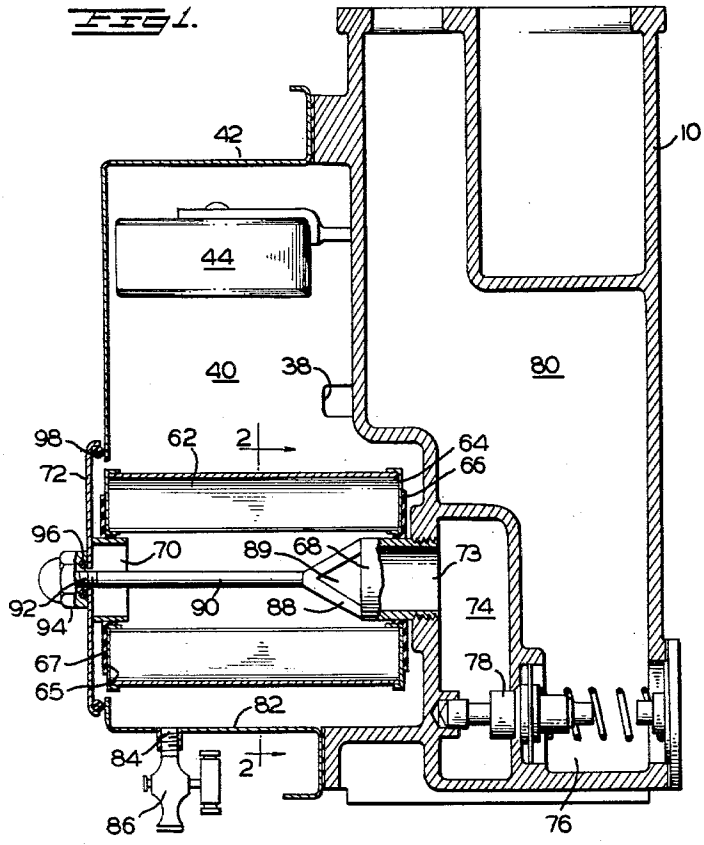
Jan. 12, 1965 F. J. BRUNS ETAL 3,165,469

VAPOR AND SOLIDS SEPARATOR FOR GASOLINE

Filed March 14, 1960 3 Sheets-Sheet 1

Fig 1.



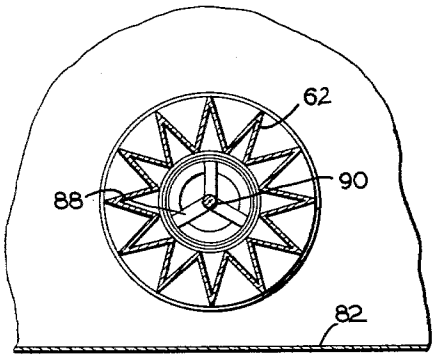


Fig 2.

F. J. BRUNS
A. H. ERON
INVENTOR

BY ADAMS, FORWARD & McLEAN
ATTORNEYS

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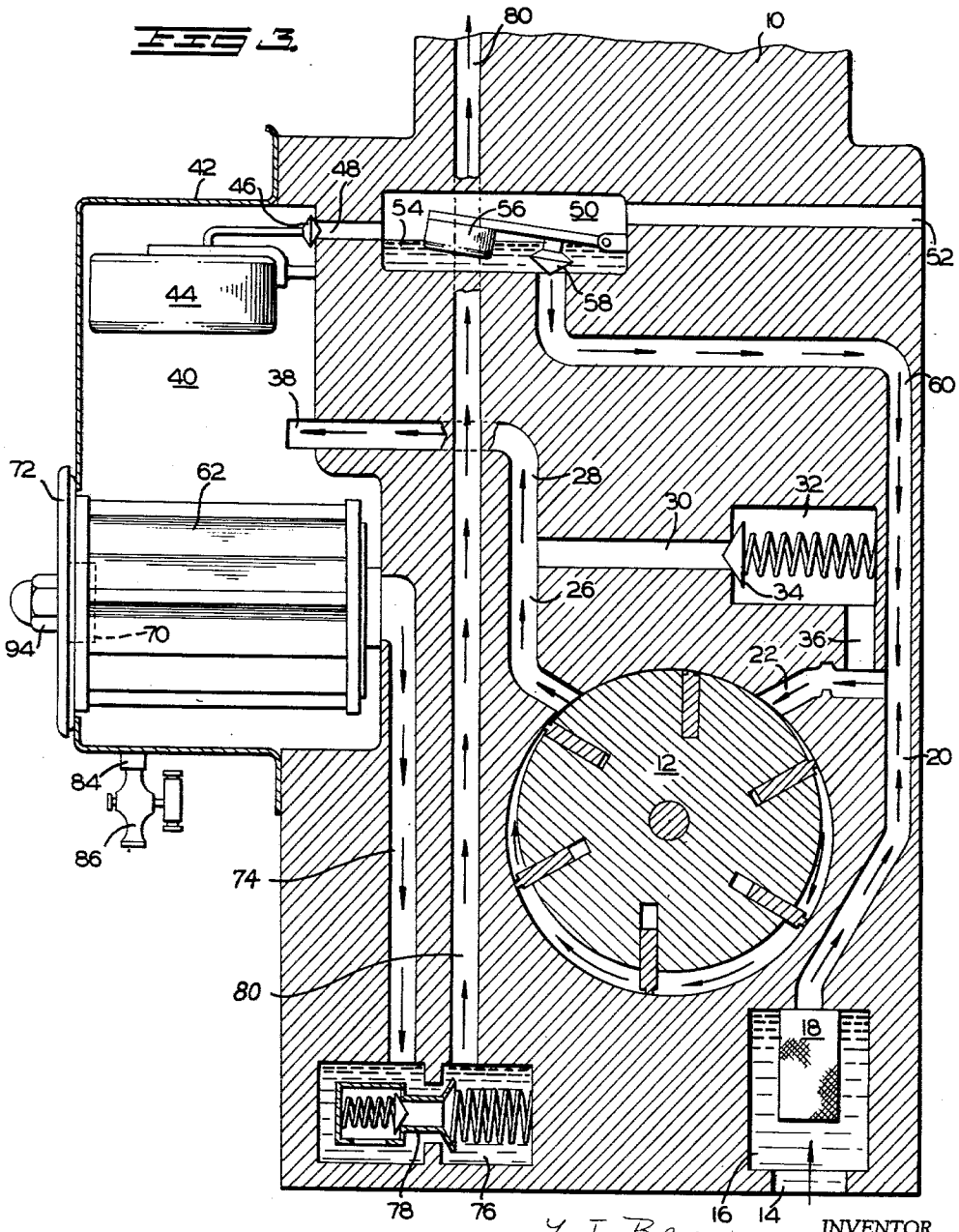
FIG. 3.



F. J. BRUNS
R. H. ERON
INVENTOR

BY ADAMS, FORWARD & McLEAN

ATTORNEYS

Jan. 12, 1965 F. J. BRUNS ETAL 3,165,469

VAPOR AND SOLIDS SEPARATOR FOR GASOLINE

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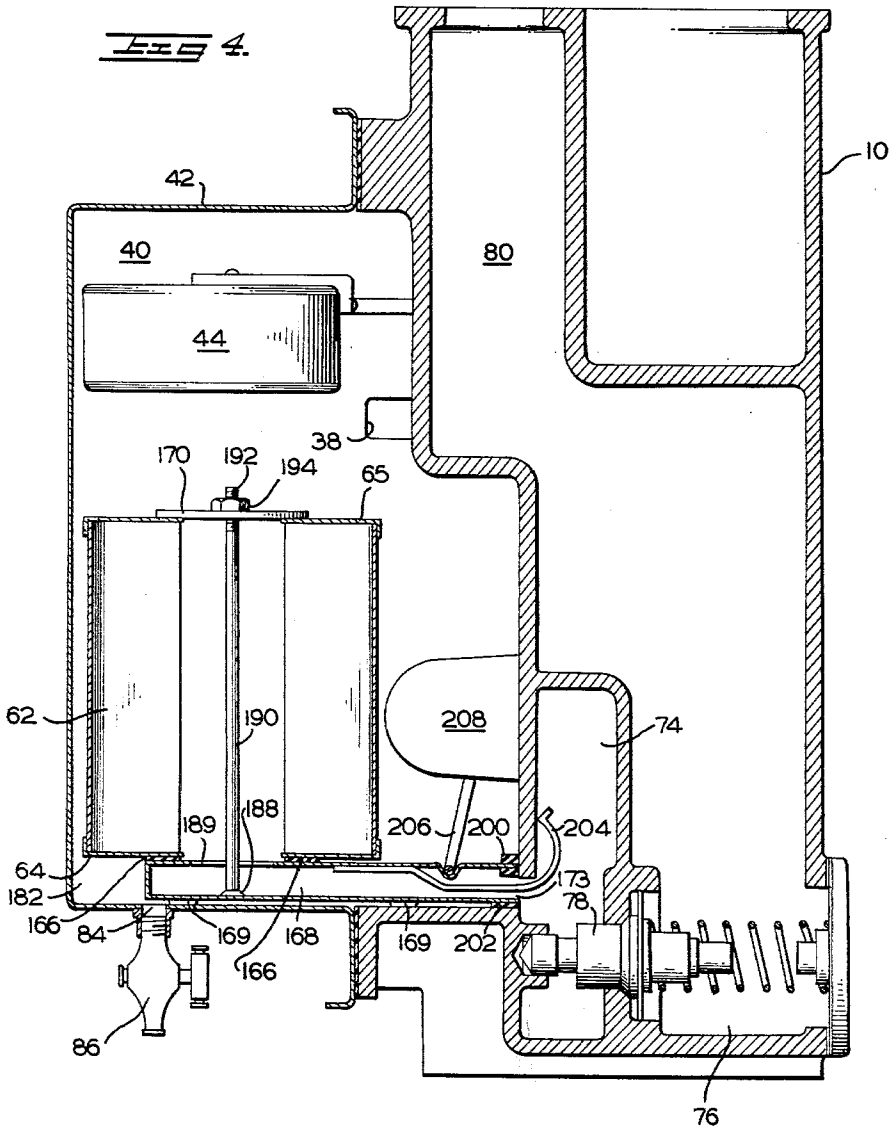
Fig 4.



F.J. BRUNS INVENTOR
A.H. ERON

BY ADAMS, FORWARD & MCLEAN

ATTORNEYS

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VAPOR AND SOLIDS SEPARATOR FOR GASOLINE

Frank J. Bruns, Hazel Crest, and Alan H. Eron, Calumet City, Ill., assignors, by mesne assignments, to Sinclair Research, Inc., New York, N.Y., a corporation of Delaware

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This invention is an improved air eliminator assembly especially intended for use in a gasoline dispenser to remove from the gasoline not only entrained air and gasoline vapor, but also to remove solids from the gasoline.

Most retail gasoline dispensers are provided with air elimination chambers to separate air and vapor from the gasoline. Without it, nozzle valves, packing glands and gasket joints would leak, and hose and see-gage glasses might burst under the effects of summer sun. Displacement meters, no matter how accurately built, could not be made to measure accurately unless the vapors, normally present in gasoline, and the air induced by deficient installation conditions can be eliminated and discharged before reaching the meter.

However, most gasoline dispensers fail to remove rust particles, dirt, scum and other solid contaminants from the gasoline dispensed. These contaminants can cause difficulties in use, such as passenger car operation, by carburetor flooding, where these particles prevent the carburetor float valve from seating. Even where the motor vehicle is equipped with a gasoline filter, the presence of this solid debris in the gasoline leads to excessive plugging of this filter. The contaminants usually originate in the service station underground tanks and the problem is common in the industry. When gasoline is delivered to the station and pumped into the underground tank the contaminants which normally rest on or near the bottom are stirred up, remain in suspension for some time, and gasoline delivered to a motorist may contain these objectionable solids. Although most dispensers now are provided with a wire mesh strainer on the suction side which removes large foreign particles, it has been found that small particle size contaminants which pass through this wire mesh can cause trouble in engine operation.

This invention provides for essentially complete removal of solid contaminants even in the micron size range, from the pumped, metered gasoline stream. It provides a filtering means which is an integral part of the dispensing system following the pump. The filtering means is a part of the air eliminator chamber assembly, is easily accessible for removal when necessary, and is arranged to filter all of the gasoline which is dispensed, with no appreciable obstruction to the flow, or decrease in the rate of delivery. The device of the invention may also remove part of the water entrained in the gasoline. Other filtering systems, such as that proposed in U.S. Patent 2,680,538 have been found unduly to diminish the flow of gasoline in the dispenser and the idea of a more thorough filtration within the compact space of the gasoline dispenser has been generally felt to be incompatible with a good rate of flow.

This invention is a unique combination, within one simple chamber, of means for separating gaseous and

solid contaminants from gasoline. The chamber has an inlet for pumped gasoline preferably in its upper portion, below the top of the chamber, and an outlet for filtered gasoline in its lower portion, preferably above the bottom of the chamber. The inlet is preferably arranged for tangential introduction of the gasoline into the chamber to provide a slow spiral movement of the gasoline downward toward the outlet. The portion of the chamber above the inlet constitutes a space for the accumulation of vapors released by the gasoline during its slow movement in the chamber. The top of the chamber is provided with a vent for release of these vapors.

The flow path for the gasoline from the inlet to the outlet is through a pleated, cylindrical paper filter. The chamber also includes a drain opening in its lower portion for removal of separated debris. The novel chamber may be built integrally into a gasoline dispenser or it may be fastened to the side of a conventional dispenser in the flow path of the gasoline between the pump and the meter.

The filter, which may be disposed in the chamber with its axis in any desired position, advantageously vertical or horizontal, is preferably made of a material which is hydrophobic in its chemical affinities, that is, it is wetted by gasoline in preference to water. This filter allows the passage of gasoline while retarding the passage of solids, and in some cases water, to the outlet. The pleating is, in general, longitudinal and the filter is manufactured from a sheet of preferentially gasoline wettable material, such as phenol-formaldehyde resin impregnated cellulose fiber. The fiber may comprise cotton linters, thread, waste, hemp, etc. and the fine mesh size of the openings in the filter serve to hold back solids while offering relatively little impedance to the flow of gasoline.

The arrangement of this filter in the air eliminator chamber is such as to provide for maximum filter surface in contact with the gasoline to be filtered. When the gasoline outlet from the air separation chamber is located a sufficient distance up the side of the chamber from the bottom of the chamber, the filter may be disposed in a horizontal position surrounding the outlet and preventing passage of gasoline to the outlet in any way other than by means of the filter. When the outlet is too near the bottom of the air separation chamber to allow horizontal disposition, the filter may be arranged vertically, and may be rigidly mounted on a pan or other conduit leading from the interior of the filter cylinder to the gasoline outlet.

The invention will be better understood by reference to the accompanying drawings which represent preferred embodiments of the invention.

FIGURE 1 is a vertical cross-section of part of a gasoline dispenser showing the separator assembly of this invention.

FIGURE 2 is a horizontal cross-section along the line 2—2 of FIGURE 1.

FIGURE 3 is a schematic flow diagram of part of a gasoline dispenser, showing the location in the flow-path of the novel separator assembly, and

FIGURE 4 is a view similar to FIGURE 1, showing a modification of the filter disposition.

The gasoline dispenser generally comprises a body or casing **10**, which houses a pump mechanism. The pump

12 is generally of the impeller type, drawing gasoline from its underground storage tank (not shown) to an inlet 14, and through a compartment 16 which contains a strainer 18. Gasoline containing the contaminants which pass through the strainer 18 is drawn into the suction side of the pump 12 through the feed conduits 20 and 22. The pumping assembly is also provided with the discharge conduit 26 which branches into the separator feed conduit 28 and the by-pass conduit 30. The by-pass conduit 30 leads to the by-pass chamber 32 which contains the by-pass valve 34. The by-pass chamber 32 is drained by the duct 36. The by-pass arrangement is provided to protect the pump and the motor (not shown) by which it is driven from overloading when the pump is operated but gasoline is not actually being dispensed. The valve 34 is generally a check valve which opens when unrelieved pressure builds up in the separator feed conduit 28. Conduit 28 leads to the inlet opening 38 in the upper part of the air elimination chamber 40. Opening 38 is preferably arranged to introduce the gasoline tangentially into the chamber 40. Gasoline enters this chamber generally in a spiral pattern, gradually descending and being disentrained of air and other vapors. The air elimination chamber 40 may be made integral with the housing 10, or it may be provided outside the housing, for example, by means of the bell 42.

The air eliminator chamber 40 contains the float 44 which operates the valve 46. This valve seats on an opening 48 between the air eliminator chamber 40 and the atmospheric chamber 50. As gasoline flows through the opening 38 it tends to fill up the chamber 40, causing flat 44 to rise, thereby closing valve 46, increasing the pressure in atmospheric chamber 40 so that gasoline can flow out through conduit 74 and can open control valve 78. When gasoline is not being dispensed and gasoline in atmospheric chamber 40 vaporizes causing depression of the gasoline level in chamber 40, the float 44 descends, due to the fall in this level. Descent of the float causes removal of the valve 46 from its seat 48, permitting escape of gases to the atmospheric chamber 50. As the vapor escapes from the air eliminator chamber 40 to the atmospheric chamber 50 the gasoline level in chamber 40 rises, causing a rise in the float 44 and consequent closing of the valve 46.

Atmospheric chamber 50 is provided with a vent 52 for escape of vapors to the atmosphere, and with a trap 54 for collection of escaped gasoline, or gasoline condensed or disentrained from the vapor which escapes into chamber 50. This trap 54 is provided with recycle means for the collected gasoline. The recycle means may comprise the float 56 which controls the valve 58 which gives access to the recycle conduit 60, which leads back to the conduit 22 and the suction side of pump 12. It will readily be seen that float 56 causes valve 58 to open upon sufficient accumulation of gasoline in trap 54.

The air eliminator chamber 40 in the novel arrangement of this invention also serves to house the means for separating fine solids from the gasoline, e.g., the filter 62, the properties of which have been described above.

The filter 62 is a cylindrical body preferably a single membrane or sheet of fibre, folded into longitudinal pleats. As an example, the filter sheet can be folded into 40 to 60 pleats about 6 inches long with the pleats having one-inch sides. The ends of the cylinder are provided with circular covers 64 and 65, which have central circular holes. In the embodiment of FIGURE 1, these holes allow one end of the cartridge to be slipped over the threaded outlet pipe 68 and the other end to receive sleeve 70, which is fastened to cover 72. As shown in FIGURE 1, the filter cartridge, consisting of filter 62 and end discs 64 and 65 and elastomer seals 66 and 67 is placed in the air eliminator chamber 40 in a horizontal position with the seals 66 and 67 deformed against pipe 68 and sleeve 70 respectively in a fluid-tight relationship.

The threaded pipe 68 leads to the outlet 73 and the gasoline effluent conduit 74 which is provided with the control chamber 76 which contains the control check valve 78. The valve, as can readily be seen, opens when sufficient pressure builds up in the effluent conduit 74, allowing passage of the filtered gasoline through meter inlet conduit 80 to the meter (not shown) and other elements of a conventional gasoline dispenser, e.g., hose and dispensing valve and nozzle (not shown).

The lower portion 82, of the air eliminator chamber comprises a sump for the collection of debris filtered from the gasoline. Due to having a specific gravity greater than gasoline, water in this debris may collect in the bottom part of the chamber. The chamber is provided with a drain opening 84, at its bottom for removal of this sludgy debris, perhaps by means of the petcock 86.

The pleated shape of the filter element provides it with an extensive surface. Also, its placement in the spirally moving gasoline causes a continual washing of collected debris from the filter surface. Both of these factors provide for a relatively long effective life for the filter. The novel arrangement of this invention also provides for ready removal of the filter cartridge. The arrangement illustrated in FIGURE 1 provides a rigid support comprising the yoke 88 which is securely fastened, as by welding, to the pipe 68, and which provides the passageways 89, and the rod 90, which is an extension of the yoke. This rod, 90, is long enough to travel horizontally through the chamber 40 and pass through the cover 72. The portion 92, of the rod 90 which passes through the cover 72, is threaded for reception of the nut 94. As illustrated the nut may be provided with a sealing O-ring 96 and the cover 72 may be provided with O-ring 98.

In the embodiment of FIGURE 4, where the filter is arranged with a vertical axis, the cartridge is provided at its bottom with a gasket 166 and at its top with a cover 170. The filter rests in a fluid-tight relationship on the pan or conduit 168, which may be provided with legs 169, and which leads to the outlet 173 and the gasoline effluent conduit 74.

The portion 182 of the lower part of the air eliminator chamber which is not occupied by the pan 168 comprises the sump for debris collection in this embodiment. The support for the filter comprises, besides the plan 168, the rod 190 which is rigidly secured to the pan 168 for example by the weld 188, and which passes through the opening 189 in the top of the pan. This rod 190 passes through the cover 170 and holds the cover, and thereby the cartridge, in place for example by means of the nut 194 fastened to the threaded end 192.

The pan is held in fluid-tight relation with the outlet 173 for example by means of the sponge neoprene gaskets 200 and 202. The pan may be held in place by any convenient means, such as by the spring clip 204 which passes through the outlet 173 into the passage 74, and the straight, or preferably U-shaped, wedge pin 206 which is force-fitted between the pan 168 and the boss 208. Pan 168 has only the openings 189 and 173 to provide the desired flow path for the filtered gasoline.

The placement of the filter around the opening 73 or 189 insures the travel of all of the gasoline through the filter before being dispensed. The filter has a mesh size designed to hold back essentially all solid particles big enough to cause carburetor plugging or other disturbances in the use of the gasoline. Thus, the filter will have a mesh size small enough to remove particles in the micron range, for instance, a mesh size not above about 100 microns, preferably not exceeding about 50 microns. The mesh size of the filter, however, should not be so small that a substantial pressure drop occurs across the filter. A pressure drop through the filter of no more than about 15% of the total head developed by the pump is permissible. Working in combination with other pressure drops in the pumping system, a pressure drop of 15% across the filter (generally about 2 p.s.i.) does not reduce the

delivery rate of the pump to any measurable degree, probably less than 2%. Thus, the filter should have openings ranging from about 5 to 100 microns in size.

The best filter medium may be determined in accordance with the following formula to fit within the framework of the above-described limiting factors.

$$\Delta P=\frac{S\mu tV}{D^2A}\frac{(1-f)^2}{f^3}\cdot 2.8\times 10^{-6}$$

where

μ=viscosity of gasoline, centipoises
t=thickness of paper filter, inches
V=gasoline flow rate, gal./min.
D=average diameter of paper fibers, inches
A=area of filter paper, square feet
f=void fraction of filter paper
S=factor which may have a value of approximately 1.0, but should be determined experimentally for each type of paper (from the equation given above).

ΔP=pressure drop across filter, #/sq. in. per cent decrease in gasoline rate

$$=\left(\frac{1.4\times 10^{-4}S\mu t(1-f)^2}{D^2f^3}\right)\frac{Vp}{\Delta Pp\times A}$$

for clean paper where

P is pressure drop in system, #/in.^{2}, before filter introduction

Vp is gasoline rate, gal./min., before filter introduction.

Since it is desirable to determine S experimentally for each type of paper the equation may be rewritten as follows:

$$\text{Percent decrease in gasoline rate}=50(S'\mu t)\frac{Vp}{\Delta Pp\times A}$$

for clean paper.

S' may be determined experimentally by testing the filter paper at a low pressure head from the equation

$$\Delta P=\frac{S'\mu tV}{A}$$

$$S'=\frac{\Delta P\times A}{\mu tV}$$

ΔP being the low head of gasoline converted to #/in.^{2}.

D, f, and S, and the constant are all inherent characteristics of the paper.

In passing through the filter essentially all solid particles are removed from the gasoline. These particles lodge in the filter element or fall off the filter and settle to the sump **82** or **182** located at the bottom of the air eliminator chamber, where they can be periodically drained through petcock **86**.

The filter is selected for its gasoline wettability and has a relatively large surface area to constitute only a minor obstruction to the flow of gasoline. Little pressure drop is shown by tests on a filter having an inlet surface area of about 2 or 3 to 5 square feet. For example, a resin-impregnated paper filter of about four square feet in area was placed in a gasoline dispenser having a normal discharge rate of about 14.7 gallons per minute. The flow rate suffered no measurable reduction due to the filter. The efficiency of this filter means was demonstrated by the fact that installed on a conventional gasoline pump and in use for only 700 gallons, a number of particles were caught by the 10 micron filter that could have caused trouble in the carburetor jets of a gasoline engine had they been allowed to pass through the dispenser.

We claim:

1. An apparatus for separating vapor and solids from gasoline and suitable for use in a gasoline dispenser comprising a chamber having an inlet for pumped gasoline and an outlet for filtered gasoline, said chamber being provided with a collection space and a vent for separated vapors, a longitudinally pleated, resin-impregnated cellulose cylindrical filter which is wetted by gasoline in preference to water, having an essentially horizontal axis in the flow path between said inlet and outlet, said chamber being provided with a drain for separated solids, said chamber comprising a bell having an opening at its side sufficient to allow passage of the filter through the opening, a cover for the said opening, a pipe secured to said outlet and a rod secured to said outlet pipe engageable with said cover, said cover and said outlet pipe holding the filter in operative position.

2. A gasoline dispenser filter apparatus comprising a longitudinally pleated cylindrical filter which is wetted by gasoline in preference to water having an essentially vertical axis supported by a pan having an opening which is in fluid-tight relationship with the interor of the filter, said pan having an opening at its side for conducting fluid in an essentially horizontal path, said pan being provided with spring means passing through the pan side opening engageable with a gasoline dispenser to hold it in fluid-tight engagement with said gasoline dispenser.

3. An apparatus for separating vapor and solids from gasoline, and suitable for use in a gasoline dispenser, comprising a chamber having an inlet for pumped gasoline and an outlet for filtered gasoline and being provided with a collection space for separated vapors, and a longitudinally pleated cylindrical resin-impregnated cellulose filter, which is wetted by gasoline in preference to water, in the flow path between the inlet and the outlet having an essentially vertical axis and supported by a pan having an opening which is in fluid-tight relationship with the interior of the filter, said pan having an opening at its side for conducting fluid in an essentially horizontal path to the said outlet, said chamber being provided with a drain for separated solids.

4. The apparatus of claim 3 in which the pan is provided with spring means passing through the pan side opening engageable with a chamber wall to hold it in fluid-tight relationship with the said outlet.

5. An apparatus for separating vapor and solids from gasoline and suitable for use in a gasoline dispenser comprising a chamber having an inlet for pumped gasoline in an upper portion of the chamber below the top of the chamber and an outlet for filtered gasoline in a lower portion of the chamber said chamber being provided with a collection space and a vent for separated vapors above the inlet, a longitudinally pleated cylindrical filter having an essentially horizontal axis in the flow path between said inlet and outlet, said chamber being provided with a drain for separated solids, said chamber comprising a bell having an opening at its side sufficient to allow passage of the filter through the opening, a cover for the said opening, a pipe secured to said outlet and a rod secured to said outlet pipe engageable with said cover, said cover and said outlet pipe holding the filter in operative position.

6. An apparatus for separating vapor and solids from gasoline, and suitable for use in a gasoline dispenser, comprising a chamber having an inlet for pumped gasoline in an upper portion of the chamber below the top of the chamber and an outlet for filtered gasoline in a lower portion of the chamber and being provided with a collection space and a vent for separated vapors above the inlet, and a longitudinally pleated cylindrical filter in the flow path between the inlet and the outlet having an essentially vertical axis and supported by a pan having an opening which is in fluid-tight relationship with the interior of the filter, said pan having an opening at its side for conducting fluid in an essentially horizontal path to the said outlet, said chamber being provided with a drain for separated solids.

7. An apparatus for separating vapor and solids from gasoline and suitable for use in a gasoline dispenser, comprising a chamber having an inlet in the upper portion of the chamber for pumped gasoline and an outlet in the lower portion of the chamber for filtered gasoline and being provided with a collection space for separated vapors, and a longitudinally pleated cylindrical filter having an essentially vertical axis, said filter having a mesh size in the range of about 5 to 100 microns in the flow path between the inlet and outlet and supported by a pan having an opening which is in fluid-tight relationship with the interior of the filter, said pan having an opening at its side for conducting fluid in an essentially horizontal path, said chamber being provided with a drain for separated solids.

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