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SAMPLE VAPORIZER

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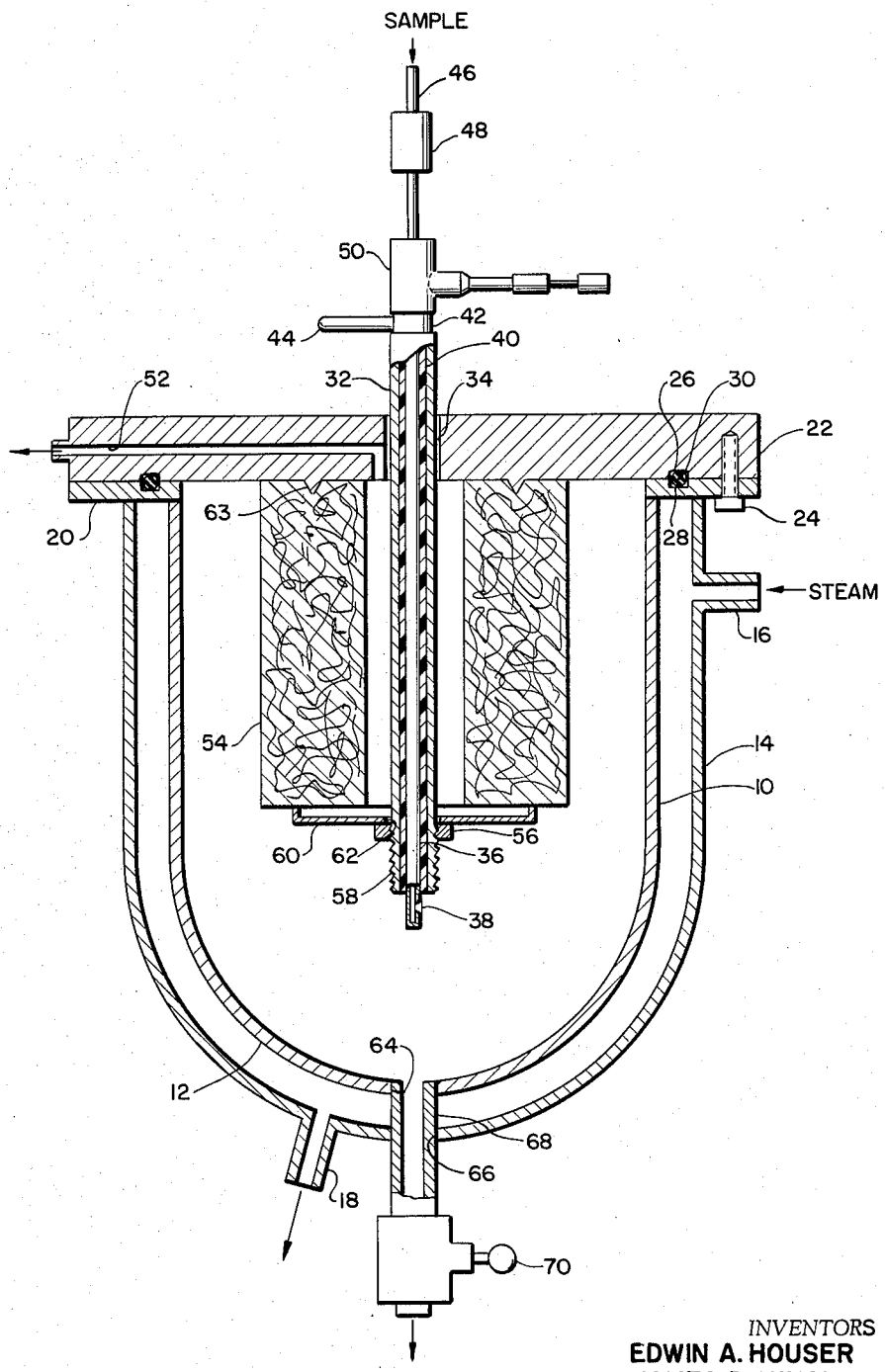

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SAMPLE VAPORIZER

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This invention relates to an apparatus for vaporizing liquids and, more particularly, to an apparatus for vaporizing liquid samples for analysis purposes.

There are various designs of vaporizers available on the market today for converting liquid samples to vapor samples for analysis of the vapor sample.

A typical application for such vaporizers is in the petroleum industry for converting liquid hydrocarbon samples such as mixtures of methane through octane into a vapor state for continuous instrumental analysis. Such samples are almost primarily volatile materials but they generally contain a small portion of nonvolatile materials. Upon vaporization of these samples, the nonvolatile materials tend to clog, plug or otherwise render inoperative the conventional vaporizers. Moreover, these vaporizers are not capable of converting the liquid petrochemical samples into vapor samples which have the same chemical composition as the volatile portion of the liquid sample delivered to the vaporizer.

It is therefore the principal object of the present invention to provide a vaporizer which is capable of converting the volatile portion of liquid samples into vapor without a change in the chemical composition thereof for analysis purposes or the like.

A further object of the invention is to provide a sample vaporizer which may operate for a long period of time even when vaporizing samples having nonvolatile materials therein, without being subject to clogging or plugging.

Still a further object of the invention is to provide a sample vaporizer which converts a liquid sample into a vapor without any discontinuity in the composition of the vapor other than occurs during actual changes of the liquid sample composition.

According to a principal aspect of the invention, the scope of which is defined in the appended claims, an atomizer is provided for converting the volatile portion of liquid samples into vapor samples having the same composition as said volatile portion comprising generally a vapor chamber and a means for applying heat to the vapor chamber for converting liquid sprayed into the chamber into a vapor state. The means for delivering the liquid into the chamber comprises a tube extending into the chamber which has a nozzle adjacent the end thereof. The tube is insulated to prevent premature vaporization or fractionation of the liquid sample in the delivery tube. Therefore, vaporization of the liquid sample does not occur until the liquid is discharged from the nozzle at the end of the delivery tube whereupon vaporization will occur only in the vapor chamber. Thus, premature vaporization or fractionation which might occur in the sample delivery tube is eliminated which in prior art devices resulted in the nonvolatile substances in the sample precipitating out and clogging the nozzle. The insulation further prevents the separation of the samples in the delivery tube into intermediate slugs of liquid and vapor which resulted in prior devices in discontinuity in the composition of the sample vapor produced. Therefore, by the vaporizer of the invention an instantaneous and rapid vaporization of the liquid sample will occur within the vapor chamber with said vapor having a composition exactly the same as the volatile portion of the liquid sample delivered to the chamber and continuity of the vapor sample will be maintained.

According to an additional aspect of the invention the sample delivery tube of the vaporizer apparatus is rotatably mounted in the vapor chamber and the nozzle extends at an angle with respect to the axis of the sample delivery tube so that the delivery tube may be rotated to change the direction of the nozzle. Consequently, after nonvolatile materials resulting from the vaporization of the liquid sample have coated one side of the vapor chamber, thus cutting down the heat characteristics of the chamber wall, the nozzle may be selectively positioned to spray the liquid sample toward another wall of the vapor chamber which is free of the nonvolatile, corrosive materials.

Other objects, aspects and advantages will become apparent from the following description taken in connection with the accompanying drawing wherein the sample vaporizer of the invention is shown partially in section.

A preferred embodiment of the sample vaporizer as shown in the drawing comprises a generally cylindrical vaporizer chamber **10** having a cup-shaped bottom portion **12**. A steam chamber **14** surrounds the vapor chamber and is spaced therefrom to provide a passage for steam therethrough. Inlet and outlet ports **16** and **18**, respectively, in the wall of the steam chamber permit the flow of steam through the space between the walls of the chambers **10** and **14**. The two chambers are attached to a flange **20** by welding or the like and a top plate **22** is secured to the flange **20** by a series of screws **24**, only one being shown. The opposite faces of the plate **22** and flange **20** are provided with annular grooves **26** and **28**, respectively, which receive an O-ring seal **30**.

To deliver liquid sample to the vapor chamber there is provided a supporting tube **32** which is mounted within a central opening **34** in the plate **22**. The tube **32** may be secured to the plate by welding or the like. As seen in the drawing, the tube is coaxially mounted with respect to the cylindrical vapor chamber **10** and terminates at a position near the bottom of the chamber. Coaxially positioned within the supporting tube **32** is the sample delivery tube **36** which extends beyond the end of the tube **32** within the vapor chamber. The end of the sample delivery tube is provided with a conical opening **38** which provides the nozzle for spraying a mist or fog of the liquid sample into the vapor chamber. An important feature of the invention is the provision of an insulating material such as a Teflon tubing **40** which surrounds the sample delivery tube **36** and fills the annular space between the outer wall of the delivery tube and the inner wall of the tube **32**. The insulation **40** ensures that there will be no premature vaporization or fractionation of the liquid sample in the sample delivery tube **36** which would result in discontinuity in the compositoin of the sample vapor discharged from the vapor chamber. Furthermore, such insulation prevents the formation of any precipitates of nonvolatile materials which might otherwise be developed in the tube and clog the nozzle **38**.

The sample delivery tube **36** is preferably rotatably mounted with respect to its axis in the vapor chamber **10**. The tube **36** has integral therewith or fixed by any suitable means a boss **42** which is supported on the top of the tube **32**. The boss also includes a handle **44** whereby an operator may rotate the tube **36** within the insulated tubing **40**. When Teflon is used as the insulation, an excellent bearing surface for rotation of the sample tube is provided. At the inlet end **46** of the sample tube **36** there is provided a filter for filtering out any nondissolved substances in the liquid sample. An example of a suitable filter is porous stainless steel or bronze. Intermediate the filter **48** and the boss **42** is a needle valve **50** for controlling the flow of sample through the sample delivery tube **36**.

A sample vapor discharge duct **52** for the vaporizer is provided in the plate **22** and opens into the vapor cham-

ber 10 at a point closely adjacent to the sample delivery tube 36. Surrounding the tubes 32 and 36 and coaxial therewith is a cylindrical filter element 54 which has a large enough inner diameter so that the vapor discharge duct 52 communicates with the hollow portion of the cylindrical filter. The filter may be formed of glass fiber or any other suitable material for removing any liquids or solids entrained in the sample vapor generated in the vaporizer. The filter 54 is retained against the bottom side of plate 22 by means of a nut 56 threaded onto the threaded lower portion 58 of tube 32. The nut 56 presses upward against a circular plate 60 which has a central opening 62 receiving the end of tube 32. Sufficient pressure is applied by the nut to force the top portion of the filter against a sharp-edged ring 63 machined in the face of plate 22 thereby preventing passage of entrained material in the vapor through the discharge duct 52.

The cup-shaped bottom portion 12 of the vapor chamber 10 has an opening 64 therein aligned with an opening 66 in the steam chamber 14. Secured in the openings 64 and 66 is a discharge duct 68 which permits the flow of any liquids not vaporized. A back pressure regulator 70 disposed in the discharge duct 66 continuously passes excess vapors not taken out through the filter 54, as well as non-vaporizable liquids.

In operation, a liquid sample which might comprise a mixture of several liquid hydrocarbons is delivered under pressure through the inlet end 46 of the sample delivery tube 36. Any nondissolved substances in the sample will be removed by the filter 48. The needle valve 50 provides for control of the flow of sample through the sample delivery tube 36. For most hydrocarbon samples, it is preferable that the valve 50 be set to permit about 10 liquid cc./minute flow. The liquid sample delivered through the tube 36 is sprayed from the nozzle 38 against the hot surface of the vapor chamber 10 thereby causing an instantaneous and complete vaporization of the liquid sample. As explained before, since the sample delivery tube 36 is insulated, no premature vaporization of the sample will occur in the tube and, therefore, no precipitates will be developed in the delivery tube which clog the nozzle and the sample vapor generated in the chamber 10 will have the same composition as the volatile portion of liquid sample delivered to the chamber. The nonvolatile materials sprayed from the nozzle 38 will collect on the inner surface of the vapor chamber 10. This is not undesirable, however, since the nonvolatile materials in the liquid sample are not desired in the final vapor sample. After a period of time the nonvolatile materials, which may be corrosive products, will cover an area of the vapor chamber 10 to such a degree that insufficient heat will be transferred through the wall of the vapor chamber to cause a complete vaporization of the liquid sample. Therefore, one merely need to rotate the sample delivery tube 36 by means of the handle 44 to direct the nozzle 38 to another portion of the wall of the vapor chamber. Any of the liquid sample which might not be vaporized and any portion of the nonvolatile materials which do not deposit upon the wall of the chamber 10 will be prevented from exhausting through the discharge duct 52 of the vaporizer since the sample passes through the filter 54. It is seen that the filter as arranged has a large surface area and ensures that the entrained substances in the sample vapor will be removed. After a period of time, some liquid will condense on the wall of the vapor chamber 10. Due to the configuration of the bottom of the chamber 10, the liquid will drain to the discharge duct 68 and can be drained therefrom by opening the valve 70.

It has been found that the sample vaporizer of the invention may remain in operation for much longer periods of time than conventional vaporizers without requiring disassembly and cleaning. The apparatus is not subject to the extreme clogging and plugging as in prior vaporizers and provides a complete conversion of the volatile portion of the liquid sample into a vapor with no change in the chemical composition thereof. Thus, the sample vaporizer is extremely useful for producing vapor samples for chemical analysis purposes.

Although only one embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes can be made in the form, details, arrangement and proportion of the various parts without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
- a vapor chamber;
- means for applying heat to the wall of said chamber;
- a normally stationary sample delivery tube extending into said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to a portion of the wall of such chamber.
- means insulating said sample delivery tube in said chamber to prevent premature vaporization of liquid sample therein; and
- means for discharging sample vapor from said chamber.

2. An apparatus as set forth in claim 1 including filter means in said chamber, enclosing said vapor discharging means.

3. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
- a vapor chamber;
- means for applying heat to the wall of said chamber;
- a rotatable sample delivery tube extending into said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to a portion of the wall of said chamber;
- means for selectively rotating said tube for directing said nozzle toward different portions of said wall of said chamber; and
- means for discharging sample vapor from said chamber.

4. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
- a vapor chamber;
- means for applying heat to the wall of said chamber;
- a rotatable sample delivery tube extending into said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to a portion of the wall of said chamber;
- means for selectively rotating said tube for directing said nozzle toward different portions of said wall of said chamber;
- means insulating said sample delivery tube in said chamber to prevent premature vaporization of liquid sample therein; and
- means for discharging sample vapor from said chamber.

5. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
- a generally cylindrical vapor chamber;
- means for applying heat to the wall of said chamber;
- a rotatable sample delivery tube coaxially mounted in said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to the axis of said tube;
- means for selectively rotating said tube for directing said nozzle toward different portions of said wall of said chamber;
- means insulating said sample delivery tube in said chamber to prevent premature vaporization of liquid sample therein; and
- means for discharging sample vapor from said chamber.

6. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
a generally cylindrical vapor chamber;
means for applying heat to the wall of said chamber;
a rotatable sample delivery tube coaxially mounted in said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to the axis of said tube;
means for rotating said tube for selectively directing said nozzle toward different portions of said wall of said chamber;
means insulating said sample delivery tube to prevent premature vaporization of liquid sample therein;
means for discharging sample vapor from said chamber; and
cylindrical filter means surrounding said tube and coaxial therewith with said discharging means opening into the hollow space within said cylindrical filter means, said cylindrical filter means being closed at each end thereof.

7. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
a substantially vertical, cylindrical vapor chamber having a generally cup-shaped bottom portion and a plate closing the upper end of said chamber;
steam chamber means surrounding the major portion of said vapor chamber;
said plate having a central opening therein;
a sample delivery tube rotatably mounted in said opening and extending into said vapor chamber, said tube having a nozzle at the end of said tube in said vapor chamber, said nozzle being substantially normal to the axis of said tube;
means for rotating said tube for selectively directing said nozzle toward different portions of said wall of said vapor chamber;
means insulating said sample delivery tube to prevent premature vaporization of liquid sample therein;
means for discharging sample vapor from said vapor chamber;
cylindrical filter means surrounding said tube and coaxial therewith with said discharging means opening into the hollow space within said cylindrical filter means, said cylindrical filter means being closed at each end thereof; and
a discharge duct at the bottom of said vapor chamber extending through said steam chamber means for draining condensate fromed on the wall of said vapor chamber.

8. An apparatus for vaporizing liquid sample for analysis purposes or the like comprising:
a vapor chamber;
means for applying heat to the wall of said chamber;
a sample delivery tube extending into said chamber and having a nozzle at the end of said tube in said chamber, said nozzle being substantially normal to a portion of the wall of said chamber;
means for discharging sample vapor from said chamber; and
cylindrical filter means in said chamber, said cylindrical filter means surrounding said tube except for said nozzle and being coaxial with said tube, said discharging means opening into the hollow space within said cylindrical filter means, and said cylindrical filter means being closed at each end thereof.

9. An apparatus for vaporizing liquid samples for analysis purposes or the like comprising:
a vapor chamber having an open end;
a plate closing said open end of siad chamber and being separably mounted thereon;
means for applying heat to the wall of said chamber;
a sample delivery tube mounted in said plate and extending into said chamber, said tube having a nozzle at the end thereof in said chamber, said nozzle being substantially normal to a portion of the wall of said chamber;
means in said plate for discharging vapor from said chamber; and
cylindrical filters means in said chamber separably mounted on said plate, said cylindrical filter means surrounding said tube except for said nozzle and being coaxial with said tubes said discharging means opening into the hollow space within said cylindrical filter, and said cylindrical filter means being closed at each end thereof.

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