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(71) Applicant: **DOVER CORPORATION**
New York, NY 10017 (US)

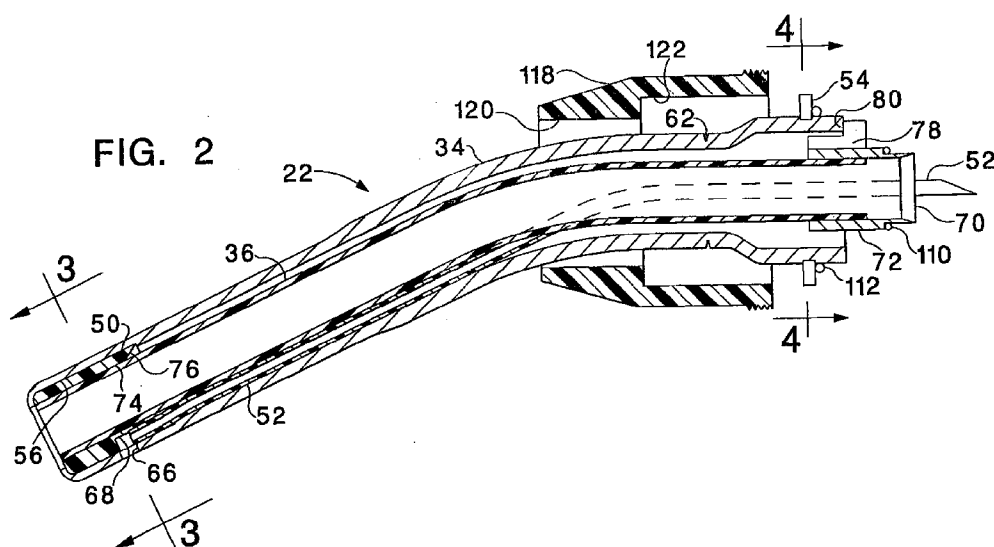
(72) Inventors:
• **Dalhart, Mark D.**
Indian Springs, Ohio 45011 (US)
• **Sunderhaus, Charles A.**
Hamilton, Ohio 45013 (US)

(74) Representative: **Klunker . Schmitt-Nilson . Hirsch**
Winzererstrasse 106
80797 München (DE)

(54) **Spout constructions for fuel dispensing nozzles and methods for making same**

(57) A vapor recovery nozzle includes a spout construction comprising an outer aluminum tube and an inner nylon tube. The distal ends of the tubes are joined so that the inner tube defines a central fuel passage and, in combination with the outer tube, defines a generally annular vapor return passage. A distal end portion of the outer tube has a reduced wall thickness and its inner end is expanded to mount a locator ring thereon. The spout assembly is telescoped into an adapter that connects the fuel and vapor passages to corresponding passages in the nozzle body. A spout nut threads into the nozzle body and engages the locator ring to mount

the spout on the nozzle. The outer spout tube is formed by lathe operations which include turning a fracture groove adjacent its inner end, and, thereafter bending the tube to angle the distal end portion of the tube downwardly from its inner end. A second embodiment teaches the use of structural, synthetic resins in forming the outer spout tube. In an alternate embodiment the outer spout tube is compositely formed an outer end portion that provides increased strength for the that portion, where a thin wall tube is employed.



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Description

The present invention relates to improvements in spout constructions employed in fuel dispensing nozzles and methods employed in the making of same. In a more specific sense the invention relates to improvements in spout constructions that are employed in fuel nozzles having a vapor recovery capability. Other aspects are directed to a nozzle construction that facilitates mounting of the spouts of the present invention.

The present invention represents improvements on vapor recovery nozzle constructions disclosed in an earlier United States application, Ser. No. 986,521, filed December 7, 1992, hereinafter sometimes referenced as the '521 application.

In recent years there has been an ever increasing pressure, by various governmental entities, to minimize the discharge of pollutants into the atmosphere. Fuel vapors are a particular concern. When a vehicle's fuel tank is filled, hydrocarbon vapors in the tank are displaced as liquid fuel enters the tank. Prior to the concerns over atmospheric contamination, the displaced vapors were simply allowed to escape into the atmosphere. While the amount of contamination from an individual fuel tank is insignificant, when multiplied by literally millions of tankfuls per day, measurable and significant levels of pollution (directly attributable to fuel vapors) can be detected, particularly in areas of high population density.

In order to eliminate this source of pollution, governmental authorities have mandated the use of vapor recovery fuel dispensing systems in an ever increasing percentage of retail filling stations. Basically, a vapor recovery system involves the provision of a vapor return flow path from the nozzle (that is discharging fuel into a vehicle fuel tank) back to the storage tank from which the fuel is being drawn for delivery to the vehicle. Fuel vapors are thus returned to the storage tank (or other area of disposal) rather than being released into the atmosphere.

The initial efforts to comply with vapor recovery regulations were, mostly, based on the use of what is known as a "pressure balance" vapor recovery system. In such system, a vapor return conduit extends from the top of a storage tank to a dispenser pedestal. The usual fuel conduit system also connects the dispenser with the storage tank. The fuel dispensing nozzle is connected to the pedestal by a hose that includes both fuel and vapor passages. The nozzle also includes passages for both fuel and vapor. When fuel is being delivered, the nozzle vapor passage is sealed with respect to the inlet pipe for the vehicle fuel tank. Thus, as fuel displaces vapors from the vehicle tank, they are forced into the vapor passageway network that extends through the nozzle body, through the hose and then back to the fuel storage tank. As fuel is drawn from the storage tank and discharged into the vehicle tank, the increase in vapor volume in the storage tank equals (in theory) the decrease in vapor volume in the vehicle tank. There is a

concomitant pressure increase in the vehicle tank and decrease in the storage tank, which causes the return flow of vapor from the vehicle to the storage tank, as a pressure balance in the two tanks is established, hence the name "pressure balance" system.

In a pressure balance system, the sealed connection with the fuel tank inlet pipe is attained by compressing a bellows that surrounds a metal spout tube. The need to compress this bellows made use of a nozzle extremely annoying at best, and impossible for many with only moderate infirmities.

The alternative to the pressure balance vapor recovery system is what is known as a "vacuum assist" vapor recovery system. The vacuum assist vapor recovery system employs the same dual passageway network for fuel and vapors, as in the pressure balance system. The vacuum assist system differs in that it does not require a mechanical seal with the vehicle fuel tank. Instead, a negative pressure is provided at the inlet to the vapor return conduit system, at the nozzle. Displaced vapors are thus drawn into the vapor return system, to prevent their escape into and pollution of the atmosphere.

A nozzle for a vacuum assist vapor recovery system is characterized by an essentially rigid spout tube and is capable of use in essentially the same fashion and with the same facility as nozzles employed in fuel dispensing systems that do not have a vapor recovery capability.

While the basic principles of the vacuum assist system have been known for many years, early attempts at commercialization were limited by several factors. These limiting factors included difficulties in obtaining a vacuum that reliably prevent escape of vapors into the atmosphere, as well as providing nozzles that were effective in providing both a vapor passage and fuel passage in the spout, in addition to the venting passage required for automatic shut-off to prevent overfilling of a fuel tank.

The referenced, '521 application is directed to providing fuel nozzles that facilitate the use of vacuum assisted fuel nozzles. The present application has the same object and is more specifically directed to the spout construction of such nozzles and to reducing the costs involved in spout constructions that provide both a fuel passage and a vapor return passage.

Other and more general objects of the invention are directed to reducing the costs associated with the manufacture of rigid spout tubes.

These ends may be attained, in accordance with certain aspects of the invention, by a spout comprised of an outer tube and an inner tube. The inner tube defines a central fuel passage for the spout and, in combination with the outer tube, defines a generally annular vapor passage for the spout. The inner tube is formed from a synthetic resin. Preferably the inner tube is formed of a laterally flexible synthetic resin to enable the use of straight, extruded resin tubing. The latter feature is advantageous in permitting the use of straight,

extruding tubing where the distal end portion of the compositely formed spout is angled downwardly from the inner end portion that is attached to the nozzle body. It has been found that extruded, nylon 66 tubing, having a wall thickness of .051 cm. (.020 inch) is preferred as a base material for the inner tube.

The outer tube may be advantageously formed from a synthetic resin, referenced as a "structural plastic". This feature is of particular advantage in forming a spout in which the distal end portion is angled downwardly from the inner end portion.

Other advantages are found in the use of aluminum as the material for the outer spout tube. Aluminum tubing, in accordance with method aspects of the invention, may be first set up in a lathe, a counterbore can then be formed in its end and a circumferential fracture groove formed in what will become the inner end portion of the spout tube. The spout tube may then be severed from the aluminum tubing. Where the spout is to be used for the delivery of unleaded fuel, the distal end portion is turned to a reduced diameter that will freely pass through a restricter plate. (Such plates are mounted in the inlet pipes of fuel tanks in vehicles that are required to use unleaded fuel.)

Continuing with the method aspects of the invention, after the lathe operations, the spout tube may be bent to angle the distal end portion downwardly from the inner end portion. The inner end of the spout tube is then expanded to an enlarged diameter, while maintaining a substantially constant wall thickness, 1/8 being advantageous.

It is further desirable to position a locator ring in telescoped relation to the inner end portion of the tube, prior to and while it is being expanded. The tube is then expanded to an extent sufficient to swage the tubing material into engagement with the locator ring and mount the locator ring on the tube. The locator ring functions as flange means and is a component of the mechanism for mounting the spout.

It has been found that extruded 6005-T5 aluminum is advantageous, if not necessary, in forming a reliable fracture groove (the function of which is later discussed) in the spout, as well as in mounting the locator ring on the spout by a swaging action.

Other constructional features of the invention are evident in the further method steps of mounting an outer ferrule in the counterbore in the outer spout to form an outer tube subassembly. The outer tube subassembly may further comprise a vent tube that is inserted in a longitudinal slot in the outer ferrule and extends beyond the inner end of the outer tube.

An inner ferrule is then mounted on the inner end of the inner tube. The inner ferrule may comprise a central hub which is telescoped over the inner end of the inner tube and preferably bonded thereto in forming an inner tube subassembly. The distal end of the inner end of the inner tube is then inserted from the inner end of the outer tube, into the outer ferrule. Radial vanes, projecting from the inner ferrule hub, engage the inner surface

of the enlarged portion of the outer tube and position the inner end of the inner tube relative thereto.

The described spout assembly is adapted to be mounted on a nozzle body that has an adapter positioned in a bore that extends into an end of the nozzle body opposite the butt end to which a coaxial hose may be mounted. The adapter comprises an inner tubular portion which defines a central fuel passage and an outer tubular portion. The inner and outer tubular portions combine to define an annular vapor passage.

The outer spout tube is telescoped into sealing engagement with the inner surface of the outer tubular portion of the adapter and the inner ferrule of the spout is telescoped into sealing engagement with the inner tubular portion of the adapter, as the spout is mounted on the nozzle. The vapor and fuel passages of the spout are thus placed, respectively, in communication with the corresponding passages in the adapter. Also, as the spout is mounted on the nozzle body, the vent tube is inserted into a venturi venting passage of the adapter to provide an automatic shut-off function.

A spout nut, telescoped over the inner end portion of the outer spout tube, is then threaded into the nozzle body. The spout nut has a counterbore shoulder that engages the locator ring and damps it against the adapter to lock the spout in mounted relationship on the nozzle.

As is discussed in greater detail below, a major thrust of the constructional features of the invention is to provide maximized flow areas for both the fuel and vapor passages of the spout. In the same vein, it is also an objective to minimize flow obstructions at the juncture with the adapter to which the spout is connected in being mounted on the nozzle body.

The above and other related objects and features of the invention will be apparent from a reading of the following description of a preferred embodiment, with reference to the accompanying drawings, and the novelty thereof pointed out in the appended claims.

In the drawings:

Fig. 1 is an elevation of a vapor recovery nozzle having a spout construction embodying the present invention;

Fig. 2 is an elevation, in longitudinal section and on an enlarged scale, of the spout construction sub-assembly and mounting nut indicated in Fig. 1;

Fig. 3 is a section taken on line 3-3 in Fig. 2;

Fig. 4 is a section taken on line 4-4 in Fig. 2;

Fig. 5 is a view, in longitudinal section and on a further enlarged scale, illustrating the juncture between the nozzle subassembly and the body portion of the nozzle;

Fig. 5A is a section taken on line 5A-5A in Fig. 5;

Fig. 5B is a section taken on line 5B-5B in Fig. 5A;

Fig. 6 is a view, similar to Fig. 5, of the body portion of the nozzle, with the spout subassembly removed;

Fig. 7 is an exploded view of the spout assembly;

Fig. 8 is an elevation illustrating the spout assem-

bly;

Figs. 9, 10, 11, 12, 13 and 14 illustrate the successive steps in forming a component of the spout assembly;

Fig. 15 is a longitudinal section of a spout construction disclosed in said '521 application.

Fig. 16 is a section taken on line 16-16 in Fig. 15;

Fig. 17 is a view taken in the direction of arrow 17 in Fig. 15;

Fig. 18 is longitudinal section of the distal end portion of spout construction of Fig. 15, modified to comprise synthetic resin components;

Fig. 19 is a fragmentary view, partially in longitudinal section, illustrating the distal end portion of the nozzle spout positioned in an inlet pipe to a vehicle fuel tank;

Fig. 20 is an elevation, in longitudinal section and on an enlarged scale, similar to Fig. 2, of the alternate spout construction subassembly;

Fig. 21 is an elevation, in longitudinal section, separately illustrating a subassembly seen in Fig. 20;

Fig. 22 is a bottom view of the subassembly seen in Fig. 21;

Fig. 23 is a side elevation, in partial longitudinal section, of an alternate construction for the subassembly illustrated in Figs. 20-22;

Fig. 24 is a longitudinal section of a component of the alternated subassembly seen in Fig. 23;

Fig. 25 is a section taken on line 25-25 in Fig. 24;

Fig. 26 is a section taken on line 26-26 in Fig. 24;

Fig. 27 is a side elevation, in partial longitudinal section, of another alternate construction for the subassembly illustrated in Figs. 20-22;

Fig. 28 is a section taken on line 28-28 in Fig. 27; and

Fig. 29 is a section taken on line 29-29 in Fig. 27.

Fig. 1 illustrates a vapor recovery nozzle, indicated generally by reference character 20, the distal end portion of which comprises a spout assembly constructed in accordance with the present invention and indicated generally by reference character 22. The nozzle 20 comprises a body 24 on which the spout assembly 22 is mounted. A coaxial hose 26 is secured to the opposite, or butt end, of the body 24. The coaxial hose comprises two flexible tubes 28, 30, which define a central passage and a concentric annular passage. The coaxial hose extends to a dispenser pedestal where one of the passages is connected with a source of pressurized fuel and the other passage is connected to conduit means that extend to a container that receives the vapor displaced from a vehicle fuel tank, as the tank is filled with fuel discharged from the nozzle. In the usual case, the vapors are returned to the storage tank from which fuel is drawn to be discharged from the nozzle.

It will be noted that where fuel flow is through the central passage and vapor flow is through the annular passage of a coaxial hose, it is referenced as a "standard" coaxial hose. Where fuel flow is through the annu-

lar passage and vapor flow is through the central passage, it is referenced as an "inverted" coaxial hose. For sake of illustration, the hose 26 is shown as a standard coaxial hose. However, an inverted coaxial hose could be employed, by making appropriate connections with vapor and fuel passages at the butt end of the nozzle body.

The fuel flow path in Fig. 1 is indicated by outline arrows and dashed line 32. It will be seen that fuel flows from the central hose passage, defined by tube 30, through the nozzle body 24 and then through the spout assembly 22 for discharge from the distal end of the spout 22. At this point it will be noted that the spout 22 is compositely formed and comprises a spout assembly that includes an outer tube 34 and an inner tube 36. The inner tube 36 defines the fuel flow path through the spout assembly. The inner and outer tubes combine to define a flow path longitudinally through the spout assembly. This flow path is generally annular, although the inner tube 36 is not necessarily concentric of the outer tube 34 at all points along its length.

This generally annular passage provides a vapor return flow path through the spout. It extends from inlet openings 38 (spaced inwardly from the distal end of the spout) along the length of the spout, to nozzle body 24. The vapor return flow path is indicated by broken line 40 and solid arrows. It extends from the spout assembly, through the nozzle body 24, through a vapor passage cap 41, and then back through the nozzle body 24, where connection is made with the annular passage of the coaxial hose 26.

The nozzle of the present invention is primarily intended for use in a vacuum assisted vapor recovery system. In such vapor recovery system, the vapor return passage is connected to a vacuum pump, usually located at the dispenser pedestal. In conventional use of a fuel dispensing nozzle, the distal end portion of the spout is inserted into the upper end portion of the inlet pipe to a vehicle fuel tank. By providing a negative pressure in the vapor return passage, vapors are drawn into the inlet openings 38, without the need of a seal between the spout and inlet tube.

This vacuum assist system is a preferred alternative to so called pressure balance vapor recovery systems, which also include a vapor return passage system that extends from the vehicle fuel tank to the storage tank from which fuel is drawn. In pressure balance systems, a mechanical seal (usually provided by compressing a bellows) is required between the spout and the tank inlet pipe. When this seal is in effect, there is an increase in vapor pressure as fuel is introduced into the vehicle's tank. The vapor is thus forced into the vapor return flow path and return flow (from vehicle tank to storage tank) is induced as the vapor system tends to stabilize at a pressure balanced condition. It will become apparent that the present invention, or at least significant aspects thereof, is applicable to fuel dispensing nozzles employed in pressure balance, vapor recovery systems.

Operation of the present nozzle is conventional in the provision of an operating lever 42 that can be raised to open a valve 44 that controls flow of fuel through the fuel passage 32. The details of the spout assembly 22 will now be described in detail, with reference first to Figs. 2-4, 7 and 8.

The spout assembly comprises an outer tube sub-assembly 46 and an inner tube subassembly 48. The outer tube subassembly 46 comprises the outer spout tube 34, a ferrule 50, a vent tube 52 and a locator ring 54. Forming of the outer tube 34 and mounting of the locator ring 54 thereon is accomplished through novel method aspects of the invention, which will now be described.

As indicated earlier, there are several ends sought to be met by the present invention. These ends include light weight and resistance to abuse, along with an economical construction. Such ends are attained by the use of aluminum as the material for the outer spout tube 34. The specific end of resistance to abuse, while providing a minimum weight, is met by the use of aluminum tubing having a substantial wall thickness at its inner end portion and a reduced wall thickness at its distal end portion. By governmental regulation, vehicles powered by engines, that operate on unleaded gasoline, are provided with a restrictor plate in the upper end of the inlet pipe to the vehicle's fuel tank. This is illustrated in Fig. 19, where the distal end portion of the spout 22 is positioned in an inlet pipe I and inserted through an opening O formed in the restrictor plate, which is identified by reference character R.

The diameter of the restrictor plate opening thus establishes the maximum diameter for the distal end portion of a spout for a nozzle intended for delivery of unleaded fuel. The diameter of the restrictor plate opening, with appropriate allowance for clearance and manufacturing tolerances dictates a diameter for the distal end portion of the outer spout tube 34 of approximately 2.057 cm. (.810 inch). From this base point, it has been determined that a wall thickness of approximately .127 cm. (.050 inch), at the distal end portion of the tube, provides sufficient strength to avoid damage due to abuse that is inherent in normal usage of the nozzle. It is also to be noted that the wall thickness of the distal end portion of the tube 34 is a function of the length of the reduced diameter. Thus, in order to obtain a minimum wall thickness, the length of the reduced diameter section is preferably limited to that necessary to position the vapor inlet openings 38 on the fuel tank side of the restrictor plate - this relationship being necessary to minimize, if not entirely prevent, escape of vapors into the atmosphere.

In order to obtain this relationship relative to the restrictor plate, and to accommodate other constructional features, it has been found that a reduced diameter length of approximately 7 cm. (2 3/4 inches) is appropriate for the wide range of inlet pipe/restrictor plate configurations on different makes and models of vehicles.

It is to be further appreciated that this extended discussion of dimensional relationships has for its further and ultimate end the maximization of flow areas for the fuel and vapor passages, as is further dealt with below.

The required strength characteristics for the outer spout 34 are achieved by providing the inner end portion of spout tube 34 with a wall thickness of approximately .318 cm. (1/8 inch) and an outer diameter of approximately 2.44 cm. (.960 inch). Sizing of the spout tube 34 can also be affected by the sizes of commercially available extruded aluminum. Aluminum tubing having an outer diameter of approximately 2.44 cm. (.960 inch) and an inner diameter of approximately 1.8 cm. (.710 inch), which tubing is the starting point for forming the spout tube 34.

Fig. 9 illustrates a length of tubing t, mounted for lathe operations. The lathe operations are indicated in Fig. 10 and include forming a counterbore 56 in the distal end of the tube to a depth approximating, or somewhat greater than, the length of the ferrule 50. The distal end portion 58 of the nozzle is then turned down to the maximum diameter deemed suitable for insertion through the opening in a restrictor plate, or to a lesser diameter that still provides sufficient strength for the distal end portion of the nozzle to withstand normal physical abuse. The length of the reduced diameter, distal portion 58 of the spout is the minimum necessary to permit the vapor return entrance holes 38 to be positioned inside the fuel pipe restrictor plate (R), when the spout is inserted therethrough (see above discussion of Fig. 19). A reduced diameter length of approximately 7 cm. (2 3/4 inches) is typical. It is also noted that, preferably, there is a conical ramp 60 that leads from the reduced diameter portion to the inner portion of the spout, which is in its "as extruded" condition. The ramp 60 eliminates any sharp edge at the change in diameters and thus minimizes the possibility of its being a hazard, or subjected to abuse in use.

The next operation in the lathe procedures is turning a groove 62 in its inner end portion. The groove 62, referenced as a breakaway fracture groove, provides a predetermined failure mode in the event a vehicle is driven away from a fuel dispenser with the spout still inserted in the fill pipe of its fuel tank. The provision of a breakaway groove is a well known expedient. However, the present invention departs from prior teachings in that the groove is formed during the setup for lathe procedures and prior to bending the spout to angle the distal end portion relative to the inner portion thereof, as will next be described in connection with the present spout tube 34. Prior attempts to form a fracture groove prior to bending have not been successful because of an inability to obtain a spout that will reliably fail when subject to a desired predetermined force. Obtaining an accurate failure force is necessary to prevent more serious damage than the simple loss of a nozzle spout in the event of driveaway. If the spout fails to fracture at this predetermined force, more serious damage can result, such as toppling the dispenser pedestal.

It has been determined that the ability to form the fracture groove (62) during the lathe set up and before bending is due to the preferred use of 6005-T5 aluminum (American Alloy Association alloy number and temper number) the described lathe operations have been completed, a cut off tool c can be employed to sever the length of tubing t, that will comprise a spout tube 34, from the extruded length of tubing stock. It is to be appreciated that the counterboring, turning and groove forming steps do not necessarily have to be performed in the order described. However, this order does provide greater stability to the tubing as it is being formed and thus provides a greater accuracy in the finished spout tube.

Those skilled in the art will appreciate that the described sizing of the distal end portion of the tube 34 is to meet the requirements for unleaded fuel. Where the spout tube is to be employed for nozzles employed in dispensing leaded fuel, the step of turning the distal end portion of the nozzle is simply omitted. The remaining features of the invention are, however, suitable for spouts used in nozzles that are employed in the delivery of leaded fuel.

Following the lathe operations, the severed length of tubing t is then bent to angle the inner end portion of the length of tubing relative to what will become the distal end portion of the spout. The bending procedure is illustrated in Figs. 11 and 12, showing the length of tube being appropriately restrained by dies that are displaced to provide the bending function.

The final step of making the spout tube 34 is to enlarge a short portion of what will become the inner end portion of the tube and to simultaneously mount the locator ring 54 thereon. This step can be performed with the inner and distal end portions of the tubing length maintained clamped in the same dies that were employed in the bending step. The end of expanding the upper end portion of the tubing can be obtained by a straightforward swaging (cold forming) operation wherein a tapered plunger p is telescoped downwardly into the end of the tube t, to the depth desired for the diameter of the inner end portion to be enlarged. After this depth is reached, the forming plunger is raised, permitting the formed tube to be removed.

Prior to the upper end portion of the tube being enlarged in this fashion, a locator ring 54 is positioned at a desired location spaced downwardly from the upper end of the tube and in a horizontal plane, relative to the vertical axis of the tube. It is to be appreciated that the locator ring 54 has a plurality of angularly spaced lugs 64 projecting inwardly from its inner diameter, which ring diameter approximates the outer diameter to which the tube is to be expanded by the plunger p. Thus, as the tube t is expanded, the lugs 64 become embedded in the tube wall to lock the locator ring 54 rigidly and securely thereon. It is to be further appreciated that this attachment is achieved without unduly weakening either the tube wall or the locator ring itself.

The inner diameter of the tube is increased approx-

imately 25% in the enlarging/ swaying process. This substantial increase in diameter contributes to the economies achieved in manufacturing the present spout assembly, in that it facilitates maintaining a required minimum flow area for the vapor flow path at its juncture with the nozzle body, all as will be fully discussed in subsequent description. In any event, the enlarging/swaying process is facilitated by the referenced use of 6005-T5 aluminum tubing as the spout tube material. It is to be understood that the bending operation could be performed subsequent to the step of enlarging the inner end portion of the tube and mounting of the locator ring thereon. However, the described order of steps is preferred. After attachment of the locking ring 54, the vapor inlet holes may be formed in the tube 34 along with a vent opening 66 that is employed in providing an automatic shut-off function for the nozzle.

The vent tube 52 may be positioned in a longitudinal slot 68, formed in the ferrule 50, which slot terminates short of the distal end of the ferrule 50. The distal end of the tube 52 is spaced from the distal end of the slot 68. The tube 52 is formed of a standard nylon material, nylon 66 being suitable. The ferrule 50 may be injection molded, with nylon 66 also being a suitable material.

The ferrule 50 and tube 52 may then be inserted through the distal end of the spout tube to bottom the ferrule 50 against the inner end of the counterbore 56. The distal end of the tube is then swaged inwardly to secure the block in place. It is also to be appreciated that there is a close fit between the ferrule 50 and the outer tube so that, preferably, the holes 38 provide the sole entrance means to the annular, vapor return passage 40. The objective is to minimize the entrainment of liquid fuel in the vapor return passage. It is also to be appreciated that the distal end of the slot 68 is registered with the tube opening 66, thereby providing an outlet for the vent tube 52, at the bottom of the spout tube and immediately above its distal end.

The inner tube subassembly 48 comprises the inner tube 36 and an inner ferrule 70. The inner ferrule 70 may be an injection molded, acetal or nylon resin, and comprises a central hub 72, which is telescoped over the inner end of inner tube 36. The tube 36 is bottomed against the end of a counterbore in the hub 72. The tube 36 is formed as a resin extrusion, nylon 66 again being a suitable material. A suitable adhesive or solvent may be employed to bond the inner ferrule 70 to the inner tube 36.

The inner tube assembly 48 is then joined to the outer tube assembly 46 by inserting the distal end of the inner tube 36 through the inner end of the outer spout tube 34. The significance of the inner tube being formed of a relatively flexible resinous material becomes apparent at this point, in that the inner tube, flexes and follows the curvature of the relatively rigid outer tube, as it is telescoped into the outer tube. Nylon 66 is a thermoplastic material. Thus, the inner tube can be heated to facilitate its taking a curvature without collapsing the wall.

This is to point out that there is some criticality in configuring the inner tube and in the selection of its material. As indicated, it is highly desirable that the tube essentially maintain its circular cross section, as it is bent to a longitudinal curvature, otherwise, the cross sectional area of the fuel flow passage will be unduly reduced and the rate at which fuel can be delivered will be reduced to an unacceptable level. It is again noted that the orifice of the restricter plate is the primary limiting factor on flow rates. That is, the cross sectional areas for both fuel flow and vapor return flow must be sized within the constraint of the restricter orifice and still provide for a tube wall thicknesses that will provide sufficient strength to withstand normal abuse in use, and more particularly a strength such that the tube wall will not collapse when bent. It has been found that nylon 66 tubing, having a 1.27 cm. (half inch) outer diameter and a wall thickness of .051 cm. (.020 inches) allows for longitudinal bending of the tube with a minimal decrease in fuel flow area, while at the same time meeting the other desired and necessary characteristics, such as having sufficient strength to withstand the internal pressure generated by the fuel being delivered.

It will be further noted that the outer ferrule 50 has a bore 74 which is vertically offset from the central axis of the ferrule. This offset has two purposes. First, it facilitates connection of the vent tube 52, as previously described. Second, the offset facilitates connection of the inner tube thereto, in that the degree to which the inner tube must be flexed is minimized. Connection of the inner tube 36 to the outer ferrule 50 is further facilitated by a beveled, or conical inner, entrance end, indicated at 76.

The inner end of the inner tube subassembly 48 is positioned relative to the inner end of the outer tube assembly 46, by vanes 78, projecting radially from the inner ferrule hub 72. The inner ends of the vanes 78 slidably engage the inner diameter of the enlarged, inner end portion of the outer spout tube 34 to position the inner tube 36 centrally thereof. The vanes 78 have shoulders 80, which are engaged with the inner end of the spout tube 34 to longitudinally position the inner tube assembly 48 relative to the outer tube assembly 46.

In telescoping the inner tube assembly into the outer spout tube 34, the vent tube 52 is positioned, in a relative sense, with respect to the spout tube 34. That is, the inner tube assembly is positioned in an angular sense about the axis of the spout tube 34. The spout tube 34 has an angled indentation 82, at a three o'clock position, as viewed in Fig. 5A, reference also Fig. 5B. It will next be noted that the inner ferrule has a fifth radial vane 84 that defines a recess for receiving the inner end of the vent tube 52. As the inner tube 36 is inserted into the outer spout tube 34, the vent tube, positioned in the recess defined by the fifth vane 84, is aligned with the recess 82, in the outer spout tube. The vent tube 52 is thus spiraled from a lower, six o'clock position at the distal end of the spout to a three o'clock position at its inner

end.

It has been found that the friction forces effective between the inner subassembly 48 and outer subassembly 46 are sufficient to maintain their assembled positions, without the need for a locking means in either a longitudinal or angular sense. It is to be further noted that, when mounted on a nozzle body there are no forces on the spout assembly that would tend to cause relative movement between the subassemblies in either a longitudinal or angular direction. The absence of a locking means facilitates disassembly of the subassemblies for replacement of one or the other that might become damaged.

The nozzle components with which the spout assembly cooperate will next be described, with reference to Figs. 5 and 6. Prior to such description it will be pointed out that the major portions of the nozzle body 24 and vapor cap 41 are enclosed within a scuff guard 85 of relatively soft, vinyl plastic. The scuff guard embodies known teachings.

The distal end portion of the nozzle body 24 defines a portion of the fuel flow passage 32, downstream of the main valve 44. A multi-diameter adapter 86 extends inwardly from the distal end of the nozzle body 24 into an appropriately stepped bore, which diameters are, respectively, sealed with the bore. A venturi check valve 88 is disposed at the upstream end of the adapter 86 and comprises a valve seat 90, threaded into the upstream end of the adapter 86, a poppet 92 that is slidable in a central hub of the adapter 86 and a spring 95, that urges the valve poppet to a closed position.

The adapter 86 has a central tubular portion 93 that defines the portion of the inner, fuel passage 32, downstream of the venturi valve 88. The hub for the venturi popper is supported by vanes that span the fuel passage. The adapter further comprises an outer tubular portion 94, that is spaced from the inner tubular portion and defines, in combination therewith, a portion of the vapor return passage 40. Vanes 96 span the vapor return passage 40 to support the inner tubular portion 93 of the adapter. One of the diameters of the adapter 86, that is sealed with respect to the nozzle body 24, is in the form of a flange 95 that projects outwardly from the tubular portion 94. The second sealed diameter is provided by a flange that projects outwardly from the inner tubular portion 93, which inner tubular portion extends inwardly beyond the outer tubular portion 94. An annular chamber 98 is thus defined in the vapor return passage 40. A passage 100, in the nozzle body 24, connects the chamber 98 with the vapor return passage in the vapor cap 41.

There is a third passage through the adapter 86 for venting the suction generated by the venturi valve 88, in providing an automatic shut-off function. In operating principle, the automatic shut-off function is well known. Briefly, it will be noted that the main valve, operating lever 42 is pivoted on a trip stem 102. The stem 102 extends through a housing to a trip mechanism 104 having a chamber 106. (The fuel passage 32 splits and

goes around the housing for the trip stem 102.) When there is fuel flow through the venturi valve 88, a reduced pressure is formed at the throat of the venturi passage defined by the poppet 92. This reduced pressure draws air from an annular chamber 106, surrounding the valve seat 90. The annular chamber 106 is connected to a passage 108 formed in the vane 96, that connects the inner and outer tubular portions of the adapter 86. The trip mechanism chamber 106 is also connected to the annular, venturi chamber 106, by appropriate passages (not shown) through the inner tubular member 93.

To complete the description of the automatic shut-off feature, when the spout assembly is mounted on the nozzle, as will soon be described, the vent tube 52 is connected to the passage 108 and thus to annular chamber 106. While the spout inlet 66, to the vent tube 52 is not blocked, there is a flow of air therethrough to the annular chamber 106, so that air is drawn into the fuel flowing through the venturi passage. The trip mechanism chamber 104, is thus maintained at a pressure that is at, or minimally below atmospheric pressure. When the spout is inserted into the fill pipe of a vehicle fuel tank, and when the fuel reaches a height sufficient to block the vent inlet 66, the system being otherwise sealed from atmosphere, a vacuum (negative pressure) is generated in the annular chamber 106 and in the trip mechanism chamber 104. The trip mechanism is responsive to this negative pressure, to release the trip stem 102, resulting in valve 44 dosing to shut off fuel flow and prevent fuel from overflowing the fill pipe. For a more detailed description of this type of automatic shut-off device, reference is made to the previously identified '521 application.

Reverting to a description of the spout assembly and with particular reference to Figs. 2 and 4, an O-ring 110 is telescoped over a reduced diameter at the inner end of the inner ferrule hub 72, a second O-ring 112 is telescoped over the inner, expanded end portion of the outer spout tube 34. The vent tube 52 is extended beyond the inner end of the spout assembly so that it can be readily inserted into the passage 108. Passage 108, preferably, has an entrance taper of approximately 1° to provide a sealed connection therewith, without the need of adhesives or other sealing means. Continued movement of the spout assembly toward the distal end of the nozzle body 24, enables the inner end of the inner ferrule to be telescoped into the bore that defines the fuel passage 32 of the adapter 86. This bore is counter-bored to receive the hub 72 of the inner ferrule, with both the hub and its reduced diameter being received with a minimal clearance and the O-ring 110 compressed therebetween.

Continued inward movement of the spout assembly causes the spout tube 34 to be inserted into the inner diameter of the outer tubular portion 94, of the adapter 86, compressing, the O-ring 112 therebetween. Inward movement of the spout assembly is limited by engagement of the locator ring 54 with the end of the outer tubular portion 94 of the adapter 86. It will be noted that

the end of the outer tubular portion 94 is slotted and the locator ring comprises lugs 114 that are received in these slots and bottom thereagainst to longitudinally position the spout assembly. It is to be noted that the adapter 86 is longitudinally positioned relative to the nozzle body 24 by engagement of the flange on the inner end of the inner tubular portion 93, with the counterbore in which it is received. The lugs 114 are received in slots 115 formed in the distal end of the adapter 86 (seen only in Fig. 6) to lock the spout assembly in an angular sense with respect to the adapter 86. The adapter is, in turn, locked in an angular sense, with respect to the nozzle body 24, by a screw 116 that extends through the nozzle body 24 and is threaded into the vane 96 opposite the vent passage 108.

The final step, in mounting the spout assembly on the nozzle body, is to telescope a spout nut 118 over the distal end of the spout tube 34 and then thread it into an enlarged, distal portion of the nozzle body bore that receives the sealing flange of the outer tube portion 96 of the adapter. The spout nut 118 is provided with a central bore 120 that provides a relatively small clearance with the outer diameter of the spout tube 34 and a counterbore that provides a close clearance with the locator ring 54. The counterbore 122 also forms a shoulder that engages the full annulus of the locator ring 54 to lock the spout assembly against the adapter 86 and thus prevent the spout assembly from being pulled from the nozzle body.

The described construction uniquely minimizes flow losses at the connection of the three fluid passages (fuel, vapor and venting air) in the spout to the corresponding passages in the adapter. Further, in so connecting such passages, a compact space envelope is maintained, all to the end of providing a nozzle that can be used by a service station customer with the same convenience as found in a conventional nozzle that does not have a vapor recovery capability.

The features providing such advantages include the inner ferrule 70 and the enlarged inner end portion of the outer tube 34. The enlarged outer tube portion enables the seal between the tube 34 and the adapter to be obtained through the use of an O-ring that is effective on cylindrical surfaces thereof. This is a highly effective means of attaining a seal, and is preferred to seals in which the O-ring is compressed between two clamping surfaces and can be extruded so that its sealing effectiveness is lost. To digress briefly, there is a further O-ring 123 effective between the spout nut 120 and the outer spout tube 34. The counterbore for this seal can also be dimensioned so that the O-ring 123 does not extrude and lose its effectiveness, when the spout nut is fully torqued.

The enlarged inner end of the tube 34 also enables the flow areas for fuel and vapor to be sized that any flow losses are minimized, while a compact space envelope is maintained. Thus, the flow area of the fuel, is essentially the same throughout the length of the spout. The annular flow area for the vapor return passage is

also essentially the same throughout length of the spout and particularly at its juncture with the adapter 86. Thus, even though the inner diameter of the generally annular flow path is increased, there is a corresponding increase in the outer diameter of the flow path, due to the enlarged diameter of the inner end portion of the outer tube 34. This increase in diameter is sufficient to provide, at a minimum, approximately the same vapor flow area as in the distal portions of the spout, notwithstanding the presence of the ferrule hub 72 and vanes 78, 84

In completing the description of the spout assembly 22, its failure mode will be detailed. When fuel is being dispensed from the nozzle 20, the spout is inserted into the fill pipe of a vehicle fuel tank. It will be noted that a wire 119 is coiled about the outer spout tube 34. Such a coiled wire, also referenced as a spring, is conventionally provided to assist in maintaining the nozzle spout in its inserted position in the fill pipe (illustrated in Fig. 19). The present spout construction permits this convenience feature to be provided, without any additional expense insofar as providing the other advantages of the invention.

From time to time, a motorist is forgetful and drives away with the nozzle spout still inserted into the inlet pipe of his vehicle's fuel tank. The groove 62, in the aluminum outer spout tube 34 provides a predetermined failure mode that minimizes the extent of damage that will be incurred when a driveaway occurs. The provision of such a fracture groove is a known expedient in non-vapor recovery nozzles. Aluminum tube spouts and fracture grooves therefor have been developed to a highly reliable state. One feature of the present invention is that this proven technology is incorporated in a spout that provides a vapor return passage. Thus loading which will cause the spout tube 34 is reliably set at less than the force, or loading, required to rupture the hose, or topple the dispenser to which the hose is attached. Rupturing of the hose or toppling of the dispenser would result in damage to more expensive components, and, further, would involve the additional hazard of an uncontrolled discharge of fuel.

It is to be further appreciated that, once the outer spout tube 34 fractures at the groove 62, it can readily release from the inner tube 36. This is to note that, preferably, there is no bonded connection between the outer ferrule 50 and the inner spout tube 36. Thus there is no need to rupture the tube 36, and introduce the possibility that the force required to rupture that tube would be sufficient to rupture the coaxial hose or topple the dispenser, or otherwise impede separation of the outer spout tube from the nozzle.

Figs. 15-17 illustrate a spout assembly 22' that is also shown in the above-referenced application, Ser. No. 986,521. The spout assembly 22' is, likewise, adapted to be mounted on a nozzle body (not shown) to provide a fuel dispensing nozzle having a vapor recovery capability. The spout assembly 22' comprises an outer tube 34' and an inner tube 36'. The inner tube 36'

defines the spout portion of a fuel passage 32' and combines with the outer tube 34' to define an annular, vapor return passage 40'. Holes 38', in the tube 34', adjacent its distal end, provide an entrance to the vapor return passage 40'.

The distal ends of the tubes 34' and 36' are joined by a ferrule 50'. A vent tube 52' is mounted in a slot in the ferrule 50' and is in communication with a vent opening 66' in the outer tube 34'. The vent tube 52' extends from a six o'clock position at the distal end of the nozzle to a three o'clock position at the inner end of the spout 22', as viewed in Fig. 17. As will be evident from the foregoing, the distal end portion of the spout assembly 22' is configured in substantially the same fashion as the distal end portion of the spout assembly 22, first described. The inner end portion of the spout assembly 22' is configured in a different fashion. The differences in the inner end portion of the spout assembly 22' are designed to enable the spout assembly 22' to be mounted in a nozzle body and adapter design that differs from the nozzle body and adapter on which the present spout assembly (22) is mounted. The configuration of the inner end portion of the spout assembly 22' has no relation to the present invention. It is sufficient to appreciate that the spout assembly 22, when joined to the nozzle body described in said '521 application, is provided with appropriate connections with vapor return passages and fuel passages in the nozzle body. The vent tube 52' is likewise connected to a venturi automatic shut-off mechanism.

The spout assembly 22' may also be advantageously formed employing synthetic resin components, commonly referenced as plastics. Fig 18 illustrates the distal end portion of a spout construction 22", employing "plastic" components. These components are identified by like reference characters, which have a "double prime" designation. The outer tube 34" may be of a "structural" type resin. There are many "structural" type resins that could be employed for such purpose, delrin being an example. The ferrule 50", inner tube 36" and vent tube 52" may also be formed of "structural" resins. In general, "structural" resins have a relatively low resilience, that is, they take a permanent set, after they have been strained to a relatively limited extent. Because of the widely varying temperatures to which fuel nozzles are subject, and the resultant thermal expansion and contraction, there is a tendency for the effectiveness of interference fits to be lost over a period of time. Thus, when employing "structural" resins, it is preferred to employ an independent bonding mechanism, such as a glue, solvent or thermal fusion, to hold the spout components in assembled relation.

The inner tube 36" could also, and preferably is formed of a flexible type resin, or rubber, which is essentially rigid when subject to axial compression despite being laterally flexible, i.e., bendable. By so doing, fabrication and assembly of the spout may be simplified. This is to say that the outer tube 34" could be molded, of a "structural" resin in the final, curved configuration

illustrated in Fig. 15. Then, with the inner tube 36" formed of a flexible material and attached to a ferrule 50", which may also be formed of a synthetic resin, the inner tube can be inserted into the curved outer tube and then bonded, by adhesive or the like, to complete the spout subassembly. The inner tube 36" is adapted to be sealingly telescoped into sealing relation with the fuel passage of an adapter, taking note that the inner tube 36, of the first embodiment, is likewise telescoped into sealed relation with the fuel passage of adapter 86.

In the first embodiment, there is an inner ferrule interposed between the inner tube 34 and the adapter 86. In said '521 application the adapter fuel passage is adapted to directly receive the inner end of the inner spout hose. The point being made is that, in both cases, where flexible synthetic resins are employed, as nylon 66, the inner tube has sufficient axial strength to resist the forces associated with the telescoping action by which a sealed connection is made as the inner tube is telescoped into connected relation.

The vent tube 52" may also be formed of a flexible, axially rigid resin. The same properties which facilitate connection of the flexible, axially rigid inner tube 36", to the nozzle portion of the fuel passage 32" also facilitate connection of the flexible, axially rigid vent tube 52" to an adapter, in a fashion equivalent to that described in connection with the first embodiment. Where synthetic resins are used for the tubes 34" or 36" it is preferred that the resin be electrically conductive. Electrically conductive resins, suitable for the present purposes are well known and commercially available.

The use of resinous materials can also enable elimination of the ferrule 50" as a separate element, as is illustrated in Fig. 18. This is to say that the reinforcement function provided by the ferrule 50" can be economically attained by forming the ferrule as an integral part of the outer tube 34" or as an integral part of the inner tube 36". The ferrule 50" is not a separate element, but, instead is integrally molded with the inner tube 36".

Reference is next made to Figs. 20-22 for a description of an alternate spout construction that is generally identified by reference character 222. The primary advantage of this embodiment of the invention is in providing greater strength for the distal end portion of the outer spout tube. As discussed above, the conflicting constraints of a maximum diameter that is insertable through a no lead restricter plate, and the need for maximized flow areas for fluid and vapor flows, lead to a minimization of the wall thickness of the outer spout tube. The distal end portion of the outer spout tube thus becomes vulnerable to damage in the normal wear and tear in usage of the nozzle.

This vulnerability is overcome in spout assembly 222 by forming the outer spout tube as an inner portion 234A and an outer portion 234B. The inner spout portion 234A is preferably formed of aluminum in the same fashion described above and differs from the outer spout tube 34 primarily in that it has a shorter, distal end

portion. The advantages described with respect to the inner end portion of the spout tube 34, e.g., enlarging of the inner end and mounting of a locator ring 54 remain the same.

The outer end portion 234B of the spout tube is formed of stainless steel, which provides a much greater strength for this portion of the spout tube, with the same or even a reduced wall thickness. The stainless steel tube is simply telescoped into the distal end of the aluminum, inner tube 234A and then secure in place. Preferable, the distal end portion of the aluminum spout tube 234A is counterbored to provided an accurate fit between and axial positioning of the stainless steel tube relative thereto. The tube portion 234 is then secured in place. An effective way of securing the tube 234B is to form a groove 235 circumferentially on its inner end portion. Then after it has been telescoped into the outer tube 234A, a rolling operation is performed to swage the outer tube metal into the groove 235.

The outer tube portion 234B, at its distal end may be provided with the same ferrule 50, as was employed with the spout 34, previously described. The distal end of the tube 234B is then rolled to lock the ferrule in place. The ferrule 50 makes provision for mounting a vent tube 52, in the same fashion as before, for communication with a vent opening 66 in the tube 234B. The tube 234B is also provided, as before with entrance holes 38 to the vapor return passage 40.

The ferrule 50 and vent tube 52 are indicated, in Figs 21, 22, as being mounted, on the outer tube 234B to form a subassembly, which is then mounted on the inner tube portion 234A. However, it would also be possible to first mount the tube portion 234B on the tube portion 234A, and then to mount the ferrule 50 and vent tube 53.

Figs. 23-26 illustrate an alternate approach to strengthen the outer end portion of the outer spout tube. This spout construction, identified by referenced character 222', may be the same as the spout construction 222, just described except for the outer end tube portion 234B. The tube portion 234B' is preferably formed from an extruded aluminum tube, which has longitudinal strengthening ribs 241. The ribs 241 permit the economical use of extruded aluminum tubing, with a minimum of machining, to form the tube portion 234B'.

The extrusion, after being cut to the proper length, is simply counterbored (to remove the ribs) to form a seat for a modified ferrule 250. The ferrule is preferable formed of a structural resinous material, such as nylon, and is simply telescoped into assembled relation with the outer tube portion 234B', abutting against a shoulder 251, so that the outer tube portion is formed by the resinous plastic ferrule 243. The ferrule 243 can be held in assembled relation by appropriate solvent or adhesive means.

While illustrated in connection with the compositely formed outer tube 234', it is to be understood that the resinous ferrule 243 could also be employed, with advantage, in joining an inner tube (36) to an integral

outer tube (34) construction as was described in connection with the first embodiment of Figs. 1-7.

The compositely formed outer spout tubes 234A/234B or 234A'/234B' can be assembled with an inner tube assembly 48 as previously described. In this connection it is to be noted that the inner ends of the ribs 241 are beveled at 245 to facilitate entrance of the distal end of the inner tube 38 during assembly.

With respect to the outer tube 234B' it is to be noted that the lower two ribs 241 are closely spaced and adapted to receive the vent tube 52 and facilitate its positioning during assembly.

Figs. 27-29 illustrate another alternate approach to strengthening the outer end portion of the outer spout tube. This spout construction, identified by reference character 222", may be the same as the spout construction 222, just described except for the outer end tube portion 234B. The tube portion 234B" is preferably formed from by a die cast structural resin, nylon or acetal resins being suitable. The tube portion 234B" has integral longitudinal strengthening ribs 247, which are similar to the ribs 241 in the previous embodiment.

The tube portion 234B" is simply inserted in the bore in the distal end of the aluminum tube portion 234A and then may be secured, as by bonding with a suitable adhesive. In this embodiment, the use of a ferrule is eliminated. Thus after the tube portion 234B" is secured in place, the inner tube assembly 48 may be assembled with the modified outer tube assemble to dispose the inner tube 36 in its illustrated position. In this case, it may be appropriate to seal the inner tube 36 with respect to the bore in the tube portion 234B" that receives it. A suitable adhesive or solvent could provide the sealing function.

Vapor return entrance openings 38 permit flow of vapor to the portion of the vapor return passage that is defined by the tube portion 234B" and the inner tube 36. Return vapor then flows between the ribs 247 to the annular passage defined by the upper spout tube 234A.

Similar to the previous embodiment, the bottom two ribs 247 define a means for mounting the vent tube 52. The entrance to the vent passage tube is illustrated in Fig. 29 at 249.

It is to be noted that, in the embodiments employing a compositely formed outer tube 234, the outer portion 234B, 234B' and 234B", are preferably straight lengths of tubing like elements. The curvature that is provided to angle the distal end of the spout is all provided in the inner spout portion 234A.

Other variations and deviations from the specific embodiment first described, will occur to those skilled in the art, within the spirit and scope of the invention, as set forth in the following claims.

Claims

1. A spout for a vapor recovery fuel nozzle where said nozzle (20) comprises a nozzle body (24) and

a spout (22) projecting therefrom, said nozzle body and spout each having communicating fuel passages (32) for directing pressurized fuel through the nozzle and discharging it from the spout, said nozzle body and spout each also having communicating vapor return passages (40) for directing vapors from the discharge end of said spout through the spout and nozzle body for disposal at a remote location, and said spout comprises an outer tube (34) which is essentially rigid, in an axial sense, an inner tube (36), which is essentially rigid, in an axial sense, and means (50, 70) joining the distal ends of said inner and outer tubes, and laterally spacing the inner end portions thereof, the spout portion of the fuel passage being defined by the inner tube and the spout portion of the vapor passage being defined by inner end portions of the inner and outer tubes, characterized in that the inner tube is formed of a synthetic resin.

2. A vapor recovery fuel nozzle as in claim 1 further responding to one or more of the following:
 - (A) the distal end portion of the spout being angled downwardly from the inner end portion of the spout, and further characterized in that the inner tube is flexible in a lateral sense,
 - (B) further characterized in that the outer tube is formed of a structural, synthetic resin.
 - (C) further characterized in that the joining means comprises a thickened portion integrally formed on one of said tubes and bonded to the other of said tubes.
3. A spout for mounting on a vapor recovery nozzle, said nozzle (20) comprising a nozzle body (24) said spout (22) having
 - A. an inner end which is mounted on the nozzle body and a distal end from which fuel is discharged, the distal end portion of the spout being angled downwardly from the inner end portion of the spout,
 - B. an inner tube (36) and an outer tube (34),
 - C. means (50) joining the distal ends of said inner and outer tubes, wherein the outer tube is rigid and

characterized in that
the inner tube is a laterally flexible, thin walled,
synthetic resin extrusion.

4. A vapor recovery fuel nozzle as in claim 3
further responding to one or more of the following:

(A) further characterized in that
the means for joining the distal ends of said
inner and outer tubes comprise an outer ferrule
(50) disposed within the distal end of the outer
tube, the distal end of the inner tube is tele-
scoped into said ferrule, and opening means
(38) are formed in the outer tube, adjacent to
and

inwardly of the ferrule to thereby provide an
inlet to the vapor passage;

(B) further characterized by
an inner ferrule (70) telescoped into the inner
end of the outer tube and positioning the inner
tube relative to the inner end of the outer tube;

(C) further characterized by
a vent tube (52) for an automatic shut-off ven-
turi (88), and

the outer ferrule has a slot (68) to receive said
vent tube,

the outer tube has a vent opening (66) that reg-
isters with said ferrule slot and provides an inlet
for venting air, and

the inner tube is upwardly offset relative to the
outer diameter of the ferrule;

(D) further characterized by
means for positioning the inner end of the inner
tube in fixed relation to the inner end of the
outer spout tube.

(E) further characterized in that
the means for positioning the inner end of the
inner tube in fixed relation to the inner end of
the outer tube comprise an inner ferrule (70),
said inner ferrule comprising a central hub and
outwardly projecting vanes (74),
said inner ferrule being telescoped over the
inner end of inner tube,

said outwardly projecting vanes engaging the
inner diametrical surface of the outer tube,
adjacent its outer end, to position the inner tube
relative to the outer tube,

further characterized in that
the inner end of the outer spout tube is
enlarged and

the vapor flow area at the inner end of the
spout is substantially as large as it is distally of
the inner ferrule;

(F) further characterized by
a locator ring (54) mounted in fixed relation on
the outer diameter of the outer tube,
said locator ring being spaced a relatively short
distance distally from the inner end of the outer
tube and disposed in a plane normal to the axis

of the inner end portion of the outer tube;

(G) further characterized by
a vent tube (52) extending from an opening
(66) in the outer tube wall, adjacent the distal
end thereof, through the vapor passage,
between vanes of the inner ferrule, for connec-
tion with a venturi vent passage (106) in the
nozzle,

said vent tube being formed of a synthetic resin
that is relatively rigid in an axial direction and
relatively flexible in a lateral direction;

(H) further characterized in that
the outer spout tube is formed of aluminum,
and

the inner spout tube is formed of nylon;

(I) further characterized in that
the outer tube is formed of aluminum and the
inner end portion thereof has a wall thickness
of approximately .318 cm. (1/8 inch),

a circumferential groove is formed in the inner
end portion of the outer tube, and

the inner tube is axially separable from the
means for joining the inner and outer tubes at
the distal end of the spout,

whereby, in the event of a vehicle being driven
away with the spout inserted in its fill pipe, the
failure mode for the spout will be a fracturing of
the outer tube at the circumferential groove,
with the distal end portion of the outer tube
then axially separating from the inner tube;

(J) the outer tube has
a smoothly curved portion intermediate its
angled, distal and inner end portions, and
vapor passage inlet means (38) closely adja-
cent its distal end,

further characterized in that

the outer tube has a substantially constant
inner diameter from its distal end to the curved
portion that extends to the angled inner portion,
the distal end portion of the outer tube has a
minimal wall thickness for a distance, inwardly
of the its distal end, sufficient to permit the
outer tube to be inserted through a restricter
plate and position the vapor passage inlet
means inwardly of the restricter plate, and
the outer tube has a substantially increased
wall thickness through the remainder of its
length;

(K) further characterized in that

the outer tube

is formed of aluminum,

has a wall thickness of approximately .127 cm.
(.050 inch) at its distal end portion, and

has a wall thickness of approximately .318 cm.
(1/8 inch) for the remainder of its length;

(L) further characterized in that

the inner tube is an extruded nylon 66 tubing
having a wall thickness of approximately .051
cm. (.020 inch);

(M) the joining means is ferrule (243) formed of a structural resin and forms an outer nose portion of the spout.

5. A vapor recovery, fuel nozzle comprising
 - a nozzle body (24) adapted for attachment of a coaxial hose to a butt end thereof,
 - a spout (22) mounted on an end of the nozzle body opposite the butt end,
 - an adapter (86) disposed in a bore that extends inwardly of the nozzle body from said opposite end, said adapter comprising
 - an inner tubular portion (93) defining a central fuel flow passage, that is in communication with a fuel passage in the coaxial hose, and
 - an outer tubular portion (94) defining, in part, an annular vapor passage, that is in communication with a vapor passage in the coaxial hose,
 - said spout
 - having an inner end that is adapted to be detachably secured to the nozzle body and a distal end that is adapted to be inserted into the fill pipe of a fuel tank,
 - the distal end portion of said spout assembly being angled downwardly with respect to the inner end portion thereof,
 - comprising an inner tube (36) and an outer tube (34),
 - said inner tube defining a spout fuel passage,
 - said inner and outer tubes, in combination, defining an annular, spout vapor passage,
 - characterized in that
 - the inner end of the outer tube is telescoped into the outer tubular portion of the adapter, with opposed circumferential surfaces in sealed relation,
 - telescoping means (72) connect the fuel passage of the inner tubular portion of the adapter with the fuel passage defined by the inner spout tube,
 - flange means (54) project outwardly from the outer tube, adjacent its inner end,
 - a spout nut (is threaded into the nozzle body and engages the flange means to mount the spout on the nozzle body.
6. A vapor recovery fuel nozzle as in claim 5 further responding to one or more of the following:
 - (A) further characterized in that the flange means are embedded in swaged portions of the outer tube.
 - (B) further characterized in that the inner end portion of the outer tube has a generally uniform wall thickness, and a portion of the outer tube, extending distally from its inner end, has an enlarged diameter, and
 - an inner ferrule (70) having a central hub (72) is mounted on the inner end of the inner tube, and said inner ferrule also has vanes (74) that

engage the inner surface of the enlarged portion of the outer tube and laterally position the inner end of the inner tube relative thereto;

(C) further characterized in that the spout is formed from an extruded aluminum tubing, the flange means comprise a locator ring (54) having inwardly projecting lugs that are embedded in swaged portions of the spout, which portions mount the locator ring on the spout tube, outwardly projecting lugs adapted to be received by slots in the nozzle adapter and angularly position the spout tube relative thereto;

(D) further characterized by an outer ferrule (50) mounted in the distal end of the outer tube and having a longitudinal bore for receiving the inner tube, and further characterized in that a circumferential fracture groove (62) is formed in the outer spout tube adjacent to and distally of the enlarged portion, the inner tube is formed of a thin walled, extruded nylon tubing, bonded to the hub of the inner ferrule, and is freely slidable from the outer tube;

(E) further characterized in that the nozzle adapter has vane means (96) interconnecting its inner and outer portions, said interconnecting vane means having a longitudinal venturi venting passage (108), and further characterized by a vent tube (52), formed of extruded nylon tubing, and extending from the outer ferrule, through the vapor passage defined by the inner and outer tubes, and projecting beyond the inner end of the inner ferrule for insertion into the longitudinal venturi venting passage in the adapter vane means;

(F) wherein the distal end of the inner tubular portion of the adapter is spaced inwardly from the distal end of the outer tubular portion of the adapter, and further characterized in that the inner ferrule has radial outwardly projecting vane portions (78) that engage the inner end of the outer spout to limit movement of the inner tube distally of the outer tube and space the outer tube from the distal end of the inner tubular portion of the adapter.

7. A method of manufacturing a spout for a fuel nozzle where the spout (22)

A. has an inner end secured to a nozzle body (24) and a distal end for insertion into the inlet pipe of a vehicle fuel tank,

B. has its distal end portion angled downwardly from its inner end portion,

C. comprises an inner spout tube (36) and an outer spout tube (34),

wherein the steps of forming the outer spout tube comprise

characterized by the steps of

1. in a lathe setup

a. forming a counterbore (56) in a length of aluminum tubing to form the distal end of the outer spout tube, and

b. forming a fracture groove (62) in the length of aluminum tubing adjacent the inner end of the outer spout tube,

2. bending the length of tubing to angle the distal end portion of the outer spout downwardly from its inner end portion,

3. expanding the diameter of the inner end portion of the tube, while maintaining a substantially constant wall thickness.

8. A method for manufacturing as spout as in claim 7 further responding to one or more of the following:

(A) further characterized in that the length of tubing is extruded 6005-T5 aluminum tubing;

(B) further characterized in that in the lathe setup, the further step of turning the distal end portion of the outer spout is performed to reduce its outer diameter and wall thickness;

(C) further characterized by the further step of positioning a locator ring adjacent to and distally of the inner end of the outer spout prior to and during the expanding step, and expanding the outer tube to an extent sufficient to swage the tube material into engagement with the locator ring (54) and mount it on the spout tube;

(D) further characterized in that the method steps are performed in the sequence stated;

(E) further characterized in that the length of tubing mounted in the lathe is extruded 6005-T5 aluminum tubing, and after the bending operation,

by the further step of positioning a locator ring (54) adjacent to and distally of the inner end of the outer spout tube prior to and during the expanding step, and expanding the outer spout to an extent sufficient to swage the tube material into engagement with the locator ring and mount it on the spout tube;

(F) further characterized by the further steps of mounting an outer ferrule (50) in the distal end of the outer spout,

mounting an inner ferrule (70) on the inner end of the inner tube, and

inserting the distal end of the inner tube into the outer tube, from its distal end and further inserting the distal end of the inner tube in the outer ferrule and also inserting the inner ferrule into the expanded, distal end of the outer tube, thereby laterally positioning the inner tube relative to the outer tube;

(G) further characterized

after the forming and bending steps,

by the additional steps of

forming a vent air opening (66) in the outer tube at a six o'clock position,

forming vapor inlets (38) in the outer tube adjacent to and inwardly of the counterbore,

mounting a vent tube (52) into a slot (68) formed longitudinally of the outer ferrule, prior to mounting the outer ferrule on the outer spout tube, and

telescoping the vent tube through the outer tube in mounting the outer ferrule on the outer tube with the longitudinal slot registered with the vent opening in the outer spout.

9. A method of making a spout to be mounted on a fuel nozzle body where the spout (22)

A. has a distal end and an inner end, and

B. comprises a spout tube (34), wherein the method of forming the spout tube comprises the steps of

1. mounting a length of aluminum tubing in a lathe setup, and forming a fracture groove (62) in the length of aluminum tubing,

2. bending the length of tubing to angle the distal end portion of the outer spout downwardly from its inner end portion.

10. A method for manufacturing as spout as in claim 9 further responding to one or more of the following:

(A) further characterized by the additional step of

expanding the diameter of the inner end portion of the tube, while maintaining a substantially constant wall thickness.

(B) further characterized by the additional step of

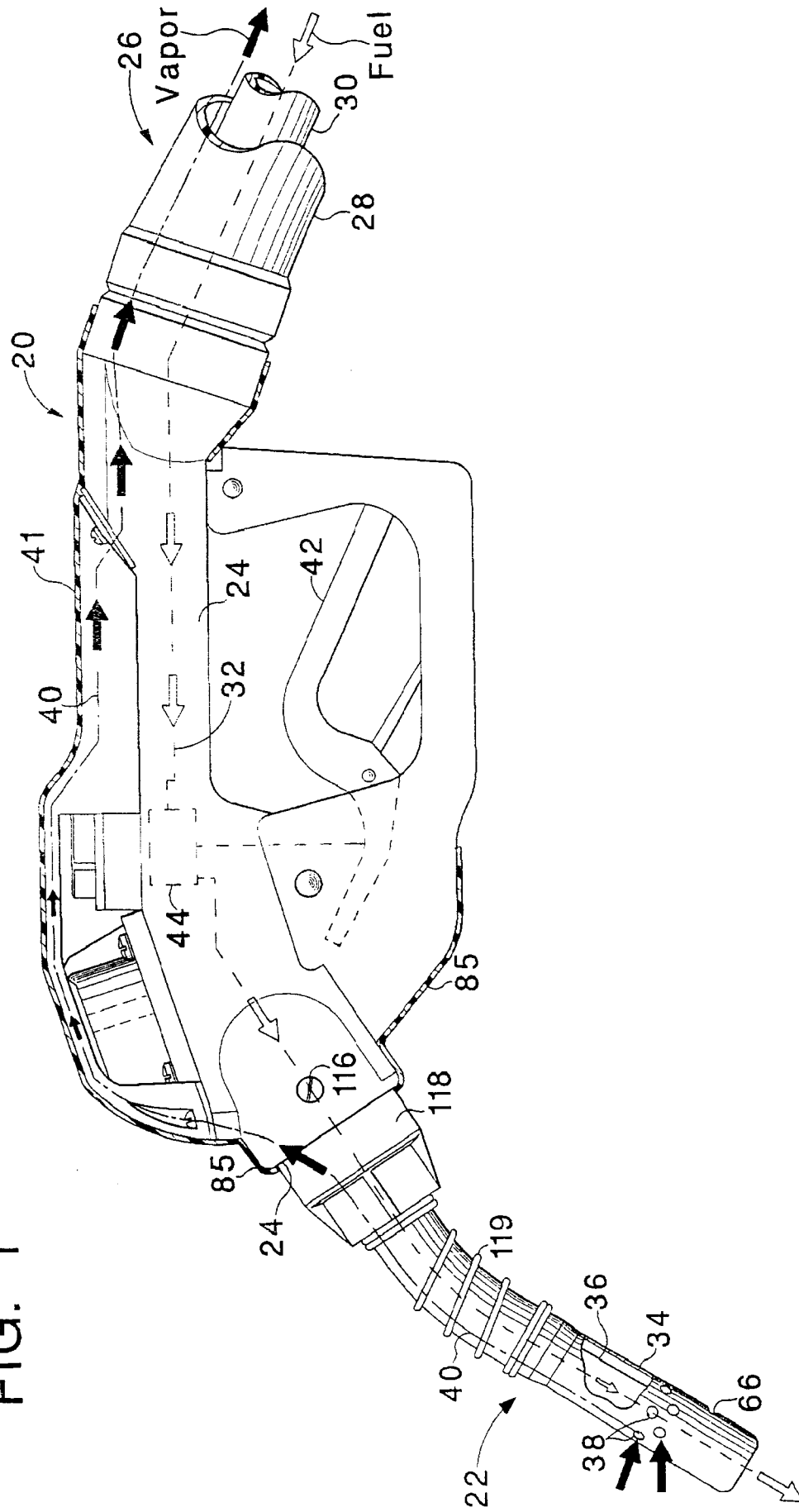
positioning a locator ring (54) adjacent to and distally of the inner end of the spout tube prior to and during the expanding step, and expanding the spout tube to an extent sufficient to swage the tube material into engagement

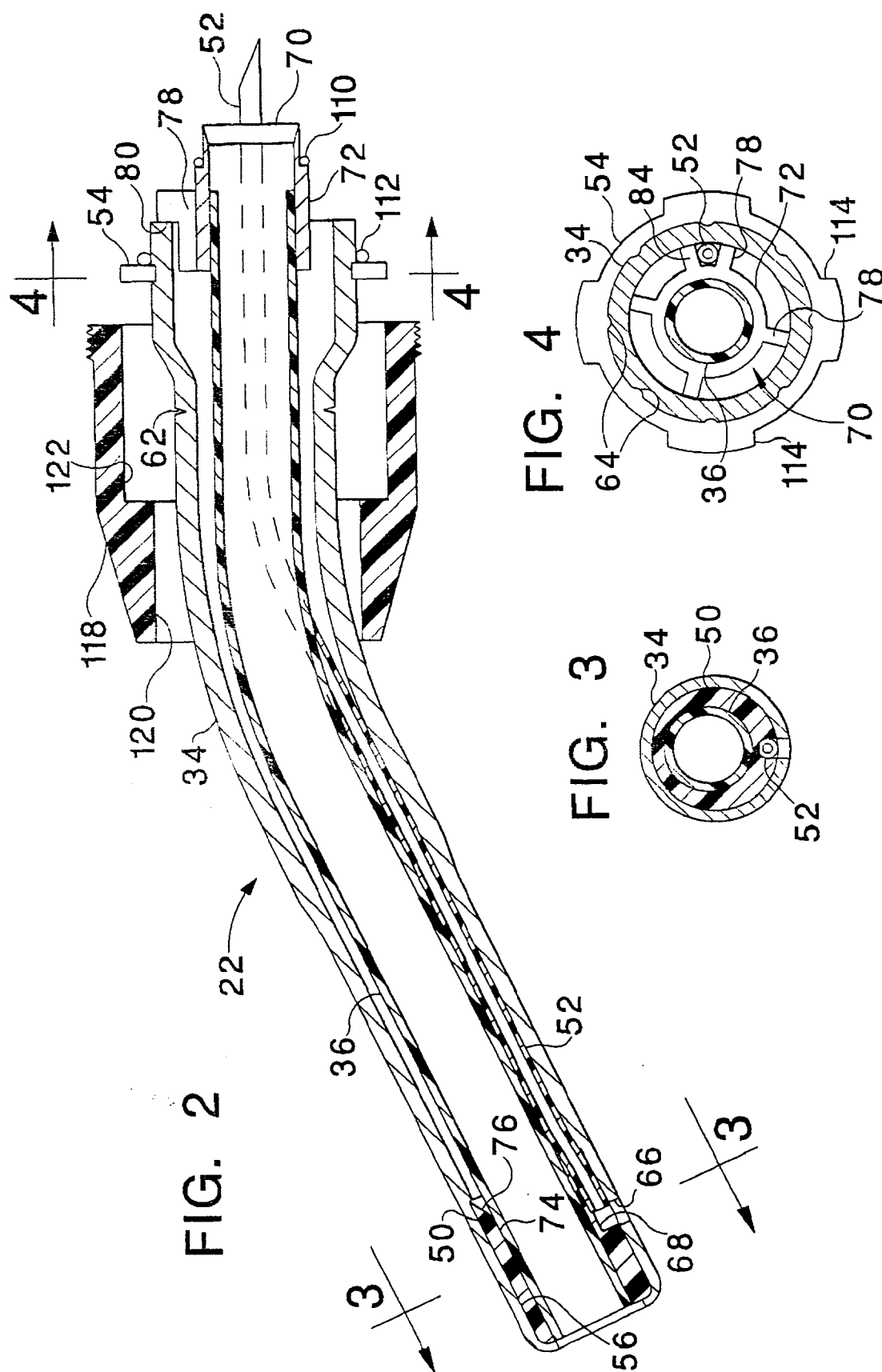
with the locator ring and mount it on the spout tube.

11. A spout for mounting on a vapor recovery nozzle, said nozzle (20) comprising 5
a nozzle body (24)
said spout (22) having
- A. an inner end which is mounted on the nozzle body and a distal end from which fuel is discharged, 10
the distal end portion of the spout being angled downwardly from the inner end portion of the spout,
- B. an inner tube (36) and an outer tube (34), 15
C. means (243) for joining the distal ends of said inner and outer tubes, characterized in that
- the outer tube is rigid and
the inner tube is a laterally flexible, thin walled, 20
synthetic resin extrusion, and
the distal end portion of the outer tube has a bending strength greater than that of the inner end portion thereof.
- 25
12. A vapor recovery fuel nozzle as in claim 10 further responding to one or more of the following:
- (A) the inner portion (234A) of the outer tube is formed of aluminum, and the distal portion 30
(234B) of the outer tube is formed of stainless steel;
- (B) the inner portion (234A) of the outer tube is formed of aluminum, and
the distal portion of the outer tube comprises 35
an aluminum extrusion (234B') having longitudinal, inwardly projecting, reinforcing ribs;
- (C) the inner portion of the outer tube is formed of aluminum, and
the distal tube portion (234B'') is formed by a 40
structural resin, which forms the nose portion of the spout and receives the inner tube;
- (D) the outer tube is counterbored and
the joining means comprises an outer ferrule telescoped into said counterbore, with the inner 45
tube being telescoped into the outer ferrule, and
said outer ferrule projects beyond the distal end of the distal portion of the outer tube,.
- 50

55

FIG. 1





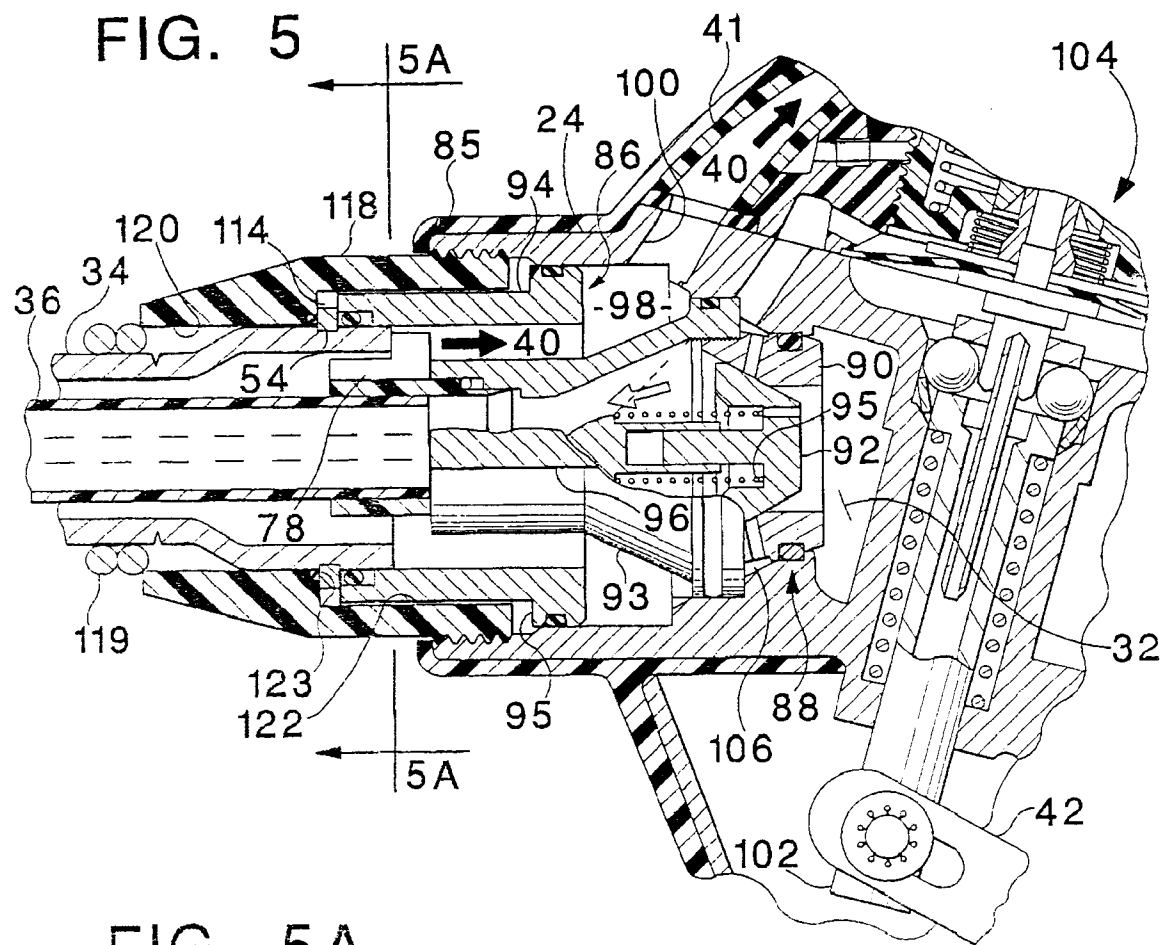


FIG. 5A

FIG. 5B

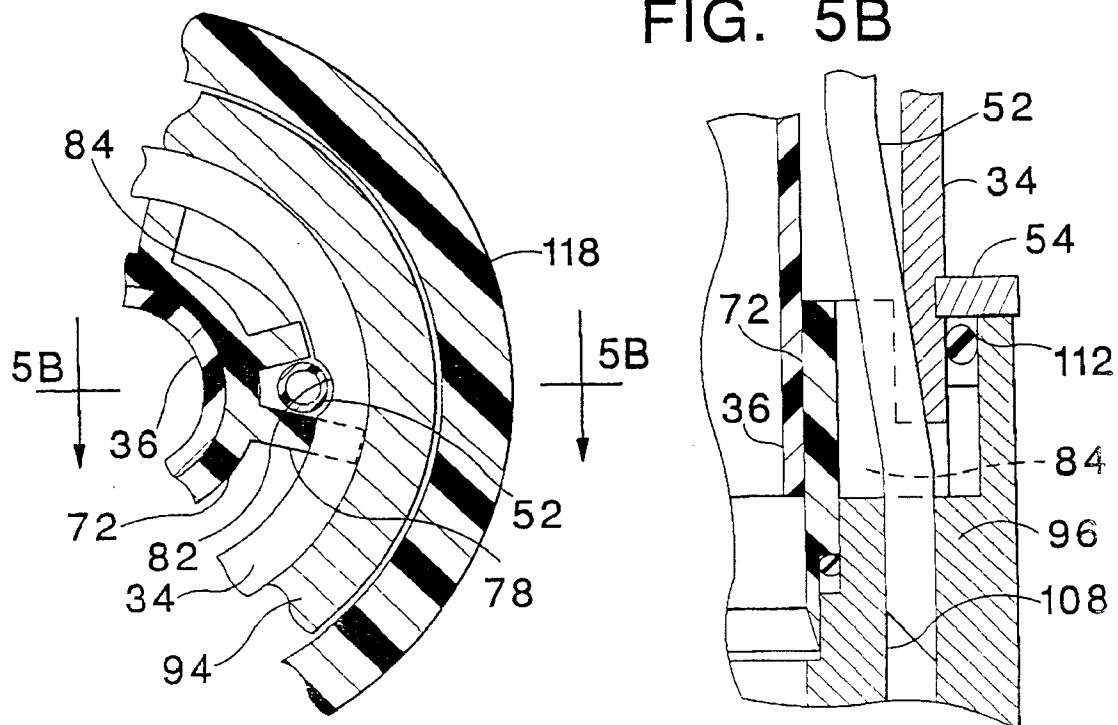


FIG. 6

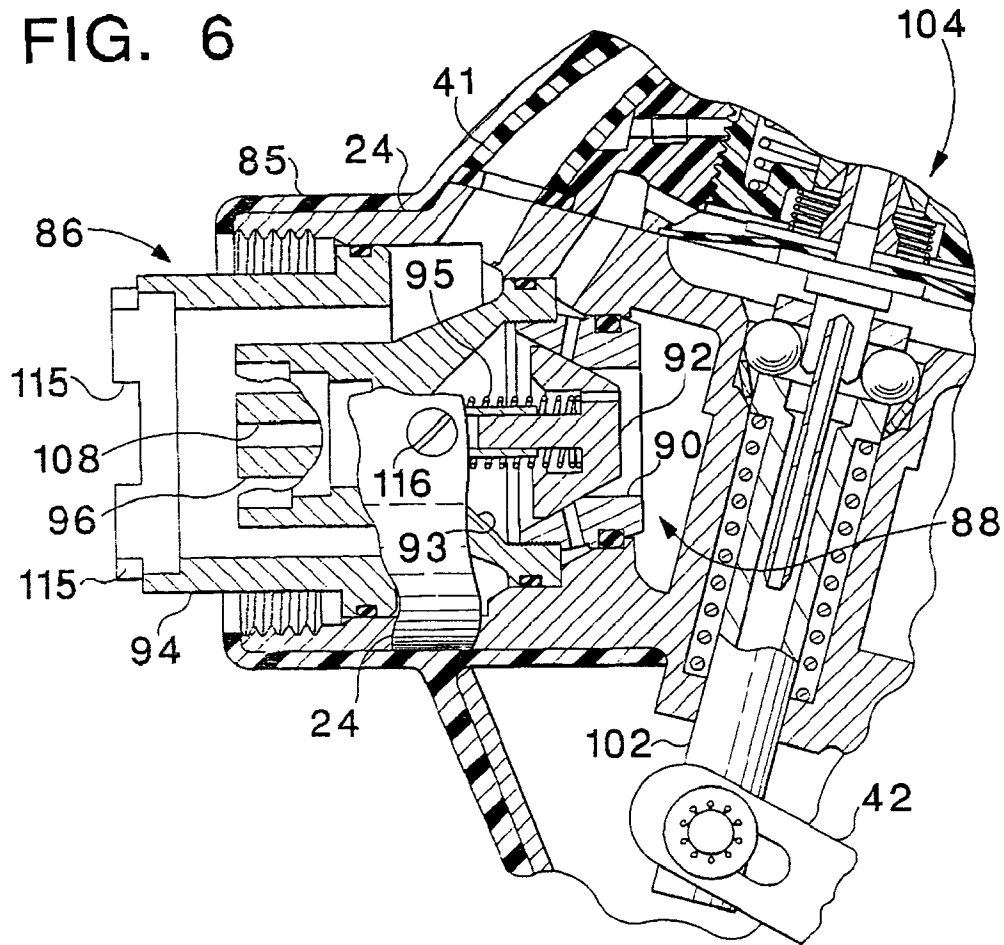


FIG. 19

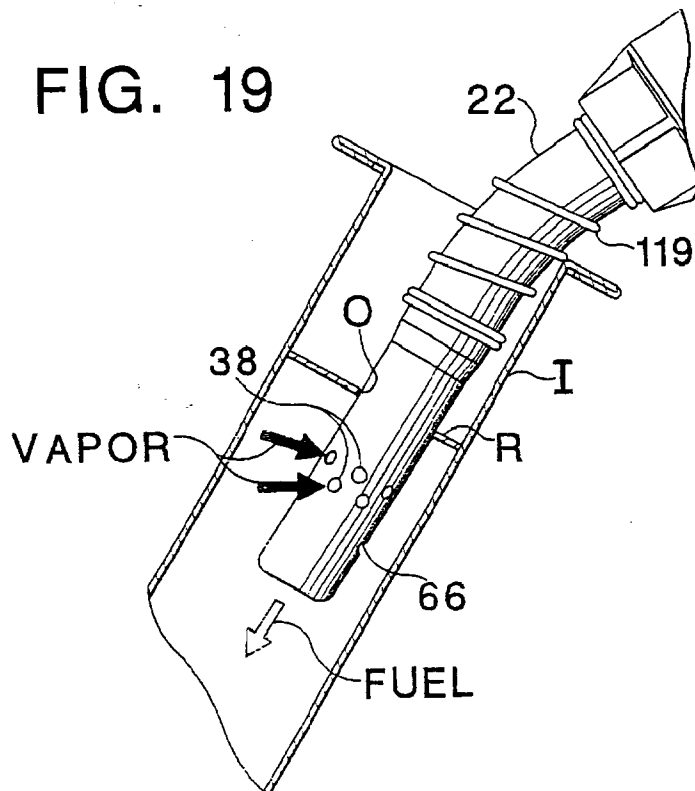


FIG. 7

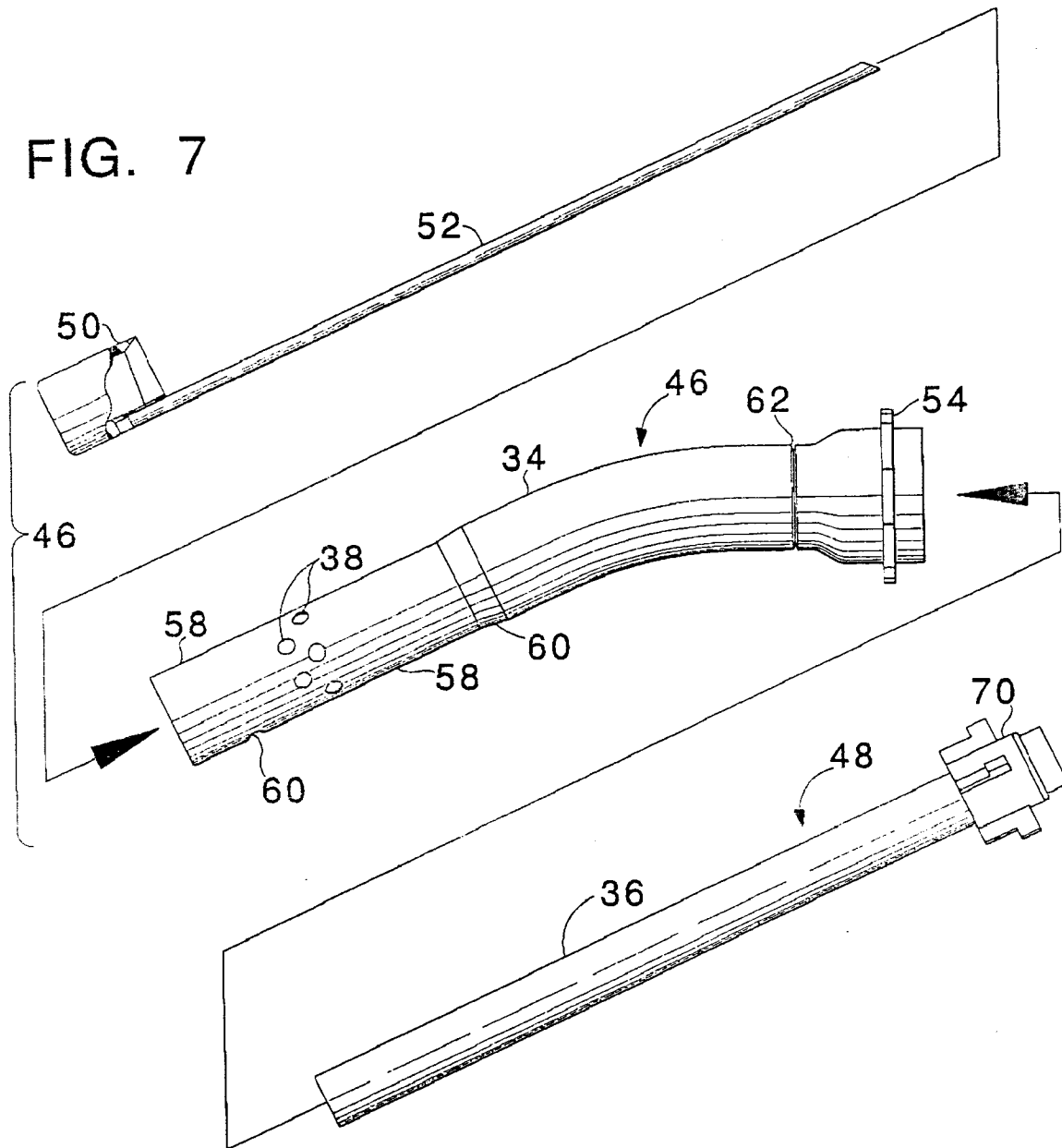


FIG. 8

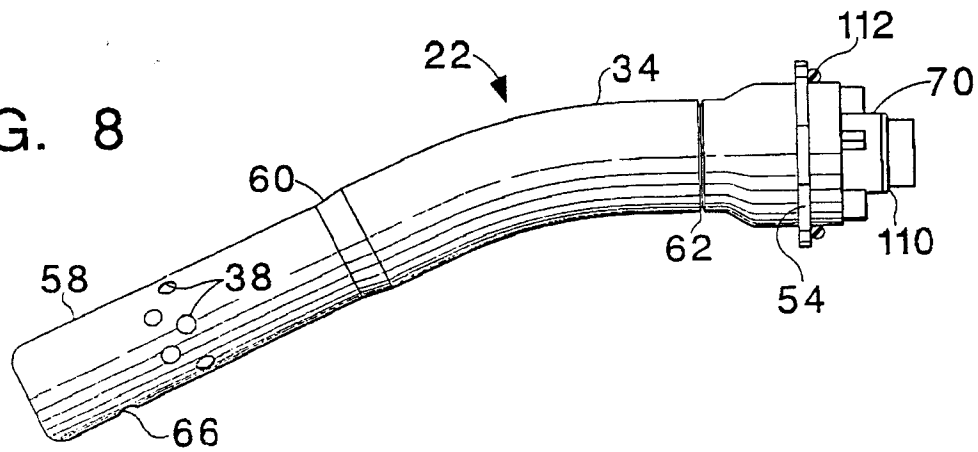


FIG. 9

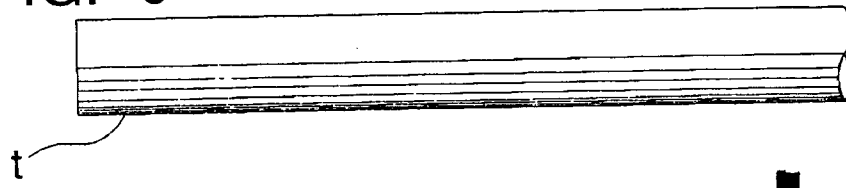


FIG. 10

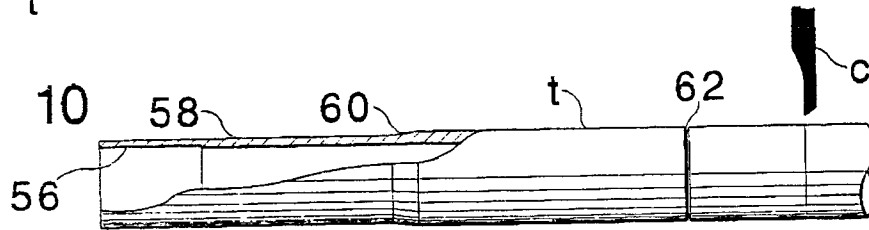


FIG. 11

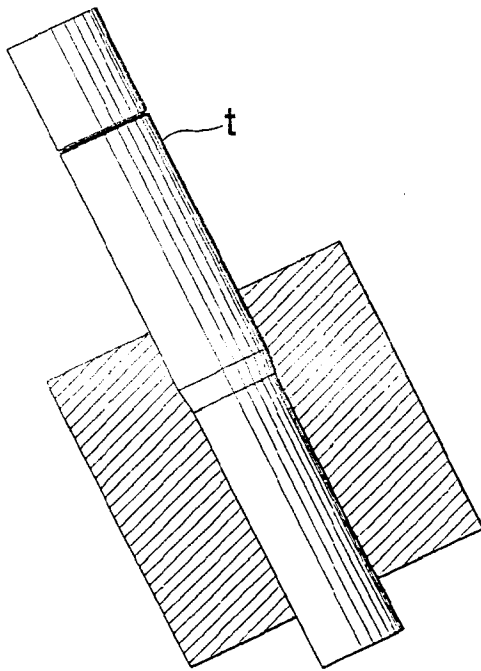


FIG. 12

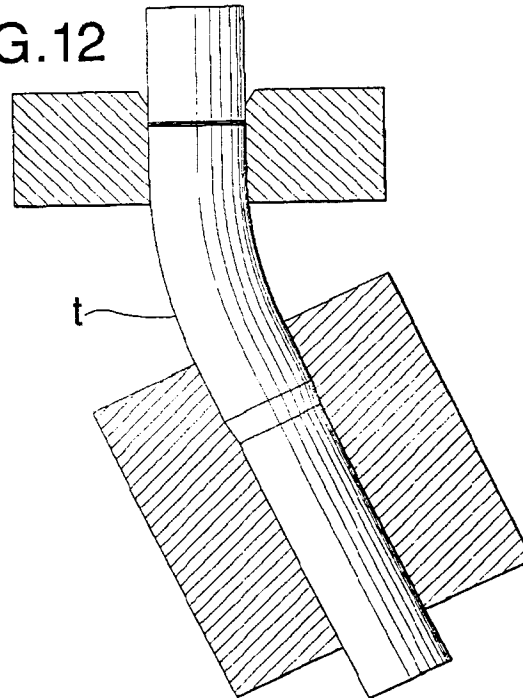


FIG. 13

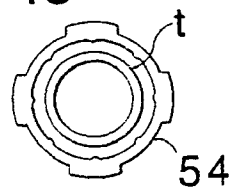
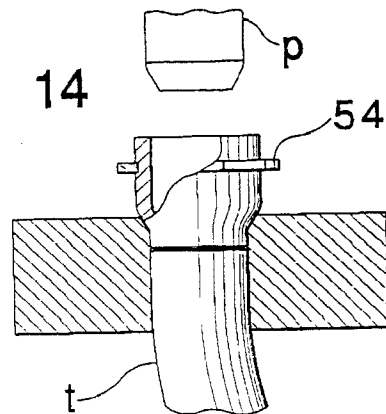


FIG. 14



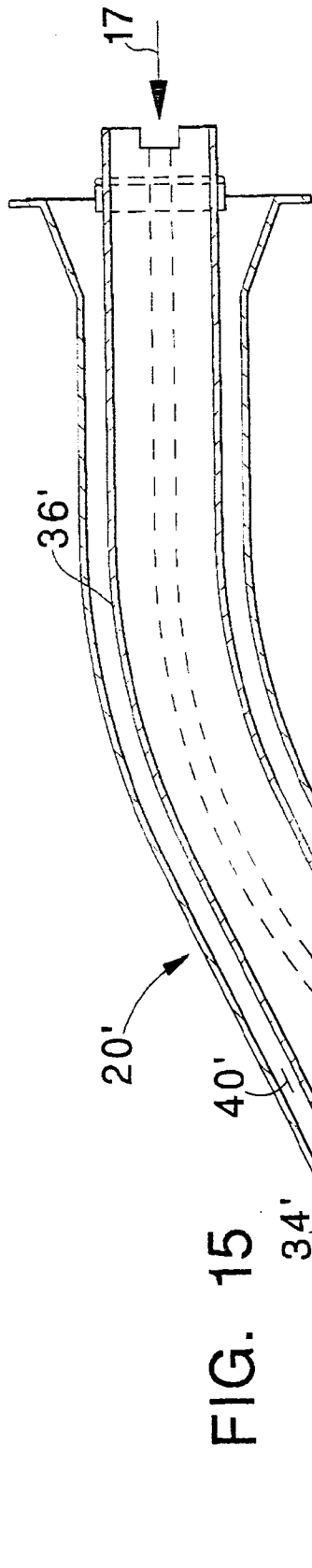


FIG. 15

FIG. 16

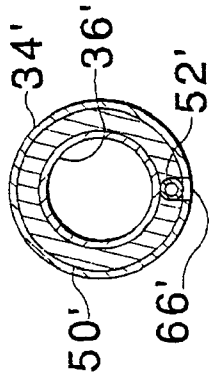


FIG. 17

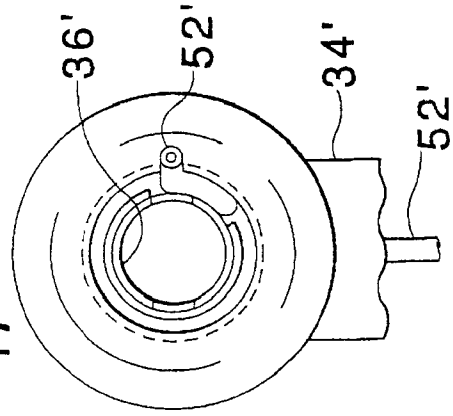


FIG. 18

