention;

FIG. 2 is a section view taken through line 2-2 of FIG. 1;

FIG. 3 is a section view taken through line 3-3 of FIG. 2.

The lighter shown in FIG. 1 comprises a body portion 10 having a horizontal top wall 12 which supports a burner nozzle 14, a sparking wheel 16 and a flint tube 18 in operative positional relationship to each other. A closure cap 20 covers the operative components of the lighter when the lighter is not being used.

The body portion 10 is hollow and has formed therein a fuel container 22 which is tightly sealed to maintain highly volatile fuel such as butane in its liquid form above atmospheric pressure. Because of the pronounced temperature sensitivity of most such fuels, whereby in their liquid state they undergo great changes in volume in response to even moderate temperature changes, such lighters are filled only to a given point such that a cushion of vapor 24 is maintained above the maximum liquid level of the fuel within the lighter. This allows the liquid fuel to expand with changes in ambient temperature, the expansion being absorbed by the cushioning effects of the vapor within the fuel container. The amount of space allotted to the vapor cushion 24 of course is determined according to the construction of the fuel container 22 and the temperature characteristics of the fuel, commensurate with accepted standards of safety.

The burner nozzle 14 rests upon an adjustable valve element 26. The adjustable valve element in turn operatively engages a valve housing 28 which protrudes through the top wall 12 from within the fuel container 22. The valve housing 28 is sealed to the horizontal top wall to prevent leakage of fuel from the container. It extends downwardly within the container to a point near its bottom.

The construction of the valve housing 28, the adjustable valve element 26 and their operative relationship to each other is best shown in FIG. 2. The valve housing 28 is of generally tubular construction and is open at both ends. The lower portion of the valve housing 28 encases a porous element 30. The material comprising this element is characterized by a myriad of minute interconnected tortuous passageways of a size which permits restricted but positive flow of liquids and relatively free flow of gases through the material. Preferred forms of such material include pressed and sintered granules of some plastic such as nylon or Teflon, or of some metallic oxide such as iron oxide. Certain porous ceramics also may be used for this purpose. It is essential however that the material be of relatively uniform density and that the passageways contained therein are of a proper size. Also the material itself must not be chemically reactive to the fuel used by the lighter.

The valve housing 28 is provided with a cylindrically shaped fuel passageway 32 immediately above the porous element 30. The cylindrical passageway 32 is of much smaller cross-sectional area than is the porous element 30 for reasons to be explained herein.

The adjustable valve element 26 is threadedly engaged in the valve housing 28 just above the cylindrical passageway 32. A conically shaped protrusion 34 is located centrally of the element and extends into the cylindrical

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passageway 32 of the valve housing 28. By turning the adjustable valve element 26, the conically shaped protrusion 34 is moved longitudinally into or out of the cylindrical passageway 32 thus varying its effective area. This in turn controls the volume rate of flow of fuel through the valve housing. The adjustable valve element 26 includes an internal passageway 36 (shown in dotted lines) which extends between the burner nozzle 14 and the lower portion of the adjustable valve element 26 in communication with the cylindrical passageway 32. There is thus provided a complete connection for fluid passage from a point near the bottom of the container 22 up through the valve housing 28 and the adjustable valve element 26 to the burner nozzle 14. The adjustable valve element 26 is also provided with an upper peripherally knurled portion 38 which permits convenient manual adjustment for changing the volume rate of fuel being emitted from the burner nozzle. An O-ring 40 or similar resilient seal is provided between the adjustable valve element 26 and the upper portion of the valve housing 28 in order to prevent undesired leakage of fuel from between the threaded regions of these elements.

Because of the fact that the valve housing 28 extends to a point near the bottom of the fuel container 22, the porous element 30 is always maintained in contact with the liquid fuel even though no fibrous wick as such is provided. Furthermore, because of the fact that the porous element 30 is surrounded by the fluid impermeable sides of the valve housing 28, none of the vapor from the vapor cushion 24 above the liquid level of the fuel can "short circuit" through the side of the porous element 30 to the burner nozzle 14. This insures that all of the fuel which reaches the burner nozzle passes through the entire length of the porous element 30 and is evaporated therein. Thus smooth and efficient flow of fuel as well as complete flame control is always present regardless of the liquid level within the fuel container.

It is important in carrying out the present invention that the porous element 30 extend continuously from a point near the bottom of the fuel container to a point above the liquid level in the fuel container which is not wetted by the capillary effects of the porous material on the fuel. This is necessary in order to prevent liquid fuel from gradually being drawn up into the cylindrical passageway 32 when the lighter is not in use. Such a situation would result in dangerous flaring when the lighter is operated. The minimum amount by which the porous element should extend above the liquid level depends of course upon the density of the liquid fuel, its surface tension characteristics and the size and condition of the openings within the porous element 30. In most cases, however, it need not extend significantly above the top of the container. When the fuel container is freshly charged the liquid fuel reaches a maximum level well below the top of the container in order to provide space for the vapor cushion 24. In most cases this distance is more than adequate to overcome the capillary effects within the porous material comprising the element 30.

It is to be noted that as the lighter is used and the liquid level in the fuel recedes, the liquid level in the porous element 30 correspondingly recedes. However, in spite of this, flame height and controllability are negligibly affected. Even though the evaporation process takes place further and further toward the bottom of the porous element 30 as the fuel in the container is consumed, the vapors produced by the evaporation are of negligible viscosity compared to that of the liquid fuel. They thus pass through the porous material with ease and are substantially unaffected by its length.

Because the cross-sectional area of the porous element 30 is large compared to that of the cylindrical passageway 32, liquid fuel can be absorbed into the bottom of the material at a greater rate than gaseous fuel is emitted

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through the passageway. This helps to insure that evaporation takes place well within the porous element and not at its lower surface. A further advantage of the large cross-sectional area of the porous material lies in the increased liquid fuel storage capacity thus afforded. Because of this there is always a supply of liquid fuel sufficient for at least one normal operation regardless of the fact that fuel in the container 22 may be at a very low level and that the lighter itself may be tilted or even inverted during use.

It should be noted that there are certain dimensional and other related structural limitations which must govern the particular porous element. It is important, for example, to maintain a substantially constant flame height as the quantity of fuel in the lighter fuel container decreases. Thus it is necessary that the quantity or rate of fuel emission be kept constant. Since the porous element extends down to near the bottom of the lighter fuel container, evaporation will take place, allowing for capillary effects, at a point slightly above the liquid level in the fuel container. The porosity of the porous element should be high enough so that the viscosity of the evaporated fuel will have negligible effect in retarding its flow through the element no matter at which level evaporation takes place. On the other hand, it is important that the porosity of the element, as well as its height above the highest liquid level of the fuel container, be such as to prevent non-evaporated fuel from being emitted.

The rate of fuel flow out of the porous element can be expressed as follows:

$$X = \frac{PA}{K_1 L}$$

where

X = the volume rate of flow of fuel in its vapor state

P = the porosity of the element

A = the cross sectional area of the element

L = the distance through the element which the vaporized fuel must travel

K_1 = a constant which is governed by the density and viscosity of a particular fuel in its gaseous or vapor state.

It will be noted that as the liquid level in the lighter fuel container decreases, the distance L through which the fuel must travel correspondingly increases, thus tending to reduce fuel flow rate and flame height. The effect produced by this length, however, is rather small for vapors because of the extremely small K values which they possess. Further, by increasing the porosity P to its maximum permissible amount the length effect can be reduced even more significantly.

The amount by which the porosity can be increased, however, is limited by its ability to prevent fuel in its liquid state from flowing completely through the porous element. Thus when the lighter fuel container is filled the porous element must extend above the liquid level by a distance 1 , sufficient to ensure that no liquid passes out through the top of the element. The relation between this distance and the porosity of the element can be expressed as follows:

$$1 = \frac{P}{K_2}$$

where K_2 = a constant governed by the density and viscosity of the fuel in its liquid state.

The maximum porosity P , for a given fuel, is limited by the distance 1 , which in turn is governed by the practical dimensional limitations of the lighter. This maximum porosity in turn governs the necessary cross-sectional area which the porous element must possess to obtain a given maximum fuel flow rate with a minimum of variation due to a decreasing amount of fuel in the lighter fuel container.

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The cross-sectional view of the lower portion of the valve housing 28 shown in FIG. 3 indicates the preferred configuration of this element to be rectangular or square in shape. The purpose for this is to afford a more closely controlled manufacture of the porous element 30 contained within the housing when the porous element is made by compression and sintering. Most granulated particles, when subjected to compression in connection with sintering, exhibit a high degree of friction relative to one another. This causes an unevenness in applied pressures particularly when the source of pressure is far removed from certain points within the sintered material. For this reason it is preferred to compress this elongated element laterally rather than longitudinally as is the conventional practice. By applying lateral pressure no portion of the sintered material is far removed from the pressure source and thereby achieves an ultimate density commensurate with the average density throughout the element. It has also been found that rectangular or square shapes are better suited to lateral compression in that they respond more evenly to the forces imparted during such compression than do cylindrical or rounded shapes.

Having thus described my invention with particular reference to the preferred form thereof, it will be obvious to those skilled in the art to which the invention pertains, after understanding my invention, that various changes and modifications may be made therein without departing from the spirit and scope of my invention, as defined by the claims appended thereto.

What is claimed as new and desired to be secured by Letters Patent is:

1. An improved lighter comprising, a fuel container capable of holding highly volatile fuel in its liquid state above atmospheric pressure, a burner nozzle mounted above said fuel tank for directing the flow of gaseous fuel from said tank, a passageway interconnecting said fuel container and said burner nozzle, an elongated porous element containing therethrough a myriad of tortuous interconnected passageways of a size sufficient to permit restricted but positive flow of liquids and free flow of gases, said elongated porous element mounted to extend from a lower point within said casing near its bottom to an upper point within said tubular passageway located sufficiently above the maximum liquid level capacity of said container to prevent capillary wetting of said porous element above said upper point, said elongated porous element further being provided over its entire length with a fluid impervious lateral surface which is tightly sealed to said tubular passageway.

2. The lighter described in claim 1 wherein said porous element is a sintered mass of granules of preselected size compressed to a predetermined density, said granules being chemically inert to lighter fuels.

3. The lighter described in claim 2 wherein said porous element is of rectangular cross-sectional configuration and is pressed laterally to uniform density.

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4. An improved lighter comprising, a pressurized fuel container characterized by a maximum liquid fuel level commensurate with accepted standards of safety, a burner nozzle mounted above said fuel tank for directing the flow of gaseous fuel from said tank to a flame at the outlet of said burner nozzle, an elongated fuel vaporizing element located between said fuel container and said burner nozzle, said fuel vaporizing element including a myriad of interconnected tortuous fluid passageways which extend from a lower point within said fuel container near its bottom to an upper point located above said maximum liquid fuel level by an amount greater than the maximum capillary effect producible by said passageways upon liquid lighter fuel, and fluid impervious means laterally surrounding said fuel vaporizing element over its entire length, but permitting contact between the lowermost surface of said fuel vaporizing element and liquid fuel within said container.

5. An improved lighter comprising, a fuel container capable of holding highly volatile fuel in its liquid state above atmospheric pressure, an elongated tubular valve housing open at both ends and extending upwardly from a point within said fuel container near its bottom out through its top and sealed thereto, a porous material chemically resistant to lighter fuels and characterized by a myriad of tortuous interconnected passageways which permit restricted but positive flow of liquids and free flow of gases, said porous material filling the lower portion of said valve housing to a level located sufficiently above the maximum liquid level capacity of said fuel container to prevent capillary wetting thereabove, and a burner nozzle mounted above and connected to said valve housing.

6. The lighter described in claim 1 wherein said burner nozzle is connected to said valve housing through a closeable cylindrical passageway within said valve housing above said porous material, said cylindrical passageway having a cross-sectional area considerably less than the cross-sectional area within the lower portion of said valve housing.

7. The lighter described in claim 6 further including means for controllably varying the effective cross-sectional area of said cylindrical passageway.

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