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(54) Title: FUEL HOSE DEVICE

(57) Abstract: The present invention provides an improved fuel hose device for insertion into a vehicle's fuel inlet pipe to deposit fuel therein. The device deposits the fuel into the pipe and avoids problematic back splashing even if the device is angled toward an inner surface of the inlet pipe when inserted therein. In one embodiment, the device comprises a hose and a nozzle. The nozzle has an input end that defines an input opening that is connected to the fuel hose for receiving fuel therefrom. The nozzle also has an output end defining a fuel output opening that is angled relative to the input opening for exiting the fuel at an angle that is oppositely directed from the device angle to the inlet pipe's inner surface. In this manner, the angled output opening compensates for the angled device and sufficiently inhibits problematic back splashing.
FUEL HOSE DEVICE

Technical Field of the Invention

The present invention relates generally to the field of fuel hoses and nozzles. In particular, the present invention relates to a fuel hose device for an automatic refueling system.

Background of the Invention

Figure 1 shows an end effector 50 for a robot within an automatic refueling system. Such systems are used for the automatic refueling of vehicles without the need for the vehicle drivers to exit the car. Such a system is akin to an automatic carwash. Among other things, the end effector is used by a robot apparatus to open the fuel door lid, and insert into the fuel inlet opening a fuel nozzle for depositing fuel into the vehicle. For a description of such a system, reference may be made to U.S. Pat. No. 5,609,190, which discloses an automated refueling system with an end effector. This patent is commonly owned by the assignee of this invention and is hereby incorporated by reference into this specification.

As shown in Figure 1, end effector 50 includes a door arm assembly 70 for opening the fuel inlet door and fuel hose and nozzle assemblies 60 and 100, respectively, for inserting fuel into the fuel inlet of a vehicle. A fuel hose bracket 62 secures the fuel hose assembly 60 within the end effector, and a vapor recovery assembly 64 is mounted to hose 60 for recovering fuel vapor while the refueling process is occurring. A boot assembly 90 is mounted about the end of the nozzle assembly 100 for seating the nozzle assembly on the exterior portion of the fuel inlet opening. A bellows assembly 95 is mounted about the nozzle assembly 100 behind the boot assembly 90 for protectively covering the nozzle assembly and permitting extension and retraction thereof. A cable assembly 80 is also included for electrically controlling and receiving sensor information from various devices within end effector 50. Cable assembly 80 includes sensor lines 82, which communicate with a high level cutoff sensor, a filler neck pressure sensor, and a fuel hose position sensor.

Figure 2 shows the nozzle assembly 100 without either the boot or bellows assemblies. Nozzle assembly 100 includes nozzle actuator assembly 105, which includes a controllably extendable and retractable hose device that comprises a hose 110 with a
nozzle 120 mounted at its end that is to be inserted into the fuel inlet of a vehicle. Responsive to receiving an appropriate control signal and with the hose 110 and nozzle 120 properly aligned with respect to the fuel inlet opening, actuator 105 causes the hose 110 and nozzle 120 to be extended into the fuel inlet so that fuel may be pumped into the vehicle's fuel tank. The fuel hose 110 has generally been constructed from buta rubber.

Figures 3A through 3C show the hose device with hose 110 and nozzle 120 in greater detail. At its input opening, nozzle 120 is connected to hose 110 through nozzle coupling 115. The nozzle includes four fuel opening slits 122 where fuel departs from the hose nozzle 120. The nozzle also includes at its upper portion filler neck pressure sensor hole 124 and high level cutoff sensor hole 126. The pressure sensor hole fluidly communicates the fuel inlet to a pressure sensor for measuring the pressure within the fuel inlet to ensure that it does not exceed an unacceptable level. Likewise, the fuel cutoff hole 126 fluidly communicates the fuel inlet with a sensor for sensing an increase in vacuum which signals the presence of liquid fuel for determining when the fuel tank has been filled. Unfortunately, it has been discovered that this hose 110 and nozzle 120 design has several operational drawbacks. To begin with, the hose material, which is a buta rubber, tends to become sticky after coming into contact with the fuel such as when it is back splashed onto the nozzle. This can adversely affect the operation of the actuator 105 by impeding its ability to extend and retract the hose into and out of the fuel inlet pipe. In addition, the high-level cutoff sensor tends to errantly sense the presence of fuel and perceive that the tank has been filled even when it has not been filled, which causes the system to prematurely terminate pumping fuel into the vehicle.

Accordingly, what is needed is an improved hose device for depositing fuel into a vehicle.

**Summary of the Invention**

The present invention provides an improved fuel hose device for insertion into a vehicle's fuel inlet pipe to deposit fuel therein. The device deposits the fuel into the pipe and avoids problematic back splashing even if the device is angled toward an inner surface of the inlet pipe when inserted therein. In one embodiment, the device comprises a hose and a nozzle. The nozzle has an input end that defines an input opening that is connected to the fuel hose for receiving fuel therefrom. The nozzle also has an output
end defining a fuel output opening that is angled relative to the input opening for exiting the fuel at an angle that is oppositely directed from the device angle to the inlet pipe=s inner surface. In this manner, the angled output opening compensates for the angled device and sufficiently inhibits problematic back splashing. The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

**Brief Description of the Drawings**

For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

- Figure 1 is a perspective view of an end effector for an automatic refueling system.
- Figure 2 shows a nozzle assembly from the end effector of Figure 1.
- Figure 3A shows a perspective view of a nozzle actuator assembly from the nozzle assembly of Figure 2.
- Figure 3B shows a top view of a fuel hose device from the nozzle assembly of Figure 3A.
- Figure 3C shows a front view of the fuel hose device of Figure 3B.
- Figure 3D shows an end view of the fuel hose device of Figure 3C taken along lines 3D-3D.
- Figure 4 shows a fuel hose device inserted into a fuel inlet pipe.
- Figure 5A shows a front view of one embodiment of a nozzle having a fin.
- Figure 5B shows a top view of the nozzle in Figure 5A taken along lines 5B-5B
- Figure 6A shows a side sectional view of the nozzle of Figures 5A and 5B without the fin.
Figure 6B shows a frontal view of the nozzle in Figure 6A taken along lines 6B-6B. Figure 7A shows a perspective view of the nozzle of Figures 5A, 5B, 6A, and 6B without the fin. Figure 7B shows a bottom perspective view of the nozzle of Figure 7A. Figure 7C shows an end view of the nozzle in Figures 7A and 7B. Figure 8A shows a frontal view of the fin of Figures 5A and 5B. Figure 8B shows an end view of the fin in Figure 8A. Figure 9 shows a fuel hose device with the nozzle of Figures 5 through 8 inserted into a fuel inlet pipe.

Detailed Description of the Preferred Embodiments

A. Examination of the Back Splash Problem

Figure 4 shows the hose 110 and nozzle 120 fully inserted into a fuel inlet (or filler) pipe 30. Inlet pipe 30, which is a conventional (e.g., Ford) fuel inlet pipe, includes a neck down portion 32 with an inner surface 33 that is generally conical in shape and tapers down into the smaller-diameter pipe that connects with the fuel tank (not shown). The typical cap has been removed, and an adapter 34 has been inserted over the end of the filler pipe. The adapter 34 is used to receive and guide the tip of the fuel nozzle 120 so that it appropriately enters the filler pipe. As the hose enters the filler pipe, it pushes back a spring loaded door (not shown), which is mounted on a conventional unleaded fuel opening control insert 38, which forms a part of the filler pipe. As the fuel hose 110 is inserted through the adapter 34 and the opening in the insert 38 it has a tendency to droop downwardly as illustrated at the arrow labeled D. It has been determined that this causes the fuel exiting from the nozzle openings 122 to impact against the inner surface 33 of the neck down portion 32 of the fuel filler pipe 30. This causes splash back of the fuel to occur in such a manner that it covers the high level cut-off port 126 located at the upper portion (twelve o'clock position) of the nozzle 120. This incorrectly indicates to the system that the fuel tank is full and generates a high level cut-off signal stopping fuel flow. It has been determined that this problem can be combated through any of several different approaches.

In the depicted Figure 4, the nozzle 120 is fully extended into the filler pipe 30, which is the normal insertion depth. Through testing, however, it has been determined that if the nozzle 120 is retracted from between 0.1 and .4 inches from this normal, full extension
position while fuel is being deposited, the back splash problems are significantly reduced and become tolerable from an operational perspective. Unfortunately, with some automatic system designs, it is not feasible for the nozzle not to be fully extended (inserted into the inlet pipe) during the refueling process.

As noted above, when hose 210 is fully inserted into the inlet filler pipe 30, it tends to bend downwardly, which exacerbates the back splash problems resulting from the exiting fuel hitting the neck down portion 232 of filler pipe 230. One reason for this downward bending is that with some nozzle actuators, the fuel hose 210 is stowed at an angle (20 degrees). The buta rubber material forming the hose has poor memory (spring) retention, which causes the hose to remain bent even after it is extended from the actuator, which directs fuel flow from the nozzle 220 into the neck down surface 132 of inlet pipe 230. It has been discovered that if the fuel hose is constructed from a polyurethane material rather than the buta, the bend retention is greatly reduced. The polyurethane material has much better memory and tends to return to its normal straight position even after having been stored in a bent position. This provides a better dimensional stability for the fuel hose than was capable before. It has also been discovered that the exterior surface of the urethane material when wet from fuel, water or the like, has greater lubricity and thus, makes it easier to insert into the fuel filler pipe 30 through the cap adapter 34. It has also been discovered that the urethane material has much more capability with the use of the fuel for the automobiles than was the buta material.

Another reason for the downward bending of fuel hose 210 is that in some vehicles, the hole in the unleaded control insert 38, rather than being located in the center of the disc, is located toward the lower part (e.g., at six o’clock) of the disc. This causes the approach of the hose 210 to be directed downward at an angle as the end effector inserts it into the inlet pipe 30. To compensate for this bending (whether resulting from this downward insertion or otherwise), the exit end of the nozzle 120 is redesigned (as will be shown below) to cause the fuel flow to exit the nozzle 120 so that it is located more centrally within the filler pipe 30. In this manner, the splash back is sufficiently inhibited. Also by utilizing the urethane material for the fuel hose 110 it will cause the fuel hose to assume a straighter position than was possible with the buta previously used.
B. Improved Nozzle

Figures 5 through 9 show one embodiment of an improved nozzle 220 of the present invention. The basic changes with respect to the nozzle of Figure 3 is that the four slit openings previously used for discharge of the fuel have been replaced with a more open, upper-directed opening, and a fin has been added for guiding the nozzle to make up for the elimination of part of the nozzle’s former upper output-end portion.

Figures 7A, 7B and 7C show the nozzle 220 without the fin. The nozzle 220 includes slit 222, fuel output opening 226, filler neck pressure hole 232, and high level cutoff hole 234. Slit 222 corresponds to one of the four former openings. Fuel output opening 226 is angled with respect to the nozzle’s input opening, as will be discussed below. Figures 8A and 8B show the generally planar fin 238.

Figures 5A, 5B, 6A, and 6B show nozzle 220 with fin 238 operably mounted into slit 222. Fin 238 may be secured into place by brazing or soldering. It should be recognized, however, that this is but one of numerous ways to accomplish this structure. For example, the nozzle (including the fin) could be formed from a unitary piece, which is then affixed to the end of the hose 210.

The edge surface of the fin 238 which appears when inserted in place in the upper or cut-out portion 224 of the nozzle 220, as shown in Figure 5A, is primarily used for guidance purposes to cause the nozzle to properly enter the adapter 34 and go through the fitting 38 into the inner portion of the filler pipe 30. With the depicted nozzle, as seen in Figure 6B, the fuel opening 226 from the nozzle 220 has been formed to be at an angle 228 (e.g., from approximately 10 to 20 degrees) from the center line C of the nozzle’s input opening. By this angular displacement of the exit 226, the fuel is caused to move upwardly and exit from the nozzle as shown in Figure 9.

Referring to Figure 9, with nozzle 220, fuel will exit at an upward angle (as represented by the dashed arrows) from the centerline C of the hose 220. This upwardly directed fuel stream compensates for any downward curvature of hose 210 as indicated at D. Even without downward curvature of hose 210, nozzle 220 with its upwardly directed fuel stream tends to operate sufficiently well for reducing problematic back splashing. A fifteen degree redirection angle serves as a suitable compromise between too much
redirection when the hose is not curved and insufficient redirection when the hose is problematically curved downward.

Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.
CLAIMS:
1. A fuel hose device for insertion into a fuel inlet pipe of a vehicle for depositing fuel therein, comprising:
   (a) a fuel hose having an insertion end; and
   (b) a nozzle fluidly mounted to the fuel hose at said insertion end, the nozzle having an upwardly angled opening for exiting the fuel at an upward angle to compensate for downward positioning of the fuel hose when inserted into the fuel pipe, wherein said compensation sufficiently inhibits problematic back splashing.

2. The device of claim 1, wherein the nozzle has a proximal end with respect to the fuel hose, the proximal end including a hole for a fuel cutoff sensor.

3. The device of claim 2, wherein the proximal end further includes a hole for a fuel inlet neck pressure sensor.

4. The device of claim 1, wherein the upwardly angled opening is at an angle between 10 and 20 degrees.

5. The device of claim 4, wherein the upwardly angled opening is at an angle of about 15 degrees.

6. The device of claim 1, wherein the nozzle further comprises a fin.

7. The device of claim 6, wherein the fuel inlet pipe includes an unlead control insert that has a hole for receiving the fuel hose device, the fin being operably mounted to the nozzle for guiding the nozzle through the hole of the control insert.
8. The device of claim 6, wherein the fin substantially bifurcates the nozzle.

9. The device of claim 8, wherein the nozzle has an input fuel opening that is connected to the fuel hose, the input opening having a cross-sectional plane, the fin being generally planar and perpendicularly aligned with the cross-sectional plane of the input opening.

10. The device of claim 9, wherein the upwardly angled fuel opening is angled with respect to the input opening.

11. The device of claim 1, wherein the hose comprises urethane.

12. An automatic refueling system for automatic refueling of a vehicle with a fuel inlet pipe, the system comprising an end effector having a nozzle assembly, the nozzle assembly comprising:
   (a) a nozzle actuator;
   (b) a fuel hose operably mounted within said actuator for controllable insertion and retraction into and out of the fuel inlet pipe, the hose having an insertion end to be inserted into the fuel inlet pipe; and
   (c) a nozzle fluidly mounted to the fuel hose at said insertion end, the nozzle having an upwardly angled opening for exiting the fuel at an upward angle to compensate for downward positioning of the fuel hose when inserted into the fuel pipe, wherein said compensation sufficiently inhibits problematic back splashing.

13. The device of claim 12, wherein the nozzle has a proximal end with respect to the fuel hose, the proximal end including a hole for a fuel cutoff sensor.

14. The device of claim 13, wherein the proximal end further includes a hole for a fuel inlet neck pressure sensor.

15. The device of claim 12, wherein the upwardly angled opening is at an angle between 10 and 20 degrees.
16. The device of claim 15, wherein the upwardly angled opening is at an angle of about 15 degrees.

17. The device of claim 12, wherein the nozzle further comprises a fin.

18. The device of claim 17, wherein the fuel inlet pipe includes an unlead control insert that has a hole for receiving the fuel hose device, the fin being operably mounted to the nozzle for guiding the nozzle through the hole of the control insert.

19. The device of claim 17, wherein the fin substantially bifurcates the nozzle.

20. The device of claim 19, wherein the nozzle has an input fuel opening that is connected to the fuel hose, the input opening having a cross-sectional plane, the fin being generally planar and perpendicularly aligned with the cross-sectional plane of the input opening.

21. The device of claim 20, wherein the upwardly angled fuel opening is angled with respect to the input opening.

22. The device of claim 12, wherein the hose comprises urethane.

23. A fuel hose device for insertion into a vehicle=s fuel inlet pipe for depositing fuel therein, the fuel inlet pipe having (1) an entrance with an adaptor defining a hole for receiving the hose device, and (2) a control insert downstream from the adaptor, the insert also defining a hole for receiving the hose device after it passes through the adaptor, the hose device comprising:

   (a) a fuel hose; and

   (b) a nozzle having (1) an input end defining an input opening that is connected to the fuel hose for receiving fuel therefrom, and (2) an output end defining a fuel opening that is upwardly angled relative to the input opening for exiting the fuel at an upward angle to compensate for downward positioning of the fuel hose when inserted into the fuel pipe, wherein said compensation sufficiently inhibits problematic back splashing.
24. The device of claim 23, wherein the input end includes a hole for a fuel cutoff sensor.

25. The device of claim 24, wherein the input end further includes a hole for a fuel inlet neck pressure sensor.

26. The device of claim 23, wherein the upwardly angled opening is at an angle between 10 and 20 degrees.

27. The device of claim 26, wherein the upwardly angled opening is at an angle of about 15 degrees.

28. The device of claim 23, wherein the nozzle further comprises a fin.

29. The device of claim 28, wherein the fin is operably mounted to the nozzle for guiding the nozzle through the holes of the adaptor and control insert.

30. The device of claim 28, wherein the fin substantially bifurcates the nozzle.

31. The device of claim 23, wherein the hose comprises urethane.

32. A fuel hose device for insertion into a vehicle's fuel inlet pipe to deposit fuel therein, wherein the device when inserted is angled toward an inner surface of the inlet pipe, comprising:
   (a) a fuel hose; and
   (b) a nozzle having (1) an input end defining an input opening that is connected to the fuel hose for receiving fuel therefrom, and (2) an output end defining a fuel output opening that is angled relative to the input opening for exiting the fuel at an angle that is oppositely directed from the device angle to the inlet pipe inner surface, wherein said angled output opening sufficiently inhibits problematic back splashing.
33. The device of claim 32, wherein the device is downwardly positioned toward the inner surface and the output opening is upwardly angled from the input opening to compensate for the downward positioning.

34. A method for depositing fuel into a fuel inlet pipe, comprising:
(a) inserting a fuel hose device into the inlet pipe, the device having a nozzle with an input and an output opening, wherein the device is positioned toward an inner surface of the inlet pipe;
(b) passing fuel through the device to the input opening of the nozzle; and
(c) redirecting the fuel from the input opening to the output opening so that it exits the nozzle at an angle that compensates for the device=s positioning toward the inlet pipe inner surface to sufficiently inhibit problematic back splashing.