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APPARATUS FOR DISPENSING LIQUIDS

The present invention relates to an apparatus for dispensing a liquid, for instance, for dispensing gasoline and like liquid fuels to vehicles, and is more particularly
5. concerned with such apparatus of the type with which so-called "full tank dispensation" can automatically be accomplished.

Fuel dispensing services in commercial gasoline stations are generally of the so-called "amount designated dispensation" kind wherein an operator dispenses fuel in an amount requested
10. by a customer, or the so-called "full tank dispensation" kind wherein the operator dispenses fuel until a fuel tank in the customer's vehicle is filled. Full tank dispensation is troublesome for the operator in so far as he has to manually control a lever of the usual dispensing nozzle to
15. dispense the fuel into the vehicle fuel tank which requires an unknown amount of fuel for filling purposes, and to attain the full state of the tank under his visual control. With such manual operation under visual control avoidance of possible overflow due to excess dispensation cannot be ensured,
20. and the operation is thus inconvenient.

In order to overcome this problem, automatic dispensing nozzles are known which have at the discharge ends thereof a fuel level sensor which detects the presence of fuel at the level of the sensor and issues a signal to automatically
25. stop discharge of the fuel from the nozzle (for instance, USP 3,085,600, BP 955,163). In theory, the level sensor is actuated when it contacts the actual surface of the fuel

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accommodated in the vehicle fuel tank so as to issue the fuel detection signal and stop the fuel dispensing operation. In practice, however, depending on the sectional configuration of the inlet of the fuel tank, the level sensor makes contact

5. with a splash of the fuel due to rebound of fuel discharged from the dispensing nozzle to the fuel tank, or with a fuel bubble which is formed by the fuel discharge and rises up in advance of the actual fuel level in the fuel tank whereby the fuel detection signal is issued and as a

10. result, the fuel dispensing operation stops prior to complete filling of the fuel tank with the fuel.

For attaining the full state of the fuel tank with this prior art arrangement therefore the operator must manually reopen a valve to recommence the fuel dispensation. In this

15. case, it is required for the operator to squeeze the valve in a suitable state, in order to avoid a too-early issuance of the fuel detection signal by the level sensor due to the aforesaid fuel splash or bubble of fuel, but such valve operation requires some skill. In other words, a non-skilled

20. operator may recommence the fuel dispensing operation at a high discharge rate and as a result, then has to repeat the fuel dispense operation, until the fuel tank is completely filled with the fuel. This reduces working efficiency.

A basic object of the invention is to provide a liquid

25. dispensing apparatus which is suitable for use in dispense of a liquid, such as gasoline or the like liquid fuel into a vehicle fuel tank so as to completely fill the tank with the

fuel, without requiring particular skill in its operation and with which an automatic full tank dispensation is possible.

According to the invention therefore there is provided an apparatus for dispensing a liquid, which comprises a

5. liquid reservoir, means for pumping up the liquid from said reservoir, electric motor means for actuating said pump means, flow meter means for measuring an amount of the liquid passing therethrough, means for indicating the amount of liquid measured by said flow meter means, valve means for controlling
10. a flow of the liquid passing therethrough, stationary piping including a first conduit connecting said pump means to said reservoir, a second conduit connecting said flow meter means to said pump means, a third conduit connecting said valve means to said flow meter means and a fourth conduit connected
15. to an outlet of said valve means, a flexible conduit means connected to a free end of said fourth conduit, dispensing nozzle means connected to a free end of said flexible conduit means and having a liquid level sensor means at an outlet end thereof arranged to detect the presence of liquid at the
20. level of said sensor means, and a control circuit connected electrically to said level sensor means and arranged to operate so as to issue a signal for automatically stopping discharge of the liquid from said nozzle means in response to receipt of a liquid detection signal from said level
25. sensor means, so as to issue another signal after elapse of a predetermined time period for recommencing the discharge of liquid from said nozzle means if a signal is received from



said level sensor means showing absence of the liquid at the level of said sensor means, and then finally to issue the signal for stopping the discharge of liquid.

It is desirable that the liquid dispensing apparatus
5. should be arranged to check the operational state of the level sensor means prior to commencement of the liquid dispensing operation with the aim of avoiding a possible excessive dispensation due to problems with the level sensor means.

It is also desirable that the liquid dispensing apparatus
10. should be able to dispense a liquid, only when the level sensor means is in a normal operational state, and should operate with a high discharging rate at the start of a dispensing operation and, in subsequent automatically recommenced dispensing operations carried out after the first
15. dispensing operation due to contact of the level sensor means with a rebounded splash or rising bubble causing issuance of the liquid detection signal, with a rate of discharge progressively decreased in each operation thereby to improve the dispensing efficiency.

20. In line with the above desiderata, preferably said control circuit comprises a level sensor signal judging circuit which is connected to said liquid level sensor means through a protective barrier circuit and is arranged to produce normal and abnormal output signals depending on whether said level
25. sensor means is in a normal state corresponding to the absence of liquid at the level thereof and an abnormal state corresponding to the presence of liquid at the level thereof, a

- motor control circuit which is arranged to drive said motor means on receiving the normal signal from said judging circuit so as to actuate said pump means, and a valve control circuit which is arranged to issue a first signal on receiving the
5. normal signal from said judging circuit and to feed this to a valve opening memory circuit, said valve control circuit being arranged to receive a signal from the memory circuit and to issue a second signal for actuating a valve body arranged in a flow passage in said valve means.
10. It is further desirable that the liquid dispensing apparatus should operate to dispense a liquid in an amount which does not produce any fraction in corresponding monetary amount to avoid possible problems with customers and to simplify transactions. In this specification, such fraction-
15. less dispensation is referred to as "integral dispensation" and the term "integral" is not employed in the mathematical sense.

- According to a further embodiment of the invention therefore the apparatus further comprises a control dispensing
20. circuit which is connected to a counter circuit and is arranged to receive pulse signals from said flow meter means, said dispensing circuit being arranged to control the amount of the liquid finally dispensed from said nozzle means so that said indicator means, which displays dispensed litres to two
25. decimal places, displays zero in the second decimal place.

The drawings illustrate an embodiment of the apparatus according to the invention wherein:-



Fig. 1 is a diagrammatic illustration of the apparatus applied for dispensing a liquid such as gasoline or the like liquid fuel accommodated in an underground reservoir;

Fig. 2 is a block diagram showing a control circuit 5. employed for the apparatus shown in Fig. 1;

Fig. 3 is a time chart showing one of manners for controlling an amount of the liquid to be discharged from a dispensing nozzle by adjusting an opening in a valve means;

Fig. 4 is a diagrammatic illustration showing a state 10. that a tip end of the dispensing nozzle is inserted in an inlet of a vehicle fuel tank to show in detail a relation between a level sensor arranged at tip end of the nozzle and a fuel level in the tank;

Fig. 5 is a longitudinal section of the dispensing 15. nozzle;

Fig. 6 is illustrative sections showing the level sensor, in which Figs. 6a and 6b show respectively a state that a medium between two elements for the level sensor is air or the liquid;

20. Fig. 7 is a wiring for a sensor circuit;

Fig. 8 shows wave forms of various signals, in which a represents a signal issued from an oscillator shown in Fig. 7, b a signal to be issued from the sensor circuit shown in Fig. 7, when no liquid is detected by the sensing elements 25. shown in Fig. 6, c a signal to be issued from the sensor circuit shown in Fig. 7, when the liquid or either of bubble or splash thereof is detected by the sensing elements shown in Fig. 6, and d a signal to be issued from the sensor

circuit shown in Fig. 7, when a dispensation selection switch button arranged on the dispensing nozzle is pushed down; and

Fig. 9 is a vertical section showing a flow control valve.

5. The invention will now be further explained in detail with reference to a preferred embodiment shown in the Figures but please note that the following explanation will mainly be made as that the invention is applied for an apparatus for dispensing
10. a fuel to vehicles in the manner of "full tank dispensation".

In Fig. 1, there is shown generally the fuel dispenser according to the invention. A housing of

15. this dispenser 10 consists of an upper case 12, a lower case 14 and a hollow support 16 connecting both of said cases. In the upper case 12, there are arranged a control device 18, an indicator 20 for displaying an amount of dispensed fuel, other

20. indicators 22, 24, 26 which will be described later, and indication concerning members such as a nozzle switch 32 which detects whether a dispensing nozzle 28 is mounted on or demounted from a nozzle hanger 30. In the lower case 14, there are arranged fuel

25. discharging members such as a pump 34 for pumping up a fuel F in an underground reservoir RS, an electric motor 36 for actuating said pump, a flow meter 38 for measuring an amount of the fuel F passing therethrough with an aid of said pump and a flow

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control valve 40, and a stationary piping 42 extending from a position near bottom of said underground reservoir RS to an outside of the lower case 14 through said pump 34, flow meter 38 and flow 5. control valve 40. In the hollow support 16, there is arranged a wiring 43 which electrically connects the control device 18 with the driving motor 36 in said lower case 14, a signal generator (rotary encoder) 381 arranged to said flow meter 38 and a 10. valve actuating part 401 of said flow control valve 40.

The nozzle 28 to be normally accommodated or rested by the nozzle hanger 30 arranged on outer 15. side wall of said upper case 12 is connected through a flexible conduit 44 to a free end of the stationary conduit 42 at outside of said case 14, and has a liquid level sensor 46 near the tip end thereof (structure of the nozzle 28 as well as 20. structure and arrangement of the liquid level sensor 46 will be described later with reference to Figs. 5 and 6).

Operations of the apparatus 10 will now be 25. explained with reference to Fig. 2 which illustrates one of preferable circuit structures for the control device arranged in said upper case 12 as well as



Fig. 3 which illustrates one of time charts for fuel dispensation working.

When the nozzle 28 is demounted from the nozzle hanger 30 (see Fig. 1; this period corresponds to a point a in the time chart of Fig. 3), a signal from the nozzle switch 32 is fed to a counter circuit 181 and an AND circuit 182a. This erases a memory on a value of previous dispensed fuel amount, which was stored in said counter circuit 181 and thus the indicator 20 is reset to display zero value. While a signal from the liquid level sensor 46 arranged to the nozzle 28 (see also Fig. 1) is applied through a barrier circuit 47 to a sensor signal judging circuit 183 to check whether the liquid level sensor 46 operates in normal or not (detail of said liquid level sensor, barrier circuit and sensor signal judging circuit will be described later with reference to Figs. 7 and 8). In the checking operation, it is confirmed as in normal state, when the liquid level sensor 46 is in a state that it detects no liquid and can detect the liquid, if it is and otherwise as in abnormal state. If in the latter case, a signal from the sensor signal judging circuit 183 is fed to a defect indicator 24 to visibly or audibly transmit the fact to an operator, so that he can take a suitable counter measure. When

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a normal operation of the liquid level sensor 46 is confirmed, the output signal of the sensor signal judging circuit 183 is applied to one of input terminals of said AND-circuit 182a.

5.

The AND circuit 182a issues an output signal, when it receives both of signals from the sensor signal judging circuit 183 and the nozzle switch 32. The output signal is applied to a motor control

10. circuit 361 to actuate the electric motor 36 and

make the pump 34 ready for its operation, and is applied also to a valve control circuit 184. The valve control circuit 184 is adapted to issue a valve opening reading out signal to a valve opening

15. memory circuit 185 and receive a reply signal

therefrom, when the circuit 184 receives a signal from the AND circuit 182a (the reply signal is also fed to a valve opening judging circuit 186 but this will be explained later). The valve opening memory

20. circuit 185 stores memories on several valve opening degrees to attain from a maximum to minimum discharges. In the embodiment as shown in Fig. 3, 4 steps for discharging the liquid at a rate of 3 l/min, 20 l/min, 30 l/min and 45 l/min are set as the

25. memories to feed a corresponding signal of 10, 30,

40 or 60 pulses to the valve actuating part 401 from said valve control circuit 184. The valve opening

memory circuit 185 has another memory to feed the minimum discharge signals of 10 pulses to the valve actuating part 401 through the valve control circuit 184, at beginning state, namely when it

5. receives the reading out signal from the valve control circuit 184.

As the valve actuating part 401 for operating a valve mechanism for the flow control valve 40, a

10. stepping motor is preferable, which is so adapted that it is driven by the signal of 10 pulses to make the valve opening as that corresponding to the minimum discharge and by the signal of 60 pulses to make the valve opening as that corresponding to the

15. maximum discharge.

By receiving the reading out signal from the valve control circuit 184, the valve opening memory circuit 185 issues, as aforesaid, the minimum

20. discharge signal of 10 pulses (3 l/min) as the reply or valve opening signal to the valve control circuit 184 and this signal is then fed to the valve actuating part (stepping motor) 401 to set the opening of valve mechanism for the flow control

25. valve 40 as that corresponding to said minimum discharge. This time period is shown as b in Fig. 3.

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If the operator inserts a tip end of the dispensing nozzle 28 in an inlet of a vehicle fuel tank and operates a dispensing lever thereof, therefore, a fuel dispensation is commenced at the

5. rate of said minimum discharge. This time period is shown as point c in Fig. 3. As described later, the full tank dispensation with use of the apparatus according to the invention stops automatically and thus he may take another service operation, if he

10. engages the dispensing lever to its latch to keep the dispensing nozzle in its discharging state.

With the fuel dispensation, the encoder 381 of the flow meter 38 converts an amount of the fuel

15. passing through the flow meter 38 into a pulse signal which is fed to the counter circuit 181. A signal on number of pulses counted by the counter circuit 181 is fed to the indicator 20 to display the same as an amount of dispensed fuel. The

20. opening of valve mechanism for the flow control valve 40 set in the minimum discharge (3 l/min) as described before and thus, even if the dispensing lever of the nozzle 28 is operated before inserting tip end of the nozzle into an inlet of vehicle fuel

25. tank due to a possible mistake by the operator, for instance when the nozzle 28 is demounted from its

hanger 30, the amount of fuel to be discharged on a floor can be made small one.

- When the counter circuit 181 counted a predetermined number of the pulse signal issued from the encoder 381 of the flow meter 38, for instances 5 pulses corresponding to 0.05 litre of dispensed fuel, a signal is issued from the counter circuit 181 and fed to the valve control circuit 184. This time period is shown as point d in Fig. 3. By receiving the signal from the counter circuit 181, the valve control circuit 184 issues the valve opening reading out signal to the valve opening memory circuit 185 which issues, as a reply, a signal of 50 pulse ($60-10 = 50$) corresponding to the maximum discharge (45 l/min) to feed the same to the valve control circuit 184. The reply signal is fed to the valve actuating part 401 to drive the stepping motor constituting the valve actuating part 401 by 50 pulses to make the valve mechanism for the flow control valve 40 in its full open state and to commence the maximum discharge. This time period is shown with point e in Fig. 3. A sudden change from the minimum to maximum discharge causes an unsuitable situation of too early detection of the fuel by the liquid level sensor 46 due to splash of the discharged fuel. In order to avoid such

situation, a transition of 2 seconds is set between the minimum and maximum discharges as shown in Fig. 3.

When the vehicle fuel tank becomes near its full

5. filled state as a result of such fuel dispensation under the maximum discharging condition and the liquid level sensor 46 detects the fuel by contacting with raising bubbles or splash of the discharged fuel, a liquid detection signal is issued
10. from the liquid level sensor 46 and is fed through the barrier circuit 47 to the sensor signal judging circuit 183 and then an output signal of the circuit 183 is applied to the valve control circuit 184. This time period is shown with point f in Fig. 3.
15. In this case, the valve opening reading out signal is issued from the valve control circuit 184 to the valve opening memory circuit 185. The resulting read out signal of 60 pulses is fed through the valve control circuit 184 to the valve actuating
20. part 401 to reversely drive the stepping motor by 60 pulses, so that the valve mechanism for the flow control valve 40 becomes its full close state. This time period is shown with point g in Fig. 3.
25. It is assumed that said liquid detection signal was issued from the liquid level sensor 46 by contacting with a raising up fuel bubble. There are

required several seconds until the bubbles disappear. Therefore, even if the valve mechanism for the flow control valve 40 takes its full close state and thus the discharge of fuel F from the

5. nozzle 28 stops, the liquid level sensor 46 continuously issues the liquid detection signal. When the valve mechanism of the flow control valve 40 takes its full close state, a signal is fed from the valve control circuit 184 to a timer 187 which

10. issues a signal and feed the same to the valve control circuit 184, after having lapsed a predetermined time period, for instance 3 seconds by taking the bubble disappearing time into consideration. This time period is shown with point h in

15. Fig. 3. In that time, namely after having lapsed 3 seconds from the time when the valve mechanism of the flow control valve 40 is closed, there is issued no liquid detection signal from the liquid level sensor 46, since the fuel bubbles have already been

20. disappeared.

By receiving the signal from the timer 187, the valve control circuit 184 issues the valve opening reading out signal to the valve opening memory

25. circuit 185 as similar in the point d but in this case, the valve opening signal issued from the valve opening memory circuit is that of 40 pulses and thus

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the fuel dispensing operation is recommenced with a corresponding discharging rate, for instance 30 l/min. This time period is shown with point i in Fig. 3. Since the vehicle fuel tank is already in 5. near full state, the liquid level sensor 46 will issue in earlier time the liquid detection signal to commence the valve closing operation as in the aforesaid manner. This time period is shown with point j in Fig. 3. Points k and l in Fig. 3 show 10. respectively time periods of finish of valve closing operation as in the point g and recommencement of fuel dispensation as in the point h. A point m is similar to the point i but in this case, the discharging rate is set as 20 l/min and in other 15. words, the valve actuating part 401 is driven by 30 pulses at the point l.

A third liquid detection point is shown with point n in Fig. 3. A valve closing operation in 20. this stage is carried out in a similar manner as in the points f and j in the previous stage, so that the valve mechanism of the flow control valve 40 becomes in its closed state. This time period is shown with point o in Fig. 3.

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If the liquid detection signal from the liquid level sensor 46 disappears, namely the vehicle fuel

tank has not yet been fully filled with the fuel, the valve opening operation is again carried out. The beginning point of this fourth valve opening operation is shown with point p in Fig. 3. In this

5. case, a signal to be fed from the valve opening memory circuit 185 to the valve actuating part 401, in response to the valve opening reading out instructions from the valve control circuit 184 is that of 10 pulses and thus fuel dispensation is carried out

10. with the minimum discharge of 3 l/min. This time period is shown with point q in Fig. 3. At this time, a signal is issued from the valve control circuit 184 and continuously applied to an AND circuit 182b. Another input terminal of the AND

15. circuit 182b is connected with the liquid level sensor 46 through the sensor signal judging circuit 183 and the barrier 47. When receiving the signal from the valve control circuit 184 and the liquid detecting signal from the liquid level sensor 46,

20. the AND circuit 182b issues an output signal (this time period is shown with point r in Fig. 3) which is fed to an integral dispensation control circuit 188. In this case, a dispensed fuel amount reading out signal is fed from the integral dispensation control

25. circuit 188 to the counter circuit 181 and the resulting read-out signal is fed to the integral dispensation control circuit 188 to operate a liquid

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amount so that the second figure of decimals in litre makes zero. Although this operation may be made by finding a value for carrying the second figure of decimals, there is a possible case of no

5. sufficient time on the response of the valve mechanism for the flow control valve 40. It is preferable, therefore, to set the operation as in that in case of 23.54 litre, 6 pulses are fed to make the dispensed fuel amount to 23.60 litre and in
10. case of 23.59 litre, not 1 but 11 pulses are fed to make the final amount to 23.70 litre. After having additionally counted the number of said pulses by the counter circuit 181, a dispensation stop signal is fed from the integral dispensation control
15. circuit 188 to the valve control circuit 184 (this time period is shown with point s in Fig. 3), said stop signal is then fed to the valve actuating part 401 to make fully closed state the valve mechanism for the flow control valve 40 and to complete the
20. dispensation working (this time period is shown with point t in Fig. 3). Said stop signal is fed both of a dispensation finish indicator 26 and a motor control circuit 361 to visibly and/or audibly indicate the finish of the dispensation working and
25. stop the actuation of the electric motor 36, respectively.

It is assumed in said dispensing operation that the vehicle fuel tank is made full with the fuel at the time, for instance the point g, k or o and the liquid detection signal is continuously issued from

5. the liquid level sensor 46, even if the valve opening signal is issued from the timer 187 after having lapsed a predetermined time period, for instance 3 seconds as aforesaid, namely the liquid level sensor 46 still contacts with the fuel per se,

10. even when the fuel bubbles in the vehicle fuel tank are disappeared. In this case, an AND circuit 182c having an input terminal connected to the liquid level sensor 46 and another input terminal connected to the timer 187 issues an output signal which is

15. fed to the integral dispensation control circuit 188 to carry out the operations as referred to in the previous paragraph and to complete the fuel dispensation working.

20. According to the embodiment as referred to hereinbefore, the valve opening-closing operations are repeated with the aid of the liquid level sensor 46 and in the second or subsequent valve opening operation, while automatically squeezing the opening

25. of the valve at each dispensing stage into such a level as avoiding a possible contact of the liquid level sensor 46 with a splash of the discharged

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fuel, so that number of the dispensing stages for full tank dispensation can be decreased to increase the total fuel dispensation efficiency without causing any over flow of the fuel from the vehicle fuel

5. tank.

In the embodiment, the valve (flow control valve 40) is throttled in stepwise but the throttle may continuously be made, for instance from the point f in Fig. 3. Further, the flow control by the valve actuation part 401 may be carried out with a rotational velocity control of the electric motor 36 which actuates the pump 34.

15. In the aforesaid embodiment, the fuel discharging rate is controlled based on the detection of fuel by the liquid level sensor 46 but this control may be carried out based on an amount of the fuel as previously dispensed or a time
20. required from recommencement of fuel dispensation to the next detection of the fuel by the liquid level sensor 46.

There is a possible case that it is preferable
25. to maintain the discharging rate in constant, for instance at a high discharging rate, without throttling the valve. For this purpose, a

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- dispensation selection switch 281 is arranged to the nozzle 28 (see also Fig. 1). When the switch 281 is turned-on, the signal from the liquid level sensor 46 to the sensor signal judging circuit 183 through
5. the barrier circuit 47 is fed as dispensation selection one to the valve control circuit 184. In this case, a full opening signal is issued from the valve opening memory circuit 185, in response to a reading out signal from the valve control circuit
 10. 184, to make the valve mechanism for the flow control valve 40 in full-open state. If the liquid level sensor 46 issued the liquid detection signal, the valve closing operation will be carried out in the manner same with that as referred to before to
 15. make the valve mechanism for the flow control valve valve 40 in full close state. The valve opening and closing operations will be repeated until the liquid level sensor 46 continuously issues the liquid detection signal over a predetermined time period, for
 20. instance 3 seconds.

- Fig. 4 shows a state that a fuel dispensation was carried out by inserting a cylindrical part of the nozzle 28 into a neck portion FT' of a vehicle
25. fuel tank FT and actuating a dispensing lever 58 and as a result, the fuel F reaches to a level L where the liquid level sensor 46 mounted in tip end of the

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nozzle 28 continuously issues a liquid detection signal. As illustrated in the Figure, the neck portion of the fuel tank FT has in general a cylindrical configuration and thus the fuel tank FT

5. has a space ES with a height H, which may accommodate an additional amount of fuel. In usual automobiles, 0.20 litre or more can be accommodated in the space ES and thus an additional fuel dispensation can be carried out without causing any over-flow, if the

10. fuel amount is less than 0.15 litre.

According to the invention, the space ES is utilized for aforesaid integral dispensation to make zero in second figure of decimals on the display of

15. the dispensed fuel amount or produce no fraction in monetary amount corresponding to the dispensed fuel amount, or for additional dispensation in a constant amount, which is to be carried out when the dispensed fuel reaches to said level L to attain a

20. more complete full tank dispensation.

An exemplar liquid level sensor to be employed for the invention will now be explained with reference to Figs. 5, 6a and 6b.

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A structure per se of the dispensing nozzle 28 shown generally with reference numeral 28 has been

known in the art. A nozzle body 54 is rotatably connected to the flexible conduit 44 through a swivel 52 and a fixing 50. A main valve 56 arranged in a bore formed in the nozzle body 54 can be opened 5. against a force of spring 561, by operating the dispensing lever 58. The fuel will be dispensed from a nozzle aperture 62 through the main valve 56 and a check valve 60 which is arranged in the bore at downstream of the main valve 56. A member shown 10. by reference numeral 64 is a latch for maintaining the lever 58 in its operating position, namely for keeping the main valve 56 in open state.

The liquid level sensor 46 is mounted in a 15. cylindrical part 66 of the nozzle body 54 at a position near the nozzle aperture 62 in the manner as separated by a partition plate 68 from a fuel passage 661 and thus it shall not be affected by the fuel passing through the passage 661. An aperture 20. 662 is formed in the nozzle cylindrical part 66 at a position corresponding to a space 70 wherein the liquid level sensor 46 is mounted, said aperture 662 making easy flow-in of fuel into the space 70 at the time of the fuel detection.

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Figs. 6a and 6b show the liquid level sensor 46 as seen from the side of the nozzle aperture 62 in

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Fig. 5 in state that it does not detect any fuel and that it detecting the fuel, respectively. Any type of liquid level sensors may be employed but in the illustrated embodiment, the liquid level sensor 46

5. comprises a light emitter 461, a light receiver 462 and two lenses 461a, 462a, each of which is attached to the light emitter 461 and light receiver 462, respectively. The light emitter 461 and light receiver 462 may be of a light emission diode to

10. emit a pulse beam and a phototransistor which will be made its through-state by receiving the beam from said diode. The lenses 461a and 462a serve to make the light emitted from the diode 461 a parallel beam when a medium is air and to condense or converge the

15. parallel beam on the phototransistor 462, respectively.

Therefore, if the medium between the light emitter 461 and light receiver 462 is air, the light

20. from the light emitter 461 is made to a parallel light beam by the lens 461a, transmitted to the other lens 462a and condensed by the lens 462a on the light receiver 462 to issue an electric output therefrom, as shown in Fig. 6a. While if the medium

25. between the light emitter 461 and light receiver 462 is a fuel, the light from the light emitter 461 is not only weakened by a photo-passing resistance of

the fuel per se but also scattered by a change of refraction index of the lens 461a due to the presence of fuel, as shown in Fig. 6b. Therefore, almost no light reaches to the light receiver 462
5. and thus the light receiver issues no or very low level output.

As a result, it can easily be judged whether the liquid level sensor 46 contacts with and detects
10. the fuel or not.

A wiring for the liquid level sensor 46 will now be explained with reference also to Fig. 5. Signal lines 68 each of which is connected to the
15. light emitter 461 and light receiver 462, respectively at one end is once led outside of the nozzle body 54 through the fuel passage 661 in the cylindrical nozzle part 66 and a bore 541 formed in the nozzle body 54 and connected to a connector 71 which serves
20. for repairing or exchanging the liquid sensor 46. In the illustrated embodiment, the fuel dispensation selection switch 281 is also arranged outside of the nozzle body 54, this switch 281 and said connector 71 being covered by a removable common lid 72,
25. although an operation button 281a for the switch 281 extends to outside of the lid 72 and is pushed down to repeat full open-full close operations of the flow

- control valve 40, as referred to before. A signal line to the connector 71 and another signal line to the switch 281 are made together as line 74, led again into the nozzle body 54 through a bore 542,
5. and finally connected to the control device 18 (Fig. 1). The signal line 74 is covered with a coil spring 76 at its part passing through the swivel 52 in order to reduce an extent of its twist but this counter measure is not sufficient for avoiding a
10. possible break down of the signal line due to the twist and thus there is arranged means 78 for restricting a relative rotation between the swivel 52 and the nozzle body 54.
15. The sensor circuit will now be explained with reference mainly to Figs. 7 and 8. The sensor circuit comprises mainly the light emitter 461 and light receiver 462 of the liquid level sensor 46, the barrier circuit 47, and the sensor signal
20. judging circuit 183 (see also Fig. 2), is actuated by receiving a signal from the nozzle switch 32, when the nozzle 28 is demounted from the nozzle hanger 30, and deactuated when the nozzle 28 is mounted on the nozzle hanger 30 (see also Fig. 1).
25. The barrier circuit 47 comprises a fuse F, resistors R and zener diodes Z but an explanation thereof will

not be made, since circuit structure per se has been known in the art.

In the embodiment illustrated in Fig. 7, it is assumed that the light emitter 461 and light receiver 462 are of the light emission diode and phototransistor, respectively, as stated before. In the sensor signal judging circuit 183, a bus B of for instance +5V is connected to an emitter of a transistor Tr having a base connected to an oscillator 80. The oscillator 80 issues a pulse signals as shown in Fig. 8(a) and thus a corresponding pulse signal is issued at collector side of the transistor Tr. The pulse signal is applied to the light emission diode 461 through a resistor R_1 and the barrier circuit 47 and thus the light emission diode 461 issues a light pulse signal having a wave form similar to that as illustrated in Fig. 8(a). A cathode side of the diode 461 is grounded.

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While a collector of the phototransistor 462 is connected to said bus B through the barrier circuit 47 and a resistor R_2 and an emitter thereof is grounded.

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Further, a comparator 82 is arranged to convert the pulse signal into a signal with a rectangular

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- wave form. The comparator 82 has a first input terminal T_1 connected to a line between a resistor R_2 and the phototransistor 462 and a second input terminal connected between two resistors R_3 and R_4
5. having same resistance and connected in series on a line which connects between the bus B and an earth and thus a half of the bus B voltage, namely +2.5V is applied on the terminal T_2 .
10. If a sufficient light pulse beam reaches from the light emission diode 461 to the phototransistor 462 as shown by arrows a, the phototransistor 462 is made to its through-state to reduce the voltage at the terminal T_1 less than +2.5V. While
15. if the phototransistor 462 receives no or insufficient light pulse beam, the phototransistor keeps its non through-state to increase the voltage at the terminal T_1 . Since the voltage signal at the terminal T_1 is inverted from the signal issued by
20. said oscillator 80, an output signal of the comparator 82 has a wave form inverted that as shown Fig. 8(a) [the wave form is shown in Fig. 8(b) and left parts of Figs. 8(c) and (d)]. Fig. 8(b) shows an output signal of the comparator 82, in case of
25. that the medium between the light emission diode 461 and the phototransistor 462 is air and that the light pulse signal is sufficiently supplied from the

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light emission diode 461 to the phototransistor 462 to turn the same into its through-state. Fig. 8(c) shows the output signal of the comparator 82, in case that the medium between the light emission
5. diode 461 and the phototransistor 462 is changed from air to a fuel or its bubble at the time period as shown by X, namely shows a high level signal Hi.

The dispensation selection switch 281 is
10. connected in parallel with the phototransistor 462 and if the switch is pressed down, the terminal T_1 is grounded and thus the output signal of the comparator 82 becomes a low level signal Lo [This signal is shown in Fig. 8(d), as that the switch is
15. pressed down at point Y].

The output signal of the comparator 82 is led from its output terminal T_3 to the judging circuit 84 to make various judges and resulting signal is fed
20. to the subsequent circuit (see Fig. 2) to use the same mainly as control signal and secondarily to convert the same an audible and/or visible signal to inform a result to the machine operator, as referred to hereinafter.

25.

When the dispensing nozzle 28 is demounted from the nozzle hanger 30 (Fig. 1), an environment medium

for the liquid level sensor 46 is air and thus the pulse signal as shown in Fig. 8(b) is fed from the comparator 82 to the judging circuit 84. On receiving the pulse signal, the judging circuit 84

5. judges as that the liquid level sensor operates in normal, to issue a corresponding judge signal. Based on this judge signal, a motor driving signal is fed to the motor control circuit 361 to actuate the electric motor 36 and a valve opening signal is

10. fed to the valve control circuit 184 to open the valve mechanism for the flow control valve 40 (Fig. 2). The fuel dispensation operation can be stated by manually operating the dispensing lever 58 of the nozzle 28 (Fig. 5). During the dispensation

15. working, the pulse encoder 381 of the flow meter 38 converts an amount of fuel passing through the same into a corresponding pulse signal to feed the same to the counter circuit 181 which counts the number of pulses to feed same to the indicator for

20. displaying the fuel amount as dispensed.

If a signal to be fed from the comparator 82 to the judging circuit 84 is not one as illustrated in Fig. 8(b) when the nozzle 28 was demounted from its

25. hanger 30 prior to the actual fuel dispensing operation, the judging circuit 84 judges as that the liquid level sensor 84 is in its abnormal state, and

issues a corresponding judge signal to feed the same to the trouble indicator 24 for transmitting the matter to the operator, so that he can take a suitable counter measure thereto, for instance an
5. exchange of the failed liquid level sensor.

Returning now to the fuel dispensing operation, the liquid level sensor 46 will detect the fuel per se, bubble thereof raising up prior to the actual
10. fuel level or splash thereof due to the fuel jettedly charged in the vehicle fuel tank from the nozzle 28, when the dispensing operation is continuously carried out. The fuel detection is shown in Fig. 8(c) by the point X and at this time,
15. the comparator 82 issues the high level signal Hi to feed the same to the judging circuit 84. The judging circuit 84 then judges the signal Hi to feed the valve closing signal to the valve control circuit 184, so that the valve mechanism for the
20. flow control valve 40 is closed to stop the fuel dispensation.

If said fuel detection is temporary one due to the contact of the liquid level sensor 46 with a
25. bubble or splash of fuel and thus the liquid level sensor 46 then detects air again, the pulse signal as shown in Fig. 8(b) is again fed from the

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comparator 82 to the judging circuit 84 to recommence the fuel dispensing operation but explanation thereabout will not be made, since this has already been done with reference to the time chart 5. illustrated in Fig. 3.

If the fuel dispensation selection switch 281 arranged to the nozzle 28 is pressed down, the low level signal Lo is fed from the comparator 82 to the 10. judging circuit 84, as referred to before [the time when the switch 281 is operated is shown by the point Y in Fig. 8(d)]. The low level signal Lo is transmitted to the valve control circuit 184 to fully open the valve mechanism for the flow control 15. valve 40 and thus the valve mechanism repeats full open-full close operations due to the signal from the liquid level sensor 46 until the liquid level sensor 46 becomes in a state of continuously detecting the fuel.

20.

A preferred embodiment of the flow control valve 40 will now be explained in detail with reference to Fig. 9.

25. The flow control valve 40 comprises a valve housing 90 having an inlet 92 and an outlet 94 and in which there is formed a valve seat 901 to receive

a valve body 902. The valve body 902 has a hollow cylindrical configuration, an aperture 902b in its side wall 902a to control a position of the valve body 902, a guide 96 with a central flow passage 5. 961, and a passage or longitudinal channel 902c formed in an inner surface of the side wall 902a to communicate a chamber 98 with the flow passage 961.

On the valve housing 90, there is mounted a 10. casing 100 for accommodating a driving mechanism for said valve body 902. An inner space of the casing 100 is separated into 2 compartments. The first compartment which constitutes said chamber 98 and accommodates a spring 102 to push the valve body 902 15. normally toward the valve seat 901, a receiver 104 for the spring 102, and a bellows 106 to support movably the receiver 104. An output shaft 108a of a stepping motor 108 projects into the second compartment of casing 100 and has a lever 110 20. attached to its free end. The rotation of stepping motor 108 by the signal from the valve control circuit 184 as described with reference to Fig. 2 is set so as to cause a motion of the lever 110 between a solid line position and a chain line position in 25. Fig. 9 with the aid of the output shaft 108a. A free end of the lever 110 is pivoted to a valve body driving rod 112 which is connected through a guide

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member 114 with a planted pin 114a to a needle valve rod 116 having at its free end a piston 118 with a poppet 118a to open or close the flow passage 961. A compression spring 120 is arranged between the

5. piston 118 and the guide member 114, to normally close the flow passage 961 with the poppet 118a.

On operation of the flow control valve 40, it is assumed that the lever 110 is in the position as

10. shown in solid line. Since a pressure due to actuation of the pump 34 is applied to the inlet 92, the fuel flows through the aperture 902b into the hollow valve body 902 and then into the chamber 98 to press the valve body 902. Therefore, the inlet 92

15. is not communicated with the outlet 94 to prevent any flow out of the fuel from the outlet. If the stepping motor 108 is then rotated in stepwise in response to a number of pulse by a pulse signal from the valve control circuit 184 (for instance 0.45°

20. per pulse), the lever 110 correspondingly rotates in clockwise to cause an upwardly movement of the piston 118 in the figure, so that the fuel in the chamber 98 flows out from the outlet 94 through the passages 902c and 961, to reduce a pressure in the

25. chamber 98. This pressure reduction causes an upper movement of the valve body 902 to cause the communication between the inlet 92 and the outlet 94

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whereby the fuel flows through the inlet and outlet. At beginning of this state, the fuel flows from the inlet 92 to the outlet 94 through the aperture 902b as well as passages 902c and 961, but if the piston 5. 118 more raises to close the aperture 902b, the fuel does not enter in the chamber 98 and thus the pressure in the chamber 98 reduces to cause the upper movement of the valve body 902. In other words, a position of the valve body 902 depends on a 10. positional relation between the piston 118 and the aperture 903b, namely the amounts of fuel flows into and flows-out from the chamber 98. In more frankly speaking, if the piston 118 is in its upper (or lower) position, the valve body 902 is also in its 15. upper (or lower) position and thus the valve opening depends on the position of the lever 110 due to the rotation of the stepping motor 108.

As a precautional measure to a possible 20. interruption of electric supply or trouble of the stepping motor 108, another lever 114 for actuating said lever 110 or a combination of a passage 121 communicating between the outlet 94 and the chamber 98 and a valve 122 arranged in the passage 121 may be 25. provided.

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The flow control valve 40 with such mechanism and to be operated in the manner as referred to is quite suitable for the apparatus according to the invention, since the needle valve rod 116 can rapidly

5. be actuated and stopped at an optional position, whereby a response of the valve mechanism is rapid and ensures, so as to be able to set any optional flow amount.



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CLAIMS

1. An apparatus for dispensing a liquid, which comprises a liquid reservoir, means for pumping up the liquid from said reservoir, electric motor means for actuating said pump means,
5. flow meter means for measuring an amount of the liquid passing therethrough, means for indicating the amount of liquid measured by said flow meter means, valve means for controlling a flow of the liquid passing therethrough, stationary piping including a first conduit connecting said pump means to said
10. reservoir, a second conduit connecting said flow meter means to said pump means, a third conduit connecting said valve means to said flow meter means and a fourth conduit connected to an outlet of said valve means, a flexible conduit means connected to a free end of said fourth conduit, dispensing
15. nozzle means connected to a free end of said flexible conduit means and having a liquid level sensor means at an outlet end thereof arranged to detect the presence of liquid at the level of said sensor means, and a control circuit connected electrically to said level sensor means and arranged to
20. operate so as to issue a signal for automatically stopping discharge of the liquid from said nozzle means in response to receipt of a liquid detection signal from said level sensor means, so as to issue another signal after elapse of a predetermined time period for recommencing the discharge of
25. liquid from said nozzle means if a signal is received from said level sensor means showing absence of the liquid at the level of said sensor means, and then finally to issue the signal for stopping the discharge of liquid.

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2. The apparatus as claimed in claim 1, wherein said flow meter means has encoder means to issue a pulse signal representing an amount of the liquid passing through said flow meter means and feed the same to said indicator means through
5. a counter circuit.

3. The apparatus as claimed in claim 1, wherein said control circuit comprises a level sensor signal judging circuit which is connected to said liquid level sensor means through a protective barrier circuit and is arranged to produce normal
10. and abnormal output signals depending on whether said level sensor means is in a normal state corresponding to the absence of liquid at the level thereof and an abnormal state corresponding to the presence of liquid at the level thereof, a motor control circuit which is arranged to drive said motor
15. means on receiving the normal signal from said judging circuit so as to actuate said pump means, and a valve control circuit which is arranged to issue a first signal on receiving the normal signal from said judging circuit and to feed this to a valve opening memory circuit, said valve control circuit
20. being arranged to receive a signal from the memory circuit and to issue a second signal for actuating a valve body arranged in a flow passage in said valve means.

4. The apparatus as claimed in claim 1, wherein said valve means comprises a housing with a liquid inlet and outlet, a
25. biased valve body arranged in said housing to communicate or shut off between the inlet and outlet, and lever means which is driven by motor means to actuate said valve body stepwise.

5. The apparatus as claimed in claim 1, wherein said liquid



level sensor means comprises light emission means and light receiving means.

6. The apparatus as claimed in claim 3, further comprising a control dispensing circuit which is connected to a counter circuit and is arranged to receive pulse signals from said flow meter means, said dispensing circuit being arranged to control the amount of the liquid finally dispensed from said nozzle means so that said indicator means, which displays dispensed litres to two decimal places, displays zero in the second decimal place.

7. The apparatus as claimed in claim 3, wherein said valve opening memory circuit stores information relating to a degree of opening of said valve means corresponding to a first discharge rate during a previous dispensing operation and, on a recommenced subsequent dispensing operation, issues a signal to set the degree of opening and hence the discharge rate to a lower level.

8. The apparatus as claimed in claim 4, wherein said valve body is a hollow cylindrical member with an aperture formed in its side wall and a longitudinal channel at its inner wall, and cooperates with piston-like means to be operated by said lever means.

9. The apparatus as claimed in claim 5, wherein said light emission means is a light emission diode to emit a pulse beam by a signal from an oscillator and said light receiving means is a phototransistor which will be made to its through state by receiving the beam from said diode.

10. The apparatus as claimed in claim 6, wherein said control



dispensing circuit is arranged to permit dispensation of an additional small amount of liquid after said level sensor means has issued said signal for stopping discharge of liquid, so as to enable said final amount of liquid to be accurately 5. dispensed.

11. The apparatus as claimed in claim 9, wherein lens means are arranged to respectively make the light beam emitted from said light emission diode into a parallel one and make the parallel beam converge on said phototransistor.
10. 12. Apparatus according to claim 1, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.
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