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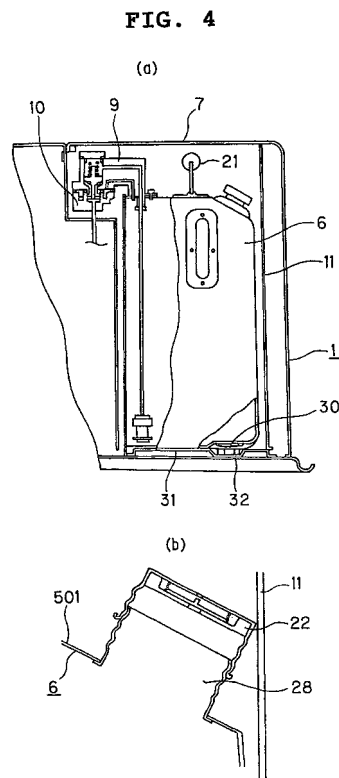
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(54)

LIQUID FUEL COMBUSTION DEVICE

(57)

A liquid fuel burning apparatus wherein a fuel supply tank(6) having a filler port(28) and its filler cap (22) in the upper part thereof is detachably mounted in a tank holding compartment(500) of a main apparatus body(1), includes a filler port release preventing means for prohibiting release of the shutoff member when the fuel supply tank is set in the main body. The filler port release preventing means is constructed so that part of the top face and side faces of the fuel supply tank are shaped forming a bevel (501) on which the filler port is disposed, and when the tank is set in the main body, release of the filler cap is prohibited by the wall face of the tank holding compartment.



Description

Technical Field

[0001] The present invention relates to a liquid fuel burning apparatus such as a kerosene fan heaters and the like.

Background Art

[0002] Fig.84 is a partly abbreviated, front sectional view showing a conventional kerosene fan heater; Fig. 85 is a side sectional view of the above; and Fig.86 is a sectional view showing a filler cap of a fuel supply tank and its socket.

[0003] As shown in Fig.84, a conventional kerosene fan heater incorporates a fuel supply tank P2 for being previously filled with a liquid fuel P4 such as kerosene as reserve fuel, at one side of its main body P1, so that an ample amount of liquid fuel P4 will be supplied to a fuel tank P3 connected under the fuel supply tank P2.

[0004] Liquid fuel P4 held in the fuel tank P3 is led by a fuel pressure-feed electromagnetic pump P5 to a vaporizer P7 by way of an oil feed pipe P6. The thus fed liquid fuel P4 is vaporized by a vaporizer heater (not shown) provided for vaporizer P7. Designated at P9 is a combustion chamber, which supports and fixes a burner P8 at the bottom of thereof.

[0005] The fuel vaporized through the vaporizer P7 is intensely jetted from a nozzle and led together with combustion air into burner P8 and burns at a flame port P8a, whereby air inside combustion chamber P9 is heated. As indicated by the arrows in Fig.85, air is suctioned through a filter P12 from the room by a blower fan P11 attached to a fan motor P10 of a single-phase induction motor or the like arranged at the rear side of main body P1 and blown out together with the heated air and combustion gas inside combustion chamber P9, as warm air through an air outlet P13 to the room.

[0006] A flame sensor P14, arranged slightly above flame port P8a, is to detect flame current derived from the burning flame and when it detects a flame current equal to or greater than the preset value, it activates fan motor P10 so that blower fan P11 starts rotating, whereby air sucked from the room is blown out as warm air through air outlet P13 to the room.

[0007] At the same time, the room temperature is sensed by a room temperature thermistor P15, and based on the temperature difference between the room temperature and a set temperature, a controller (not shown) controls the drive of fuel pressure-feed electromagnetic pump P5, whereby the amount of liquid fuel P4 supplied to vaporizer P7 is regulated to control the power of the burning flame at burner P8.

[0008] Accordingly, when, for example, a kerosene fan heater starts its operation when the room temperature is low, a large amount of liquid fuel P4 is supplied to vaporizer P7 so as to quickly raise the room temper-

ature to the set level and thereafter the supplied amount of liquid fuel P4 is regulated so as to maintain the temperature at about the preset level.

[0009] Fuel supply tank P2 is refueled by taking out fuel supply tank P2 from main body P1 and turning it upside down, removing a filler cap P16 having a valve element of fuel supply tank P2, and charging fuel through a mouth P17 (Fig.86). After confirmation of correct refueling fuel supply tank P2, filler cap P16 is fastened to the threaded portion of mouth P17, and the tank is turned upside down so that filler cap P16 is downside. The tank is inserted into main body P1 and placed on the top face of fuel tank P3 so that filler cap portion P16 fits into a socket P18 attached to the top face of fuel tank P3.

[0010] The conventional kerosene fan heaters need tedious handling: that is, it is necessary when refueling to take out the fuel supply tank from the main body and invert the fuel supply tank to turn it filler cap side up. Further, after refueling, it is necessary to fasten the filler cap and turn the tank upside down once again in order to fit it into the main body.

[0011] Further, since the engagement of the filler cap with the mouth is made by screw fastening, there have been problems such that the filler cap falls off and fuel flows out when the fuel supply tank is turned upside down if fastening of the filler cap is insufficient. In particular, in an aging society, there has been a demand for improvement because the grip strength and also force for tightening the screw lowers as users become older.

[0012] When fuel is supplied into the fuel tank, fuel in the fuel supply tank is delivered by air replacement while the oil level rises up to the valve element of the filler cap and is kept at the fixed height. This means that the valve element of the filler cap is constantly wetted with fuel. Accordingly, there have been problems such that when the filler cap needs to be removed to refuel the fuel supply tank, the hands are stained with fuel and hence slip when the screw is fastened as well as the hands being left polluted and smelling of fuel.

[0013] Further, in a case where fuel is charged into a fuel supply tank as it is set in the kerosene fan heater body, there has been a problem of fuel spilling out inside the kerosene fan heater body.

[0014] It is therefore an object of the present invention to provide a liquid fuel burning apparatus having a fuel supply tank which allows its refueling to be done without turning the tank upside down and without any staining of the hands with fuel and which prohibits its refueling when the fuel supply tank is set in place in the kerosene fan heater body.

Disclosure of Invention

[0015] In the present invention, in a liquid fuel burning apparatus wherein a fuel supply tank having a filler port and its shutoff means in the upper part thereof is detachably mounted in a tank holding compartment of a main

apparatus body, a filler port release preventing means for prohibiting release of the shutoff means when the fuel supply tank is set in the main body is provided so that refueling cannot be done unless the fuel supply tank is taken out from the main body.

[0016] In this case, as long as the filler port of the fuel supply tank is positioned in the upper part when the tank is set in the main body, either the indirect oil feed system in which a fuel tank is provided under the fuel supply tank so as to feed fuel to the burner unit by way of the fuel tank, or the direct oil feed system in which fuel is directly supplied to the burner unit from the fuel supply tank, can be used as the oil supply system. However, use of the directly burning system is preferred.

[0017] Various configurations can be adopted as the filler port release preventing means. A first preventing means can be constructed such that part of the top face and side faces of the fuel supply tank are shaped forming a bevel on which the filler port is disposed, and when the tank is set in the main body, release of the shutoff means is prohibited by the wall face of the tank holding compartment. In other words, in a configurational example, the space formed between the bevel and the wall face of the tank holding compartment is sized so as not to allow the shutoff means to be released from the filler port.

[0018] The bevel may be not only the one formed by shaping part of the top face and one side face of the fuel supply tank, but also can be formed by beveling the top face and two side faces adjacent to the top face by a predetermined angle.

[0019] A second filler port release preventing means can be constructed such that the filler port is disposed in an upper part of one side face of the tank, and when the tank is set in the main body, release of the shutoff means is prohibited by the wall face of the tank holding compartment. In other words, in a configurational example, the space formed between the tank side face and the wall face of the tank holding compartment is sized so as not to allow the shutoff means to be released from the filler port.

[0020] A third example of filler port release preventing means can be constructed such that the filler port is disposed on the tank top face and a limiting part for limiting release of the shutoff means when the tank is set in the main body is provided.

[0021] This limiting part may be provided either on the tank side or the wall face of the tank holding compartment, and it is preferred that it cannot be manually released when the fuel supply tank is set in the main body. As an example, it is possible to provide a configuration where, based on detection of the fuel supply tank being set in the main body, a solenoid or the like may be actuated to cause the limiting part to stop the shutoff means. Alternatively, in a configuration where the shutoff means is pivotally released with respect to the filler port, the pivoting fulcrum of the shutoff means is disposed on the wall side of the tank holding compartment

and a limiting part is arranged at a more outer position than the pivot while part of the tank holding compartment wall is set back to the side, forming a stepped portion that opposes the limiting part, so that the limiting part will abut the stepped portion to prohibit release of the shutoff means when the shutoff means is tried to be turned and released while the tank is set in the main body.

[0022] Here, examples of the shutoff means include a screw cap that is fitted on the mouth of the filler port or a structure which is comprised of a fixing plate integrally formed with the filler port, a moving plate pivotally supported on the fixing plate in an openable and closable manner, a lid member with a packing, provided for the moving plate for closing the filler port and an engaging means for keeping the moving plate at the filler port closing position.

[0023] The engaging means may be disposed on the free end side or on the side opposite to the pivoting fulcrum of the moving plate, and for example, it may comprise: an engaging lever which has an engaging part and is pivotally supported on either the moving plate or the fixing plate; an engagement hold which is disposed on the remaining part, the moving plate or the fixing plate, and is engaged with the engaging part so as to keep the moving plate at its closed position; and a lever spring for urging the lever in the direction the engaging part becomes engaged with the engagement hold.

[0024] When the engaging means is disposed on the wall side of the tank holding compartment, the filler port release preventing means may be, for example, constructed such that the engaging lever is partly extended and when the fuel supply tank is set in the main body, rotational release movement of the engaging lever is prohibited by abutment of this extended portion against the wall face of the tank holding compartment.

[0025] The above filler port release preventing means may be used sole or in combination. For example, a more reliable release prevention of the shutoff means can be realized by effective combination of the bevel configuration of the first preventing means and the arrangement of the extended portion or limiting part in the pivotal shutoff means having an engaging means.

[0026] The fuel supply tank of the above configuration may also include a means for detecting its insertion into the main apparatus body to confirm it.

[0027] Further, it is also possible to provide a means for detecting the liquid level of fuel in the tank in the lower part of the fuel supply tank. In this case, if the fuel supply tank has a water drain hole formed at its bottom, the liquid level detecting means may be arranged with the lid member for opening and closing the water drain hole. Alternatively, the liquid level detecting means may be arranged in the lower part of the suctioning pipe for suctioning fuel in the fuel supply tank.

[0028] In order to attain the above object, the liquid fuel burning apparatus of the present invention includes: a fuel supply tank detachably mounted into a main body;

a burner unit having a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel; an oil feed pump for sending fuel from the fuel supply tank to the vaporizer; and a joining portion for connecting the fuel supply tank to an oil feed passage reaching to the burner unit when the fuel supply tank is set in the main body so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel under the fuel supply tank, whereby charging of fuel into the fuel supply tank can be done without turning the tank up side down for refueling.

[0029] In the liquid fuel burning apparatus of the above configuration, since fuel in the fuel supply tank is directly fed to the burner unit without use of any fuel tank for holding fuel, an air hole for preventing occurrence of a negative pressure in the fuel supply tank is preferably formed. However, if this air hole is opened as is, there is concern that fuel might scatter outside the tank when the tank is carried for refueling and that fuel might leak when the fuel supply tank falls down.

[0030] To deal with such situations, in the present invention, an air hole shutoff means for preventing fuel from scattering outside the tank when the tank is carried for refueling or fuel from leaking when the fuel supply tank falls down is provided for the air hole so that no negative pressure will occur in the fuel supply tank.

[0031] As a first means for closing the air hole, it is possible to provide a configurational example in which a fuel scatter shield that encloses the inner side of the air hole is provided while a conduit hole is formed on this scatter shield at a position deviated from the point directly below the air hole so as to create communication between the tank interior and the air hole, whereby fuel in the tank becomes unlikely to scatter from the air hole when the tank is carried. In this case, if the scatter shield is configured so that its bottom is inclined and the conduit hole is formed at the deepest point in the inclined face while the air hole is positioned right above the most shallow point, the two holes can be maximally separated from each other, leading to a great suitable prevention against fuel scattering.

[0032] As a second means for closing the air hole, it is possible to provide another structure which is comprised of a guide disposed on the inner side of the air hole, a weight put within the guide so as to move up and down therein and a shutoff plate interposed between this weight and air hole to close the air hole, following the up-and-down movement of the weight. This arrangement has the advantage that the air hole can be reliably closed by the shutoff plate by virtue of up-and-down movement of the weight when the tank falls down.

[0033] In this case, if the corner portion of the shutoff plate in contact with the guide is rounded so that the shutoff plate can be reliably guided, the rounded face of the shutoff plate makes its movement smooth. Further, when the bottom of the weight guide is formed of a tapered surface so that the weight can move up and down

rolling on the tapered surface, it is possible to realize a compact configuration while reducing the impact sound arising with the up-and-down movement of the weight.

[0034] The above mechanism, i.e., the air hole shutoff means using a weight, will leave the air hole open when the fuel supply tank is taken out (when it is carried). In contrast, a third example of air hole shutoff means includes: a valve for closing the air hole; a tank valve lever having the valve attached thereto and moving up and down outside the tank; and a moving rod for moving the tank valve lever up and down, and is configured so that the tank valve lever is moved in the valve opening direction as the moving rod is thrust to move upwards by the main body structure when the fuel supply tank is inserted into the main body, whereas the tank valve lever moves down due to gravity or is forcibly moved down by a spring in the valve closing direction when the fuel supply tank is taken out from the main body. This arrangement makes it possible to close the air hole when the fuel supply tank is taken out from the main body and open it when it is set in the main body.

[0035] In this case, when the air hole shutoff means is adapted to function sooner than the joining means for the oil feed passage does when the fuel supply tank is inserted into the main body, it is possible to release an abnormal pressure inside the fuel supply tank before the connection of the joining means is completed, hence create a smooth flow of fuel. Further, since the air hole of the tank is closed when the fuel supply tank is taken out from the main body, no fuel will leak in case the tank falls down.

[0036] The arrangement of causing the air hole shutoff means to function sooner than the joining means for the oil feed passage may be realized by adapting the moving rod to abut the main body structure sooner than connection of the connecting joint unit on the fuel supply tank side when the fuel supply tank is inserted into the main body. As an example, the moving rod is fitted in a vertical hole formed in the connecting joint unit on the fuel supply tank side so that the rod can move up and down and its lower end is projected more downwards than the connecting joint unit, whereby the moving rod is made to push against the abutment of the joint socket unit on the burner unit side to cause the moving rod to move vertically before the establishment of connection to the oil feed path. In this case, since part (moving rod) of the air hole shutoff means is arranged with the connecting joint unit on the fuel supply tank side, a compact configuration can be realized.

[0037] Since the fuel supply tank is always kept with its filler port up, provision of a filter, for removing dust and the like in the fuel, in the filler port prevents dust and dirt from entering the fuel supply tank when fuel is charged.

[0038] In this case, when the filter is provided in a cylindrical form, having a mesh portion permeable to fuel, extended up to the vicinity of the filler port, it is possible to increase the area for fuel to pass and also prevent

malfunction of the refueling pump. Further, when the filter is formed with a projection raised upwards on the bottom thereof, it is possible to create a clearance between the front end of the refueling pump and the bottom of the filter so that fuel can be charged smoothly.

[0039] When guides for guiding a hose of a refueling pump are formed on the inner face of the cylindrical filter, the hose of the refueling pump becomes unlikely to slip off, thus preventing the hose of the refueling pump from slipping out of the fuel supply tank while refueling, hence avoid fuel being spilt over.

[0040] Further, when the mesh portion provided on the side face of the filter is composed of an upper mesh portion permeable to water and a lower mesh portion impermeable to water, or when the filter is adapted to have a mesh portion permeable to water on its side and a mesh portion impermeable to water at the bottom, the water content, if mixed, will not directly enter the tank but is trapped within the filter and can be easily post processed when fuel is charged into the fuel supply tank.

[0041] Here, the above liquid fuel burning apparatus may include: a return oil passage that allows fuel to return from the burner unit to the fuel supply tank; and a joining means on the return oil side for connecting this return oil passage with the fuel supply tank. Such a liquid fuel burning apparatus may be characterized in that part of the piping for connection between the burner unit and the return oil joining means is formed to be long and extended substantially horizontal so that this substantially horizontal portion functions as a reservoir for permitting fuel to temporarily stay.

[0042] In order to solve the above problems, in the present invention, the fuel in the fuel supply tank can be directly fed to the burner unit without using any fuel tank for temporarily holding fuel, whereby the filler port cap of the fuel supply tank can be prevented from being stained with fuel while various necessary functions accompanied by the omission of the fuel tank are added to the fuel supply tank.

[0043] That is, a fuel quantity detecting means for detecting the amount of fuel in the fuel supply tank is provided in order to quickly detect the end of fuel in the fuel supply tank; a water detecting means for detecting generation of water in the fuel supply tank is provided so as to prevent deficiencies due to feed of water from the fuel supply tank to the burner unit; and a tank insertion detecting means for detecting the insertion of the fuel supply tank in the main body is provided so as to prohibit start of operation until the tank is inserted in place. These are the adopted configurations.

[0044] In this case, the fuel quantity detecting means, water detecting means and tank insertion detecting means may be disposed at any position of the tank, but in view of physical properties of fuel and water and the functionality of detection, these means are preferably disposed on the underside of the tank.

[0045] An example of fuel quantity detecting means may be comprised of a float incorporating a magnet, dis-

posed inside the tank and a lead switch which is disposed on the tank placement board side so as to turn on and off as the magnet moves closer and away.

[0046] An example of water detecting means may be comprised of a conductive water receptacle which is arranged at the conductive tank bottom to collect condensation of water, an electrode in contact with the water receptacle, an electrode in contact with fuel supply tank and an insulator which provides electric insulation between the water receptacle and the fuel supply tank and is configured to detect water based on the difference in electric resistance between fuel and water collected in the water receptacle.

[0047] In order to perform precise water detection, the water receptacle is preferably formed separately from the tank and is attached to the attachment hole on the tank bottom with an electric insulator interposed therebetween. The receptacle should be composed of a conductive material, and use of a stainless steel sheet is advantageous in preventing rust.

[0048] An example of the electric insulator is a resilient non-conductive packing, which is interposed between the peripheral wall of the attachment hole formed on the bottom of the tank and the peripheral flange of the water receptacle. This packing may be subjected to a water-repellent treatment, so that water becomes unlikely to pool after drainage, thus making it possible to prevent malfunction.

[0049] The electrodes in contact with the water receptacle and the tank, respectively, are disposed on, for example, a tank placement board outside the fuel supply tank, and are brought into contact with the water receptacle and tank, respectively. This arrangement is also preferable in view of the electrode arrangement. In this case, the points of the water receptacle and the tank, which are located closest to each other, function as the front electrodes. Water detection is made based on the difference in resistance of fuel or water collected between them. In this case, it is possible to improve the precision of water detection by coating part of water receptacle with a non-conductive paint. Further, providing a guard means for guarding the water receptacle on the tank side to which the water receptacle is attached, makes it possible to prevent the water receptacle from being damaged or pitted when the tank is taken out from the main body and refueled.

[0050] Examples of tank insertion detecting means may be constituted of a micro-switch arranged on the top surface of the tank placement board or a combination of a magnet on the tank bottom and a lead switch on the tank placement board.

[0051] When the liquid fuel burning apparatus is controlled based on the input signals from the fuel quantity detecting means, water detecting means and tank insertion detecting means, a controller makes control of stopping the operation when the tank insertion detecting means is off (no tank) and also makes control of actuating an operation mode for baking the vaporizer when

the same detecting means is on. It is also able to determine that the operation is permissible when the tank insertion detecting means is in the ON state and the fuel quantity detecting means for detecting the amount of fuel is in the OFF state (fuel present) and make control of starting the operation. Further, it is possible to perform control of stopping the operation when the tank insertion means is in the ON state (the tank inserted) and when the fuel quantity detecting means for detecting the amount of fuel is in the ON state (no fuel present). It is also possible to make control of displaying refueling warning on the display when the ON state of the fuel quantity detecting means (no fuel present) is detected.

[0052] Further, in order to solve the above problems, the present invention is configured as follows: fuel in the fuel supply tank can be directly fed to the burner unit without providing any fuel tank that temporarily holds fuel, so that the filler cap of the fuel supply tank will not be stained with fuel while the combustion control circuit is adapted to make combustion control based on the signal from the water detecting means in order to prevent water, which, resulting from disuse of fuel tank, might pool in the fuel supply tank, from being delivered to the burner unit so as to suppress influence of water on the burner unit as much as possible.

[0053] Specifically, the present invention is comprised of a burner unit for burning fuel fed from a fuel supply tank; a flame detecting means for detecting the condition of the flame at the burner unit as a flame current value; and a combustion control circuit for controlling the burner unit based on the value detected by the flame detecting means. Further, a water detecting means for detecting water in the fuel supply tank is provided so that the combustion control circuit can control the burner unit based not only on the signal from the flame detecting means but also on the water detection signal from the water detecting means, whereby water pooled in the fuel supply tank is prevented from being fed to the burner unit.

[0054] As the water detecting means, difference in electric resistance between water and fuel is preferably utilized to detect water by applying electric current between the first electrode provided in the fuel supply tank and the second electrode provided outside the fuel supply tank.

[0055] As to water detection, it is best if the combustion control circuit always checks it. However, since water detection is made by flowing a micro current between the electrodes as stated above, electric corrosion to the tank is liable to occur, so that rust other problems may occur. Accordingly, it is preferred that water detection is made at predetermined periods of time.

[0056] Since the water detecting means and the water detecting means measure respective current values by flowing current between electrodes, there is a fear that interference may occur between the two detecting means because of use of a common electrode (earth electrode). Therefore, when the two means are activated

at the same time, precise detection cannot be obtained in some cases. For this reason, only one of the flame detecting means and the water detecting means may be adapted to be actuated at one time so as to improve the precision of detection. In this case, priority should be given to the detection of the burning state, on the basis of the combustion function. Therefore, of the flame detecting means and water detecting means, priority is preferably given to the operation of the flame detecting means and reading of its current value.

[0057] Further, in order to prevent electric corrosion to the tank, it is preferred that water detection is adapted to be made only in the predetermined states of combustion. That is, the combustion control circuit is preferably configured so as to apply current to the water detecting means and receive the signal from the water detecting means only when combustion is in the predetermined status, and detect the flame current value from the flame detecting means, in the other periods, giving priority to determination of the combustion state.

[0058] Here, the predetermined states may include periods of non-operation, time within a predetermined period after the start of operation and predetermined periods during combustion. During a period of non-operation, no flame is detected from the burner unit. Since the time within a predetermined period after the start of operation is allotted for preheating of the vaporizer, no flame is detected from the burner unit. Further, during combustion it is possible to effectively operate both the detecting means if the water detecting means is activated only in limited periods (relatively short periods) while combustion is stable.

[0059] Concerning the timing of water detection, there is a fear of malfunction occurring due to remaining water, immediately after the tank is set into the main body when water has been drained from the tank. Alternatively, the tank outer wall surface may sweat immediately after refueling because of fuel of low temperature. Therefore, water detection is preferably made in other than these periods. In practice, it is possible to avoid malfunction of water detection by providing a tank insertion detecting means for detecting whether the fuel supply tank is set in the main body while the combustion control circuit is adapted not to accept any signal from the water detecting means a fixed period of time from when it has received a tank insertion signal from the tank insertion detecting means.

[0060] The tank insertion detecting means may be, for example, a microswitch arranged on the top face of the tank placement board, or may be a reset switch and others.

[0061] The operation in the combustion control circuit in response to the water detection information may include control of issuing a combustion stop signal to the burner unit and/or control of giving a warning to the display. It is also possible to avoid malfunction of water detection by making control such that when a warning of water detection has been given to the display, combustion

tion may be continued as is and combustion is stopped only when the power of flame lowers to a fixed level.

[0062] That is, the combustion control circuit may be adapted to make such control that, when receiving a water detection signal from the water detecting means during combustion, the control circuit reads the flame current value from the flame detecting means, and continues combustion as is if the flame detection level is higher than the preset flame level and stops combustion only when the flame detection level becomes equal to or lower than the preset level.

[0063] Here, an example of water detecting means may be comprised of a conductive water receptacle which is arranged at the conductive fuel supply tank bottom to collect water, a first electrode in contact with the fuel supply tank, a second electrode in contact with the water receptacle and an insulator which provides electric insulation between the water receptacle and the fuel supply tank and is configured to detect water based on the difference in electric resistance between fuel and water collected in the water receptacle, by applying an electric current between the two electrodes.

Brief Description of Drawings

[0064]

Fig.1 is a front, partly sectional view showing a kerosene fan heater in accordance with an example 1 of the first embodiment of the present invention;
 Fig.2 is an outline view showing the liquid fuel burning apparatus of the same;
 Fig.3 is an outline view showing a fuel supply tank;
 Fig.4 (a) is a view showing the state where the fuel supply tank is set in the main body and (b) is a view showing the state where release of the filler cap is prohibited;
 Fig.5 is a structural view showing an oil feed joint;
 Fig.6 is a structural view showing suction pipes in an oil feed joint and fuel supply tank;
 Fig.7 is a structural view showing a filler cap with a built-in pressure valve of a fuel supply tank;
 Fig.8 is a structural view showing an oil feed joint socket;
 Fig.9 is a structural view showing a burner and a vaporizer;
 Fig.10 is a structural view showing a heat pump;
 Fig.11 is a structural view showing a cooling fin assembly;
 Fig.12 is a view showing the state of the joining portion of a fuel supply tank;
 Fig.13 is an outline view showing a fuel supply tank of an example 2 of the first embodiment of the present invention;
 Fig.14 is an outline view showing a fuel supply tank of an example 3 of the first embodiment of the present invention;
 Fig. 15 is a view showing the state where the fuel

supply tank is set in the main body;

Fig.16 is a perspective view showing a fuel supply tank of an example 4 of the first embodiment of the present invention;

Fig.17 is a sectional view showing a filler port in the state where the filler tank is set in the main body;

Fig.18 is a sectional view showing a filler port when the fuel supply tank is taken out of the main body;

Fig.19 is a sectional view showing a filler port in an example 5 of the first embodiment of the present invention;

Fig.20 is a sectional view showing a filler port in an example 6 of the first embodiment of the present invention;

Fig.21 is a partially sectional front view showing a kerosene fan heater in accordance with the second embodiment of the present invention;

Fig.22 is a structural view showing the liquid fuel burning apparatus of the same;

Fig.23 is a structural view showing a fuel supply tank of the same;

Fig.24 is a perspective view showing a joining portion of the fuel supply tank of the same;

Fig.25 is a structural sectional view showing an oil feed joint of the same;

Fig.26 is a structural sectional view showing a return oil joint of the same;

Fig.27 is a structural sectional view showing an oil feed side joining means of the same;

Fig.28 is a structural sectional view showing an oil feed joint socket;

Fig.29 is a structural sectional view showing a return oil side joining means of the same;

Fig.30 is a side view showing a fuel supply tank;

Fig.31 is a sectional view showing the arrangement of a fuel supply tank and placement board;

Fig.32 is a sectional view showing the bottom part of the fuel supply tank of the same;

Fig.33 is a perspective view showing a water receptacle attachment hole of a fuel supply tank of the same, viewed from the tank interior;

Fig.34 is a structural view showing a burner and a vaporizer of the same;

Fig.35 is a structural view showing a collecting container of the same;

Fig.36 is a structural view showing a cooling fin assembly of the same;

Fig.37 is a diagram showing a control circuit of a liquid fuel burning apparatus of the same;

Fig.38 is a diagram showing the analog electric circuit of the same;

Fig.39 is a perspective view showing a main body of a kerosene fan heater in accordance with the third embodiment of the present invention;

Fig.40 is a backside perspective view showing the kerosene fan heater shown in Fig.39;

Fig.41 is an outline structural view showing the liquid fuel burning apparatus shown in Fig.39;

Fig.42 is a front view of the main body shown in Fig. 39 with part of the front panel cut away;

Fig.43 is an outline view showing a burner unit and a vaporizer shown in Fig.39;

Fig.44 is an outline view showing the vaporizer shown in Fig.43; 5

Fig.45 is a sectional side view showing a burner unit in the main body shown in Fig.39;

Fig.46 is a front view showing a burner unit in the main body shown in Fig.39; 10

Fig.47 is a top view showing the tank side of the main body shown in Fig.39;

Fig.48 is an outline view showing a fuel supply tank in Fig.39;

Fig.49 is an outline view showing a connecting joint unit of the fuel supply tank of Fig.48; 15

Fig.50 is a sectional outline view showing an example 3 of an air hole shutoff means of Fig.42;

Fig.51 is a sectional outline view showing the air hole shutoff means when the fuel supply tank is set in the main body; 20

Fig.52 is a sectional outline view showing an example 4 of an air hole shutoff means in the figure;

Fig.53 is a sectional outline view showing the air hole shutoff means when the fuel supply tank is set in the main body; 25

Fig.54 is an outline structural view showing an example 1 of an air hole shutoff means of Fig.42;

Fig.55 is an outline structural view showing an example 2 of an air hole shutoff means of Fig.42; 30

Fig.56 is a sectional view showing the oil feed side joint in the connecting joint unit shown in Fig.49;

Fig.57 (a) is an exploded perspective view showing the assembled state of a suction pipe with the oil feed side joint and (b) is a sectional view cut along a plane A-A in (a); 35

Fig.58 is a sectional view showing the return oil side joint in the connecting joint unit shown in Fig.49;

Fig.59 (a) is an exploded perspective view showing the assembled state of a return pipe with the return oil side joint and (b) is a sectional view cut along a plane B-B in (a); 40

Fig. 60 is an outline view showing a water detecting means and a fuel quantity detecting means in the fuel supply tank shown in Fig.48; 45

Fig.61 is an outline view showing a filler port shutoff means of the fuel supply tank shown in Fig.48;

Fig.62 is a side view showing an engaging lever shown in Fig.61;

Fig.63 is an outline front view showing the connecting joint socket unit, electromagnetic pump and associated parts on the burner unit side shown in Fig. 48; 50

Fig.64 is an outline plan view showing the connecting joint socket unit, electromagnetic pump and associated parts on the burner unit side shown in Fig. 48; 55

Fig.65 is an outline view showing the connecting

joint socket unit and pipes shown in Fig.63;

Fig.66 is an outline view showing the oil feed side joint socket and air valve in the connecting joint socket unit shown in Fig.63;

Fig.67 is an outline view showing the return oil side joint socket in the connecting joint socket unit shown in Fig.63;

Fig.68 (a) is a rear view of the air valve shown in Fig.66 and (b) is an outline sectional view showing the air valve and joint socket portion;

Fig.69 is an outline view showing the detector board on the fuel supply tank side in Fig.42;

Fig.70 is an outline view showing the associated parts of the tank insertion detecting means on the fuel supply tank side in Fig.42;

Fig.71 (a) is a perspective view showing an electrode lever on the water receptacle side in the detector board shown in Fig.69 and (b) is a view showing the state of its attachment;

Fig.72 is a view showing the state of attachment of an electrode lever on the tank side in the detector board shown in Fig.69;

Fig.73 is an outline view showing the tank insertion detecting means in Fig.70;

Fig.74 is a block diagram for illustrating control of burning of Fig.42;

Fig.75 is an outline view showing the oil feed side joint and its joint socket when the tank is inserted in Fig.42;

Fig.76 is an outline view showing the oil feed side joint and its joint socket when the tank has been fitted in Fig.42;

Fig.77 is an outline view showing the return oil side joint and its joint socket when the tank is inserted in Fig.42;

Fig.78 is an outline view showing the return oil side joint and its joint socket when the tank has been fitted in Fig.42;

Fig.79 is an outline sectional view showing a filler port with a filter in the fuel supply tank in Fig.42;

Fig.80 (a) is a plan view showing the filter shown in Fig.79 and (b) is a front view of the same;

Fig.81 is an outline view of the top part of a filter body ;

Fig.82 is an outline sectional view showing an example 2 of a filter;

Fig.83 is an outline sectional view showing an example 3 of a filter;

Fig.84 is a partly abbreviated, front sectional view showing a conventional kerosene fan heater;

Fig. 85 is a side sectional view showing the same kerosene fan heater; and

Fig.86 is a sectional view partly showing a fuel supply tank and its socket of the same configuration.

Best Mode for Carrying Out the Invention

[The first embodiment]

(Example 1)

[0065] The embodiment of the present invention will be described with reference to the drawings. Fig.1 is a front overall view showing a kerosene fan heater including a liquid fuel burning apparatus in accordance with the embodiment. Fig.2 is an outline view showing the liquid fuel burning apparatus.

[0066] A kerosene fan heater body 1 is comprised of a detachable front panel 2, a top panel 3 integrally formed with side panels, a control portion 4 allowing for operation control, an outlet port 5 from which warm air is blown out, and an openable and closable lid 7 arranged at the right side in the top of top panel 3 for permitting a fuel supply tank 6 to be fitted in and taken out, and is placed and fixed on a mount base 8 for holding liquid fuel in case of leakage.

[0067] As shown in Figs.1 and 2, main body 1 incorporates detachable fuel supply tank 6 for temporarily storing fuel, an oil feed joint 9, of connecting means, having a valve for opening and closing the passage from a pipe for suctioning fuel from fuel supply tank 6, an oil feed joint socket 10 for receiving the valve of oil feed joint 9, a tank guide 11 to which oil feed joint socket 10 is attached, a vaporizer 12 for vaporizing fuel from fuel supply tank 6, an electromagnetic pump 13 for feeding fuel from fuel supply tank 6 to vaporizer 12, a burner 14 for mixing vaporized fuel through vaporizer 12 with primary combustion air and burning the mixture, a combustion chamber 15 enclosing burner 14 for burning, a partition 16 for partitioning burner 14 and combustion chamber 15, a burner box 17 for holding burner 14, a heat pipe 18 for retaining fuel from vaporizer 12, a cooling fin assembly 19 located between vaporizer 12 and heat pipe 18 to cool fuel, and an air valve 20 for sending air for shutting off fuel between fuel supply tank socket 10 and electromagnetic pump 13.

[0068] Fuel supply tank 6 is detachably accommodated in an tank holding compartment 500 partitioned by the side wall of the main body and tank guide 11 (Fig. 1), and is comprised of, as shown in Fig.3, a tank body of a vertically long parallelepiped for holding fuel, a handle 21 which is attached to the top face of the tank body for its carriage, an oil gauge 23 disposed on a face close to a filler port so as to allow visual indication of the fuel supplied state, an oil feed joint 9 disposed on the same top face as handle 21 for extracting fuel from fuel supply tank 6, a filler port 28 disposed on a bevel 501 (Fig.4(b)) formed between the top face and a side face of fuel supply tank 6 for refueling and a filler cap 22 with a built-in pressure valve, having a pressure releasing valve mechanism, for permitting opening and closing of the filler port 28.

[0069] Oil feed joint 9 is a joining means for creating

connection with an oil feed path of main body 1 when fuel supply tank 6 is inserted into tank holding compartment 500 of main body 1 and is composed of a valve mechanism 24 of a spindle type for shutting off fuel and a suction pipe 25 for suctioning fuel from fuel supply tank 6.

[0070] If refueling of fuel supply tank 6 is permitted without fuel supply tank 6 being taken out from main body 1, there is a risk of causing a fire in case fuel overflows when fuel is charged into fuel supply tank 6 while it is mounted in main body 1. Therefore, fuel supply tank 6 is configured so that refueling is not allowed unless fuel supply tank 6 is taken out from main body 1.

[0071] As shown in Figs.3 and 4, fuel supply tank 6 of this embodiment is configured in such a manner that bevel 501 is formed by beveling the top face, designated at 26, of fuel supply tank 6, on which handle 21 is provided and the side face, designated at 27, of fuel supply tank 6, on which oil gauge 23 is provided, and a filler port 28 is arranged on this bevel 501. This bevel 501 having filler port 28 is inclined with such an angle that will not allow filler cap 22 with a built-in pressure valve, screw fitted on filler cap 22, to be opened when a lid 7 of main body 1 is just opened. Illustratively, as shown in Fig. 4 (b), the space formed between bevel 501 and the wall surface of tank guide 11 of tank holding compartment 500 is sized so as not to release filler cap 22 as a shutoff means from filler port 28, or so that the head of cap 22 will not be opened by its interference with the wall surface of tank guide 11 when the cap tries to be released.

[0072] The angle that will not allow filler cap 22 with a built-in pressure valve, screw fitted on filler cap 22, to be opened, indicates that an angle at least 30 degrees or greater is inclined downwards from the edge of the top face of fuel supply tank 6 on which handle 21 is provided, though it depends on the positional relationship between the size of the opening of lid 7 and tank guide 11 enclosing fuel supply tank 6.

[0073] Since, by the above arrangement, filler cap 22 with a built-in pressure valve, screw fitted on filler cap 22 cannot be opened while fuel supply tank 6 is inserted in main body 1, it is necessary when refueling to take out fuel supply tank 6 from main body 1 and hence there is no concern of fuel leakage inside main body 1 when fuel supply tank 6 is refueled.

[0074] Valve mechanism 24 of oil feed joint 9 as a joining means to the oil feed passage when fuel supply tank 6 is inserted in the main body is composed of, as shown in Fig.5, an inverted conical valve element 33 which will be seated on and be away from a valve seat around a valve hole formed in the lower part of the valve chamber and has, at its lower end, a projection rod 33a projected downward through the valve hole, an annular O-ring packing 34 fitted on the conical sealing surface of valve element 33 for sealing with the valve seat and a spring 35 for urging valve element 33 in the valve closing direction.

[0075] Valve spring 35 provided in a coil form is interposed between valve element 33 and a lid nut 37 fitted into the top opening of the valve chamber with a sealing packing 36 in between. A projection surrounding the valve hole is formed from the undersurface of the valve chamber. An O-ring 38 for creating sealing with oil feed joint socket 10 is fitted on the peripheral side of the projection while an entrance to a return passage 40 for returning the fuel liquefied, from vaporizer 12, to fuel supply tank 6 is formed at a peripheral position of the undersurface.

[0076] A passage 39 for suctioning fuel from fuel supply tank 6 is formed on the upstream side of valve mechanism 24. Return passage 40 for returning the fuel liquefied, from vaporizer 12, to fuel supply tank 6 is arranged along this suction passage 39. Formed on the surface of fuel supply tank 6 to which oil feed joint 9 is joined are an insert hole 41 (Fig. 6) for attachment of suction pipe 25 from fuel supply tank 6, an insert hole 42 as a return port for the fuel returned from the vaporizer and an attachment hole 43 for screw fixing the lower part of oil feed joint 9 to the fuel supply tank. Oil feed joint 9 is fixed to fuel supply tank 6 by a screw with a rubber packing 447 interposed in between.

[0077] Connected to passage 39 which flows into valve mechanism 24 of oil feed joint 9 from its upstream side is suction pipe 25 for suctioning fuel from fuel supply tank 6. Suction pipe 25 almost reaches the bottom of fuel supply tank 6 opposite to that with handle 21 and has a suction opening 444 at its distal end in which a filter 45 that blocks water and dust from permeating is fitted. This suction opening 444 may be formed at the side face as well as the bottom face at the distal end of suction pipe 25.

[0078] Further, as shown in Fig. 6, a means for detecting the residual amount of fuel in fuel supply tank 6 is arranged near suction opening 444. This detecting means is comprised of a float 46 incorporating a magnet 504 functioning as a detection portion and a lead switch 448 which is disposed opposing the float 46. Float 46 is externally fitted on a cylindrical suction port body 47 which is externally fixed at the bottom end of suction pipe 25, and is able to move vertically relatively to cylindrical suction port body 47 in accordance with the variation of the fuel level. When the surface of fuel in fuel supply tank 6 reaches a certain level, lead switch 448 incorporated in the suction port body detects magnetism from magnet 504 in float 46 and sends the detection to controller 4, so that display warnings of the end of fuel and the like can be given.

[0079] As shown in Fig. 7, filler cap 22 with a built-in pressure valve is composed of a cap 48 mating the mouth of filler port 28 which is formed on the fuel supply tank 6 side and has a thread formed on its outer periphery and a pressure valve mechanism 49. This filler cap is screw fitted to filler port 28 with a rubber packing 50 in between. Cap 48 has a pressure releasing hole 51 on its ceiling for releasing pressure. The side of the cap is

threaded and its brim is curled. Rubber packing 50 provides a sealing function between filler port 28 and cap 48 and has a pressure releasing hole 52 at the center thereof for relieving pressure. Pressure valve mechanism 49 is composed of a valve element 53 arranged in a space between this rubber packing 50 and the ceiling of cap 48 and a spring 54 for urging this valve element 53 in the direction pressure releasing hole 52 is closed. Further, in order to prevent occurrence of negative pressure in the fuel supply tank, holes 97 and 98 having a diameter equal to or smaller than 1.5 mm are formed in rubber packing 50 and the ceiling of cap 48. These holes 97 and 98 may be formed on the top face of the fuel supply tank.

[0080] When fuel supply tank 6 is mounted in the main body, oil feed joint socket 10 (Fig. 12) is located under valve mechanism 24 of oil feed joint 9. Oil feed joint socket 10 is composed of, as shown in Fig. 8, a valve retainer 55 for receiving valve element 33 of valve mechanism 24 in oil feed joint 9 and a retainer body 56.

[0081] Valve retainer 55 has a valve abutment 57 for receiving valve element 33 of valve mechanism 24 of oil feed joint 9 and a grating hole 58 of a fuel flow channel given in a latticed configuration. Retainer body 56 includes: a sealing surface 59 for creating sealing with valve mechanism 24 of oil feed joint 9; a valve retainer holder 60; a passage 61 providing connection from grating hole 58 of valve retainer 55 to electromagnetic pump 13; and a passage 62 which branches off at a halfway point of the above passage, in a T-shaped configuration and is connected to air valve 20 (Fig. 2). An annular concave groove 63 is formed around valve retainer 55. This concave groove 63 has a passage 64 connected to a heat pump 18 and functions as a path for fuel to return from heat pump 18. Here, the exits of the three passages are threaded at their mating portions so as to fix oil feed pipes to be connected to other components.

[0082] Oil feed joint socket 10 has an annular groove portion 65 outside concave groove 63. A cylindrical bellows-like packing 66 is fitted to the groove portion 65. When fuel supply tank 6 is set to main body 1, valve mechanism 24 of oil feed joint 9 is inserted to the predetermined position of oil feed joint socket 10 so that O-ring 38 fitted on the outside of valve mechanism 24 comes into sealing contact with sealing surface 59 of valve retainer body 56 of oil feed joint socket 10 while bellows-like packing 66 of oil feed joint socket 10 creates hermetic sealing with oil feed joint 9.

[0083] As shown in Fig. 2, air valve 20 is provided so as to shut off fuel in the oil feed path from fuel supply tank 6 to electromagnetic pump 13, and a path led to air valve 20 is formed from passage 62 which branches off, in a T-shaped manner, at a halfway point of the passage 61 from retainer body 56 of oil feed joint socket 10 to electromagnetic pump 13. Passage 62 is disposed above the liquid level of fuel in fuel supply tank 6 when the tank is full. Air valve 20 is closed during operation and is opened when the apparatus is not in operation,

and sends air to the oil feed path from oil feed joint socket 10 to electromagnetic pump 13 so as to shut off fuel. Further, when vaporizer 12 is baked for cleaning, air valve 20 is opened and electromagnetic pump 13 is actuated so as to send air to vaporizer 12.

[0084] As shown in Fig.9, vaporizer 12 is comprised of a vaporizing element 67 for vaporizing fuel by heating, a nozzle 68 for ejecting the fuel evaporated by vaporizing element 67, a needle 69 for opening and closing the hole of nozzle 68, a solenoid valve 70 for moving needle 69 by electricity, a fuel entrance 71 for supplying fuel to vaporizing element 67, a return port for sending out the fuel inside vaporizer 12 when the operation stops and a heat collector 773 for collecting combustion heat from burner 14.

[0085] Vaporizing element 67 is a sintered cylinder made of fine ceramic particles, and tar arising when fuel evaporates accumulates inside vaporizing element 67 from its surface inwards. Fuel entrance 71 to vaporizer 12 has a double pipe structure of an outer stainless pipe 73 and an inner copper pipe 74 so as to reduce heat conduction from vaporizer 12 and thereby suppress temperature rise of fuel entering vaporizer 12. Here, stainless pipe 73 is made greater in diameter than copper pipe 74 while the end of copper pipe 74 is extended more to the outside than vaporizer 12, to thereby further lower heat conduction.

[0086] Solenoid valve 70 is mainly composed of an electromagnetic coil 75, a moving piece 76, an attracting piece 77 and a pressure spring 78. As electric current through electromagnetic coil 75 is turned on or cut off, moving piece 76 is attracted to or departs from attracting piece 77, so as to cause needle 69 attached to moving piece 76 to move whereby the hole of nozzle 68 of vaporizer 12 is made open or closed.

[0087] Burner 14 is composed of a mixing tube 79 for mixing the combustion gas evaporated through vaporizer 12 with primary combustion air and a flame port 80 for burning the mixed combustion gas.

[0088] The electromagnetic pump 13 is a pump for feeding fuel and is arranged with its suctioning side set at bottom and its delivering side at top so as to avoid air stagnating inside the electromagnetic pump.

[0089] As shown in Fig.10, heat pipe 18 is configured so that a fuel inlet 82 from vaporizer 12 is formed on the side of a container body 81 while a fuel outlet 83 is formed on the top face of container body 81 and a pipe 84 having a funnel shaped opening 85 at the distal end thereof is inserted into outlet 83, almost reaching the bottom of container body 81. When electromagnetic pump 13 is halted by temperature control from the start to end of operation, nozzle 68 of vaporizer 12 is closed and fuel in vaporizer 12 is returned to fuel supply tank 6 by way of heat pipe 18. Here, the returned fuel roughly amounts to 0.3 to 0.5 cc each time. Since electromagnetic pump 13 can be assumed to halt roughly ten times a day if the kerosene fan heater heat is operated all day long, container body 81 is set to have a volume of about

20 cc.

[0090] Further, provided halfway along the path from vaporizer 12 to heat pump 18 is a cooling fin assembly 19 (Fig.2) for radiating heat from the fuel returned from vaporizer 12. This cooling fin assembly 19 is composed of, as shown in Fig.11, a pipe 87 and thin fins 86 formed on its peripheral side.

[0091] As shown in Fig.2, oil feed pipes 88, 89, 90, 91, 92 and 93 for connections between different parts, namely connections between oil feed joint socket 10 and electromagnetic pump 13, between electromagnetic pump 13 and vaporizer 12, between vaporizer 12 and cooling fin assembly 19, between cooling fin assembly 19 and heat pipe 18, heat pipe 18 and return oil joint socket 10 and between air valve 20 and oil feed joint socket 10, are all formed of copper pipes. Here, the pipe from fuel supply tank 6 to electromagnetic pump 13 may be formed of resin pipes or others, instead of copper pipes.

[0092] As shown in Figs.3 and 4, a magnet 30 arranged in the detection portion as a means for detecting the insertion of fuel supply tank 6 into main body 1 is disposed on the side 29 opposite to the side 26 on which handle 21 of fuel supply tank 6 is disposed while a lead switch 32 as a detecting portion is arranged on a fuel supply tank receiver 31 (Fig.4) of the main body, at a position opposing the detection portion of fuel supply tank 6. As fuel supply tank 6 is inserted into main body 1, the tank detecting means made up of the magnet 30 and lead switch 32 detects it and the apparatus becomes ready to start operation.

[0093] The operation of the above configuration will be described. Fuel is charged into fuel supply tank 6 through filler port 28 by opening lid 7 of main body 1, taking out the empty fuel supply tank 6 by holding handle 21, releasing and removing filler cap 22 with a built-in pressure valve with the handle 21 side up.

[0094] When refueling is completed, the fuel supply tank 6 filled up with fuel is set into tank holding compartment 500 after opening lid 7 of main body 1. As fuel supply tank 6 is mounted in the main body, the magnet 30 at the tank bottom actuates lead switch 32 on the main body side, whereby insertion of tank 6 in the main body is confirmed.

[0095] Upon fuel supply tank 6 being inserted into the main body, valve element 33 in valve mechanism 24 of oil feed joint 9 presses valve abutment 57 of oil feed joint socket 10 (Fig.12), and valve element 33 moves upwards so that valve element spring 35 which have extended becomes compressed, whereby a gap is created between O-ring 34 on the sealing surface of valve element 33 and the seat valve and a fuel channel flowing through this gap to the electromagnetic pump 13 side is formed.

[0096] When electric power is turned on by actuating the operating switch (not shown) of the kerosene fan heater, the vaporizer heater (not shown) attached to vaporizer 12 heats vaporizer 12. During this period, a va-

porizer thermistor (not shown) detects the temperature of the vaporizer 12. When vaporizer 12 is heated to a predetermined temperature, electromagnetic pump 13 is actuated so as to suction liquid fuel inside fuel supply tank 6 through suction pipe 25 and sends it to vaporizer 12 by way of oil feed joint 9 and oil feed joint socket 10.

[0097] The liquid fuel is gasified by the heated vaporizer 12 and the gas is ejected from flame port 80 (Fig.9) of burner 14, ignited at the flame port 80 to burn in the combustion chamber. At the same time, based on the difference in temperature between the room temperature detected by a room temperature sensor and the set temperature designated through the control portion, a controller (not shown) controls drive of electromagnetic pump 13 to vary the amount of liquid fuel fed to vaporizer 12, whereby the heat generation rate of burning is controlled appropriately.

[0098] When combustion starts and the flame sensor detects a flame current equal to or greater than the pre-set current value, a fan motor is activated so that the blower fan starts rotating to suction air from the room. The rotational rate of the fan is controlled by the controller. The air suctioned from the room absorbs the radiated heat in combustion chamber 15 and is blown out together with the combustion gas as warm air through air outlet 5 to the outside of main body 1 (the room), to thereby increase the temperature of the room.

[0099] Next, when the operation of main body 1 is stopped, drive of electromagnetic pump 13 is deactivated and electric current through the vaporizer heater is stopped. At the same time, solenoid valve 70 is also deactivated so as to release moving piece 76 and attracting piece 77, whereby the hole of nozzle 68 is closed by needle 69 attached to attracting piece 77. The fuel remaining inside vaporizer 12 passes through the gap between the sealing surfaces of solenoid valve 70 body and needle 69, and proceeds through oil feed pipes 90 and 91 to heat pump 18, where the fuel is stored.

[0100] The fuel elevated in temperature radiates heat by cooling fin assembly 19 which is arranged between the oil feed pipes 90 and 91, and is cooled and sent to heat pipe 18. When the fuel is fed into heat pipe 18, part of the fuel is present in gas, but it reduces in temperature with the passage of time, whereby the gas is liquefied.

[0101] That is, when the operation stops or when combustion is turned off by room temperature control, solenoid valve 70 is deactivated and moving piece 76 of solenoid valve 70 is released from attracting piece 77. When needle 69 attached to attracting piece 77 closes the hole of nozzle 68 of vaporizer 12, fuel residing in vaporizer 12 passes through the gap between the sealing surface of solenoid valve 70 body and that of needle 69 and is sent to heat pump 18 by way of the oil feed pipes, or pipes 88 and 89.

[0102] Upon ignition, nozzle 68 is closed for about one to two minutes until fuel is heated to change from liquid to gas inside vaporizer 12 and is emitted from nozzle 68. The internal pressure in vaporizer 12 rises to about

0.2 kg/cm due to the hole of nozzle 68 of vaporizer 12 being closed. This pressure acts on the interior of heat pipe 18 by way of oil feed pipes 90 and 91.

[0103] This pressure acts on the surface of the liquefied fuel in container 81 of heat pipe 18 so as to push down the oil surface and send the liquefied fuel out from funnel shaped port 85 at the lower end of pipe 84 arranged inside heat pipe 18. The fuel then proceeds through oil feed pipe 92 (Fig.2), passage 64 of retainer body 56 of oil feed joint socket 10 (Fig.10), concave groove 63 and return passage 40 (Fig.5) of oil feed joint 9, into fuel supply tank 6 and stored therein.

[0104] When fuel is added into fuel supply tank 6, fuel supply tank 6 is taken out from main body 1 and fuel is charged from another container outside the main body. In this situation, fuel supply tank 6 is placed on a flat site with the handle 21 side up, cap 22 with a built-in pressure valve which is present on the same side as handle 21 is loosened and removed and fuel is charged from filler port 28 of fuel supply tank 6 using a refueling pump.

[0105] In this way, it is no longer necessary to turn fuel supply tank 6 upside down when fuel is charged into fuel supply tank 6. Accordingly, it is possible to perform refueling without the filler cap of fuel supply tank 6 being stained with fuel, as used to be the case.

[0106] Since filler port 28 is provided on bevel 501 (Fig.4(b)) and filler cap 22 cannot be opened due to its interference with tank guide 11 of the main body if tried, refueling of the tank as it remains in the main body is prohibited, thus making it possible to ensure the safety.

(Example 2)

[0107] Fig.13 shows a fuel supply tank configuration of an example 2. A filler port 152 is provided on a side face 151 adjacent to the side on which an oil gauge 23 of fuel supply tank 6, so that a cap 22 with a built-in pressure valve cannot be opened when lid 7 is just opened.

[0108] This arrangement does not allow refueling unless the fuel supply tank is taken out from the main body. Thus, it is possible to prevent fuel from spilling into main body 1 during refueling.

[0109] Further a float switch 154 representing the liquid level is provided as a means for detecting the remaining fuel in fuel supply tank 6, on the side 153 opposite to the side on which tank handle 21 is provided. This float switch 154 is attached to a lid 155 covering the water drain hole through which water pooled inside fuel supply tank 6 is discharged. When the liquid level of fuel in fuel supply tank 6 reaches the predetermined level, the float switch is actuated to give a warning of display of the end of fuel or the like, on the control portion of the main body. Other configurations and operations are the same as the above example 1.

(Example 3)

[0110] Figs.14 and 15 show a fuel supply tank config-

uration of an example 3. Both a filler port 28 and a handle 21 are provided on the top face of fuel supply tank 6. Handle 21 is pivotally supported so as to be upright and laid down. A structural part 183 that braces a cap 22 with a built-in pressure valve, screw fitted on filler port 28, after insertion of fuel supply tank 6 into main body 1 is attached to handle 21. Further, a stopper part 181 (Fig.15) and a solenoid 182 of an electromagnetic coil which stop rotation of handle 21 with structural part 183 when the handle is laid down after insertion of fuel supply tank 6 into main body 1 are provided on the wall of the tank holding compartment, at a position opposing filler port 28.

[0111] Detailedly, when fuel supply tank 6 is inserted into main body 1 and handle 21 is laid down to the filler port 28 side to close lid 7, a tank detecting means detects the fact of insertion of fuel supply tank 6 into main body 1 and the electromagnetic coil is actuated to move stopper part 181 attached to solenoid 182 to the fuel supply tank 6 side to thereby hold down structural part 183 which braces cap 22 with a built-in pressure valve for fuel supply tank 6.

[0112] Since this arrangement prohibits cap 22 with a built-in pressure valve, screw fitted on filler port 28 of fuel supply tank 6, from being removed when the tank is set in main body 1, it is impossible to refuel the tank unless the fuel supply tank is taken out from the main body, whereby is possible to prevent fuel from spilling inside main body 1 when refueling.

[0113] Here, the tank detecting means may be composed of a magnet 30 and a lead switch 32 in the same manner as in the above example 1 and is configured so as to detect insertion of the fuel supply tank and get the apparatus ready to start operation when fuel supply tank 6 is set in main body 1.

(Example 4)

[0114] Figs.16 and 18 are views showing an example 4. Fig.16 is a perspective view showing a fuel supply tank; Fig.17 is a sectional view showing a filler port when the fuel supply tank is set in the main body; and Fig.18 is a sectional view showing the filler port when the fuel supply tank is taken out from the main body.

[0115] As illustrated, a fuel supply tank 6 is constructed such that a bevel 501 that extends at a predetermined angle, of at least 30 degrees, downwards from the top face, cutting two side faces which adjoin to the top face, is formed and a filler port 28 (Fig.17) is provided on this bevel 501.

[0116] Filler port 28 is closed by a pivotal lid component. Specifically, a shutoff means 600 of filler port 28 is composed of a fixing plate 601 which has an opening fitted to filler port 28 and is spot-welded on bevel 501, a moving plate 603 which is pivotally supported by an upturned piece 602 formed on this fixing plate 601 on the top handle side, a lid part 605 which has a packing 604 and is disposed on the inner side of moving plate 603

for closing a mouth 28a of filler port 28, a coil spring element 606 interposed between this lid part 605 and the inner side of moving plate 603 for pressing lid part 605 toward mouth 28a of filler port 28, and an engaging means 607 for keeping moving plate 603 in its filler port closed position.

[0117] Fixing plate 601 extends from bevel 501 to the tank top face and also has a shaft support 623 (Fig. 16), in that extended part, which pivotally supports handle 21 at its lower leg end so as to be upright and laid down. Moving plate 603 is supported on the handle side at a pivot 611 while engaging means 607 is provided at the free end side. The length of moving plate 603 is designed so that when moving plate 603 is tried to be opened with the tank inserted in the main body, it cannot be opened due to its free end being blocked by tank guide 11.

[0118] Lid part 605 is formed like a dish and has an outer flange 608, which is engaged by an annular stopper part 610 formed in the inner face of moving plate 603, so as not to slip off and so as to move in a direction perpendicular to the plate surface of the moving plate. A packing 604 is an annular part and fitted to the outer periphery of the central projected portion of the lid part so that it will be pressed against the brim of mouth 28a. Spring element 606 is disposed in the inner space between moving plate 603 and lid part 605.

[0119] Engaging means 607 is disposed on the side opposite to pivot 611 of moving plate 603 or the free end side thereof, in other words, on the lower end side of bevel 501 close to tank guide 11 of the tank holding compartment. The engaging means is composed of an engagement lever 615 with a pin-like engaging piece 614 rotationally supported on a shaft 613 on the free end side of the moving plate, a hook-like engaging hold 616 provided on fixing plate 601 for meshing engaging piece 614 to hold moving plate 603 in its closed position and a lever spring 617 for urging lever 615 in the direction engaging piece 614 is engaged with engaging hold 616.

[0120] Lever spring 617 is a coil spring element which is wound on a rotary axle 618 of engaging lever 615, with one end hooked on a cut and upturned piece 619 of the engaging lever and the other end engaged by stopper part 610 of moving plate 603. This spring is arranged on the inner face side of engaging lever 615 so as to urge engaging lever 615 more to the outside than moving plate 603. The reason no coil spring element is used on pivot 611 of moving plate 603 is to prevent moving plate 603 from spring up over fuel supply tank 6 and rotating when the engaged state of engaging lever 615 is released. This arrangement eliminates unsafeness such as jeopardy and the like.

[0121] Engaging hold 616 has a space for permitting engaging piece 614 to enter between itself and the side wall of mouth 28a and opens to the mouth 28a side, so as to engage engaging piece 614, in a detachable manner.

[0122] Engaging lever 615 is so formed that its outer

edge partly extends, forming a triangular shape, and when engaging lever 615 is in the engaged position, the lever is positioned so that its back opposes, and is spaced only a slight gap from, tank guide 11, prohibiting a finger, for releasing the engaging lever, from being inserted into the gap. Further, when engaging lever 615 is in the engaged position, it does not protrude outside beyond the tank side face. If engaging lever 615 is tried to be rotated so as to release when the tank is mounted in the main body, the extended part 620 interferes with the wall 11 of the tank holding compartment to thereby prohibit rotation and release of engaging lever 615.

[0123] In the above configuration, when engaging lever 615 is pushed toward the mouth while engaging lever 615 is in its engaged state, engage piece 613 comes off engaging hold 616, and the engagement of shutoff means 600 (Fig. 18) is released. However, since the filler port is provided on bevel 501 and since engaging lever 615 is formed with extended part 620 (Fig. 17), if engaging lever 615 is tried to be rotated and released, engaging lever 615 is hidden by moving plate 603 when tank 6 is mounted in the main body. Further, since, in this situation, the back of engaging lever 615 opposes the wall of the tank holding compartment so as not to allow a finger to enter the gap, it is impossible to release engaging lever 615.

[0124] Even if, in order to release engaging lever 615, a releasing member is forcibly inserted into the gap between engaging lever 615 and tank guide 11 and thereby if the engagement of engaging lever 615 is released, extended portion 620 of engaging lever 615 and the free end 63a of moving plate 603 abut the wall surface (tank guide) 11 of the tank holding compartment, so as to prohibit moving plate 603 from being released. Therefore, no refueling is allowed unless fuel supply tank 6 is taken out from the main body. Thus, it is possible to prevent fuel from spilling into the main body when refueled.

[0125] Other configurations and operations are the same as the above example 1, description is omitted. In the above embodiment, the description was made referring to a case where the engaging lever is provided on the moving plate side, but the engaging lever may be arranged on the fixing plate side.

(Example 5)

[0126] Fig. 19 is a sectional view showing a filler port and its vicinity of an example 5. This example is similar to example 4 in that a rotary shutoff means with an engaging means 607 is arranged on a bevel 501, and differs from example 4 in that the free end side is arranged on the tank center side and a pivot 611 is on the tank guide 11 side while a limiting part 625 for preventing the shutoff means from opening when the tank is set in the main body is arranged at a position more outside than pivot 611 of the moving plate.

[0127] Specifically, the end part of moving plate 603 outside pivot 611 is bent upwards, forming limiting part

625 opposing tank guide 11, so that, if moving plate 603 is tried to be rotated for disengagement by releasing the engaging means while the tank is set in the main body, limiting part 625 abuts the wall surface of tank guide 11 to thereby prohibit rotation and release of the moving plate.

[0128] In the above configuration, a filler port disengagement stopper means is constructed by bevel 501, limiting part 625 and tank guide wall 11, so that no refueling is allowed unless fuel supply tank 6 is taken out from the main body. Thus, it is possible to prevent fuel from spilling into the main body when refueled.

[0129] Other configurations of the shutoff means are the same as in example 4. The other components are the same as example 1, so description is omitted.

(Example 6)

[0130] Fig. 20 is a sectional view showing a filler port and its vicinity of an example 6. In this example, a shutoff means 600 is provided on the top face of the tank, instead of a bevel of the tank. When a rotary shutoff means similar to that of example 4 is provided on the tank top face, shutoff means 600 may be easily opened even when the tank is set in the main body.

[0131] In this example, in order to prevent this shutoff means 600 from being released, a pivot 611 of a moving plate 603 is disposed at a position more peripheral side of fuel supply tank 6 and part of moving plate 603 outside the pivot is bent downwards, forming an L-shaped limiting part 625 while the upper part of tank guide wall 11 is set back to the sideways, forming a stepped portion 627, so that the lower end of limiting part 625 and stepped portion 627 oppose to each other, being in contact or marginally spaced from one another when the tank is set in place.

[0132] In the above configuration, when the shutoff means is tried to be rotated and released, the lower end of limiting part 625 on the pivot 611 side abuts stepped portion 627 of the tank guide, hence moving plate 603 cannot be opened more than that. Accordingly, no refueling is allowed unless fuel supply tank 6 is taken out from the main body. Thus, it is possible to prevent fuel from spilling into the main body 1 when refueled.

[0133] Other configurations of the shutoff means are the same as in example 4. The other components are the same as example 1, so description is omitted.

[Other examples]

[0134] The present invention should not be limited to the above examples and many changes and modifications can be of course added within the scope of the present invention. Since this invention is characterized in that a filler port on the top of the tank is prevented from being released when the tank is set in the main body, other constituents, for example, the burning system should not be limited to that including the vaporizer

and burner unit illustrated in the drawings, but an appropriate system can be adopted.

[0135] In the description of the above embodiment, both the oil feed passage and the return oil passage are included in the joining means of the fuel supply tank, but a configuration including only an oil feed passage may be possible. Further, in the above embodiment, the oil feed passage and the return oil passage are arranged in a single joint, but the two passages may be constructed by separate joints.

[0136] As has been described heretofore, according to the present invention, since a filler port disengagement stopper means is provided to prevent the shutoff means for closing the filler port from being released when the fuel supply tank is set in the main body, refueling is not allowed unless the fuel supply tank is taken out from the main body. Thus, it is possible to improve safety while eliminating concern of fuel leakage.

[0137] Further, provision of a means for detecting insertion of the fuel supply tank into the main body makes it possible to check the setting of the fuel supply tank, hence prevent start of the operation when no fuel supply tank is set. Moreover, provision of a means for detecting the liquid level of fuel in the fuel supply tank makes it possible to give warnings and display of refueling.

[The second embodiment]

[Main body arrangement]

[0138] Fig.21 is a front overall view showing a kerosene fan heater including a liquid fuel burning apparatus in accordance with the second embodiment of the present invention. Fig.22 is an outline view showing the liquid fuel burning apparatus.

[0139] As illustrated, a kerosene fan heater body 1 is formed in a box-like configuration and comprised of a detachable front panel 2, a top panel 3 integrally formed with side panels, a control portion 4 allowing for operation control, an outlet port 5 from which warm air is blown out, an openable and closable lid 7 arranged at the right side in the top of top panel 3 for permitting a fuel supply tank 6 to be fitted in and taken out. This main body 1 is placed and fixed on a mount base 8 for holding liquid fuel in case of leakage.

[0140] As shown in Figs.21 and 22, the interior of main body 1 is divided by a tank guide 11 and partitioning plate 16 into a tank holding compartment 1a for accommodating fuel supply tank 6, a functional part compartment 1b for accommodating a vaporizer A12, electromagnetic pump 13 and the like and a burner unit compartment 1c including a burner 14 and a combustion chamber 15.

[0141] Arranged in tank holding compartment 1a are fuel supply tank 6 of a cartridge type which temporarily stores fuel and is detachable, oil feed side joining means A9 and A10 that create a detachable connection between fuel supply tank 6 and an oil feed passage 300

for transferring fuel from fuel supply tank 6 to the vaporizer side, and oil return side joining means A21 and A22 (Fig.24) that create a detachable connection between fuel supply tank 6 and an oil return passage 301 for returning fuel from the vaporizer A12 side to fuel supply tank 6. A cushioning mount base 1d for absorbing and relieving impacts acting on joining means A9, A10, A21 and A22 when the fuel supply tank is inserted is provided at the bottom of tank holding compartment 1a. Further a guide portion is preferably formed in tank holding compartment 1a so that oil feed side joining means A9 and A10 and oil return side joining means A21 and A22 will reliably fit to each other when fuel supply tank 6 is inserted.

[0142] The oil feed side joining means is composed of an oil feed joint A9 incorporating a valve for opening and shutting off the passage to the suction pipe and an oil feed joint socket A10 for receiving the valve of the oil feed joint A9. Connected to oil feed joint socket A10 is an air valve 20 for taking air into the oil feed passage in order to shut off oil feed passage 300 for supplying fuel from fuel supply tank 6 to electromagnetic pump (oil feed pump) 13. This oil feed joint socket A10 is attached to the upper part of the wall surface of tank guide 11, where the wall is projected to the functional part compartment side (Fig.21).

[0143] The functional part compartment 1b is located between tank holding compartment 1a and burner unit compartment 1c and includes vaporizer A12 for evaporating fuel from fuel supply tank 6, electromagnetic pump 13 for feeding fuel from fuel supply tank 6 to vaporizer A12, a collecting container 18 (Fig.22) for holding fuel from vaporizer A12 and a cooling fin assembly 19 arranged between vaporizer A12 and collecting container 18 for cooling the fuel.

[0144] Burner unit compartment 1c is defined by partitioning plate 16 and incorporates burner 14 that mixes the evaporated fuel through vaporizer A12 with primary combustion air and burns it, a combustion chamber 15 enclosing burner 14 for burning and a burner box 17 that holds burner 14. Thus, the burner unit for burning fuel is constituted of the vaporizer A12, burner 14 and other parts.

[0145] Oil feed passage 300 (Fig.22) is composed of a pipe 203 connecting oil feed joint socket A10 and electromagnetic pump 13 and a pipe 204 connecting electromagnetic pump 13 and vaporizer A12. Return oil passage 301 is composed of a pipe 205 connecting vaporizer A12 and cooling fin assembly 19, a pipe 206 connecting cooling fin assembly 19 and collecting container 18 and a pipe 207 connecting collecting container 18 and return oil joint socket A10. These pipes 203 to 207 are all formed of copper pipes. The pipe from fuel supply tank 6 to electromagnetic pump 13 may be formed of resin pipes or others, instead of copper pipes.

[Fuel supply tank configuration]

[0146] Fig.23 is an outline view showing a fuel supply tank; Fig.24 is a perspective view showing a joining portion of the fuel supply tank; Fig.25 is a sectional view showing the connected state of an oil feed joint and a suction pipe in the fuel supply tank; and Fig.26 is a structural view showing a return oil joint.

[0147] As illustrated, fuel supply tank 6 is formed in a vertical box-shaped configuration made up of a metallic material presenting conductivity (e.g., galvanized steel sheet), having a handle A23 on the top face of the tank for carriage with fuel therein, a bevel 501 formed between the top face on which the handle A23 is formed and one side face adjacent to the top face, a filler port A26 arranged on this bevel 501 for refueling, a filler cap 600 for closing the filler port A26 in a rotationally openable and closable manner, an oil gauge A25 disposed on the side face near the filler port A26 to make the supplied fuel visible, oil feed joint A9 and return oil joint A21 arranged on the side opposite to filler port A26, on the same top face as handle A23.

[0148] As shown in Fig.25, oil feed joint A9 is comprised of a side-facing L-shaped connecting pipe A43 projected from the top face of fuel supply tank 6 and extended sideways of the tank and a joint body 9a with a built-in spindle type valve mechanism A28, arranged at the distal end of the connecting pipe A43.

[0149] Joint body 9a is formed of a vertical cylinder having a small-diametric projective cylinder 9b shaped at the bottom end thereof so as to be fitted into the oil feed joint socket A10 (Fig.24) side. Further, an O-ring A41 for connection sealing is tightly fitted on the outer periphery of the cylinder 9b. An openable and closable lid nut A38 is screw fitted on the top opening of joint body 9a so as to allow valve mechanism A28 to be inserted.

[0150] Valve mechanism A28 inside joint body 9a is composed of a center valve hole 9c in small-diametric projective cylinder 9b of joint body 9a, a spindle-like valve element A30 which can fit on and separate from an inverted conical valve seat 9d formed in the lower part of the joint body, a spring 35A interposed between the top of valve element A31 and lid nut A38 for urging valve element A31 in the valve closing direction and an O-ring A33 for sealing fitted on the peripheral side of valve element A31 so as to oppose the valve seat. When the valve mechanism is in the closed state, the lower end of valve element A31 is set so as to project out and downwards from small-diametric projective cylinder 9b.

[0151] Connecting pipe A43 has a suction passage 43a formed therein which communicates with the valve chamber inside joint body 9a and the end that is extended sideways of the tank is integrally connected to the side part of joint body 9a. The lower end of connecting pipe A43 is inserted into the tank through an insert hole A46 formed on the top face of fuel supply tank 6. The connecting pipe has a flange 43b formed in the lower part thereof so that the flange is fastened to a hole A47

on the top face of fuel supply tank 6 by a screw with a rubber packing A50 interposed therebetween. The outer peripheral side at the lower end of connecting pipe A43 is incised with a male thread, on which the upper end of a suction pipe A27 inside the fuel supply tank is screw fitted.

[0152] Suction pipe A27 almost reaches the bottom of fuel supply tank 6 and has a suction opening A44 on the side at its lower end, to which a filter A45 that blocks water and dust from permeating is fitted. This suction opening A44 may be formed at the bottom face of suction pipe A27.

[0153] Return oil joint A21 is arranged on the top face of fuel supply tank 6 at the side of oil feed joint A9 as illustrated in Fig.26 and has basically the same structure as that of oil feed joint A9 except in that no suction pipe A27 is connected and a pressure valve mechanism 700 is provided for fuel supply tank 6. Accordingly, description will be made briefly except for the above differences.

[0154] As shown in Fig.26, return oil joint A21 is comprised of a side-facing L-shaped connecting pipe A30 projected from the top face of fuel supply tank 6 and extended sideways of the tank and a joint body 21a with a built-in spindle type valve mechanism A29, arranged at the distal end of the connecting pipe A30.

[0155] Joint body 21a is formed of a vertical cylinder and has a small-diametric projective cylinder 21b formed at the bottom end thereof so as to be fitted into the return oil joint socket A22 (Fig.29) side. Further, an O-ring A42 for connection sealing is tightly fitted on the outer periphery of the small-diametric cylinder. An openable and closable lid nut A40 is screw fitted on the top opening of joint body 21a so as to allow valve mechanism A29 and pressure valve mechanism 700 to be inserted.

[0156] Valve mechanism A29 inside joint body 21a is composed of a center valve hole 21c in small-diametric projective cylinder 21b of joint body 21a, a spindle-like valve element A32 which can fit on and separate from an inverted conical valve seat 21d formed in the lower part of the joint body, a spring A36 for urging valve element A32 in the valve closing direction and an O-ring A34 for sealing which is fitted on the peripheral side of valve element A32 so as to oppose the valve seat.

[0157] When valve element A32 is in its closed position, its lower end projects out and downwards from the small-diametric projective cylinder 21b. Further, this valve element integrally has a pushing rod 709 on top which can press a ball valve piece 703 of pressure valve mechanism 700. Spring A36 is interposed between the top face of valve element A32 and the bottom face of a valve seat element 702 of pressure valve mechanism 700 which is to be described later.

[0158] Connecting pipe A30 has a return passage 30a formed therein which communicates with the valve chamber inside joint body 21a and the end that is extended sideways of the tank is integrally connected to

the side part of joint body 21a. The lower end of connecting pipe A30 is inserted into the tank through an insert hole A48 formed on the top face of fuel supply tank 6. The connecting pipe has a flange 30b formed in the lower part so that the flange is fastened to a hole A49 on the top face of fuel supply tank 6 by a screw with a rubber packing A51 interposed therebetween.

[0159] In the present embodiment, pressure valve mechanism 700 is provided for return oil joint A21 in order to prevent fuel leakage due to a rise of the liquid level in the tank as the air pressure inside the tank increases due to difference in temperature between the interior and exterior of fuel supply tank 6 and also in order to prevent occurrence of a negative pressure inside the tank.

[0160] This pressure valve mechanism 700 is comprised of valve seat element 702 with a cylindrical valve hole 701, located over valve element A32, ball valve piece 703 which can fit on and separate from the sealing surface in the valve chamber above valve hole 701 of the valve seat element 702, a spring 704 for urging ball valve piece 703 in the direction it is seated and lid nut A40 for positioning the valve seat element 702 inside joint body 21a.

[0161] Lid nut A40 has a pressure release hole 705 formed at the center thereof. Spring 704 is held between ball valve piece 703 and lid nut A40. Valve hole 701 has a diameter adequate enough to allow pushing rod 709 of valve element A32 to pass therethrough. When return oil joint A21 is fitted and connected to return oil joint socket A22 and valve element A32 is pushed upwards, pushing rod 709 penetrates through valve hole 701 and pushes ball valve piece 703 upwards, whereby valve hole 701 is opened and the tank interior is made to communicate with pressure release hole 705 of lid nut A40 by way of connecting pipe A30 (Fig.24).

[0162] In both the aforementioned oil feed joint A9 and return oil joint A21, valve elements A31 and A32 are set downwards in the joint bodies and arranged at the same level so that they are vertically fitted and connected respectively to oil feed joint socket A10 and return oil joint socket A22 which are arranged upwards so as to oppose them. Accordingly, just the insertion of fuel supply tank 6 into tank compartment 1a from above makes it possible to establish smooth connection between joining means A9 and A21 and between joining means A10 and A22, both.

[0163] Fig.27 is a structural view showing oil feed side joining means A9 and A10. Fig.28 is a structural view showing an oil feed joint socket. Fig.29 is a structural view showing a return oil side joining means. As illustrated, in tank holding compartment 1a (Fig. 21), oil feed joint socket A10 and return oil joint socket A22 are arranged under, and opposing, oil feed joint A9 and return oil joint A21, respectively when fuel supply tank 6 is mounted in place.

[0164] As shown in Fig. 28, oil feed joint socket A10 is comprised of a hollow socket portion A61 that has

acircularcross-section, opens to the top of a cylindrical socket body 10a to receive the small-diametric projective cylinder 9b (Fig.26) at the lower end of oil feed joint A9, and a valve mechanism A60 that is disposed in this socket portion A61 and opens and closes as valve element A31 of valve mechanism A28 (Fig. 27) of oil feed joint A9 is abutted against, and separated from, socket portion A61.

[0165] Formed at the top of hollow socket portion A61 is an annular sealing surface A67 which can make hermetic contact with the periphery of small-diametric projective cylinder 9b of oil feed joint A9. Further, a valve support holder 68A (Fig.27) is indented in the bottom of socket portion A61. A valve support A65 is fitted in this valve support holder 68A. Valve support A65 is formed with a valve hole 60b which communicates with a valve chamber 60a formed in the lower part of socket body 10a while grating channels A66 for allowing fuel to flow are formed around the valve hole.

[0166] Valve mechanism A60 is composed of a valve element A62 that can fit on and separate from the valve seat of valve chamber 60a and has an upper end passing through valve hole 60b and projecting to the socket portion A61 side, a spring A63 interposed between the head of the valve element A62 and valve support A65 so as to urge valve element A62 in the valve closing direction, and an O-ring A64 tightly fitted on valve element A62 on its valve chamber 60a side to seal against the valve seat. This valve mechanism A60 is adapted to open the valve when valve element A31 of oil feed joint A9 comes into pressure contact with the head of valve element A62 on the socket side and close the valve when it separates from the head of valve element A62.

[0167] Formed in the lower part of valve chamber 60a of socket body 10a is a conduit A69 communicating with pipe 203 which is connected to electromagnetic pump 13 (Fig.22). A conduit A70 (Fig.28) for air valve 20 is formed on the side part of valve chamber 60a. This conduit A70 is positioned at a level higher than the liquid level of fuel in the fuel supply tank when it is full.

[0168] Air valve 20 is provided to take air into oil feed passage 300 to shut off the fuel inside oil feed passage 300 from fuel supply tank 6 to electromagnetic pump 13, and is composed of a valve piece 20a located in the air taking passage of the valve body, an electromagnetic coil 20b disposed on the outer periphery of the valve body to move valve piece 20a in such a direction as to close conduit A70 when it is magnetized and a spring 20c urging valve piece 20a in the valve opening direction.

[0169] Concerning the operation of this air valve 20, air valve 20 is in the closed state while the apparatus is in operation. When the apparatus is not in operation, the valve becomes open so as to take air in to shut off fuel inside oil feed passage 300. Air valve 20 also has the function of suctioning air by opening itself during cleaning by baking so that air can be sent to vaporizer A12 (Fig.22) by actuation of electromagnetic pump 13.

[0170] On the other hand, return oil joint socket A22 basically has the same configuration as that of oil feed joint socket A10 except in that it does not have any air valve 20. Accordingly, briefly explaining the structure, return oil joint socket A22, as shown in Fig.29, is comprised of a hollow socket portion A72 formed on the top face of a socket body 22a and a valve mechanism A71 that is disposed in this socket portion A72 and opens and closes as a valve element A32 of a valve mechanism A29 of return oil joint A21 is abutted against it and separated from it.

[0171] Formed at the top of socket portion A72 is an annular sealing surface A78. Further, a valve support holder A79 is indented in the bottom of socket portion A72. A valve support A76 is fitted in this valve support holder A79. Valve support A76 is formed with a valve hole 71b which communicates with a valve chamber 71a formed in the lower part of socket body 22a while grating channels A77 for allowing fuel to flow are formed around the valve hole.

[0172] The valve mechanism is composed of a valve element A73 that can fit on and separate from the valve seat of valve chamber 71a and has an upper end passing through valve hole 71b and projecting to the socket portion A72 side, a spring A74 interposed between the head of the valve element A73 and valve support A72 so as to urge valve element A73 in the valve closing direction, and a sealing O-ring 75A tightly fitted on valve element A73 on its valve chamber 71a side. This valve mechanism is adapted to open the valve when valve element A32 of return oil joint A21 comes into pressure contact with the head of valve element A73 on the socket side and close the valve when it separates from the head of valve element A73. Formed in the lower part of valve chamber 71a of socket body 22a is a conduit A80 (Fig.29) communicating with pipe 207 which is connected to collecting container 18 (Fig.22).

[0173] In the above configuration of the fuel supply tank 6, joining means A9, A10, A21 and A22, when fuel supply tank 6 is set into tank holding compartment 1a of main body 1 from above, oil feed joint A9 and return oil joint A21 as the joining means are fitted to the predetermined positions of oil feed joint socket A10 and return oil joint socket A22, so that O-rings A41 and A42 on their sides of small-diametric projective portions 9b and 21b of joint bodies 9a and 21a abut against sealing surface A67 of oil feed joint socket A10 and sealing surface A78 of return oil joint socket A22, forming hermetic states. At the same time, in each joint, valve mechanism A28 or A29 is mated with socket side valve mechanism A60 or A71, so that mating valve elements push each other, forming a valve-open state.

[0174] Further, on the return oil joint A21 (Fig.26) side, valve element A32 moves upwards as it opens so that the upper pushing rod 709 moves upwards through valve hole 701 of pressure valve mechanism 700 and pushes ball valve piece 702 upwards hence valve hole 701 opens. Accordingly, a communication passage is

formed from the tank to valve hole 701 and air hole 705 in joint body 21a by way of connecting pipe A30, so that it is possible to equalize the tank internal pressure with the tank external pressure, whereby it is possible to prevent fuel leakage due to a temperature rise in the tank and occurrence of a negative pressure in the tank.

[0175] Fig.30 is a side view showing a fuel supply tank; Fig.31 is a sectional view showing an arrangement of the tank bottom; Fig.12 is a sectional view showing the interior of the same tank; and Fig.33 is a perspective view showing a water receptacle attachment hole in the tank bottom. As illustrated, fuel supply tank 6 of this embodiment has, at its bottom, a fuel quantity detecting means 750 (Fig.32) for detecting the amount of fuel in the fuel supply tank, a water detecting means 800 for detecting pooled water in the fuel supply tank, and a tank insertion detecting means 900 (Fig.31) for detecting whether the fuel supply tank is mounted in the main body.

[0176] Tank placement board 1d (Fig.32) is made up of a synthetic resin molding comprised of: a leg portion 755, along its periphery, which is in direct contact with mount base 8; a central part projected downwards defining a depressed holder 754 by its upper face side for accommodating a water receptacle 801 which is concave downwards; and a placement board 757 which constitutes the peripheral part for supporting the bottom face 6b of the tank. This board is placed on mount base 8 with its central projected portion 756 (Fig.31) fitted in a hollow 8a of the base.

[0177] Water detecting means 800 is comprised of a conductive water receptacle 801 which is arranged at the conductive tank bottom to collect condensation of water, a first electrode 803 in contact with the bottom of fuel supply tank 6, a second electrode 802 in contact with water receptacle 801, and an insulating water-tight packing 804 which provides electric insulation between water receptacle 801 and fuel supply tank 6, and is adapted to detect water based on the difference in electric resistance between fuel and water collected in water receptacle 801. First electrode 803 functions as the electrode disposed inside the fuel supply tank and second electrode 802 functions as the electrode disposed outside the fuel supply tank. The presence of water in the tank is detected based on the difference in electric resistance between water and fuel, by flowing a micro current between these electrodes.

[0178] Water receptacle 801 is formed of a stainless steel sheet, separately from tank 6, in order to prevent rust, and has an upper side concave similar to a dish and a peripheral flange 807 extending radially outwards, and is attached to the bottom of fuel supply tank 6 with the flange 807 fixed to a bottom-side attachment hole 805 with rubber packing 804 interposed therebetween.

[0179] Packing 804 is a resilient non-conductive member interposed between the peripheral wall of bottom-side attachment hole 805 of fuel supply tank 6 and peripheral flange 807 of water receptacle 801, and holds

water receptacle 801 so as to grip flange 807 between its upper and lower parts. Packing 804 is fixed around tank attachment hole 805 by means of an annular bracing member 809 disposed at the underside thereof, with screws 810. Thus, water receptacle 801 is fixed in a water-tight manner to attachment hole 805.

[0180] This rubber packing 804 is formed of a non-conductive rubber member having oil resistance and water-repellence. Specific examples include NBR (butadiene-acrylonitrile rubber) which is excellent in oil resistance and fluororubber which is excellent in water-repellence. Particularly, if the packing is poor in water repellence, water may pool and be left covering the packing and the metal portion of fuel supply tank 6 after water is drained off. This may be the cause of malfunction. In the present embodiment, since rubber material having water-repellence is used, correct water detection with high precision can be achieved.

[0181] Electrode 802 on the water receptacle 801 side and electrode 803 on the tank side are both attached to the tank placement board 1d outside the fuel supply tank. Water receptacle 801 side electrode 802 is a needle-like electrode which is projected from the bottom wall of the water receptacle depressed holder to the tank side and in contact with the external surface of water receptacle 801 when the tank is set in place. Tank side electrode 803 is a needle-like electrode which is exposed on peripheral placement surface 757 of placement board 1d and is in contact with the bottom face 6b of the tank when the tank is set in place. Connecting these two electrodes to a power supply constitutes a closed electric circuit, starting from the power supply, by way of water receptacle electrode 802, water receptacle 801, fuel or water on the inner surface, tank bottom surface 6b, tank side electrode 803, to the power supply, whereby it is possible to detect the presence of water based on the electric resistance of liquid (fuel or water) on the interior side of water receptacle 801.

[0182] In order to enhance the accuracy of water detection, the opening wall of attachment hole 805 on the tank side, which water receptacle 801 fits, is bent downwards forming a bent portion 811 (Fig.33) while a multiple number of needle portions 812 of a narrow sharpened tip are projected downwards at intervals along the circumference of the bent portion 811. These needle portions 812 function as the tank side front electrodes and are electrically connected through the tank bottom to tank side electrode 803. Suction port A44 for suctioning fuel from the tank is positioned above needle portions 812 so that it will not directly suction water from the water pool in the water receptacle 801. Further, the areas other than the inner side and outer side of the bottom of water receptacle 801 are coated with a non-conductive paint or the like, whereby malfunction is prevented even if water is left covering packing 804 and metal parts of fuel supply tank 6.

[0183] Further, when the inner surface of fuel supply tank 6 above the suction port A44 for suctioning fuel

from the tank is coated with a non-conductive paint or the like, it is possible to prevent adverse effects due to water on the systems other than the electric water detecting scheme.

[0184] A tank die 901 for guarding water receptacle 801 is welded around conductive water receptacle 801 in the bottom face of fuel supply tank 6, as shown in Fig. 30. This tank die 901 is configured of a rib or U-shaped structure 902 which is higher than the surface that is welded to fuel supply tank 6, has a height greater than that of water receptacle 801, and is formed at the periphery. Therefore, if, upon refueling fuel supply tank 6 with the filler port side up after being taken out from the main body, there are some foreign bodies present on the surface that is in contact with the bottom of fuel supply tank 6 or water receptacle 801, it is possible to prevent the tank bottom face and water receptacle 801 from being damaged or pitted, whereby it is possible to prevent malfunction in water detection.

[0185] Fuel quantity detecting means 750 (Fig. 32) for detecting the amount of fuel in the tank is comprised of a float 752 incorporating a magnet 751 functioning as a detection portion disposed inside the tank and a lead switch 753 which is disposed on the tank placement board 1d side, opposing float 752 so as to turn on and off as magnet 751 moves closer and away.

[0186] Float 752 has its magnet at the bottom thereof and is held inside a transparent, canopied cylindrical guide 754 in such a manner that it can move vertically as the fuel level varies. The bottom face of guide 754 is integrally fixed to the inner side of water receptacle 801 of water detecting means 800. Lead switch 753 is fixed to the underside of the central projected portion of tank placement board 1d so as to oppose float 752. Guide 754 is to prevent float 752 from coming into contact with a typical refueling hose as sold on the market when fuel is drawn off from fuel supply tank 6. Therefore, if this guide 754 is of metal, it should be machined so as not to form burrs inside.

[0187] Accordingly, when the surface of fuel reaches a certain level as the fuel inside fuel supply tank 6 is used, lead switch 753 detects magnetism from the magnet in float 752 and sends the detection to controller 950 (Fig.32), so that warnings of the end of fuel and the like can be given through a display 952.

[0188] Tank insertion detecting means 900 (Fig.31) is constituted of a micro-switch including a switch body 901a disposed beneath tank placement board 1d and a moving contact 901b arranged so as to project and retract through a hole 758 formed in peripheral placement surface 757. When tank 6 is set on the placement surface 757, moving contact 901b is pressed down by the tank so as to retract actuating the switch.

[Vaporizer and burner arrangement]

[0189] Fig.34 is a structural view showing a vaporizer and a burner unit. As illustrated, vaporizer A12 is com-

prised of a vaporizing element A81 for vaporizing fuel by heating, a nozzle A82 for ejecting the evaporated fuel by the vaporizing element A81, a needle A83 that opens and closes the hole of the nozzle A82, a solenoid valve A84 that is linked to this needle A83 to move needle A83, a fuel entrance A85 for supplying fuel to vaporizing element A81, a return oil circuit A86 for returning the fuel inside vaporizer A12 when the operation stops and a heat collector A87 for collecting combustion heat from burner 14.

[0190] Vaporizing element A81 is a sintered cylinder made of fine ceramic particles, and tar generated when fuel evaporates accumulates inside vaporizing element A81 from its surface inwards. Fuel entrance A85 to vaporizer A12 has a double pipe structure of an outer stainless pipe A88 and an inner copper pipe A89. Stainless pipe A88 is used to reduce heat conduction from vaporizer A12 and suppress temperature rise of the fuel entering vaporizer A12. Further, stainless pipe A88 is made greater in diameter than the copper pipe so as to further inhibit heat conduction from stainless pipe A88 to the copper pipe. The end of copper pipe A89 is located at a position outside vaporizer A12.

[0191] Solenoid valve A84 is composed of an electromagnetic coil A90, a moving piece A91, an attracting piece A92 and a pressing spring A93, and when electromagnetic coil A90 is turned on or off, attracting moving piece A91 becomes attracted to or away from attracting piece A92 so as to move needle A83 attached to moving piece A91 and thereby open or close the hole of nozzle A82 of vaporizer A12.

[0192] Burner 14 is composed of a mixing tube A94 for mixing the combustion gas evaporated through vaporizer A12 with primary combustion air and a flame port A95 for burning the mixed combustion gas. A flame rod 953 as a flame detecting means is arranged over this flame port A95. This flame rod 953 and conductive burner 14 constitute a pair of electrodes. When a micro electric current flows between the two electrodes, a flame current in accordance with the resistance flows by the function of ions existing in the flame. Based on this fact, the flame state can be detected.

[Configurations of the electromagnetic pump, collecting container and cooling fin assembly]

[0193] As shown in Fig.22, electromagnetic pump 13 suctions fuel from fuel supply tank 6 to send it toward the vaporizer A12 while the ejected amount of fuel and the like are controlled by controller 950 (Fig.37).

[0194] Fig. 35 is a sectional view showing a collecting container. Collecting container 18 is configured as illustrated, and is provided to temporarily retain and cool the fuel, which remains inside vaporizer A12 upon a halt of electromagnetic pump 13 and shutoff of nozzle A82 of vaporizer A12 because of room temperature control from the start to end of operation and needs to be returned to fuel supply tank 6.

[0195] A container body A96 of collecting container 18 is tightly sealed and its volume is designated to be about 20 cc. As stated already, the partly evaporated fuel remaining in vaporizer A12 becomes liquefied when it is returned to fuel supply tank 6. This unburned, returned fuel roughly amounts to 0.3 to 0.5 cc each time. If it is assumed that electromagnetic pump 13 is halted roughly ten times to change the burning intensity under room temperature control when the kerosene fan heater is operated all day long, the amount of returned fuel per day amounts to about 3 to 5 cc. Accordingly, container body A96 has a large enough volume (about 20 cc) to collect the amount of returned fuel.

[0196] Formed on the side face of this container body A96 is an entrance A97 of combustion gas from vaporizer A12 while an exit A98 for the fuel collected in container body A96 is formed on the top of container body A96. A pipe A99 almost reaching the bottom inside container body A96 is arranged through this exit A98 on the container top and is formed with a funnel shaped suction port 200 at its lower end so that the fuel collected inside the container will be suctioned easily without being affected by its surface tension.

[0197] Fig.36 is a sectional view showing a cooling fin assembly 19 provided halfway along the passage between vaporizer A12 and collecting container 18. As illustrated, cooling fin assembly 19 has many thin fins 201 formed on the outer side of pipe 202 and has the function of radiating heat from the fuel which is returned from vaporizer A12.

[Controller configuration]

[0198] Fig.37 is a block diagram of a control circuit for controlling combustion in accordance with the signals from water detecting means 800 (Fig.32), flame detecting means 953 (Fig.34) and tank insertion detecting means 900 (Fig.31). Here, the features of the present invention mainly reside in the timing of reception of water detection in the controlling combustion by flame detecting means 953, fuel quantity detecting means 750 which is unrelated to this scheme is omitted in Figs.37 and 38.

[0199] As illustrated, controller 950 is constituted of a microcomputer incorporating a CPU, ROM and RAM, and is connected on its input side to flame detecting means 953, water detecting means 800, tank insertion detecting means 900 and an operating switch 954 while the output side is connected to the burner unit (including the vaporizer heater, electromagnetic pump, valve driver and other loads) 955, display 952, so that it can control combustion in accordance with various input signals.

[0200] Controller 950 includes: a water detection determining means 961 which receives a signal from water detecting means 800 and detects the presence of water; a flame detection determining means 962 which receives a signal from flame detecting means 953 and de-

tests the state of combustion by comparing the flame current value to a set flame level; a tank insertion determining means 963 which receives a signal from tank insertion detecting means 900 and determines whether the tank is inserted; and a controller 965 which receives these detection results and the signals from operating switch 954 and a time counter means 964 and outputs control signals to burner unit 955 and display 952.

[0201] Fig.38 is an analog electric circuit diagram of the same configuration. As illustrated, in this electric circuit, electric power is supplied by an a.c. power supply AC via a transformer TR. This power input is full-wave rectified by a diode bridge DB, then is supplied to a three terminal regulator IC2 so as to provide a 24V power source. This 24V power source is stabilized by an electrolytic capacitor C5, film capacitors C3 and C4, and supplied to flame rod 953, so that the flame current value can be detected by controller (IC1) 950. Further, a 5V power source is produced from this 24V power source by a three terminal regulator IC3. The 5V power source is stabilized by an electrolytic capacitor C8, film capacitors C6 and C7 and then supplied to the power lines of operating switch 954 and microswitch 900 for tank insertion detection, so that combustion control circuit (IC1) 950 can detect the ON/OFF state.

[0202] This combustion control circuit 950 is configured so that flame detecting means 953 can operate having priority over water detecting means 800 and its current value is read with priority while the reading operation of water detecting means 800 is made only at predetermined statuses. Specifically, combustion control circuit 950 receives the signal from water detecting means 800 only when the apparatus is not in operation, within a predetermined period of time after the start of operation or at predetermined periods during combustion by controlling the electric-current to the water detecting means 800. Further, combustion control circuit 950 is adapted not to accept any signal from water detecting means 800 a fixed period of time from when it has received a tank insertion signal from tank insertion detecting means 900.

[0203] In the above way, water detection is adapted to be picked up in limited periods, so that it is possible to avoid electric corrosion to the tank. Since only one of flame detecting means 953 or water detecting means 800 is operated at a time, it is possible to enhance the detection accuracy even when a common earth-electrode is used.

[0204] In controller 965 (Fig.37), when water detection determining means 961 receives a detection signal of water, it gives a warning of the detection state of water through display 952 to urge the user to drain water from the tank. When the apparatus is not in operation or at a time immediately after the start of operation, electromagnetic pump 13 in burner unit 955 is controlled to stop its operation as soon as water is detected.

[0205] When water is detected during combustion, the apparatus is controlled such that the detection of wa-

ter is warned through display 952, and the flame current value from flame detecting means 953 is checked first, instead of stopping the operation: if the flame detection level is higher than the preset flame level, combustion is continued as is, whereas a signal for stopping electromagnetic pump 13 of burner unit 955 is issued to stop combustion only when the flame detection level becomes equal to or lower than the preset level. Accordingly, if water detecting means 800 erroneously operates during combustion, the operation can be continued as is, so that it is possible to perform efficient combustion control.

[The operation of the kerosene fan heater]

[0206] The operation of the kerosene fan heater will be described briefly. When fuel supply tank 6 is empty, fuel is charged into fuel supply tank 6 through filler port A26 by opening lid 7 of main body 1, taking out fuel supply tank 6 by holding handle A23 and releasing shutoff means 600 with the handle A23 side up.

[0207] When refueling is completed, the fuel supply tank 6 filled up with fuel is set into the predetermined position after opening lid 7 of main body 1. Upon this setting, as shown in Figs.27 and 29, valve element A31 in valve mechanism A28 of oil feed joint A9 and valve element A32 in valve mechanism A29 of return oil joint A21, of fuel supply tank 6, press valve element A62 of valve mechanism A60 of oil feed joint socket A10 and valve element A73 of valve mechanism A71 of return oil joint socket A22, respectively, and the valve elements A62 and A73 move down.

[0208] As the head parts A62a and A73a of these valve elements A62 and A73 abut the respective top faces of valve supports A61 and A72, valve element A31 of valve mechanism A28 of oil feed joint A9 and valve element A32 of valve mechanism A29 of return oil joint A21 move upwards so that urging springs 35A and A36 which have urged in the valve closing direction become compressed, whereby the O-rings A33 and A34 forming sealing surfaces of valve elements A31 and A32 depart from the respective sealing surfaces of oil feed joint A9 and return oil joint A21, forming clearances, which open oil feed passage 300 (Fig.22) for fuel to flow to the electromagnetic pump 13 side and return oil passage 301 from collecting container 18 to fuel supply tank 6.

[0209] When electric power is turned on by actuating operating switch 954 (Fig.37) of the kerosene fan heater, the vaporizer heater (not shown) attached to vaporizer A12 heats vaporizer A12. During this period, a vaporizer thermistor (not shown) detects the temperature of the vaporizer A12. When vaporizer A12 is heated to a predetermined temperature, electromagnetic pump 13 starts to be driven so as to suction liquid fuel inside fuel supply tank 6 through suction pipe A27 (Fig. 22) and sends it to vaporizer A12 by way of oil feed joint A9 and oil feed joint socket A10. The liquid fuel is gasified by the heated vaporizer A12 and the gas is ejected from

flame port A95 of burner 14, ignited at the flame port A95 to burn in combustion chamber 15.

[0210] At the same time, based on the difference in temperature between the room temperature detected by a room temperature sensor 153 (thermistor) and the set temperature designated through a room temperature setup switch 157 of the control portion, a control circuit 950 controls drive of electromagnetic pump 13 to vary the amount of liquid fuel fed to vaporizer A12, whereby the heat generation rate of burning is controlled appropriately.

[0211] When combustion starts and flame sensor 953 detects a flame current equal to or greater than the preset current value, a fan motor is activated so that the blower fan starts rotating to suction air from the room. The rotational rate of the fan is controlled by controller 950. The air suctioned from the room absorbs the radiated heat in combustion chamber 15 and is blown out together with the combustion gas as warm air through air outlet 5 to the outside of main body 1 (the room), whereby the temperature in the room rises and is regulated at an optimal temperature.

[0212] The present invention should not be limited to the above examples and many changes and modifications can be of course added within the scope of the present invention. For example, the above embodiment has been described as to flame detection and water detection with a detachable type fuel supply tank, but the combustion control as to flame detection and water detection herein can be applied to a configuration with a fuel supply tank fixed to the main body.

[0213] As has been described heretofore, according to the present invention, the state of flame in the burner unit is detected based on the flame current value while water in the fuel supply tank is detected based on the difference in electric resistance between water and fuel, so that the burner unit is adapted to be controlled based on the detected results. Therefore, it is possible to prevent water from being delivered to the burner unit side.

[0214] In this case, when only one of the flame detecting means and water detecting means is operated, it is possible to enhance the detection accuracy of each of the two detecting means. Further, when the execution of water detection is limited to specified periods during which flame detection is unneeded, such as when the apparatus is not in operation, within a predetermined period of time after the start of operation and at predetermined periods during combustion, it is possible to make efficient combustion control.

[The third embodiment]

[Main body arrangement]

[0215] Fig.39 is a perspective view showing a kerosene space heater in accordance with the present invention, viewed from the front side of the body. Fig.40 is a perspective view showing the same kerosene space

heater, viewed from the back side of the body. As shown in Figs.39 and 40, in this kerosene space heater, the external housing of a main body B1 for accommodating a burner unit and a fuel supply tank is formed of a box with the bottom open, composed of a front panel B6 for covering the front side, a side/rear panel B7 for covering the sides and backside and a top plate B8 for covering the top face, and this main body B1 is set on a base board B5.

[0216] Formed in the lower part of front panel B6 is an air outlet B2 for blowing warm air to the room. A control portion B3 including switches for changing operational states is disposed in the upper part of front panel B6. An output port 4b for a fuel supply tank is formed on the top plate B8 and the output port 4b is covered with an openable tank lid B4.

[0217] Provided on the backside of the side/rear panel B7 is a convection fan B9 for suctioning air from the room. This convection fan B9 is covered with a convection guard B10 of mesh so as to prevent dirt from being suctioned. Further, a temperature sensor B11 for detecting the room temperature is disposed on the backside of side/rear panel B7.

[0218] Fig.41 is an outline view showing a liquid fuel burning apparatus and its fuel paths in a kerosene space heater shown in Fig.39. A liquid fuel burning apparatus A comprises: a fuel supply tank B12 which is detachable from main body B1; a first joining means B13 and second joining means B17 for making connection between fuel supply tank B12 and a vaporizer B15 of a burner unit B25 when fuel supply tank B12 is inserted into the main body; an electromagnetic pump B14 as an oil feed pump for transferring fuel from fuel supply tank B12; vaporizer B15 for heating fuel from electromagnetic pump B14 to gasify it; a burner B16 for emitting gasified fuel from vaporizer B15 from a nozzle, mixing it with combustion air and burning the mixture; and an air valve B18 as a shutoff valve for shutting off fuel supply to the electromagnetic pump B14 side by sending air into the oil feed path. By connecting these components, an oil feed passage B for transferring fuel from fuel supply tank B12 to vaporizer B15 and a return oil passage C for returning fuel from vaporizer B15 to fuel supply tank B12 are created.

[0219] In oil feed passage B, a pipe B21 is provided to make connection between the first joining means B13 on the oil feed side in the fuel supply tank and electromagnetic pump B14 while a pipe B22 is provided to complete the connection between electromagnetic pump B14 and vaporizer B15. In return oil passage C, a return oil pipe B23 is provided to make connection between vaporizer B15 and the second joining means B17 on the return oil side.

[0220] Joining means B13 and B17 for joining fuel supply tank B12 and burner unit B25 is composed of the first joining means B13 arranged halfway along the oil feed passage B from fuel supply tank B12 to electromagnetic pump B14 and the second joining means B17

arranged halfway along the return oil passage C for returning fuel from vaporizer B15 to fuel supply tank B12. Each of joining means B13 and B17 has a configuration which can be separated into a connecting joint part on the fuel supply tank side and a connecting joint socket part on the burner side. Further, as will be described later, connecting joints B13a and B17a of the first and second joining means B13 and B17 are integrated on the fuel supply tank B12 side, forming a joint unit B47 (Fig. 49) while connecting joint sockets 13b and B17b of the first and second joining means B13 and B17 are integrated on the burner side, forming a joint socket unit 100 (Fig.64). Thus, the joining means is provided in a compact configuration.

[0221] Fig.42 is a view showing a state of the main body shown in Fig.39 with its front panel partially cut away. As illustrated, in the front view of main body B1, burner unit B25 is disposed on the left side, and fuel supply tank B12 and electromagnetic pump B14 are on the right side. The left side of main body B1 is comprised of burner unit B25 incorporating burner B16 and vaporizer B15, a burner unit frame B26 for enclosing burner unit B25 and a burner unit front frame B27 for covering the front and upper part of burner unit frame B26.

[0222] Burner unit B25 includes vaporizer B15, burner B16, a burner box B28 for accommodating burner B16, a burner partition board B29 for fixing burner box B28 and a combustion chamber B30 enclosing flame from burner B16.

[0223] Figs.43 and 44 are structural views showing vaporizer B15 and burner 16. As illustrated, vaporizer B15 is comprised of a vaporizing element B15a for vaporizing the fuel existing therein by heating, a nozzle B31 for ejecting the evaporated fuel by the vaporizing element B15a, a needle B32 that opens and closes the hole of the nozzle B31, a solenoid valve B33 that is linked to this needle B32 for moving needle B32, a fuel entrance B15 for supplying fuel to vaporizing element B15a, a return oil pipe B23 for returning the fuel inside vaporizer B15 when the operation stops and a heat collector B15c for collecting combustion heat from burner B16.

[0224] Vaporizing element B15a is a sintered cylinder made of fine ceramic particles, and tar generated when fuel evaporates accumulates inside vaporizing element B15a from its surface inwards.

[0225] Fuel entrance B15b to vaporizer B15 has a double pipe structure of an outer stainless pipe B34 and an inner copper pipe B22. Outer stainless pipe B34 is used to reduce heat conduction from vaporizer B15 and suppress temperature rise of the fuel entering vaporizer B15. Further, stainless pipe B34 is made greater in diameter than the copper pipe so as to further inhibit heat conduction from stainless pipe B34 to the copper pipe. The end of copper pipe B22 is located at a position outside vaporizer B15.

[0226] Solenoid valve B33 is composed of an electromagnetic coil B33a made up of wire wound in a coil, a

moving piece B33b which is located inside the coil and axially movable together with needle B32, an attracting piece B33c for attracting moving piece B33b to move in the nozzle closing direction by magnetization of electromagnetic coil B33a and a pressing spring B33d for urging moving piece B33b in the nozzle opening direction.

[0227] In the thus configured solenoid valve B33, activation and deactivation of electromagnetic coil B33a causes moving piece B33b to be attracted to and separated from attracting piece B33c, so that needle B32 linked with moving piece B33b moves to thereby open and close the hole of nozzle B31 of vaporizer B15.

[0228] Burner B16 is composed of a mixing tube 16a for mixing the combustion gas evaporated through vaporizer B15 with primary combustion air and a flame port B35 (Fig.41) for burning the mixed combustion gas.

[0229] As shown in Figs.45 and 46, burner box B28 has a top-open box configuration capable of accommodating burner B16, with an approximately rectangular hole formed in the bottom for attaching a flange of the mixing tube of burner B16 and with attachment holes for an ignition heater B35 and flame sensor B36 formed on one side face.

[0230] Attached to the underside of burner box B28 is a burner cover B37. This burner cover B37, having an inverted triangular shape and being arranged under burner B16, has a sound absorbing and heat insulating material applied on the inner side thereof and is fixed to burner box B28, so as to absorb flame noise and prevent reduction of the temperature of the burner itself.

[0231] As shown in Figs.45 and 46, burner partition board B29 is bent upwards at the left and right edges and backside edge while the front edge is bent obliquely, downward and forwards, and has an approximately rectangular hole at the center thereof, around which the top-open edges of burner box B28 is fixed, so that combustion flame from burner B16 passes through the rectangular hole. Further, partition board B29 has at its periphery a number of attachment holes for combustion chamber B30.

[0232] As shown in Fig.45, combustion chamber B30 surrounds the combustion flame from burner B16 on all sides, having an opening on the upper and front side. This chamber is composed of a combustion chamber front B38 and a combustion chamber rear B39.

[0233] Combustion chamber front B38 is bent inwards on both left and right sides and somewhat inclined inwards and upwards while the lower part is bent outwards so as to be fixed to partition board B29. Further combustion chamber front B38 is made of a heat-resisting material so that it will not be incinerated in case abnormal combustion occurs.

[0234] Combustion chamber rear B39 has an inverted U-shape when viewed from top, and the front parts of the left and right sides are bent inwards forming marginal edges, which is joined to combustion chamber front B38. The upper part of the backside wall of combustion chamber rear B39 is inclined inwards while the lower

part is bent outwards and fixed to partition board B29. Cut and upturned pieces B39a and B39b are formed in each of the left and right sides of combustion chamber rear B39, so that part of air flow from convection fan B9 can be introduced into combustion chamber B30 as secondary combustion air to improve the flammability and reduce the burning temperature.

[0235] The upper part of the backside portion of combustion chamber rear B39 is cut and press formed so as to be projected inwards in an open-V shape forming air holes B39c, whereby part of air from convection fan B9 located on the rear side thereof is flowed into combustion chamber B30 as secondary combustion air, thus suppressing the combustion flame from emerging. Combustion chamber front B38 and rear B39 are coated on both inner and outer sides with a heat resistant paint or subjected to a blackening treatment, to thereby improve the heat resistance.

[0236] As shown in Fig.45, burner unit frame B26 is configured of an inverted U-shaped box so as to surround combustion chamber B30 and create air flow passage, through which air suctioned from the room by convection fan B9 will pass, absorbing heat from combustion chamber B30. This burner unit frame B26 is fixed to the left side and backside of side/rear panel B7 of main body B1 and base board B5 by claws and screws. Burner unit frame B26 has a bevel B26a formed obliquely in the upper part on the front side. The front part is formed with a bent engaging portion to which a louver of air outlet 2 is fixed. A burner unit frame front B27 can be attached to bevel B26a after mounting burner unit B25 including burner B16 and vaporizer B15 into burner unit frame B26, obliquely from the upper and front part of main body B1.

[0237] Burner unit frame B27 is to guide air suctioned by convection fan B9 toward air outlet B2 on the front side of main body B1, and has an overheat protector on the front side thereof in order to protect the main body when the air rate of the convection fan decreases for some reason or other. Further, burner unit frame front B27 has a double-fold configuration so as to avoid local thermal influence.

[0238] As shown in Figs.47 and 69, main body B1 has, on its right side, a holding portion 4a for accommodating fuel supply tank B12 in a detachable manner by opening and closing tank lid B4 on the top face of main body B1 and a detector board B40 (Fig.69) arranged at the bottom of the holding portion 4a having parts of the after-mentioned fuel quantity detecting means B69 and water detecting means B70. Further, a joint socket unit 100 (Figs.63 and 64) on the burner unit side is arranged inside holding portion 4a, to detachably receive connecting joint unit B47 (Fig.49) on the fuel supply tank side when fuel supply tank B12 is mounted into the main body.

[0239] Tank holding compartment 4a is partitioned by a tank guide B41 (Figs.43 and 64) for guiding fuel supply tank B12 when the tank is mounted and removed. The

right front part of this tank guide B41 (Fig.64) is cut obliquely, and a tank guide fixture B42 for fixing joint socket unit 100 is attached to this part. Here, since no fuel tank, as used conventionally, exits in holding compartment 4a, the volume corresponding to the fuel tank can be allotted to increase the capacity of the fuel supply tank or to reduce the volume of the main body. Therefore, the occupied space can be reduced, providing the advantage of saving space.

[0240] The configuration of the insertion port including tank output port 4b of holding portion 4a is formed as shown in Figs.47 and 69 in an approximately similar manner to, but marginally greater than, the top view of fuel supply tank B12, and its left side is substantially perpendicular to the front and rear sides of main body B1 while the right side is substantially perpendicular to the front and rear sides of main body B1 with two corners, front and rear, rounded. As stated above, in the front right corner, tank guide fixture B42 for supporting connecting joint socket unit 100 on the burner unit side is disposed at a lower position a predetermined distance away from top face B8 of main body B1.

[Fuel supply tank configuration]

[0241] Fig.48 is a perspective view showing fuel supply tank B12 from the backside. Fig.49 is an outline view showing the connecting joint unit on the fuel supply tank side. As illustrated, fuel supply tank B12 has a roughly parallelepiped configuration, made up of a substantially flat, fuel supply tank left part B12a and a fuel supply tank right part B12b which is press formed in a sectionally U-shaped receptacle with its left side open, the two parts being joined together by Adrian-forming. When viewed from the top side, the tank is roughly rectangular with the right corners, front and rear, rounded.

[0242] Therefore, upon insertion of fuel supply tank B12 into holding compartment 4a, if the tank is attempted to be inserted into holding compartment 4a with its right-side left, the front and rear corners of fuel supply tank right part B12b collide with the front and rear rounded corners on the right side of the tank output port 4b, so that tank B12 is prohibited from being inserted.

[0243] Provided on the fuel supply tank right part B12b side are a handle B43 composed of a metal ring B43b attached to the tank top face so as to be upright and laid down and a resin grip B43a fixed at the center, a filler port B44 for refueling, formed on a bevel B12c extending over three faces, i.e., the two neighboring sides and the top face, and a shutoff means B19 for closing this filler port B44.

[0244] An oil gauge for visible indication of the liquid level of fuel in fuel supply tank B12 is provided on one side face adjacent to closing means B19. Further, one side face adjacent to this oil gauge or the corner on the front right side of the tank right part is formed with a depressed portion B12g set back and inwards so that connecting joint unit B47 on the fuel supply tank side is fixed

in this depressed portion B12g. This connecting joint unit B47 is fixed to depressed portion B12g of the fuel supply tank so that it is kept from jutting out beyond the approximately rectangular orthogonal projection of the tank, whereby the tank can be accommodated in the roughly rectangular tank holding compartment 4a.

[0245] A water receptacle B71 (Fig.60) as a part of a water detecting means B68 for detecting water in tank B12 is projected on the underside of fuel supply tank B12(Figs.48 and 60). In order to protect this water receptacle B71, a tank leg portion B50 (Fig.48) projected downwards is welded around it.

[0246] As shown in Figs.50 to 55, a small air hole B51 (of about 1.5 mm in diameter) is formed on the top face of fuel supply tank B12 so as to prevent a negative pressure state from occurring inside fuel supply tank B12. This air hole B51 is preferably complemented with a device that prevents fuel from scattering outside the fuel supply tank during carriage of the tank, a device that prevents fuel in fuel supply tank B12 from leaking from this air hole even if the fuel supply tank falls down, a device that opens and closes the hole depending on whether the fuel supply tank is set in the main body, and /or other devices. As an air hole shutoff means for these purposes, the following configurations can be used.

[0247] Illustratively, an example 1 of an air hole shutoff means B52 which prevents fuel from scattering out of the fuel supply tank through air hole B51 while the fuel supply tank is carried, is comprised of, as shown in Fig.54, a fuel scatter shield 301 that encloses the inner side of air hole B51 and a conduit hole 302 formed on the bottom side of this scatter shield at a position deviated from the point directly below air hole B51 for creating communication with the tank interior.

[0248] Scatter shield 301 has a dish-like structure and is welded on the interior surface of the tank so as to encloses air hole B51, and is configured so that its bottom is inclined and conduit hole 302 is formed at the deepest point in the inclined face while air hole B51 is positioned right above the most shallow point.

[0249] In the above configuration, when fuel supply tank B12 full of fuel is carried by gripping handle B43, fuel may pass through hole 302 of fuel scatter shield 301 but the interior space of scatter shield 301 provides cushioning functions, i.e., of collecting fuel within scatter shield 301 and discharging out fuel through conduit hole 302. Therefore, no fuel will be scattered out through air hole B51 even when fuel supply tank B12 is carried.

[0250] As an example 2 for preventing fuel leakage from fuel supply tank B12 through air hole B51 even when fuel supply tank B12 falls down, an air shutoff means C52 shown in Fig.55 can be presented.

[0251] Illustratively, in this example 2, a bracing plate 310 having an air hole B51 formed on the top face thereof is fitted into an opening 320 which is formed on the top face of fuel supply tank B12, in a sealable manner with an O-ring 314 in between. Air shutoff means C52 is comprised of a guide 313 disposed on the inner side

of air hole B51, a spherical weight 312 put within guide 313 so as to move up and down therein and a shutoff plate 311 interposed between this weight 312 and air hole B51 for closing air hole B51, following the up-and-down movement of weight 312.

[0252] A plurality of engaging means 315 for attaching bracing plate 310 to fuel supply tank B12 are formed at intervals along the peripheral side thereof while a thread 322 for receiving guide 313 of a closed bottomed cylinder is incised on the inner side of the bracing plate. Engaging means 315 is formed of wedge-shaped hooks projected radially outwards so that these hooks 315 engage a brim 321 projected downwards from the tank opening rim.

[0253] Shutoff plate 311 is to shut off air hole B51 and the top peripheral edge 316 is rounded so that the plate can move easily inside guide 313. Here, the bottom peripheral edge of shutoff plate 311 may also be rounded.

[0254] Guide 313 has a closed bottomed cylindrical configuration and its inner bottom has a tapered surface 317 which becomes lowest at the center so that rolling weight 312 can move therein. A hole 319 for allowing air to flow is formed passing through the lowest part of tapered surface 317. Further, the outer peripheral side of the top part of guide 313 is formed with a thread 323 which is screw fitted with the female thread formed on the inner side of bracing plate 310. A plurality of grooves 318 are formed on the tapered surface 317, from its top to hole 319 of its bottom, securing air flow channels when fuel supply tank B12 is set upright. The inclination of tapered surface 317 is designated so that rolling weight 312 can rotate and cause shutoff plate 311 to move upwards so as to close air hole B51 when fuel supply tank B12 falls down.

[0255] In the above configuration, when fuel supply tank B12 falls down, rolling weight 312 moves rotating on the bottom face of guide 313 or tapered surface 317 and along the side face to displace shutoff plate 311 towards air hole B51. Thereby, shutoff plate 311 shuts off air hole B51 so as to prevent fuel inside fuel supply tank B12 from leaking through air hole B51.

[0256] When fuel supply tank B12 is set upright, rolling weight 312 is located, due to gravity, on tapered surface 317 at the bottom of guide 313. Since grooves 319 formed on tapered surface 318 assure communication between air hole B51 and hole 319 which is connected to the fuel supply tank, no negative pressure will occur inside tank.

[0257] As an example 3 of an air hole shutoff means (D52), air hole B51 is opened or closed depending on whether fuel supply tank B12 is fitted in the main body or not. Specifically, as shown in Figs.49 to 51, air hole shutoff means D52 is comprised of a valve 330 which can open and close air hole B51 of fuel supply tank B12, a tank valve lever 331 having valve 330 attached thereto, a lever cover 332 for accommodating tank valve lever 331, a moving rod 333 for moving tank valve lever 332 up and down and a lever spring 334 for urging moving

rod 333 in the vertical direction.

[0258] Tank valve lever 331 has a projected portion 335 at which valve 330 is fitted, having a Z-shaped fulcrum 336 at its one end and a coupling hole 337 at the other end to be coupled to moving rod 333. Coupling hole 337 is configured so that it is coupled to moving rod 333 with some slight play.

[0259] Lever cover 332 is formed with a depressed portion for accommodating tank valve lever 331. This depressed portion opens at one end while the other side is closed and formed with a slit hole 338 for receiving fulcrum 336 of lever 331. Formed at the open side end of the depressed portion is a screw hole 339 for fixing a cushioning cover 120 of connecting joint unit B47 (Fig. 49).

[0260] Moving rod 333 is to move tank valve lever 331 up and down, and is fitted through a vertical bore 340 formed at the center of a joint body B55 of connecting joint unit B47 so that it can move up and down.

[0261] Valve 330 is composed of a valve element 341 having a pin-like tip, moving up and down through air hole B51 of fuel supply tank B12 and a sealing packing 343 attached to the base part of the pin. Here, air hole B51 is formed at the top part of a spherical portion 343 projected outwards on the top of fuel supply tank B12.

[0262] In the above configuration, to assembly air shutoff means D52 into connecting joint unit B47, moving rod 333 with lever spring 334 fitted thereon is inserted from below into vertical bore 340 at the center of joint body B55 while the Z-shaped fulcrum 336 of tank valve lever 331 is fitted into slit hole 338 of the accommodating portion of lever cover 332. Then, the upper end of moving rod 333 is coupled to hole 337 at the other side of tank valve lever 331 and fixed with a speed nut.

[0263] When fuel supply tank B12 is set in main body B1, a lower abutment seat 350 of moving rod 333 fitted to connecting joint unit B47 of fuel supply tank B12 comes into contact with a top rib portion of packing bracing 103 of connecting joint socket unit 100 on the burner side, and moving rod 333 moves upwards being thrust by the rib portion. As the rod moves, tank valve lever 331 also sways upwards, so does valve 330 attached to tank valve lever 331. Accordingly, a clearance is formed between valve 330 and air hole B51 of spherical portion 343 of fuel supply tank B12 to lead air through air hole B51 into fuel supply tank B12, thus constantly keeping the internal pressure of fuel supply tank B12 at atmospheric pressure (Fig.51).

[0264] In this case, vertical positioning of the associated components is carried out so that moving rod 333 of air hole shutoff means D52 comes into contact with the top rib portion of packing bracing 103 of joint socket unit 100 and open air hole B51 before connecting joint unit B47 on the fuel supply tank side and joint socket unit 100 on the burning side are connected. This arrangement can prevent fuel leakage at the joining means and other problems in case the fuel supply tank increased in pressure is connected to the main body.

[0265] When fuel supply tank B12 is taken out from main body B1, abutment of moving rod 333 attached to the joining means of fuel supply tank B12 against the top rib portion of packing bracing 103 of connecting joint socket unit 100 on the burner side is released and moving rod 333 is moved downwards by force by the repulsive force of lever spring 334. Therefore, valve 330 attached to tank valve lever 331 lowers downwards at the same time to close air hole D51. Accordingly, no air will flow into fuel supply tank B12 through air hole B51, and no fuel will spill out from fuel supply tank B12 in case fuel supply tank B12 falls down.

[0266] Further, since spherical portion 343 formed with air hole B51 is projected upwards, dust and dirt are unlikely to stay, and hence no problem from long term usage will occur.

[0267] A next example of an air hole shutoff means (E52), example 4, is shown in Figs.49, 52 and 53. As illustrated, an air hole B51 is formed at the bottom of a depressed face portion 348 formed on the top face of fuel supply tank B12 while a valve 330 capable of opening and closing this air hole B51 is composed of a valve element 346 having a pin-like tip, moving up and down through air hole B51 of fuel supply tank B12 and a sealing O-ring 346 attached to the base part of the pin. Other configurations are the same as in example 3.

[0268] In the above arrangement, since the depressed face portion 348 at which air hole B51 is formed is hollowed downward, dust and dirt are likely to build up, but the pin at the tip of valve element 345 of valve 330 will remove dust and dirt as it moves up and down, no problem as to opening and closing of air hole B51 will occur. Further, there is an advantage that the depressed face portion can be formed by a metal die which is more simple than that for forming the spherical projection in example 3.

[0269] In the above examples 3 and 4, lever spring 334 is used to forcibly urge tank valve lever 331 in the valve closing direction. However, it is also possible to use a configuration of closing the valve by simply moving the tank valve lever and moving rod 333 utilizing the pull of gravity, instead of using lever spring 334. Further, in the third and fourth air hole shutoff means D52 and E52, moving rod 333 is fitted through connecting joint unit B47 in a vertically movable manner so that the air hole will be opened before completion of the connection of the joining means when the fuel supply tank is set into the main body, and these components are laid out at the same site so as to make the apparatus compact. However, the air hole shutoff means may be arranged at a position other than the connecting joint unit so that it can open the air hole prior to the connection of the joining means. In this case, the moving rod may be arranged so as to abut a part, on the main body side, other than the connecting joint socket unit.

(The connecting joint configuration)

[0270] Fig.56 is a sectional view showing joint B13a on the oil feed side of the connecting joint unit; Fig.57 is an exploded perspective view showing its connection with suction pipe B20 on the tank side; Fig.58 is a sectional view showing joint B17a on the return oil side; and Fig.59 is an exploded perspective view showing its connection with a pipe B63 on the tank side.

[0271] As shown in Fig.49, connecting joint unit B47 on the tank side is an integrated structure of connecting joint B13a on the oil feed side and connecting joint B17a on the return oil side. Each of connecting joints B13a and B17a is comprised of a joint body B55, a valve mechanism B56 and a valve bracing B57, as shown in Figs.56 and 59. Each proximal flange B55d(Fig.56) of body B55 is connected to the other so as to be integrated. This connecting joint unit B47 is arranged in depressed portion B12g (Fig.48) formed at the right front corner on the side part of fuel supply tank B12 and is fixed to the bottom of depressed portion B12g of fuel supply tank B12 with a packing B53 therebetween, by a joint bracing plate B54 being fixed by screws B54f.

[0272] Each joint body B55 is made up of synthetic resin and is comprised, as shown in Figs.56 and 58, of a cylindrical barrel B55a on the front end side, a projected pipe portion B55e or B55f, projected from barrel body B55a towards the fuel supply tank side and a proximal flange B55d extended radially outwards from a mid portion of the projected portion B55e. These joint bodies are integrated by joining proximal flanges B55d of two connecting joints B13a and B17a to each other.

[0273] Barrel portion B55a is continuously integrated with a tubular tapered portion (sealing surface) B55b which gradually becomes smaller in diameter from the lower end of the barrel downwards and a cylindrical portion B55c having a predetermined length with a constant diameter equal to the predetermined diameter at the lower end of the tapered portion B55b. This integration incorporates a valve mechanism B56 therein.

[0274] Each valve mechanism B56 incorporated in cylindrical barrel portion B55a is to shut off oil feed path B from fuel supply tank B12 to electromagnetic pump B14 or a return oil path C from vaporizer B15 to fuel supply tank B12 in an openable and closable manner, and is composed of a valve element B59, an O-ring B60 fitted on the valve element and a spring B61 for the valve element.

[0275] Valve element B59 has a shape approximately analogous to the inside shape of the funnel-like portion made up of barrel portion B55a, tapered portion B55b and tubular portion B55c of joint body B55, and has a configuration which can reciprocate inside joint body B55. Specifically, valve element B59 is comprised of a plug portion (sealing surface) B59b having an approximately conical shape and a column-like movable portion B59a which is extended from the lower end of plug portion B59b and is narrower and longer than the cylindrical

portion B55c. An annular O-ring packing B60 is provided at the tapered portion of plug portion B59b so that the packing will be able to come into sealing contact with tapered portion B55b of joint body B55.

[0276] In order to regulate contact and separation between plug portion B59b and tapered portion B55b of joint body B55, the length of movable portion B59a is designated so that its front end projects out from the cylindrical portion B55a when the valve is closed or when O-ring B60 of plug portion B59b is placed in sealing contact with the inner surface of tapered portion B55b.

[0277] Valve bracing B57 hermetically confines the top hole of barrel cylinder B55a with an O-ring B58 interposed therebetween and has an annular groove formed on its underside for easily receiving valve element spring B61.

[0278] Valve element spring B61 is held within barrel portion B55a, being interposed between valve bracing B57 at the top and plug portion B59b of valve element B59 so as to urge valve element B59 in the valve closing direction.

[0279] Each proximal flange B55d is extended radially outwards, forming an approximately rectangular plate in order to integrally join the two joints B13a and B17a. Annular joint packing B53 is externally fitted inside this flange B55d so as to prevent fuel leakage from the boundary of projected portion B55e or B55f.

[0280] Each of projected portions B55e and B55f on the tank side is formed to be tubular, and the proximal extension beyond proximal flange B55d is inserted into fuel supply tank B12 through an opening B64 formed in the tank wall, so that the end part of suction pipe B20 or return pipe B63 is connected to its interior passage. The height of this interior passage is positioned above the maximum fluid level of fuel in the fuel supply tank so as to prevent fuel from accidentally spilling out of the fuel supply tank to the barrel portion B55a side.

[0281] As shown in Figs.56 and 58, the interior passage of projected portion B55e or B55f is composed of a portion having a diameter to snugly hold suction pipe B20 or return pipe B63 and a large-diametric portion from the halfway point of the passage to its tank interior end so as to receive pipe fixing members. The stepped portion B55r formed between the large-diametric passage B55q and the small-diametric passage B55s on the distal side is adapted to position a bead portion B20a of suction pipe B20 or B63a (Figs.57 and 59) of return pipe B63. Small-diametric passage B55s (Fig.58) is made to communicate with the valve chamber.

[0282] Slit gaps B55g and B55m penetrating through in the radial direction are formed on the proximal side of projected portions B55e and B55f, respectively, so as to allow the projected portions to spread in diameter by elasticity. Insertion grooves B55j or B55n (Fig.59 (b)), which are engageable with a bead portion B20a of a stopper element B65 for suction pipe B20 or return pipe B63, are formed on the interior surface of the pipe, between the slit gaps B55g or B55m.

[0283] As shown in Fig. 57, the interior part of projected portion B55e on the oil feed side is set to be shorter than that of projected portion B55f (Fig.59(a)) on the return oil side so as to facilitate connection of suction pipe 20.

[0284] Suction pipe B20 is formed in an inverted L-shape with its upper horizontal portion connected to oil feed joint B13a (Fig.41) while the lower end of the vertical portion reaches almost the bottom of fuel supply tank B12 and connected to a suction port B66 (Fig.60) in order to suction fuel in fuel supply tank B12. A flange-like bead portion B20a (Fig.57) is formed at the distal end of the horizontal portion of suction pipe B20 for positioning an O-ring when the pipe is connected to connecting joint unit B47.

[0285] The projected portion B55f (Fig.59) on the return oil side is longer than projected portion B55e (Fig. 57) on the oil feed side and formed with upper and lower slit gaps B55k and B55m. Of the upper and lower slit gaps B55k and B55m, the upper slit gap B55k is formed greater than the lower slit gap B55m. This projected portion has an inside diameter slightly greater than the outside diameter of return pipe B63, and has a bore therein to which return pipe B63 is inserted and a bead fitting groove B55n formed outwards on the interior surface of the bore for mating a bead portion B65a on a pipe fixing member B65.

[0286] Return pipe B63 is to return fuel from vaporizer B15 to fuel supply tank B12, and is bent in an L-shape inside fuel supply tank B12 so that its pipe outlet B63b is oriented upwards. With this arrangement, the pipe outlet B63b can be kept projected upward above the liquid level of fuel in fuel supply tank B12 even in case the liquid level of fuel in fuel supply tank B12 abnormally rises due to temperature difference, to thereby prevent incidental fuel leakage toward the burner unit side.

[0287] As the means for fixing suction pipe B20 and return pipe B63 to respective projected portions B55e and B55f in a fall preventative manner, a pipe fixing member B65 having a C-shaped section as shown in Figs.57 and 59 is provided. Formed on the peripheral side of pipe fixing member B65 is a flange-like bead portion B65a which can engage fitting groove B55j or B55n formed in the inner surface of projected portion B55e or B55f while a slit gap B65b is cut through. The inside diameter is formed to be slightly smaller the outside diameter of suction pipe B20 or return pipe B63.

[0288] The material of joint body B55 is not limited to resins, but may be made of metal. The cross-sections of barrel portion B55a, tapered portion B55b and cylindrical portion B55c and others should not be limited to being circular.

[0289] Joint bracing plate B54 for fixing connecting joint unit B47 to fuel supply tank B12 is formed by cutting a central part of a metal sheet and bending it forming a cut and upturned piece B54a, as shown in Fig.56. This cut and upturned piece B54a is adapted to hold valve bracings B57 of connecting joints B13a and B17a by

bracing them from the top so that the bracings will not come out from barrel portions B55a. The central part, from which cut and upturned piece B54a is removed, is shaped to be a relief opening B54b through which projected portions B55e and B55f of connecting joints B13a and B17a pass. The peripheral part of this relief opening B54b is formed to be a peripheral bracing B54d with a rib B54c for bracing the peripheral part of connecting joint unit B47 while a center bracing B54e is extended from the center bottom of relief opening B54b to and between the two connecting joints B13a and B17a.

[0290] Peripheral bracing B54d and center bracing B54e are fixed together with proximal flange B55d of connecting joint unit B47 to fuel supply tank B12 with screws B54f. Combination of relief opening B54b and center bracing B54e prevents bilateral offset of connecting joint unit B47.

[0291] This connecting joint unit B47, as shown in Fig. 49, is protected from the top face of fuel supply tank B12 by a cushioning cover B120 having an L-shaped section, in order to keep connecting joint unit B47 out of the way of other components when fuel supply tank B12 falls down. The outer face of this cushioning cover B120 is formed to be a flat guide surface B120a, opposing and in contact with, a guide surface 111a(Figs.65 and 66) which is formed opposing a protective cover 111 (Fig.68 (b)) enclosing air valve B18 (Fig.66) of connecting joint socket unit 100, and functions to be the guide when the fuel supply tank is inserted into the main body.

[0292] The connecting portion on the side of suction port B66 (Fig.60) at the lower end of the vertical portion of suction pipe B20 is also formed with a bead portion similar to that of the connecting portion with the connecting joint unit and is connected to suction port B66. Suction port B66 is formed of an approximately cylindrical configuration with multiple feet at its bottom. A mesh filter B66a of stainless steel is concurrently formed in the lower part while a pair of slit gaps B66b opposing each other for joining suction pipe B20 is formed in the upper part, so that suction pipe B20 can be connected to the top end.

[0293] As shown in Fig.60, suction port B66 is fitted in the hole of a suction port fixing plate B67 of fuel supply tank B12 so as not to move, whereby suction port B66 will not interfere with the inner wall of fuel supply tank B12.

[0294] In the above configuration, assembly of connecting joint unit B47, suction pipe B20 and return pipe B63 to fuel supply tank B12 is performed by press forming fuel supply tank left and right parts B12a and B12b (Fig.48) and fixing connecting joint unit B47 at the predetermined position of fuel supply tank right part A12b with a packing B53 (Figs. 56 and 58) interposed therebetween, using joint bracing plate B54 and screws, before Adrian forming for joining fuel supply tank left part B12a and right part B12b.

[0295] At the same time, valve bracings B57 of the joints are braced from above by cut and upturned piece

B54a of joint bracing plate B54. Therefore, each valve bracing B57 is held by cut and upturned piece B54a of joint bracing plate B54, so that it will not spring out.

[0296] The method of inserting suction pipe B20 and return pipe B63 from the interior side of fuel supply tank right part B12b and fixing them to projected portions B55e (Fig.56) and B55f (Fig.58) of joint bodies B55, respectively is performed as follows: That is, suction port B66 is assembled into suction pipe B20, then O-ring B64 is fitted at the front side of bead portion B20a (Fig.57 (a)) of suction pipe B20 and the pipe is fitted into projected portion B55e of joint body B55. This is followed by fitting pipe fixing member B65 through its slit B65b onto suction pipe B20 so that it is positioned to be closer to the suction port than bead portion B20a is, and pushing it into the connecting joint unit B47 side until bead portion B65a of pipe fixing member B65 fits into bead fitting groove B55j on the inner side of projected portion B55e. During pushing, pipe fixing member B65 is contracted inwards in diameter so that suction pipe 20 is fixed to projected portion B55e, whereby it is possible to prevent the suction pipe from coming off from connecting joint unit B47.

[0297] For the method of fixing return pipe B63 (Fig. 59), O-ring B64 is fitted at the front side of bead portion B63a of return pipe B63. When the pipe is fitted into projected portion B55f of joint body B55, by fitting return pipe B63 through the greater slit B55k of projected portion B55f of joint body B55, the return pipe B63 can be oriented upward. This is followed by fitting pipe fixing member B65 from above the pipe, through its slit B65b onto return pipe B63 and pushing it into projected portion B55f until bead portion B65a of pipe fixing member B65 fits into bead fitting groove B55n on the inner side of projected portion B55f. During pushing, pipe fixing member B65 is contracted inwards in diameter so that return pipe B63 is fixed to projected portion B55f, whereby it is possible to prevent the return pipe from coming off from connecting joint unit B47.

[0298] In the above way, it is possible to simply join suction pipe B20 and return pipe B63 to connecting joint unit B47 using pipe fixingmembers B65 without the necessity of welding. Therefore, this method is suitable to be used for assembly at a confined site or space. Further, since parts can be disassembled, the cost for maintenance is reduced.

[0299] Fig. 60 is sectional view showing the bottom of fuel supply tank B12. As illustrated, fuel supply tank B12 has, at its bottom, a water detecting means B68 for detecting water arising in the fuel supply tank and a fuel quantity detecting means B69 for detecting the amount of fuel in fuel supply tank B12.

[0300] Water detecting means B68 is comprised of a conductive water receptacle B71 which is arranged at the conductive tank bottom to collect water, an electrode B72 in contact with the water receptacle B71, an electrode B73 in contact with the bottom of fuel supply tank B12 and an insulating water-tight pecking B74 which

provides electric insulation between water receptacle B71 and fuel supply tank B12, and is adapted to detect water based on the difference in electric resistance between fuel and water collected in water receptacle B71.

[0301] Water receptacle B71 is formed of a stainless steel sheet, separately from tank B12, in order to prevent rust, and has an upper side concave similar to a dish or a shape tapered to the center as it goes downwards and a peripheral flange B71a formed around it extending radially outwards, and is attached to a bottom-side attachment hole B12d with the flange B71a fixed to the bottom face of fuel supply tank B12 with rubber packing B74 therebetween. Further, both the interior and exterior of water receptacle B71 from the outside of the contact portion with electrode B72 upwards are coated with a non-conductive paint, whereby it is possible to perform correct water detection with precision by eliminating occurrence of malfunction with leftover water.

[0302] Packing B74 is a resilient non-conductive member interposed between the peripheral wall of bottom-side attachment hole B12d of fuel supply tank B12 and peripheral flange B71a of water receptacle B71, and holds water receptacle B71 so as to grip flange B71a between its upper and lower parts. Packing B74 is fixed around tank attachment hole B12d by means of an annular bracing member B75 disposed at the underside thereof, with screws B76. Thus, water receptacle B71 is fixed in a water-tight manner to attachment hole B12d.

[0303] This rubber packing B74 is formed of a non-conductive rubber member having oil resistance and water-repellence. Specific examples include NBR (butadiene-acrylonitrile rubber) which is excellent in oil resistance and fluororubber which is excellent in water-repellence. Particularly, if packing B74 is poor in water repellence, water may pool and be left covering packing B74 and the metal portion of fuel supply tank B12 after water is drained off. Therefore this may be the cause of malfunction. In the present embodiment, since rubber material having water-repellence is used, correct water detection with high precision can be achieved.

[0304] Electrode B72 on the water receptacle B71 side and electrode B73 on the tank side are both attached to detector board B40 outside the fuel supply tank B12. Water receptacle B71 side electrode B72 is a needle-like electrode or a line-contact type electrode which is projected from the bottom wall of water receptacle depressed holder B40a to the tank B12 side and in contact with the external surface of water receptacle B71 when tank B12 is set in place.

[0305] Tank side electrode B73 is a needle-like electrode which is exposed on peripheral placement board B40b of detector board B40 and is in contact with the bottom face B12f of the tank when tank B12 is set in place. Connecting these two electrodes B72 and B73 to a power supply constitutes a closed electric circuit, starting from the power supply, by way of water receptacle electrode B72, water receptacle B71, fuel or water on the inner surface, tank bottom surface B12f, tank side

electrode B73, to the power supply, whereby it is possible to detect the presence of water based on the resistance of liquid (fuel or water) on the interior side of water receptacle B71.

[0306] In order to enhance the accuracy of water detection, the opening wall of attachment hole B12d on the tank side, which water receptacle B71 fits, is bent downwards forming a bent portion B12d while a multiple number of needle portions B12e of a narrow sharpened tip are projected downwards at intervals along the circumference of the bent portion B12d. These needle portions B12e function as the tank side front electrodes and are electrically connected through the tank bottom to tank side electrode B73.

[0307] Suction port B66 for suctioning fuel from tank B12 is positioned above needle portions B12e so that it will not directly suction water from the water pool in the water receptacle B71. Further, the areas other than the inner and outer sides of the bottom of water receptacle B71 are coated with a non-conductive paint or the like, whereby malfunction is prevented even if water is left covering packing B74 and metal parts of fuel supply tank B12. Further, when the inner surface of fuel supply tank B12 above the suction port B66 for suctioning fuel from tank B12 is coated with a non-conductive paint or the like, it is possible to prevent adverse effects due to water on the systems other than the electric water detecting scheme.

[0308] As shown in Fig.48, tank leg portion B50 for guarding water receptacle B71 are welded at the periphery of water receptacle B71 in the bottom face of fuel supply tank B12. This tank leg portion B50 is made up of rib-like or U-shaped feet B50a which are higher than the tank bottom surface that is welded to fuel supply tank B12, have a height greater than that of the water receptacle and are formed at both left and right ends.

[0309] Therefore, if, upon refueling fuel supply tank B12 with the filler port B24 side up after being taken out from main body B1, there are some foreign bodies present on the surface that is in contact with the bottom of fuel supply tank B12 or water receptacle B71 side, it is possible to avoid damage or pitting, whereby it is possible to prevent malfunction in water detection.

[0310] As shown in Fig.60, fuel quantity detecting means B69 is comprised of a float B77 incorporating a magnet B78 functioning as a detection portion disposed inside tank B12 and a lead switch B79 which is disposed on the detector board B40 side, opposing float B77 so as to turn on and off as magnet B78 moves closer and away.

[0311] Float B77 has its magnet at the bottom thereof and is held inside a transparent, canopied cylindrical guide B80 in such a manner that it can move vertically as the fuel level varies. The bottom face of guide B80 is integrally fixed to the inner side of water receptacle B71 of water detecting means B68.

[0312] Lead switch B79 is fixed to the underside of the central depressed portion of detector board B40 so as

to oppose float B77. Guide B80 is to prevent float B77 from coming into contact with a typical refueling hose as sold on the market when fuel is drawn off from fuel supply tank B12. Therefore, if this guide B80 is of metal, it is machined so as not to form burrs inside.

[0313] Accordingly, when the surface of fuel reaches a certain level as the fuel inside fuel supply tank B12 is used, lead switch B79 detects magnetism from the magnet in float B77 and sends the detection to a controller B80, so that warnings of the end of fuel and the like can be given through a display B81.

[0314] Tank leg portion B50 (Fig.48) is press formed from a sheet material, having a relief opening for water receptacle B71 in the center with U-shaped feet B50a which are extended front to rear at both the left and right ends. Further, a tank side abutment B50d against which a lever of tank insertion detecting means B70 (Fig.69) abuts is formed in an approximately Z-shape, at the corresponding site on the backside of the main body. This tank leg portion B50 is welded to the bottom face of fuel supply tank B12.

[0315] Fig.61 is a sectional view showing the tank filler port. As illustrated, in fuel supply tank B12, bevel B12c is formed between the top face and two sides adjacent to it so that it inclines at, at least 30 degrees, from the tank top surface downwards. Filler port B44 is provided on this bevel B12c. Filler port B44 has a mouth B44a projected outwards from the bevel and the opening of this mouth B44a is covered in an openable and closable manner by a pivotal lid member.

[0316] A filler port shutoff means B19 of filler port B44 of fuel supply tank B12 is composed of a fixing plate B82 which has an opening fitted to filler port B44 and is spot-welded integrally with bevel B12c, an upturned piece B82a which is cut and upturned in a Z-shape on this fixing plate B82 on the top handle side, a moving plate B83 which is pivotally supported by a fixing angle 160 welded to upturned piece B82a, a lid part B85 which has a packing B84 and is disposed on the inner side of moving plate B83 for closing mouth B44a of filler port B44, a coil spring element B86 interposed between this lid part B85 and the inner side of moving plate B83 for pressing lid part B85 toward mouth B44a of filler port B44, an engaging means B87 for keeping moving plate B83 in its filler port closed position, and a releasing hold 161 for releasing the engaging means B86.

[0317] Fixing plate B82 is formed extending from the lower part of bevel B12c to the vicinity of the tank top face. Moving plate B83 is supported on the tank top face side at a pivot B88 while engaging means B87 is provided at the free end side. The length of the moving plate is designed so that when moving plate B83 is tried to be opened with the tank inserted in the main body, it cannot be opened due to its free end being blocked by tank guide B41.

[0318] Lid part B85 is formed like a dish and has an outer flange B89, which is engaged by an annular stopper part B90 formed in the inner face of moving plate

B83, so as not to slip off and so as to move in a direction perpendicular to the plate surface of moving plate B83. Packing B84 is an annular part which is fitted covering the lid part from the peripheral part of the outer flange to the outer side of the depressed portion so that it will be pressed against the brim of mouth B44a. Spring element B86 is disposed in the inner space between moving plate B83 and lid part B85.

[0319] Engaging means B87 is disposed on the side opposite to pivot B88 of moving plate B83 or the free end side thereof, in other words, on the lower end side of bevel B12c close to tank guide B41 of the tank holding compartment. The engaging means is composed of a hook-like engagement lever B93 rotationally supported on a shaft B91 on the free end side of the moving plate, a pin-like engaging catch B94 provided on fixing plate B82 for meshing engaging lever B93 to hold moving plate B83 in its closed position and a lever spring B95 for urging engaging lever B93 in the direction it becomes engaged with engaging catch B94.

[0320] Lever spring B95 is a coil spring element which is wound on a rotary axle B96 of engaging lever B93, with one end hooked on a cut and upturned piece B93a of the engaging lever and the other end engaged by stopper part B90 of moving plate B83. This spring is arranged on the inner face side of engaging lever B93 so as to urge engaging lever B93 more to the inside than moving plate B83.

[0321] Engaging lever B93 has a hold 161 formed integrally on its outside. The rear side of this hold 161 opposes tank guide B41 when engaging lever B93 is in its engaged state, so that only a slight gap that will not allow a finger, for releasing the engaging lever to be inserted therein is formed between the two. If engaging lever B93 is tried to be rotated so as to release when the tank is mounted in the main body, the hold 161 of engaging lever B93 abuts tank guide B41 of the wall of the tank holding compartment to thereby prohibit rotation and release of engaging lever B93.

[0322] As shown in Fig.62, engaging lever hold 161 is provided on the outer side of engaging lever B93, is integrally formed of resin so as to have approximately the same shape as engaging lever B93, and composed of a arced, depressed portion 162 on the lower side so as to allow a finger to be inserted and a pair of side parts 163 to be gripped with the thumb and fingers while the surface is roughened with fine irregularity so that the thumb and fingers will not slip. Lever hold 161 has multiple pins in its inner side and is welded to engaging lever B93.

[0323] In the above configuration, by pulling engaging lever hold 161 (engaging lever B93) outwards when engaging lever B93 is in its engaged state, the hooking portion is released from engaging catch B94, opposing the urging force of spring element B95, whereby engagement of filler port shutoff means B19 is released. However, since the filler port B44 is provided on bevel B12c and since engaging lever B93 is formed with lever

hold 161, if engaging lever B93 is tried to be rotated and released, no hand can enter the gap between hold 161 and tank guide B41 when tank B12 is set in the main body, so that it is impossible to release engaging lever 93. Therefore, unless fuel supply tank B12 is taken out from the main body, no refueling will be allowed, hence it is possible to prohibit filling fuel into main body B1.

[0324] In the above embodiment, the description was made referring to a case where the engaging lever is provided on the moving plate side, but the engaging lever may be arranged on the fixing plate side.

[0325] Fig.63 is a front view showing a tank fixing member; Fig.64 is an exploded plan view showing the positional relationship between the tank guide and the connecting joint socket unit; Fig.65 is an exploded perspective view showing the state of connection of an oil feed pipe and return oil pipe to the joint socket unit; Fig. 66 is a sectional view showing an oil feed joint socket; Fig.67 is a section view showing a return oil joint socket; Fig.68 (a) is a plan view showing an upturned passage; and (b) is a vertical section of an air valve; Fig.69 is a plan view showing a detector board.

[0326] As shown in Fig.69, the peripheral four sides of holding portion 4a for fuel supply tank B12 is enclosed by tank guide B41. This tank guide B41 is formed, as shown in Fig.69, by bending a metal sheet so as to have a rectangular frame-like configuration when viewed from top with just a central part on the rear side open. The left and right ends of the central opening on the rear side are bent in an L-shape, forming bent portions B41c. The top parts of bent portions B41c are hooked by claws on the backside face of side/rear panel B7 of the main body while the lower side is fixed with screws. Tank insertion detecting means B70 is disposed under this backside opening B41d.

[0327] The lower part of tank guide B41 is arranged along the inner side of the left and right upright walls B40s of detector board B40. The front part of the lower part of the tank guide is located along the outer side of the front wall and bosses B40j of detector board B40 while the rear side is arranged between bosses B40j and upright walls B40k. The lower parts on the front and rear sides are fastened to detector board B50 (Fig.70) by screws.

[0328] Tank guide B41 (Fig.64) is unfolded to the outer side at its right corner, from the top to the mid part, so as to be opened out, forming an opening portion B41a. Tank guide fixture B42 is fixed between the unfolded tabs B41b of the opening portion with claws and screws.

[0329] Tank guide fixture B42 is to hold joint socket unit 100 and electromagnetic pump B14, having a U-shaped box-like configuration. Specifically, connecting joint socket unit 100 is fixed with screws at the predetermined position on the top while electromagnetic pump B14 is fixed on the underside with screws. The inner side of fixture B42 is projected into the tank holding compartment 4a to such a degree that it will not come

into contact with depressed portion B12g (Fig.48) in which connecting joint unit B47 of the fuel supply tank is mounted and so that joint socket unit 100 on the top face and connecting joint unit B47 (Fig.49) on the tank side can be joined to each other.

[0330] Connecting joint socket unit 100 (Fig.64) is an integrated structure of oil feed joint side socket 13b and return oil joint side socket B17b, and copper-made outward pipe B21 is connected for communication to oil feed joint side socket 13b while copper-made return oil side joint socket B17b.

[0331] Coupling of outward pipe B21 and return oil pipe B23 with this connecting joint socket unit 100 is done as shown in Fig.65. That is, sealing O-rings B99 are fitted at the front side of flange-like bead portions B21a and B23b formed at the front ends of pipes B21 and B23, and these pipes are inserted into predetermined holes 98c and 98f, respectively, of connecting joint socket unit 100. With U-shaped slots 101a formed on the bottom side of a pipe fixing plate 101 fitted from above onto pipes B21 and B23 outside their bead portions B21a and B23a, fixing plate 101 and joint socket unit 100 are fixed to each other with screws passing through screw holes 101b and 100a formed on respective members.

[0332] Outward pipe B21 and return oil pipe B23 are formed of copper material. As to the inside diameter of outward pipe B21 and return oil pipe B23, the former is formed so as to be smaller in diameter than the latter. Specifically, the inside diameter of outward pipe B21 is set at 1.5 mm and the inside diameter of return oil pipe B23 is set at 3 mm. If the inside diameter of outward pipe B21 is greater than 1.5 mm, a greater amount of fuel is left over in outward pipe B21 upon extinguishment, and it takes time to return the remaining fuel from vaporizer 14 to fuel supply tank B12 when the apparatus starts to be operated or when it is re-ignited, causing generation of odor. When the inside diameter of return oil pipe B23 is 4 mm or greater, a phenomenon of air inside the pipe displacing fuel occurs, making it difficult for fuel to return to fuel supply tank B12, so that fuel stagnates within the pipe, causing generation of odor. In contrast, the inside diameter is smaller than 3 mm, there is a possibility that fuel cannot return to fuel supply tank B12 while air only is sent due to the resistance of the pipe. Differentiation in diameter between the two pipes also is effective in preventing wrong connection from occurring when assembled.

[0333] Return oil pipe B23 (Fig.63) starting from vaporizer B15 is extended downwards first and then laid out horizontally from the body front and passes along the front side of fuel supply tank B12 on the right side of the body. The pipe is further extended approximately vertically upwards on the right side of the body and is connected to connecting joint socket unit 100 of fuel supply tank B12.

[0334] In this way, since return oil pipe B23 is formed

to have an approximately horizontal pipe portion B23d near the site where it starts from vaporizer B15, the fuel is kept temporarily within the pipe portion (approximately horizontal part) B23d when the vaporized fuel remaining in vaporizer B15 when the operation is stopped is returned to fuel supply tank B12. Then, upon ignition, the nozzle is closed for about one to two minutes until fuel is made to change from liquid to gas inside vaporizer B15 and is emitted from nozzle B31. This confinement of the hole of nozzle B31 makes the internal pressure of vaporizer B15 to rise, so that the pressure acts on return oil pipe B23, whereby the fuel remaining in return oil pipe B23 is pushed up so that the fuel is returned to fuel supply tank B12 by way of connecting joint socket unit 100 and connection joint unit B47.

[0335] Further, since the fuel remaining in vaporizer B15 upon extinguishment is temporarily held within approximately horizontal portion B23d of return oil pipe B23, fuel elevated in temperature is cooled therein so that fuel reduced in temperature can be returned to the joining means side. This also permits use of materials having low heat resistance and leads to improvement in durability and cost advantage.

[0336] Connecting joint socket unit 100 is comprised of a socket body B98 fixed with screws to the top face of tank guide fixture B42, oil feed side joint socket 13b and return oil joint socket B17b, arranged side by side in this socket body, and air valve B18 as a shutoff valve disposed with socket body B98.

[0337] As shown in Fig.66, oil feed joint side socket 13b is comprised of a rod-like valve retainer 98a, projected upwards from the center of a depressed portion formed from the top face of socket body B98, an approximately cylindrical connection packing 102 of rubber placed on the top face of socket body B98 so as to enclose the valve retainer and an approximately cylindrical packing bracing 103 which covers the periphery of this packing 102 and fixes the bottom flange 102b of packing 102 to the top face of socket body B98 with screws. Formed around valve retainer 98a in socket body B98 is a groove 98b, from which a horizontal tubular passage 98c is formed to communicate with the electromagnetic pump B14 side.

[0338] As shown in Fig.68, the passage 98c turns upwards along the way forming an inverted U-shaped upturned passage 98d which is higher than passage 98c. This upturned passage 98d is formed inside a cylindrical portion 98h which is integrally formed on the top face of socket body B98. Air valve B18 is fixed using screws to the depressed portion at the top of this cylindrical portion 98h with a packing 104 interposed therebetween. The exit 18a of air valve B18 is set to be open to the top end of inverted U-shaped passage 98d.

[0339] Further, as shown in Fig.68 (a), upturned passage 98d is composed of a vertical upward passage 98d1, having a crescent cross-section, connected to the joint retainer 13b side and a vertical downward passage 98d2, having a circular cross-section, connected to out-

ward pipe B21 on the electromagnetic pump B14 side, with a partitioning wall 98i in-between. These two passages 98d1 and 98d2 are formed so as to communicate with each other at their top ends over partitioning wall 98i.

[0340] As to the sectional areas of these two passages 98d1 and 98d2, the area of passage 98d2 is designated to be smaller than that of passage 98d1. This setting is aimed at reducing the amount of fuel left over upon extinguishment to shorten the time taken to return the remaining fuel from the vaporizer to the fuel supply tank when the apparatus starts to be operated or when the apparatus is re-ignited. This further reduces the factors causing generation of odor, and makes it possible to quickly return the fuel to the fuel supply tank side and shut off the passage.

[0341] Connection packing 102 (Fig.66) is used to reduce the impacts and create sealing when valve element B59 on the oil feed joint B13a (Fig.56) side is inserted into the oil feed joint socket B13b (Fig.66) side, and has an approximately cylindrical configuration with a hole 102a formed on top of the cylinder so as to allow cylindrical portion B55c and valve element B59 of the oil feed joint B13a side to access thereto.

[0342] Packing bracing 103 presses connecting packing 102 from thereabove to improve sealability and also functions as a guide when connecting joint unit B47 fits in from above. This has an approximately cylindrical configuration with a hole 103a formed on top of the cylinder so as to allow barrel portion B55a and tapered portion B55b of the connecting joint B13a side to access thereto.

[0343] Air valve B18 (Fig.68 (b)) takes air into the oil feed passage from fuel supply tank B12 to electromagnetic pump B14, from the outside of the passage to shut off the fuel supply through the oil feed passage, and is comprised of an electromagnetic coil B18d located at the periphery of a valve chamber B18b, a valve element B18g which can move in the valve chamber by demagnetization of the electromagnetic coil B18d to open and close an air hole B18f formed in a valve bracing B18e above the valve element, a coil spring B18h which urges valve element B18g in the direction air hole B18f is opened, and a communication exit B18a formed under the valve chamber to communicate with inverted U-shaped passage 98d on the oil feed side. Valve element B18g moves as electromagnetic coil B18d is magnetized so as to close air hole B18f while it opens air hole B18f by virtue of repulsive force of coil spring B18h when electromagnetic coil B18d is demagnetized, whereby air passes through the clearance around valve element B18g to be supplied from communication exit B18a into the upturned passage 98d side.

[0344] Valve element B18g is constructed of a closed bottomed cylinder B18i, a valve piece B18j fitted inside the cylinder so as to project out and retract with respect to the top opening, and a spring B18k urging this valve piece B18j in the projected direction, to thereby alleviate

collision with valve bracing B18e when air hole B18f is closed.

[0345] An air valve cover 111 for covering the air valve B18 to protect it is fastened together with socket body B98 of connecting joint socket unit 100. This air valve cover 111 is so formed that at least the oil feed joint socket B13b (Fig.66) side forms a vertical surface 111a, opposing protective cover 120 (Fig.50) of connecting joint unit B47 so as to provide the guide function for guiding the joint unit when fuel supply tank B12 is inserted into the main body.

[0346] On the other hand, as shown in Fig.67, socket body B98 of return oil side joint socket B17b of the second joining means has a valve chamber 98i which is located under a valve hole 98e formed on the top thereof, accommodates a valve mechanism 105 and is formed on its side wall with a horizontal passage 98f from vaporizer 14.

[0347] Valve mechanism 105 comprised of a receiver valve element 106 which shuts off valve hole 98e in an openable manner, a receiver valve element cap 108 for closing the bottom of valve chamber 98i, a receiver valve element spring 107 interposed between this cap 108 and receiver valve element 106 to urge receiver valve element 106 in the direction the valve hole is closed, an O-ring 109 fitted on the sealing surface of receiver valve element 106 and a cap O-ring 110 for sealing receiver valve element cap 108.

[0348] Receiver valve element 106 is provided in order to receive valve element B59 of joint B17a on the return oil side as the second joining means and to prevent odor leakage when fuel supply tank B12 is taken out.

[0349] Receiver valve element spring 107 becomes compressed by pressing of connecting joint B17a on receiver valve element 106 when fuel supply tank B12 is set into the main body. Receiver valve element cap 108 includes a hollowed receiver 108a for guiding the lower part of receiver valve element 106 when receiver valve element 106 is moved a predetermined distance by valve element B59 of connecting joint B17a and a rest 108b for receiver valve element spring 107, formed around that hollow.

[0350] This receiver valve element cap 108 is inserted from the opening of the fuel passage on the underside of connecting joint socket unit 100. When this connecting joint socket unit 100 is fixed to the predetermined position of the tank guide fixture B42 by screws, tank guide fixture B42 braces that part. That is, the inserted receiver valve element cap 108 is prevented from falling off by connecting joint socket unit 100.

[0351] Connecting joint socket B17b has a connection packing 102 in socket body B98, and is covered above the connection packing 102 by a packing bracing 103, similarly to the first connecting joint socket.

[0352] Fixed at the predetermined position under tank guide fixture B42 is electromagnetic pump B14 as an oil feed pump. Coupling of outward pipe B21 from this elec-

tromagnetic pump B14 and return oil pipe B23 from vaporizer B15 with connecting joint socket unit 100 may be performed, in the aforementioned manner, by fitting O-rings B99 to bead portions B21a and B23a on outward pipe B21 and return oil pipe B23, inserting these pipes into the predetermined holes, respectively, of socket body B98, then fitting pipe fixing plate 101 with its U-shaped slots 101a (Fig.65) onto pipes B21 and B23 and fixing the plate with screws.

[0353] In the above configuration, fuel in fuel supply tank B12 flows from connecting joint B13a (Fig.56) to connecting joint socket B13b (Fig.66) when electromagnetic pump B14 is driven so as to suction the fuel inside fuel supply tank B12 through suction pipe B20. Thereby, fuel flows sideways into connecting joint unit B47, passing through the gap opened in valve mechanism B56 between the main body cylindrical portion B55c and body B59 to connecting joint socket 13b. The fuel further proceeds from groove 98b through passage 98c, flowing through upturned passage 98d under air valve B18. Then the fuel is sent from electromagnetic pump B14 to vaporizer B15.

[0354] Fig.69 is a plan view showing a detector board configuration; Fig.70 is an outline view showing the position where a tank insertion detecting means is attached; Fig.71 is an outline view showing an electrode on the water receptacle side; Fig.72 is an outline view showing an electrode on the tank side; and Fig.73 is an outline view showing a tank insertion detecting means.

[0355] As illustrated, detector board B40 (Fig.70) on which fuel supply tank B12 rests is arranged at the bottom of holding compartment 4a. This detector board B40 is attached to base board B5 located under fuel supply tank B12, and includes tank insertion detecting means B70 for detecting whether fuel supply tank B12 is inserted and a structure for attachment of the electrodes of water detecting means B68.

[0356] Detector board B40 has upright walls B40s arranged at both left and right ends, extending upwards and downwards. Each upright wall B40s is bent outwards at its top end. In the approximate center of detector board B40, a depressed holder portion B40a for water receptacle B71 that is concave downwards is formed. On both left and right sides of depressed holder portion B40a, two holding hollows B40t extended front to rear for receiving tank leg portion B50 (Fig.48) on the underside of fuel supply tank B12 are formed. In the lower upright wall on the right side of detector board B40, a number of V-grooves B40c for supporting and fixing lead wires are formed.

[0357] Provided in depressed holder portion B40a and placement surface B40b on the left side of holding hollow B40t are two rectangular holes B40d and B40e through which the contacts of electrodes B72 and B73 of water detecting means B68 move up and down and two lever supports B40h and B40g functioning as the electrodes.

[0358] Four attachment bosses B40J for fixing tank

guide B41 are provided at positions front and rear on both the left and right sides in detector board B40 while guide rails B40k for guiding tank guide B41 when it is fixed to the side/rear panel B7 are arranged near the rear-side attachment bosses.

[0359] Attached to a depressed portion B40n formed on the underside of depressed holder portion B40a of detector board B40 is a lead switch B79 as a proximity switch for fuel quantity detecting means B69.

[0360] Each of electrodes B72 and B73 of water detecting means B68 is comprised of an electrode lever 115. As shown in Fig.71(a), this electrode lever 151 is formed of an elastic stainless steel sheet bent in a step-like manner. An insert receiver 151a for a lead wire connector at the proximal portion of the lever is formed with a screw hole 151b for its fixture to the detector board and a receiving hole 151c formed at a position more frontwards while the front end of the lever is bent upwards in an L-shape.

[0361] Formed on the detector board B40 side to which this electrode lever 151 is attached is a lever attachment boss B40q projected downwards. This boss has a fixing hole B40p formed therein. Further, a circular projected support B40h serving as a fulcrum on which lever 151 pivots up and down is projectively formed in the vicinity of this attachment portion.

[0362] Assembly of electrode lever 151 is performed by fitting support B40h of detector board B40 into receiving hole 151c of electrode lever 151, aligning screw hole 151b of lever 151 to attachment hole B40q of detector board B40, and fastening it to boss B40p with a screw. By this arrangement, the distal part of electrode lever 151 is set so as to come out through rectangular hole B40d or B40e above the obverse side. In order to regulate the projected height, a rib B40m is projectively formed on the underside of detector board B40. In this way, since electrode lever 151 has its pivoting fulcrum at a site different from its fixed point at the proximal end, no stresses will concentrate on the fixed point so that the durability can be improved.

[0363] Tank insertion detecting means B70 is arranged on the rear side of detector board B40, and is comprised of, as shown in Fig.61, a tank detector plate 117 fixed on the rear side of detector board B40, a lever 113 which is attached to this detector plate 117 so as to pivot vertically and come into contact with the fuel supply tank bottom when fuel supply tank B12 is inserted into the main body, a microswitch 112 (Figs.71 and 73) which is fixed to detector plate 117 so that it turns on and off as the lever moves up and down and a lever spring 116 for urging lever 113 when it is movable.

[0364] Lever 113 has an L-shaped configuration of a small width when viewed from top. A boss 113b functioning as a pivoting fulcrum is formed at one end thereof while a tank abutment 113a to be in contact with the fuel supply tank is formed on the other end and projected from tank detector plate 117 to the detector board B40 side.

[0365] Tank detector plate 117 is formed in a side-facing U-shape by bending sheet material, having an axle 117a, on its upright wall, to which the lever is fitted, a holding hollow 117b for attachment of microswitch 112 and a rectangular hole 117c having a size approximately equal to the moving distance of the tank abutment of lever 113 when it moves up and down.

[0366] Lever spring 116 is hooked between the top plate of tank detector plate 117 and lever 113 and urges lever 113 in the direction microswitch 112 is turned on.

[0367] Assembly of the insertion detecting means B70 is performed by fitting and engaging lever spring 116 to lever 113, inserting tank abutment 113b of lever 113 through rectangular hole 117c of tank detector plate 117, then fitting boss 113b formed at one end of lever 113 onto axle 117a of tank detector plate 117 and fixing it with a stopper ring. This assembly is completed by fitting microswitch 112 onto the pin of holding hollow 117b of tank detector plate 117 and fixing it with a stopper ring.

[0368] Referring to the operation of tank insertion means B70, when fuel supply tank B12 is inserted into main body B1, tank abutment 113a of lever 113 is pressed downwards by fuel supply tank B12, so that microswitch 112 is opened and the circuit becomes activated. Conversely, when fuel supply tank B12 is not mounted in the main body, fuel supply tank B12 does not rest on tank abutment 113a of lever 113. Therefore, the lever is pushed up by lever spring 116, whereby microswitch 112 is closed and the circuit becomes deactivated.

[0369] In the above way, microswitch 112 is used in such a manner that its moving contact is open when tank is attached while it is closed when the tank is removed. Accordingly, it is possible to take a large enough margin for the vertical movement of fuel supply tank B12 when microswitch 112 is operated, and occurrence of problems can be reduced.

[0370] Now, the positional relationship between the liquid level in fuel supply tank B12 and each joining means will be described. In connecting joint unit B47 of fuel supply tank B12, passage B55p (Fig.56) through which fuel suctioned from fuel supply tank B12 passes is arranged above the indicated maximum fluid level of fuel supply tank B12, so as to avoid fuel leakage at the tank joining portion in connecting joint unit B47.

[0371] In connecting joint socket unit 100, the upper end of partitioning wall 98i of upturned passage 98d (Fig.68) under air valve B18 is positioned to be higher than the fuel level in fuel supply tank B12. Here, the fuel level in the fuel supply tank means the fluid level of the maximum fuel indication at the ordinary state.

[0372] Since pipe outlet B63b of return oil pipe B63 from the vaporizer B15 side into fuel supply tank B12, in connecting joint unit B47 is positioned so as to be higher than the abnormal fluid level of fuel in fuel supply tank B12, fuel is prevented from flowing backwards, from the fuel supply tank side to the vaporizer B15 side through the return oil passage even when the fluid level

of fuel in fuel supply tank B12 rises abnormally due to difference in temperature. In this case, if some fuel is sent from connecting joint unit B47 to the electromagnetic pump B14 side, no fuel will be sent further forwards because pump B14 is deactivated. Further, air hole B18f in air valve B18 is set at such a position as to be always higher than the abnormal fluid level, so that no fuel will leak from fuel supply tank B12 to the outside by way of air valve B18.

[0373] In connecting joint socket unit 100, the upper end of partitioning wall 98i of upturned passage 98d under air valve B18 is located so as to be always higher than the normal fluid level of fuel supply tank B12. Accordingly, when air valve B18 is opened upon extinguishment so that air is taken in to the oil feed passage, fuel can be quickly returned to the fuel supply tank side because the area of passage 98d1 on the fuel supply tank side of upturned passage 98d is greater than the other. Thus, it is possible to reliably shut off fuel supply.

[Controller configuration]

[0374] Fig.74 is a block diagram showing a control circuit for controlling various modes of operation in accordance with the signals from fuel quantity detecting means B69, water detecting means B68 and tank insertion detecting means B70. As illustrated, controller 141 is constituted of a microcomputer 141 incorporating a CPU, ROM and RAM, and connected on its input side to fuel quantity detecting means B69, water detecting means B68 and tank insertion detecting means B70 while the output side is connected to an electromagnetic pump driver circuit 118, display 149 and a valve drive circuit 119, so that it can control the operation in accordance with various input signals.

[0375] For example, when tank insertion detecting means B70 is turned off (no tank) by removal of the fuel supply tank during operation, the controller receives the signal and outputs a cutoff signal for electromagnetic pump B14 to pump driver circuit 118 and also outputs an open signal for air valve B18 to valve drive circuit 119 so as to stop the operation. Alternatively, it is also possible to perform control of actuating a baking and cleaning operation mode for effecting baking of vaporizer B15 when tank insertion detecting means B70 is on.

[The operation of the kerosene fan heater]

[0376] Next, the operation of the above kerosene fan heater will be described. When fuel in fuel supply tank B12 has run out, fuel is charged into fuel supply tank B12 through filler port B44 by opening lid B4 of main body B1, taking out the fuel supply tank B12 by holding handle B43, and releasing shutoff means B19 with the handle B43 side up. In this case, since refueling is done while fuel supply tank B12 is placed on a flat site with the handle B43 side up, it is no longer necessary to turn fuel supply tank B12 upside down. Accordingly, it is pos-

sible to easily and reliably perform refueling without the filler cap of fuel supply tank B12 being stained with fuel, as used to be the case.

[0377] When refueling is completed, the fuel supply tank B12 filled up with fuel is set into the predetermined position after opening lid B4 of main body B1. Upon this setting, the lower part of cushioning cover B120 attached to connecting joint unit B47 of fuel supply tank B12 is lead to the lower part of connecting joint socket unit 100 along the outside of air valve protective cover 111 of connecting joint socket unit 100 on the burner unit side, so that connecting joint unit B47 on the fuel supply tank B12 side becomes connected to the joint socket unit 100 on the burner unit side (Figs.75 to 78).

[0378] At the same time, in oil feed side joint B13a of connecting joint unit B47, the valve element B59 is guided and inserted into hole 103a of packing bracing 103 of oil feed side joint socket 13b and enters hole 102a of connection packing 102 to abut valve retainer 98a. In this situation, hole 102a of connection packing 102 is hermetically sealed by main body cylindrical portion B55c of connecting joint unit B47 so as to eliminate the risk of fuel leakage from this connection.

[0379] As fuel supply tank B12 is further inserted into main body B1, valve retainer 98a pushes valve element B59 of oil feed joint B13a upward while valve element spring B61 becomes compressed to set valve element B59 open. Thus, oil feed passage B for flow of fuel from suction pipe B20 of fuel supply tank B12 to the electromagnetic pump B14 side via connecting joint B13a becomes open.

[0380] Similarly, return oil side joint B17a (Fig.58) of fuel supply tank B12 moves in the same manner. That is, the valve element B59 of connecting joint B17a is lead and inserted into hole 103a of packing bracing 103 of connecting joint socket unit 100 and enters hole 102a of connection packing 102, so that valve element B59 of return oil side joint B13a abuts valve element 106 in valve mechanism 105 of socket body B98. In this situation, connection packing 102 is hermetically sealed with main body cylindrical portion B55c of connecting joint unit B47 so as to eliminate the risk of fuel leakage.

[0381] As fuel supply tank B12 is further inserted into main body B1, receiver valve element 106 of valve mechanism 105 (Fig.67) moves downwards and abuts the bottom of hollowed receiver 108a of receiver valve element cap 108. Then, valve element B59 of return oil joint B17a is pushed upwards by receiver valve element 106 while valve element spring B61 becomes compressed to set valve element B59 open. Thus, return oil passage C for flow of fuel from vaporizer 15 to the fuel supply tank B12 side via pipe B23 becomes open.

[0382] When fuel supply tank B12 is inserted into main body B1 and the bottom of fuel supply tank B12 reaches detector board B40 at the bottom of holding compartment 4a, rear side lever abutment B50d of tank leg portion B50 of fuel supply tank B12 presses down lever tank abutment 113a of lever 113 of tank insertion

detecting means B70 (Figs.69 and 73) so as to turn on microswitch 112 on the circuit.

[0383] When the operation switch (not shown) of the kerosene fan heater is actuated to turn power on with the fuel supply tank mounted in place and electromagnetic pump B14 is driven, air is taken in from air hole B18f (Fig.68 (b)) of air valve B18 and sent to oil feed passage B because air valve B18 is in demagnetized state and hence is open. Therefore, no fuel in fuel supply tank B12 is suctioned through suction pipe B20, whereas fuel remaining in oil feed passage B is sent to vaporizer B15 and then it is returned together with the fuel remaining in vaporizer B15 to fuel supply tank B12 by way of return oil passage C so that no fuel will remain in the passage.

[0384] In vaporizer B15, the vaporizer heater is heated as the operation switch is turned on so that vaporizer B15 is preheated to the predetermined temperature. When it reaches the predetermined preheat temperature, air valve B18 is actuated and electromagnetic coil B18d is magnetized so that valve element B18g moves so as to close air hole B18f and stop taking air from air hole B18f. As a result, oil feed passage B is made to communicate from fuel supply tank B12 to electromagnetic pump B14 by way of the joining means, and fuel is sent from fuel supply tank B12 to oil feed passage B.

[0385] At vaporizer B15, the fuel sent by electromagnetic pump B14 is evaporated into gaseous fuel in vaporizer B15 so that it is blown out from nozzle B31 of vaporizer B15 and mixed with combustion air in the burner. This mixture is emitted from flame port 16b of burner B16, and ignited at flame port 16b and made to burn in combustion chamber B30. At the same time, based on the temperature difference between the room temperature detected by room temperature thermistor 11 and a set temperature designated through control portion B3, controller 141 (Fig.74) controls the drive of electromagnetic pump B14, whereby the amount of liquid fuel supplied to vaporizer B15 is varied to appropriately control the power of heating from burning.

[0386] When combustion starts and flame sensor B36 (Fig.42) detects a flame current equal to or greater than the preset current value, an unillustrated fan motor is activated so that blower fan B9 starts rotating to suction air from the room. The rotational rate of the fan motor is controlled by controller 141. The air suctioned from the room absorbs the radiated heat obtained in combustion chamber B30 and is blown out together with the combustion gas as warm air through air outlet 2 to the room, whereby the temperature in the room rises and is regulated.

[0387] When the operation of main body B1 is stopped, drive of electromagnetic pump B14 is deactivated and air valve B18 is opened so that air flows into the passage from the outside, whereby supply of fuel is reliably shut off.

[Other embodiments]

[0388] The present invention should not be limited to the above embodiments and many changes and modifications can of course be added within the scope of the present invention. For example, as a filler port configuration, a filter shown in Figs.79 to 83 may be of course added to the configuration shown in Fig.61.

[0389] Fig.79 is a sectional outline view showing another embodiment of a filler port shutoff portion; Fig.80 (a) is a plan view showing a filter and (b) is a side sectional view showing a filter; and Fig.81 is an enlarged view of the top part of a filter body.

[0390] As shown in Figs.79 and 80, a filter 300 is disposed at a filler port B44 of a fuel supply tank 6 so that dust and dirt in fuel can be removed when fuel is charged into fuel supply tank 6.

[0391] Filter 300 is constructed of a filter body 301 and a mesh portion 302 with a fine mesh. Filter body 301 is a closed bottomed cylinder and is extended more downwards than the maximum fluid level of fuel at filler port B44 when it is fitted in the filler port. A flange 301a resting on the brim of the mouth of filler port B44 is formed on the top opening edge of the filter body while the side face is formed with a grate extending from the vicinity of the flange down near to the bottom.

[0392] As shown in Fig.80, a plurality of ribs 303 are projected inwards on the inner side in the upper part of filter body 301 so as to guide the hose of a typical refueling pump as sold on the market and make the hose unlikely to slip off once it is inserted. To deal with various commercially available refueling pumps different in hose diameter, ribs 310 projected inwards like a bow having a free lower end are preferably formed as shown in Fig.81, so that when a hose is inserted, ribs 310 may flex spreading outwards and admit the hose into the filter.

[0393] Further, as shown in Fig.80, an air hole 305 is formed near flange 301a on the inner face of filter body 301 so as to avoid occurrence of a negative pressure state due to fuel flow during refueling. Alternatively, when fuel or water remaining in the fuel supply tank needs to be drain, the fluid is discharged from air hole 305 by turning the fuel supply tank upside down.

[0394] Formed at the inner bottom of filter body 301 is a rib 304 which is projected upwards. This creates a clearance between the lower end of a hose of a commercially available refueling pump and the bottom of the filter body so that fuel can flow smoothly even when the end of the hose abuts the bottom.

[0395] Mesh portion 302 is formed of as fine as an approximately 200 mesh, which is stretched from the vicinity of the top flange to near the bottom in the side grating portion of filter body 301. This mesh portion 302 is formed at the same time when filter body 301 is formed.

[0396] Fig.82 is a sectional view showing an example 2 of a filter 300. As illustrated, a filter 300a is divided into

two upper and lower grating portions on the side face of filter body 301 in order to prevent contamination of water from the outside when refueling. That is, two types of meshes are stretched across respective grating positions: the upper mesh portion 302 on the opening side is adapted to be permeable to both water and oil; and the lower mesh portion 315 is subjected to a water repellent treatment so as to be impermeable to water. Thereby, in case water enters during refueling the fuel supply tank, water will not directly enter the tank but can be trapped by the filter, so that water can be simply post processed.

[0397] Fig.83 is a sectional view showing an example 3 of a filter 300. As illustrated, a filter 300b is comprised of a side mesh portion 302 stretched across the grating portion formed on the side face of a filter body 301 and a bottom mesh portion 320 stretched across the opening formed at the bottom of filter body 301. The side mesh portion 302 is adapted to be permeable to water and oil and the bottom mesh portion 320 is subjected to a water repellent treatment so as to be impermeable to water. Thereby, water will not directly enter the tank during refueling the fuel supply tank but can be trapped by the filter so that water can be simply post processed.

[0398] As has been described heretofore, according to the present invention, since fuel in the fuel supply tank is directly fed to the burner unit without providing any fuel tank for temporarily holding fuel under the fuel supply tank, it is possible to charge fuel without the necessity of turning the tank upside down when the fuel tank is refueled.

[0399] Thus, in a liquid fuel burning apparatus in which fuel in the fuel supply tank is directly fed to the burner unit without using any fuel tank, an air hole shutoff means for preventing fuel from scattering and leaking is provided for the air hole which is formed so as not cause negative pressure states in the fuel supply tank. Accordingly, it is possible to prevent fuel from scattering during carriage of the tank and prevent fuel from leaking when the tank falls down.

[0400] Further, since the refueling system is so constructed that the fuel supply tank is always kept with its filler port set up, provision of a filter for removing dust, etc., at the filler port makes it possible to prevent dust and dirt from entering the fuel supply tank when refueling.

Industrial Applicability

[0401] As has been described, the liquid fuel burning apparatus according to the present invention is suitably applied to a space heater for the winter or cold sites, for example, a kerosene fan heater and the like, which is refueled by taking out a fuel supply tank from the main body and returning it in place after charging fuel.

Claims

1. A liquid fuel burning apparatus wherein a fuel supply tank having a filler port and its shutoff member in the upper part thereof is detachably mounted in a tank holding compartment of a main apparatus body, comprising a filler port release preventing means for prohibiting release of the shutoff member when the fuel supply tank is set in the main body. 5
2. A liquid fuel burning apparatus comprising: a fuel supply tank having a filler port and its shutoff member in the upper part thereof and being detachably mounted in a tank holding compartment of a main apparatus body; and a burner unit for burning fuel, being constructed so that fuel is directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel under the fuel supply tank, the liquid fuel burning apparatus further comprising a filler port release preventing means for prohibiting release of the shutoff member when the fuel supply tank is set in the main body. 10 15 20
3. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the filler port release preventing means is constructed so that part of the top face and side faces of the fuel supply tank are shaped forming a bevel on which the filler port is disposed, and when the tank is set in the main body, release of the shutoff member is prohibited by the wall face of the tank holding compartment. 25 30
4. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the filler port release preventing means is constructed so that the top face and two side faces adjacent to the top face are beveled by a predetermined angle, forming a bevel on which the filler port is disposed, and when the tank is set in the main body, release of the shutoff member is prohibited by the wall face of the tank holding compartment. 35 40
5. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the filler port release preventing means is constructed so that the filler port is disposed in an upper part of one side face of the tank, and when the tank is set in the main body, release of the shutoff member is prohibited by the wall face of the tank holding compartment. 45 50
6. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the filler port release preventing means is constructed so that the filler port is disposed on the top face and a limiting part for limiting release of the shutoff member when the tank is set in the main body is provided. 55
7. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the shutoff member is comprised of a fixing plate integrally formed with the filler port, a moving plate pivotally supported on the fixing plate in an openable and closable manner, a lid member with a packing, provided for the moving plate for closing the filler port and an engaging member for keeping the moving plate at the filler port closing position.
8. The liquid fuel burning apparatus according to Claim 7, wherein the engaging member is disposed on the free end side or on the side opposite to the pivoting fulcrum of the moving plate, and comprises: an engaging lever which has an engaging part and is pivotally supported on either the moving plate or the fixing plate; an engagement hold which is disposed on the remaining part, the moving plate or the fixing plate, and is engaged with the engaging part so as to keep the moving plate at its closed position; and a lever spring for urging the lever in the direction the engaging part becomes engaged with the engagement hold.
9. The liquid fuel burning apparatus according to Claim 8, wherein the engaging lever is partly extended so that the extended portion and the wall face of the tank holding compartment constitute a filler port release preventing means, and when the fuel supply tank is set in the main body, rotational release movement of the engaging lever is prohibited by abutment of the extended portion against the wall face of the tank holding compartment.
10. The liquid fuel burning apparatus according to Claim 8, wherein the pivoting fulcrum of the moving plate is disposed on the more outer peripheral side of the fuel supply tank than the free end, a limiting part is provided on the pivoting fulcrum side of the moving plate so that the limiting part and the wall face of the tank holding compartment constitute a filler port release preventing means, and rotational release movement of the moving plate is prohibited by abutment of the limiting part against the wall face of the tank holding compartment.
11. The liquid fuel burning apparatus according to Claim 1 or 2, wherein a liquid level detector for detecting the liquid level of fuel in the tank is provided at a lower part of the fuel supply tank.
12. The liquid fuel burning apparatus according to Claim 1 or 2, wherein a water drain hole is formed in the bottom of the fuel supply tank and the liquid level detector is attached to a lid for opening and closing the water drain hole.
13. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted into a main body;

a burner unit having a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel; an oil feed pump for sending fuel from the fuel supply tank to the vaporizer; and a joining portion for connecting the fuel supply tank to an oil feed passage reaching to the burner unit when the fuel supply tank is set in the main body so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel under the fuel supply tank,

characterized in that the fuel supply tank has an air hole so as to prevent occurrence of a negative pressure in the fuel supply tank and an air hole shut-off mechanism for preventing fuel from scattering or leaking from the air hole.

14. The liquid fuel burning apparatus according to Claim 13, wherein the air hole shutoff mechanism is comprised of a valve disposed outside the fuel supply tank for shutting off the air hole in an openable and closable manner, a tank valve lever having the valve attached thereto and swaying vertically, and a moving rod for moving the tank valve lever up and down, and the moving rod is moved upwards as it is pressed by the main body structure when the fuel supply tank is inserted into the main body so that the tank valve lever moves to the valve opening side, and the tank valve lever is moved in the valve closing direction when the fuel supply tank is taken out from the main body.
15. The liquid fuel burning apparatus according to Claim 14, wherein a spring which forces the tank valve lever to move in the valve closing direction when the fuel supply tank is taken out from the main body is provided.
16. The liquid fuel burning apparatus according to Claim 13 or 14, wherein, when the fuel supply tank is inserted into the main body, the air hole shutoff mechanism is adapted to function sooner than the joining portion to the oil feed passage does.
17. The liquid fuel burning apparatus according to Claim 14, wherein the moving rod is fitted in a vertical hole formed in the joining portion on the fuel supply tank side so that the rod can move up and down and its lower end is projected more downwards than the joining portion.
18. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted into a main body; a burner unit having a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel; an oil feed pump for sending fuel from the fuel supply tank to the vaporizer; and a joining portion for connecting the fuel supply tank to an oil feed passage reaching to the burner unit when the fuel

supply tank is set in the main body so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel under the fuel supply tank,

characterized in that a filter for removing dust and the like from fuel is provided at the filler port of the fuel supply tank.

19. The liquid fuel burning apparatus according to Claim 18, wherein the filter is provided in a cylindrical form, having a mesh portion permeable to fuel, extended up to the vicinity of the filler port.
20. The liquid fuel burning apparatus according to Claim 18 or 19, wherein the filter has a projection raised upwards on the bottom thereof.
21. The liquid fuel burning apparatus according to Claim 18 or 19, wherein a guide for guiding a hose of a refueling pump for charging fuel into the tank are formed on the inner face of the filter.
22. The liquid fuel burning apparatus according to Claim 20, wherein a guide for guiding a hose of a refueling pump for charging fuel into the tank are formed on the inner face of the filter.
23. The liquid fuel burning apparatus according to Claim 18, 19 or 22, wherein the mesh portion provided on the side face of the filter is comprised of an upper mesh portion permeable to water and a lower mesh portion impermeable to water.
24. The liquid fuel burning apparatus according to Claim 20, wherein the mesh portion provided on the side face of the filter is comprised of an upper mesh portion permeable to water and a lower mesh portion impermeable to water.
25. The liquid fuel burning apparatus according to Claim 21, wherein the mesh portion provided on the side face of the filter is comprised of an upper mesh portion permeable to water and a lower mesh portion impermeable to water.
26. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel, wherein a fuel detector for detecting fuel is provided on the bottom side of the fuel supply tank.
27. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a

burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel, wherein a water detector for detecting water in the fuel supply tank is provided on the bottom side of the fuel supply tank.

28. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel, wherein a tank insertion detector for detecting whether the fuel supply tank is set in the main body is provided on the bottom side of the fuel supply tank.
29. The liquid fuel burning apparatus according to Claim 26, wherein the fuel detector is comprised of a float which incorporates a magnet functioning as a detection portion and moves up and down as the liquid level of fuel in the fuel supply tank varies, and a lead switch which is disposed on a tank placement board side, opposing the float so as to turn on and off as the magnet moves closer and away.
30. The liquid fuel burning apparatus according to Claim 27, wherein the water detector is comprised of a conductive water receptacle which is arranged at the conductive tank bottom to collect water, an electrode in contact with the water receptacle, an electrode in contact with the fuel supply tank and an insulator which provides electric insulation between the water receptacle and the fuel supply tank, and is adapted to detect water based on the difference in electric resistance between fuel and water collected in the water receptacle.
31. The liquid fuel burning apparatus according to Claim 30, wherein the water receptacle is formed separately from the fuel supply tank and is attached to a bottom-side attachment hole of the fuel supply tank with an electrical insulator therebetween.
32. The liquid fuel burning apparatus according to Claim 30 or 31, wherein the water receptacle is formed of a stainless steel sheet.
33. The liquid fuel burning apparatus according to Claim 32, wherein the underside of the water receptacle that is formed of the stainless steel sheet is coated with a non-conductive paint.
34. The liquid fuel burning apparatus according to Claim 31, wherein the electric insulator is a non-

conductive packing interposed between the peripheral wall of the hole formed in the bottom face of the fuel supply tank and the peripheral part of the water receptacle.

35. The liquid fuel burning apparatus according to Claim 34, wherein the packing has been subjected to a water-repellent treatment.
36. The liquid fuel burning apparatus according to Claim 27 or 30, wherein a guard structure for guarding the water receptacle is attached to the fuel supply tank side to which the water receptacle is attached.
37. The liquid fuel burning apparatus according to Claim 28, wherein the tank insertion detector is constituted of a microswitch placed on the upper surface of the fuel supply tank placement board.
38. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel, the liquid fuel burning apparatus further comprising: a tank insertion detector for AICHI whether the fuel supply tank is set in the main body; and a controller which stops the operation when it receives a tank absence signal from the tank insertion detector.
39. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel, the liquid fuel burning apparatus further comprising: a tank insertion detector for detecting whether the fuel supply tank is set in the main body; and a controller which actuates an operation mode of baking of the vaporizer in the burner unit when it receives a tank presence signal from the tank insertion detector.
40. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted in a tank holding compartment inside the apparatus body; and a burner unit for burning fuel fed from the fuel supply tank and being constructed so that fuel can be directly fed from the fuel supply tank to the burner unit without having any fuel tank for temporarily holding fuel,

the liquid fuel burning apparatus further comprising:
a fuel detector for detecting fuel in the fuel supply
tank; and a tank insertion detector for detecting
whether the fuel supply tank is set in the main body,
wherein control is made such that the operation can
be started based on the input of the tank insertion
signal from the tank insertion detector and the pres-
ence-of-fuel signal from the fuel detector.

41. A liquid fuel burning apparatus comprising: a fuel
supply tank detachably mounted in a tank holding
compartment inside the apparatus body; and a
burner unit for burning fuel fed from the fuel supply
tank and being constructed so that fuel can be di-
rectly fed from the fuel supply tank to the burner unit
without having any fuel tank for temporarily holding
fuel,
the liquid fuel burning apparatus further comprising:
a fuel detector for detecting fuel in the fuel supply
tank; and a tank insertion detector for detecting
whether the fuel supply tank is set in the main body,
wherein control is made such that the operation is
stopped based on the input of the tank insertion sig-
nal from the tank insertion detector and the end-of-
fuel signal from the fuel detector.

42. A liquid fuel burning apparatus comprising: a fuel
supply tank detachably mounted in a tank holding
compartment inside the apparatus body; and a
burner unit for burning fuel fed from the fuel supply
tank and being constructed so that fuel can be di-
rectly fed from the fuel supply tank to the burner unit
without having any fuel tank for temporarily holding
fuel, the liquid fuel burning apparatus further com-
prising: a fuel detector for detecting fuel in the fuel
supply tank; and a display for displaying the detec-
tion result of the fuel detector, wherein a warning on
refueling is given on the display based on the input
from the end-of-fuel signal from the fuel detector.

FIG. 1

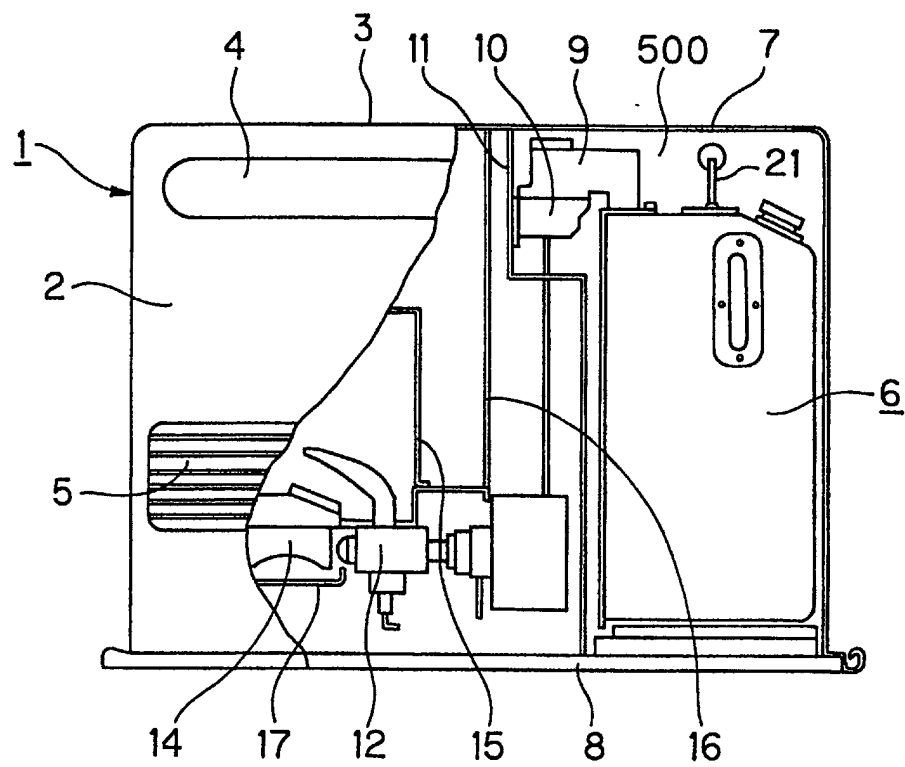


FIG. 2

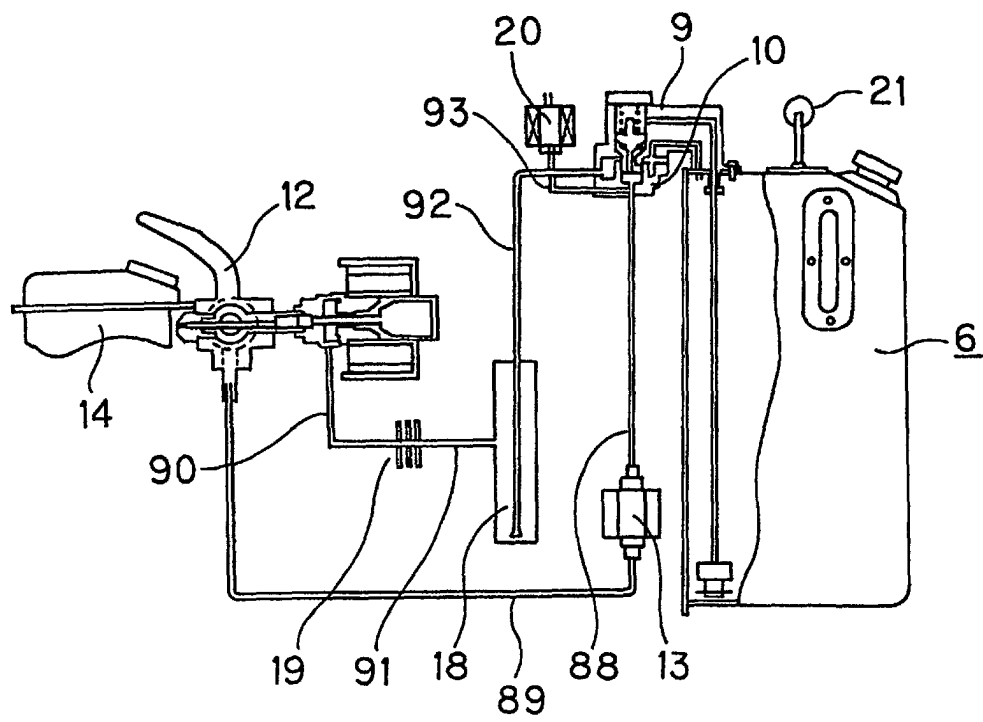


FIG. 3

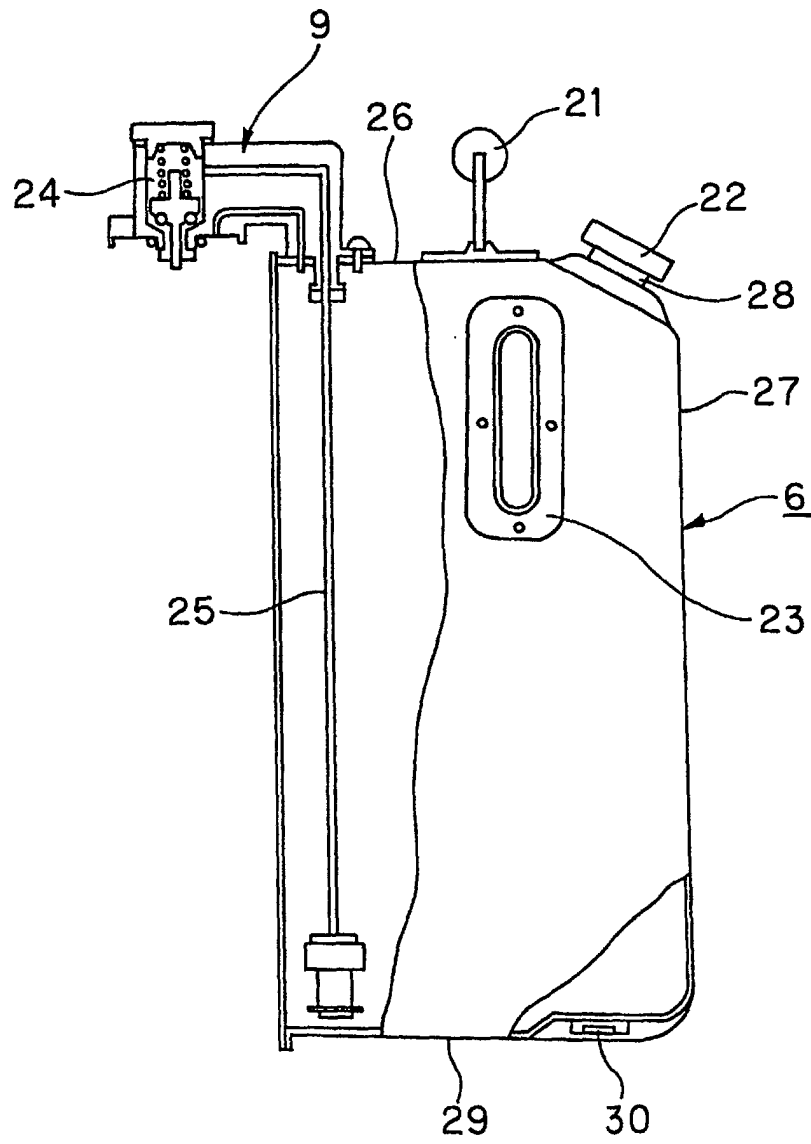
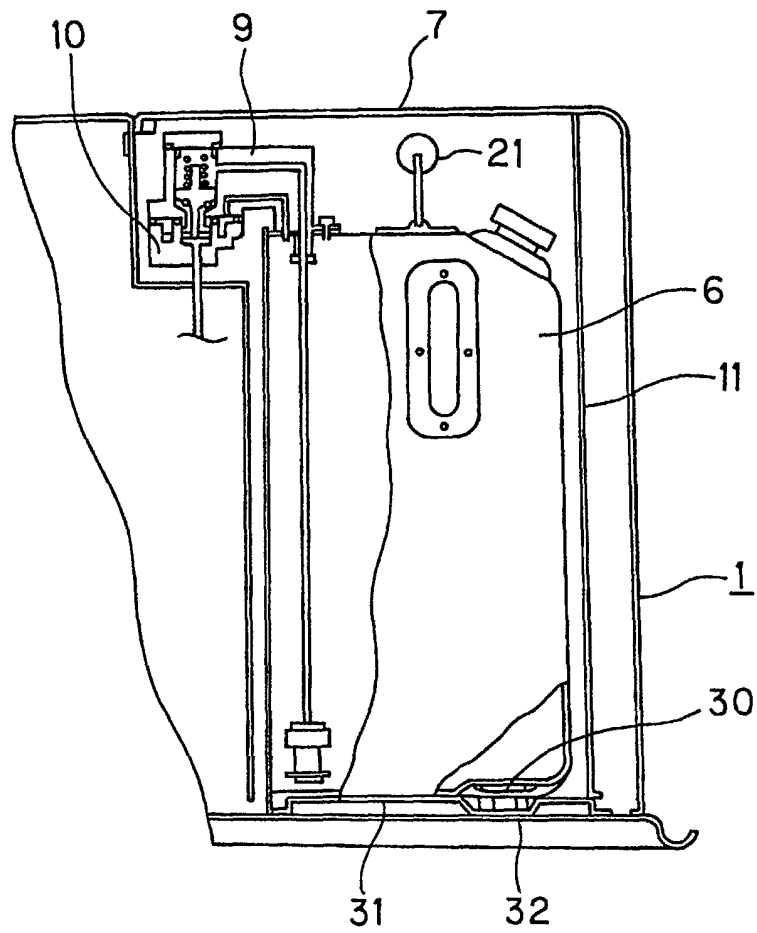


FIG. 4

(a)



(b)

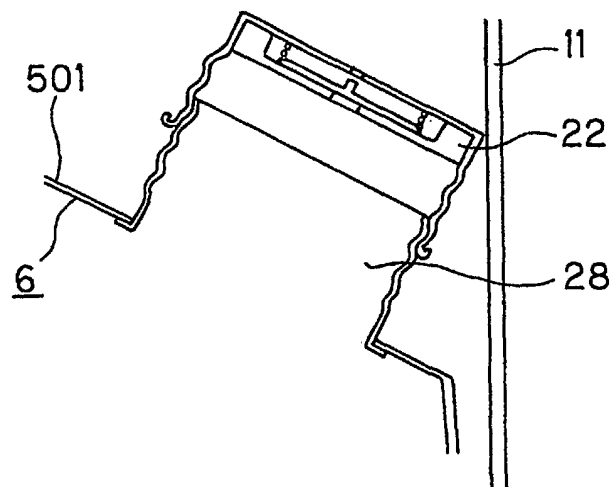


FIG. 5

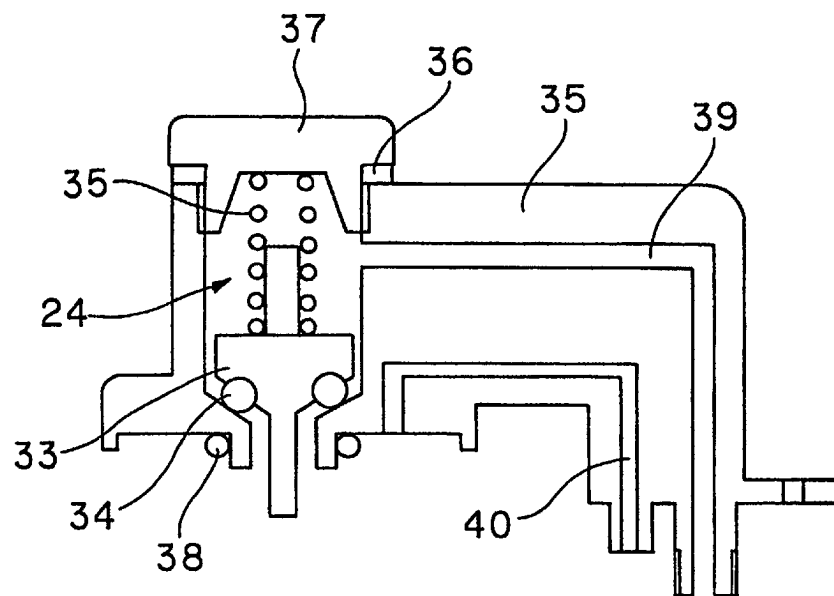


FIG. 6

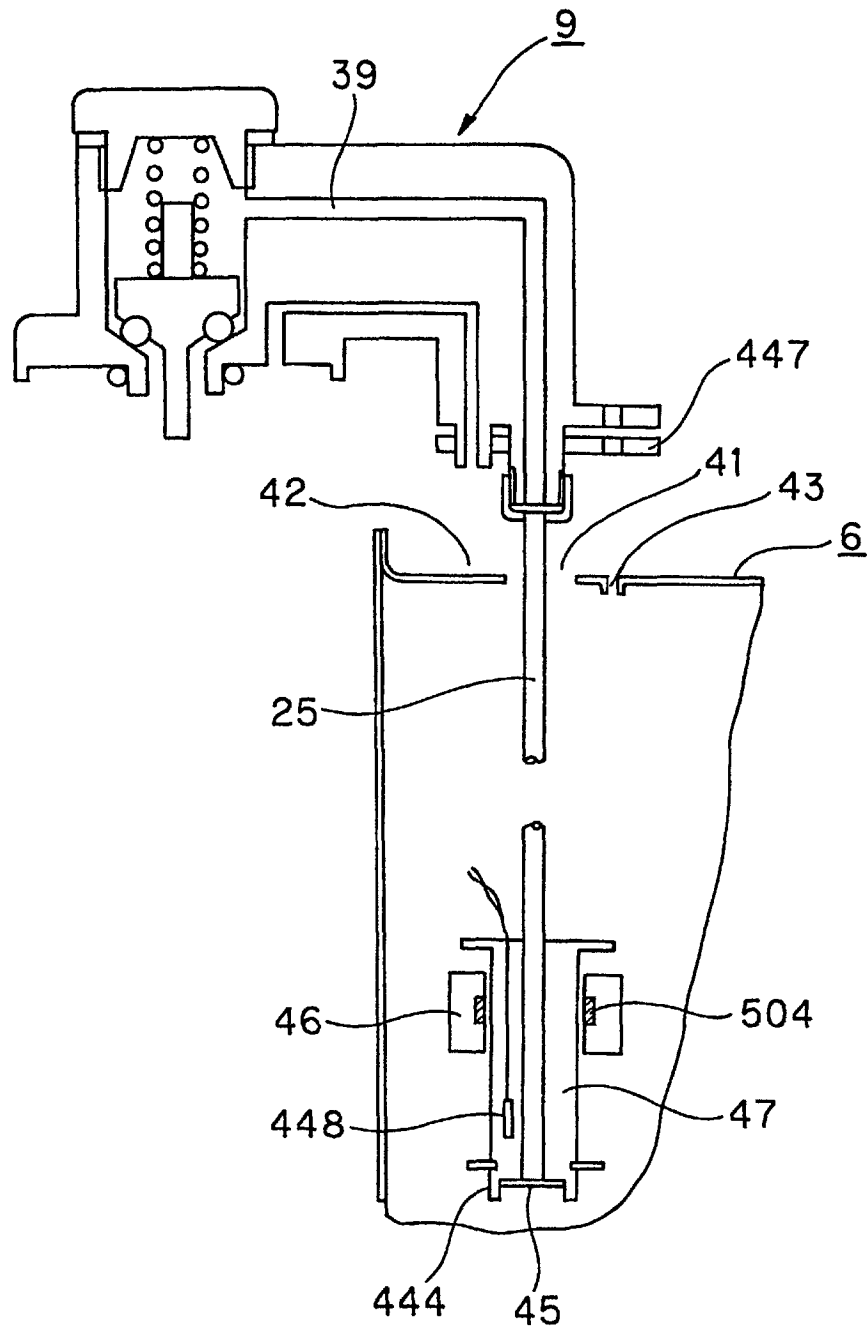


FIG. 7

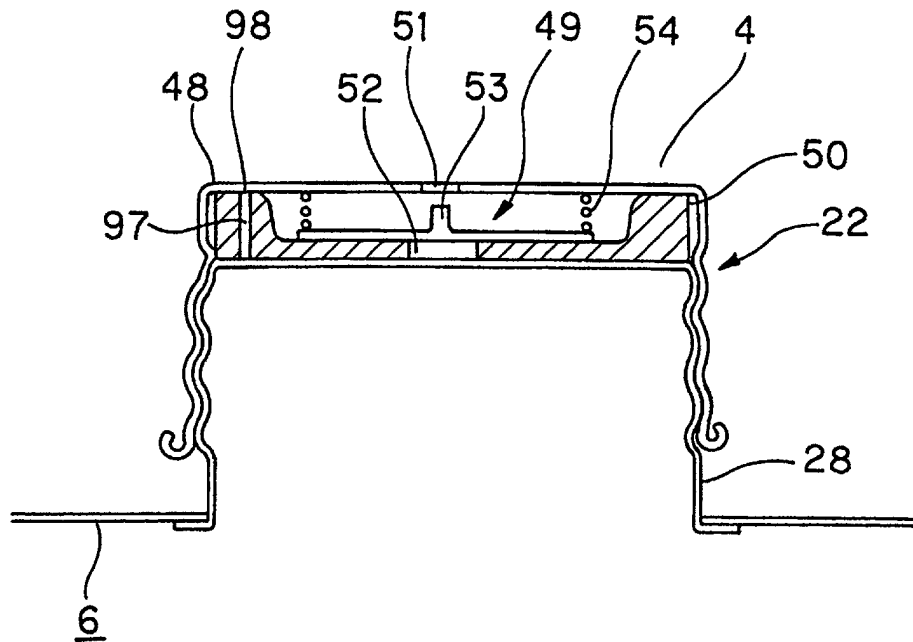


FIG. 8

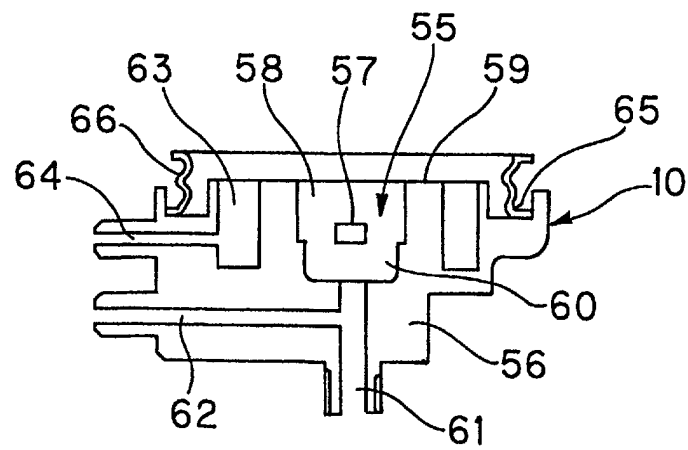


FIG. 9

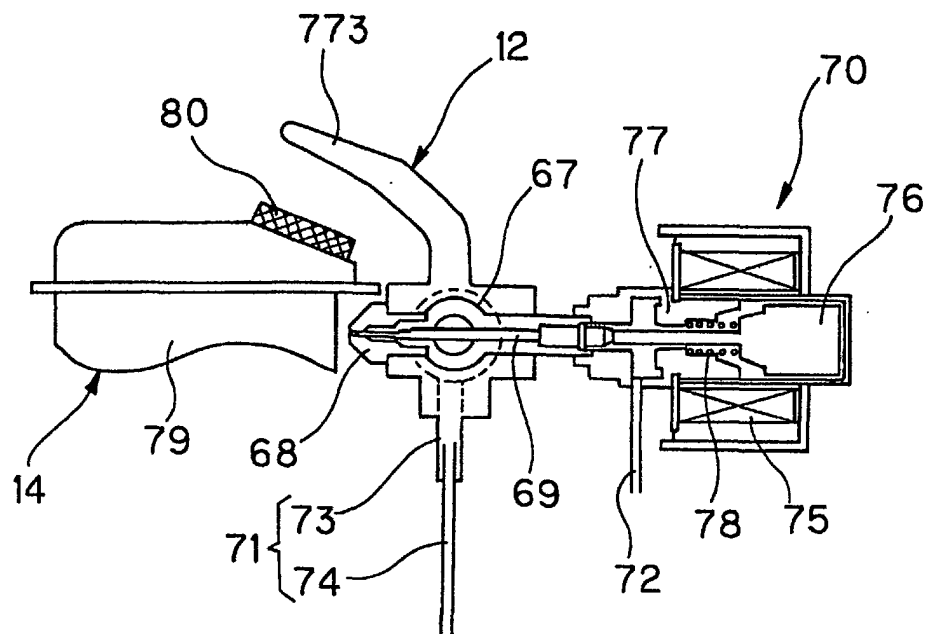


FIG. 10

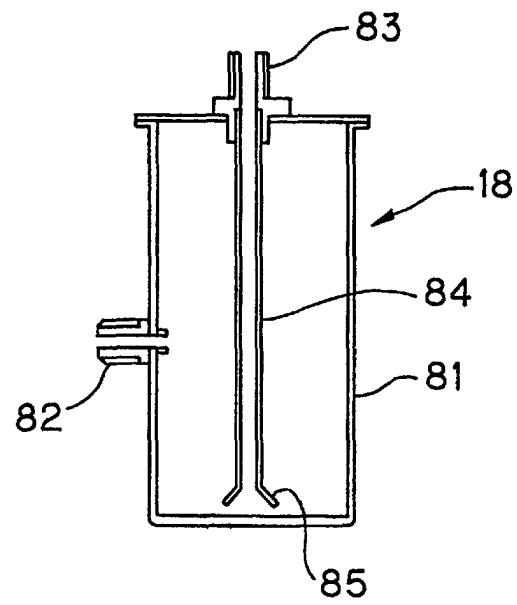


FIG. 11

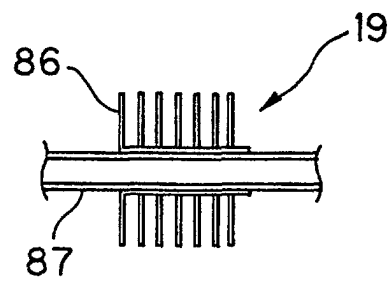


FIG. 12

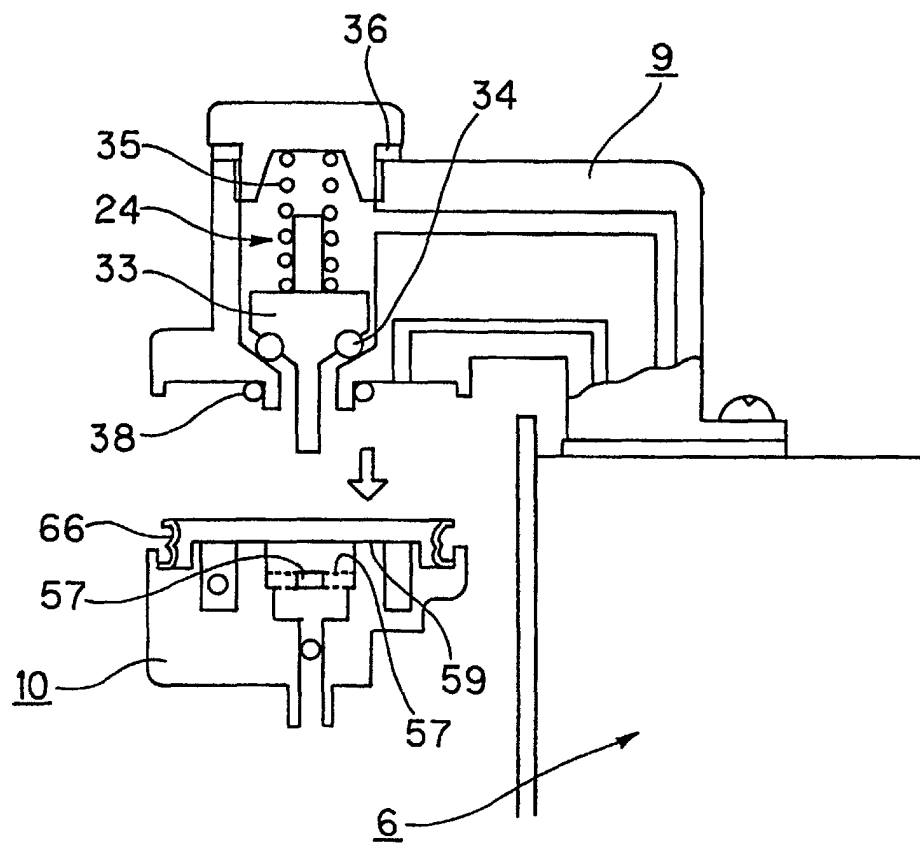


FIG. 13

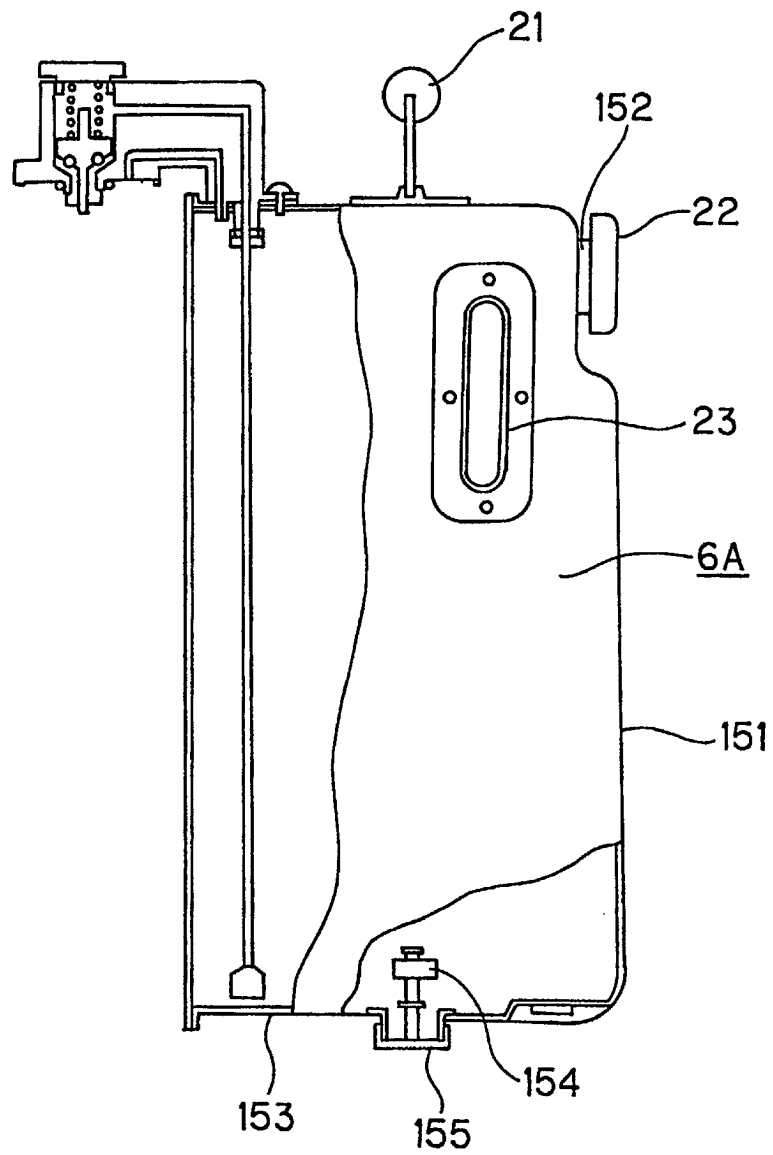


FIG. 14

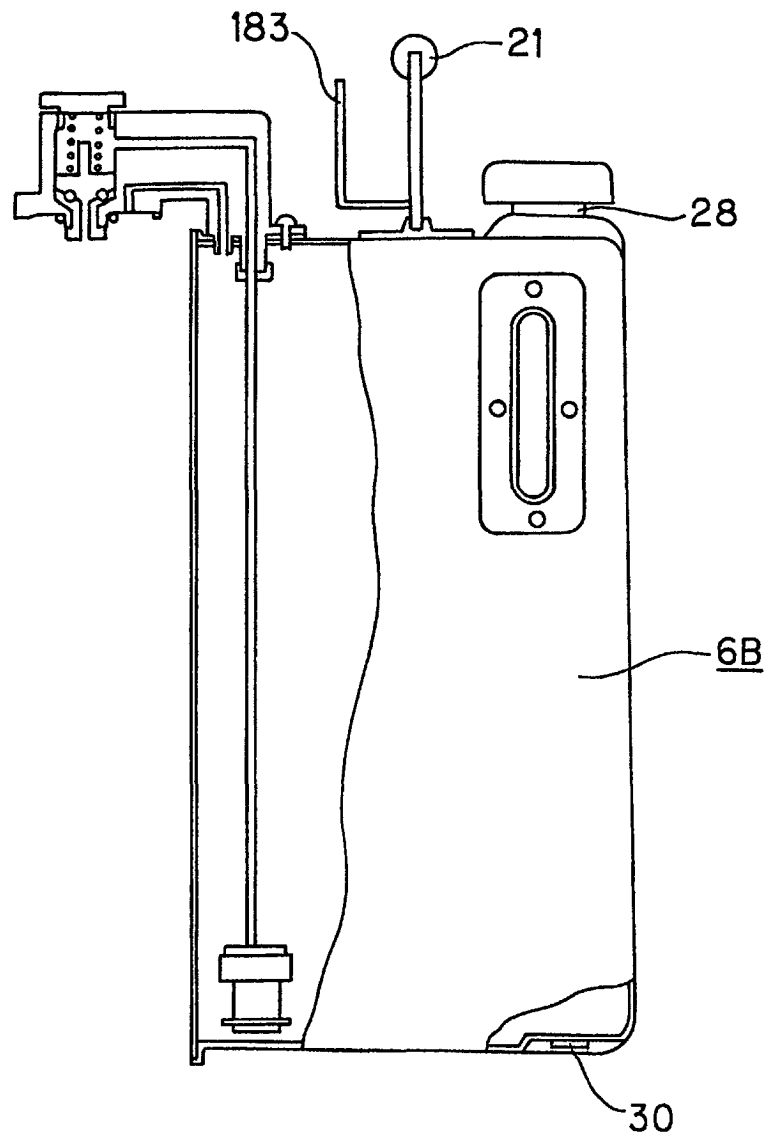


FIG. 15

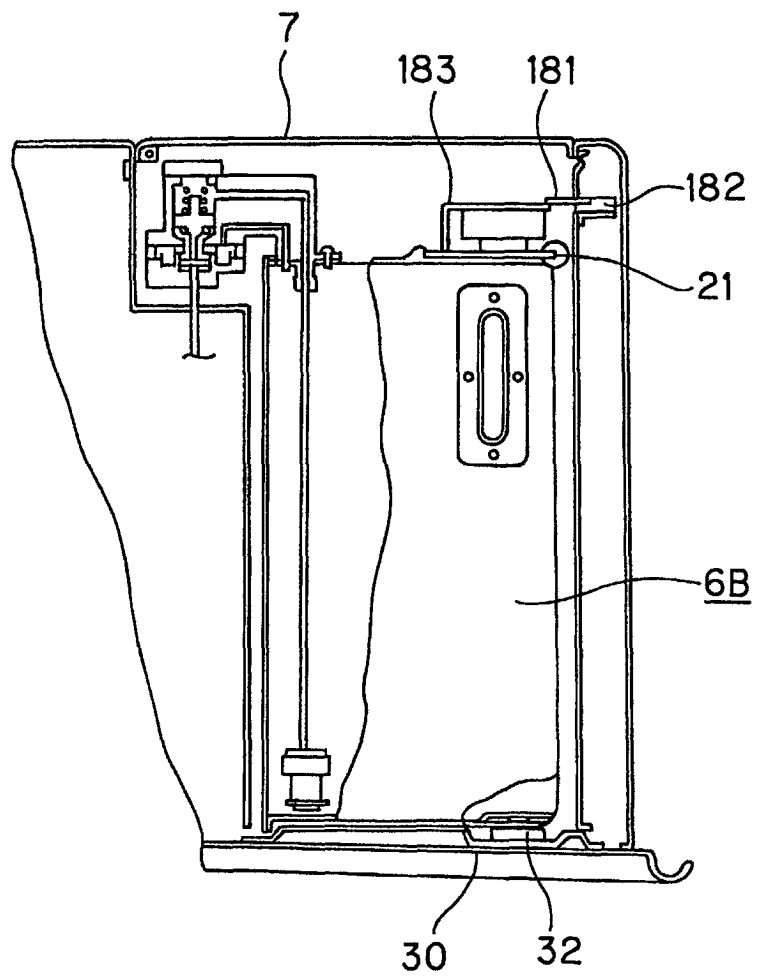


FIG. 16

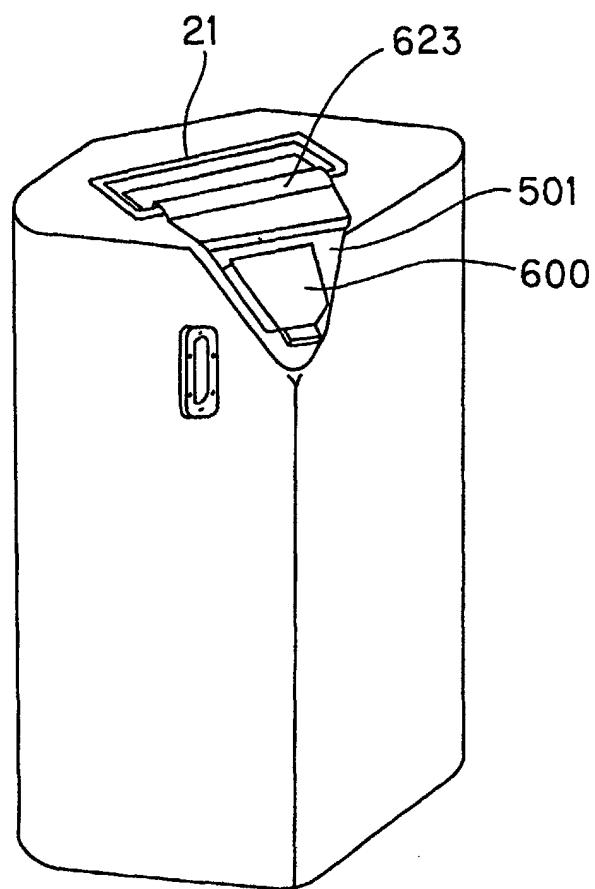


FIG. 17

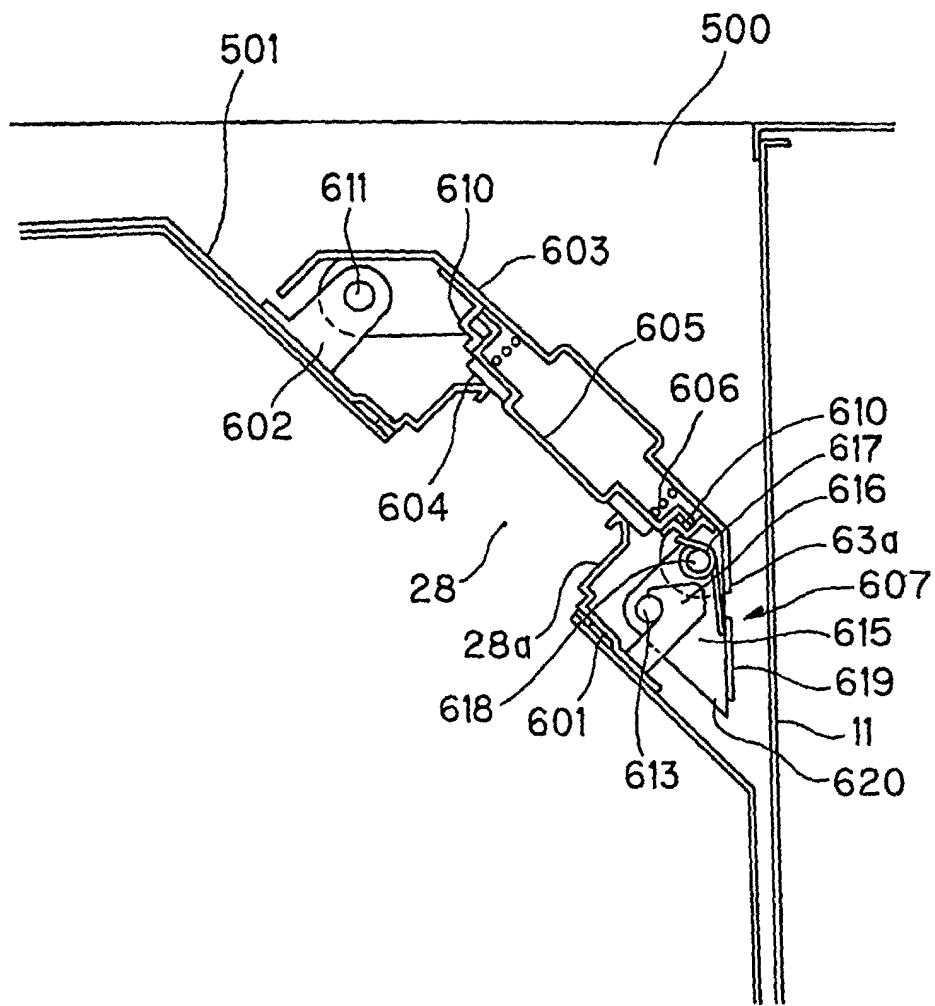


FIG. 18

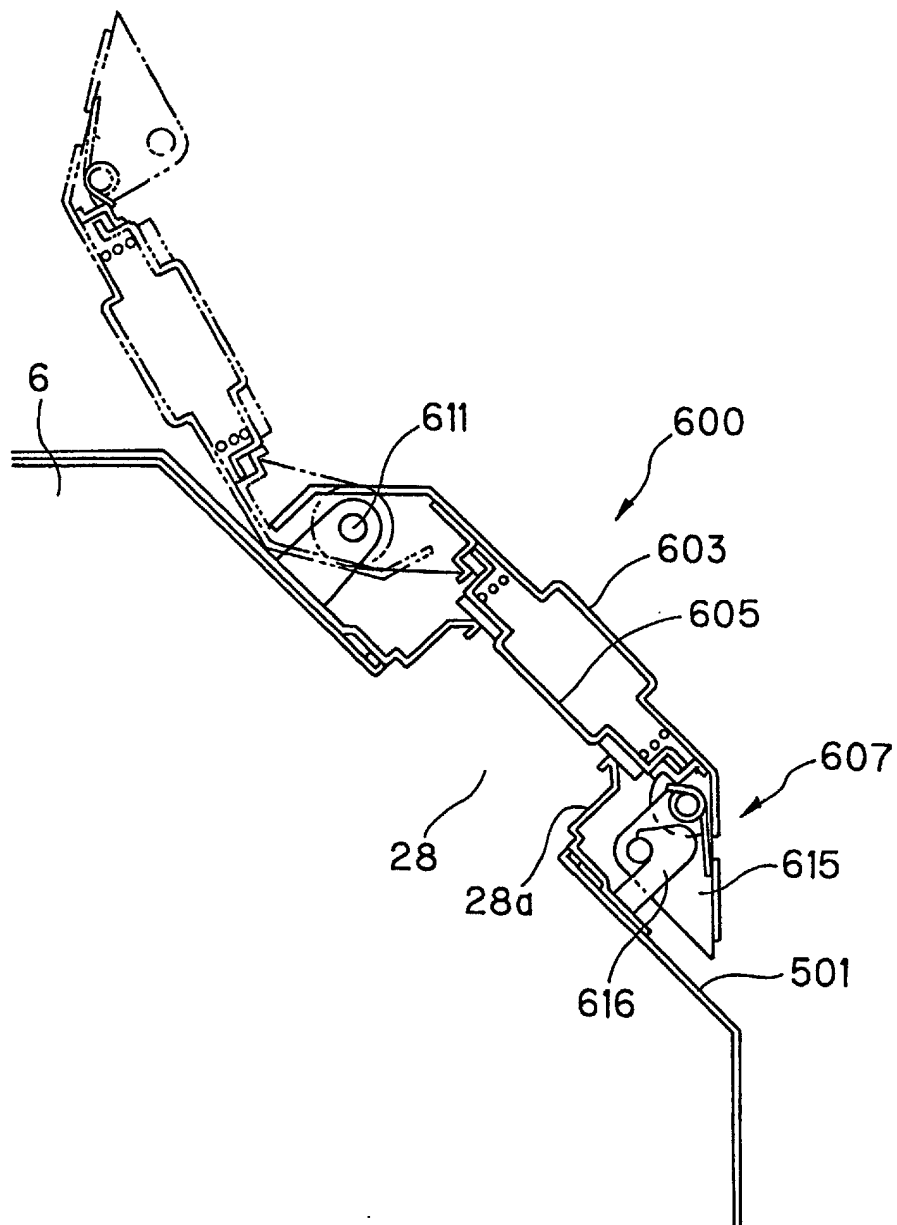


FIG. 19

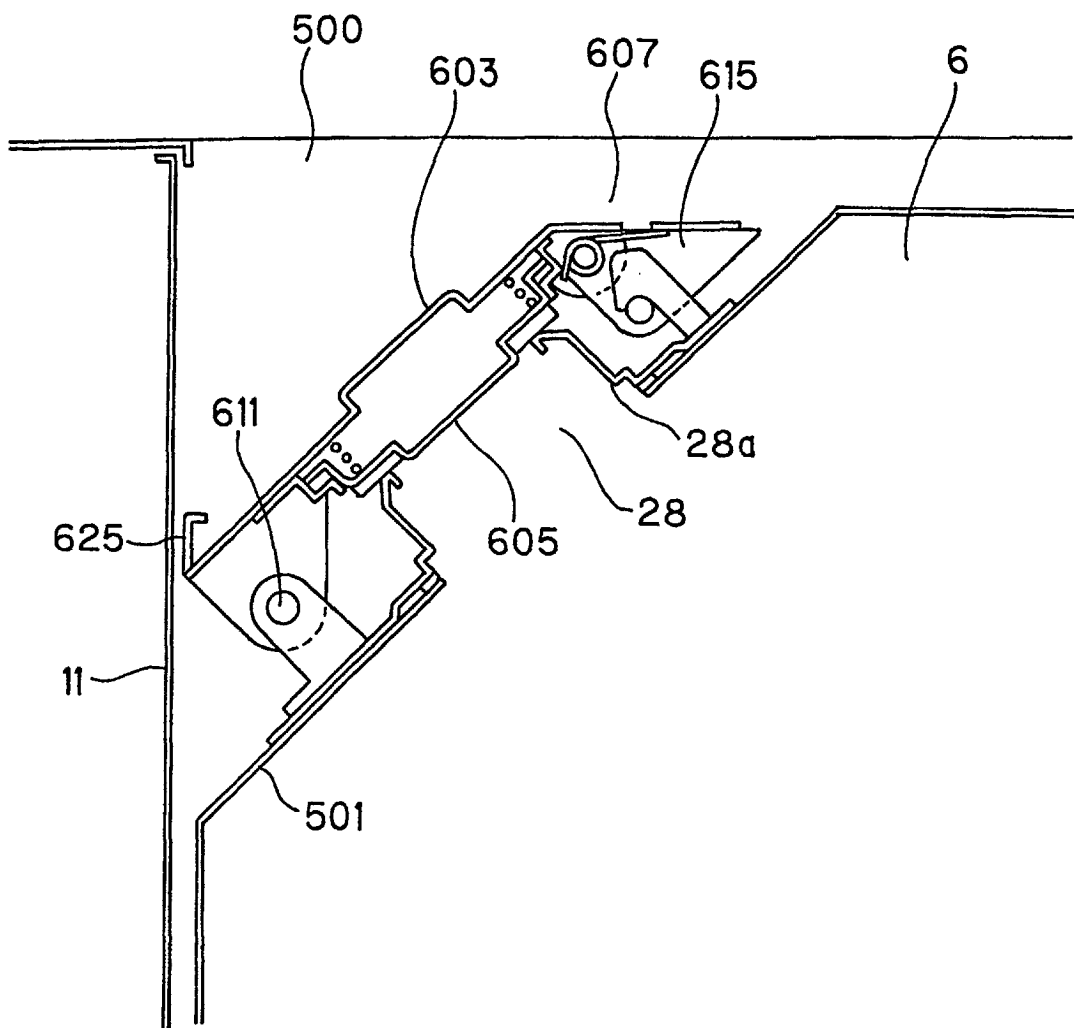


FIG. 20

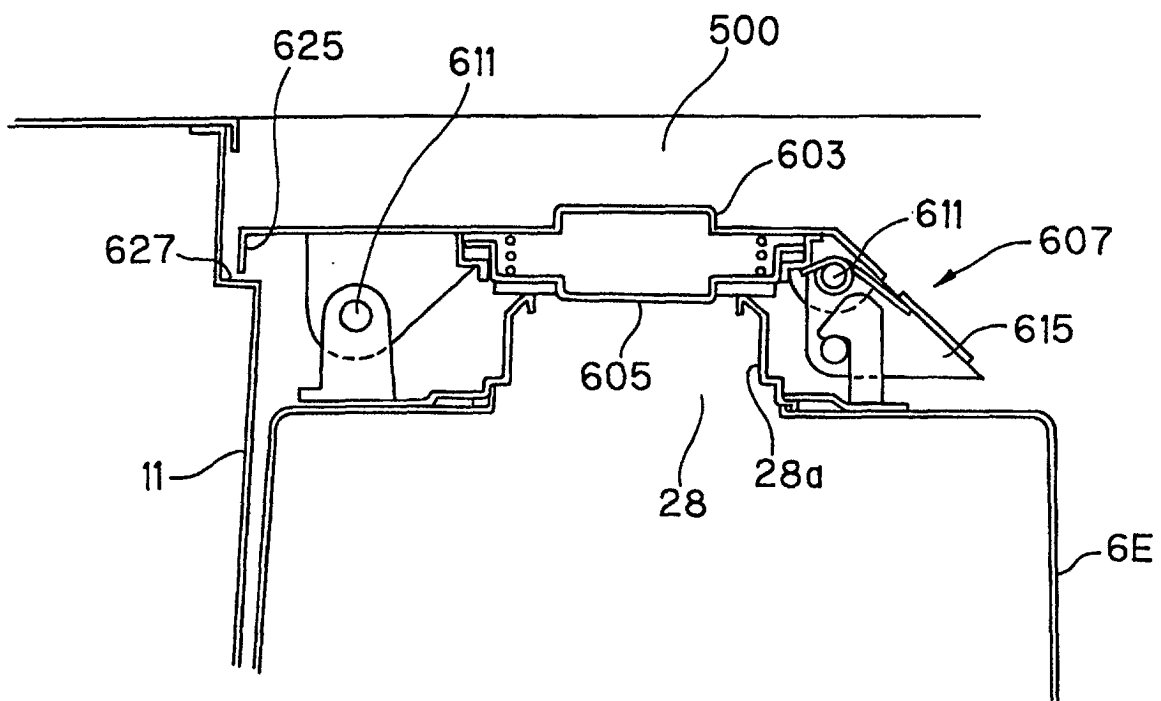


FIG. 21

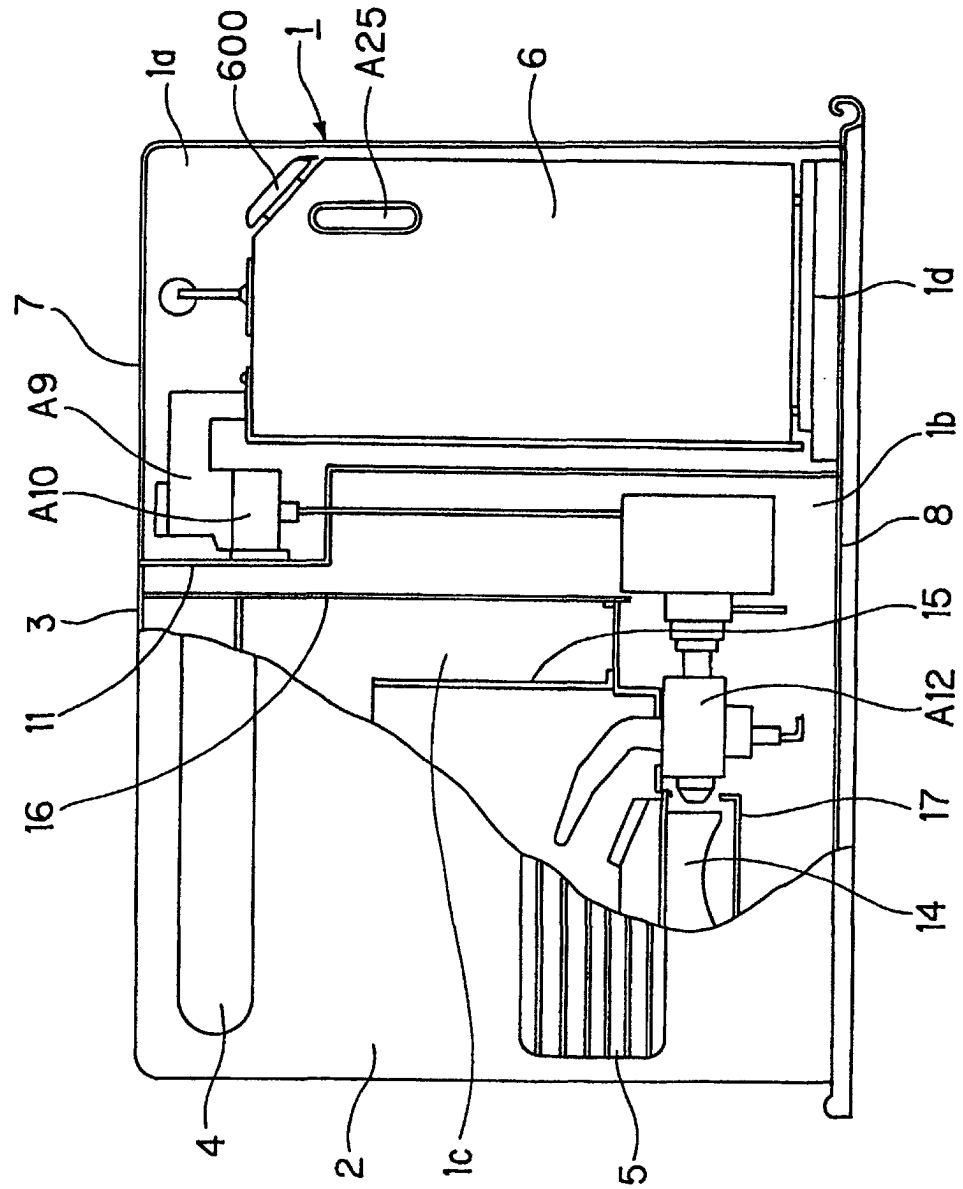


FIG. 22

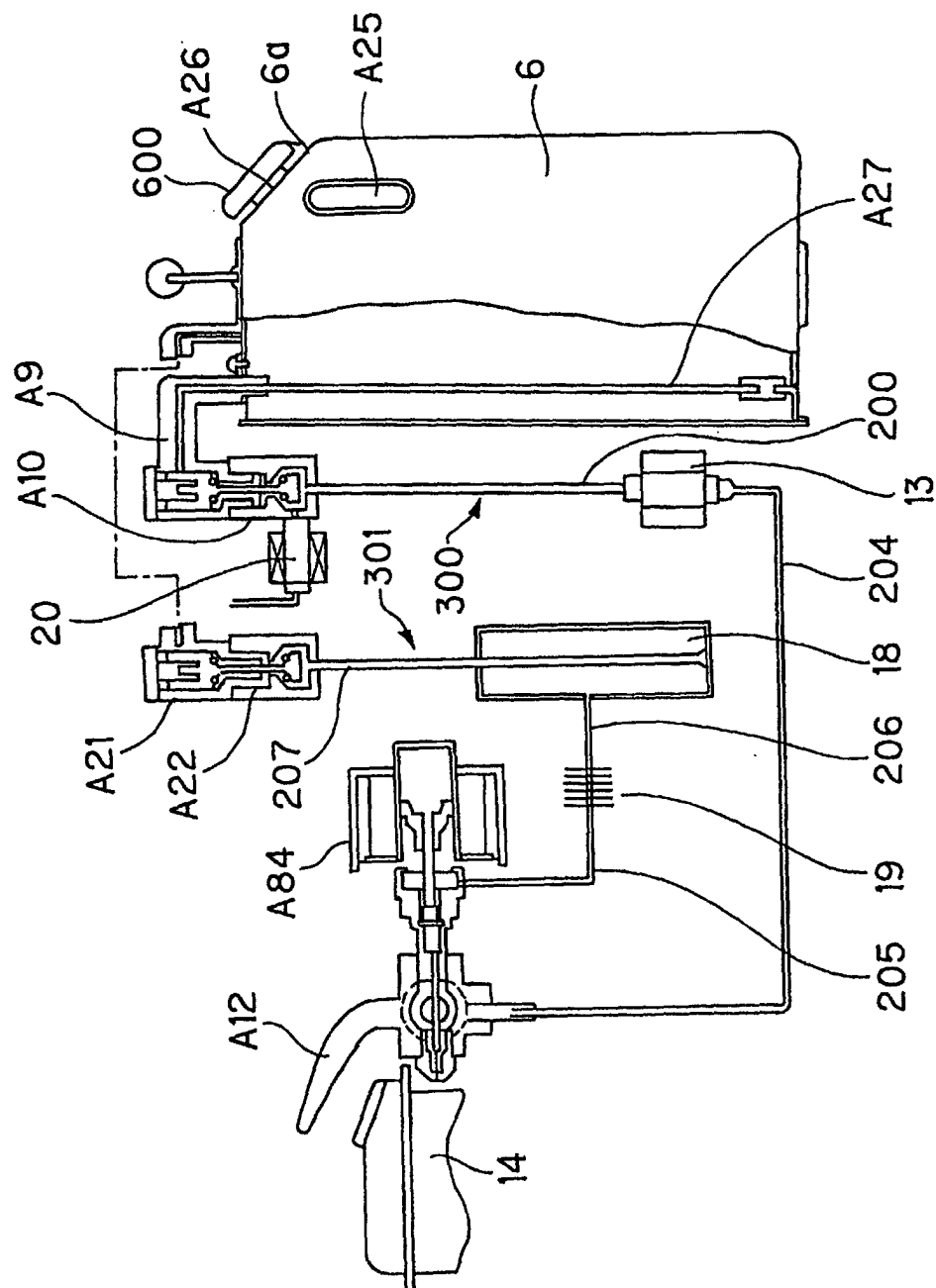


FIG. 23

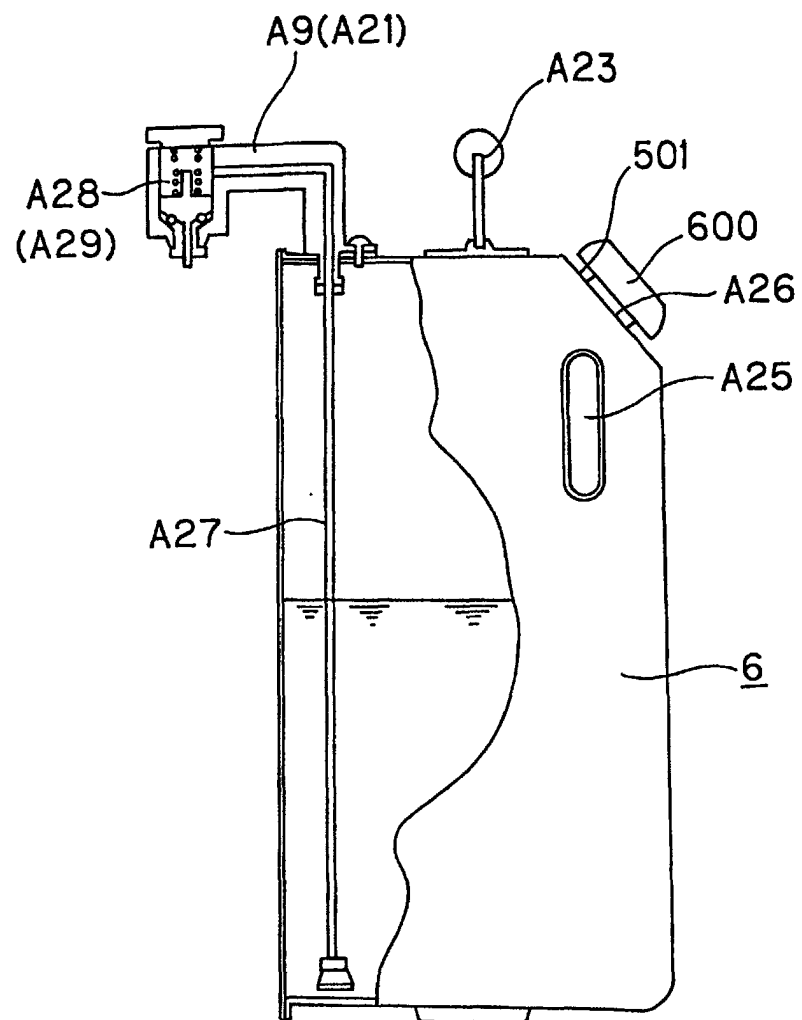


FIG. 24

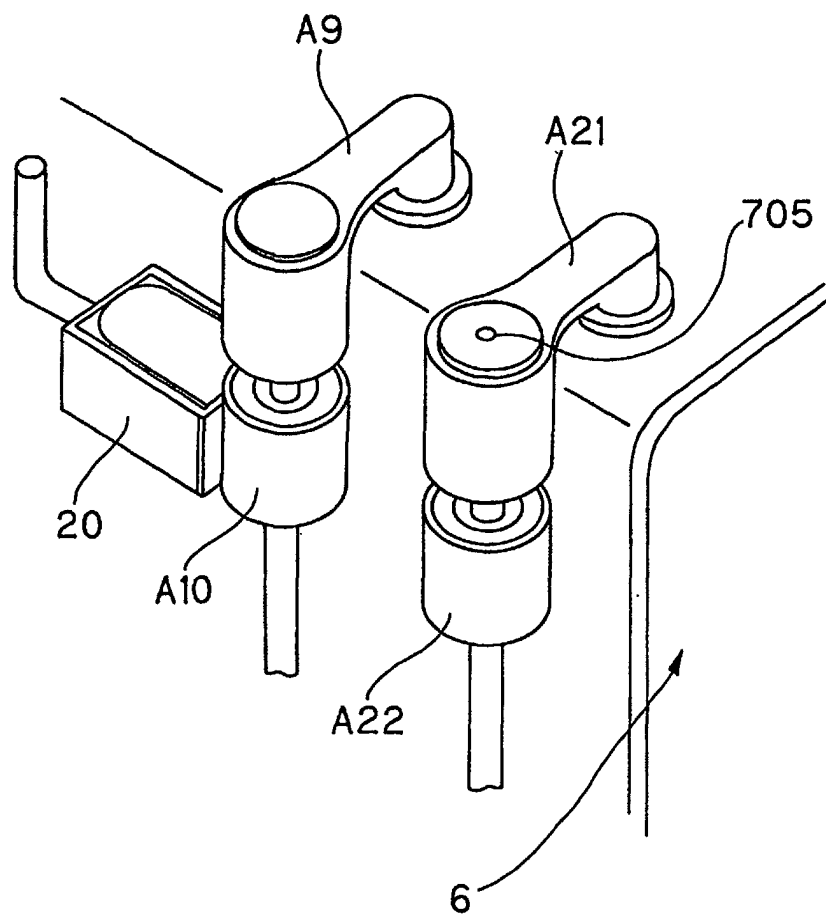


FIG. 25

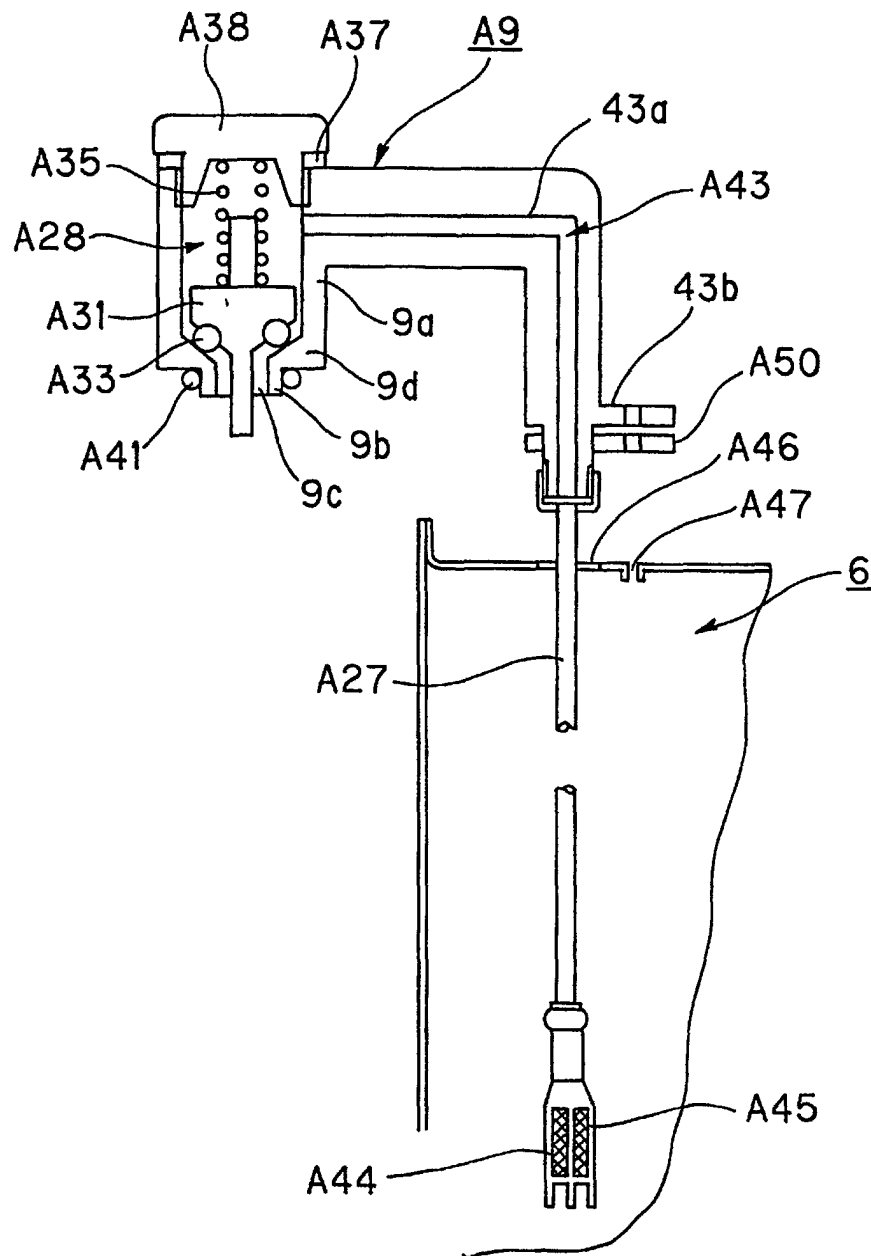


FIG. 26

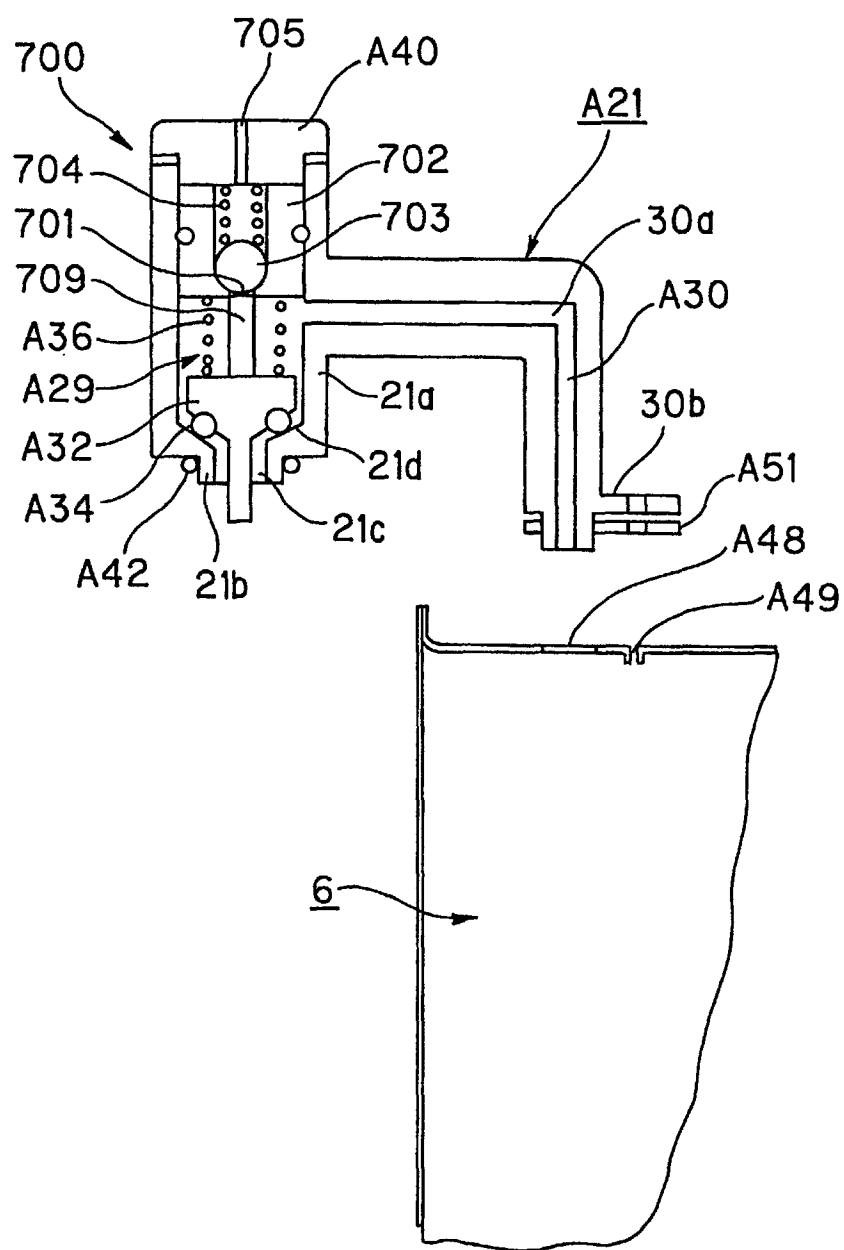


FIG. 27

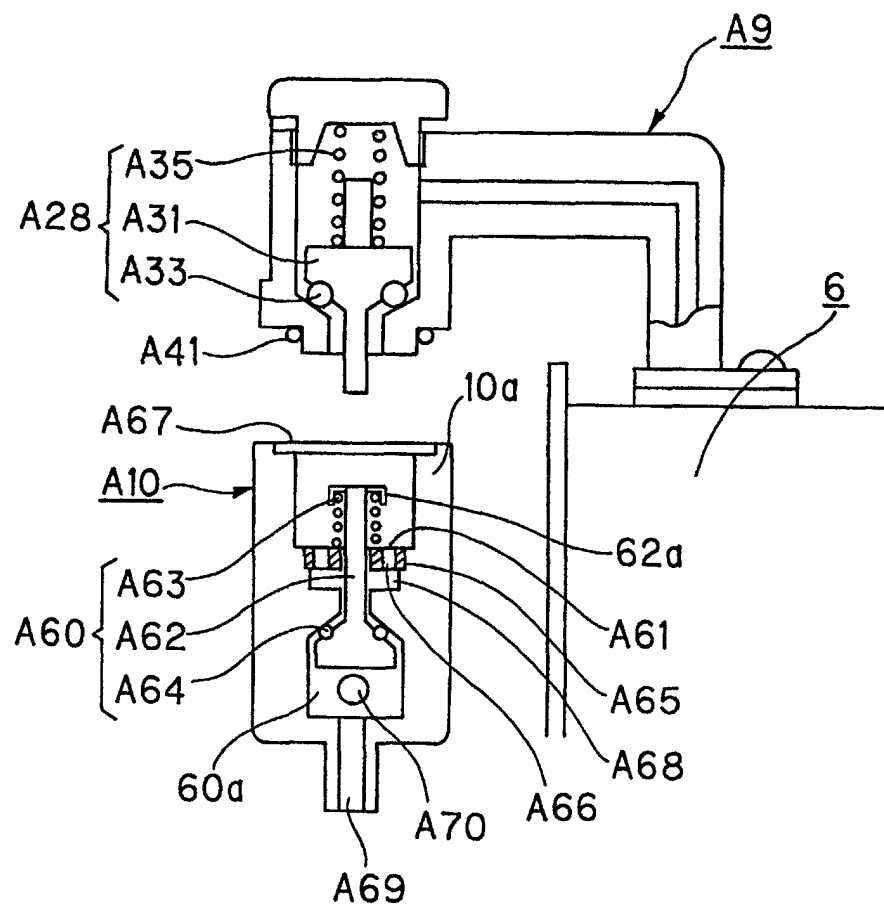


FIG. 28

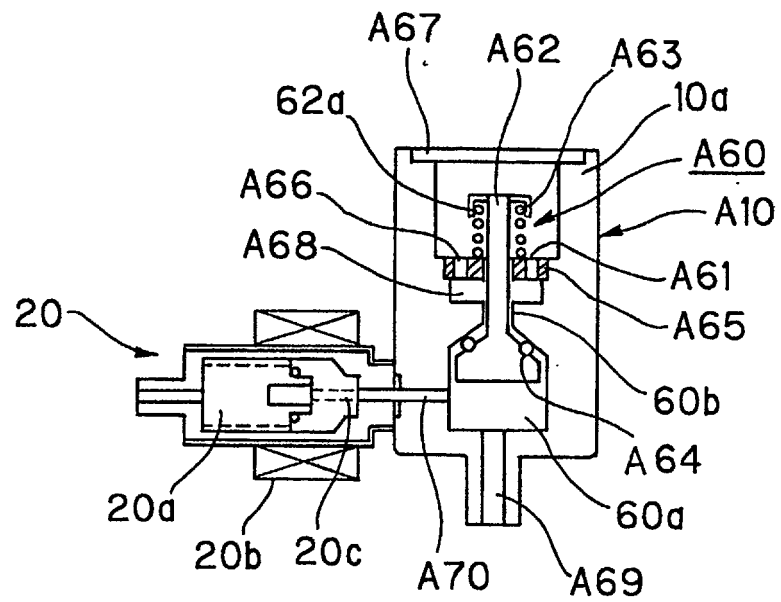


FIG. 29

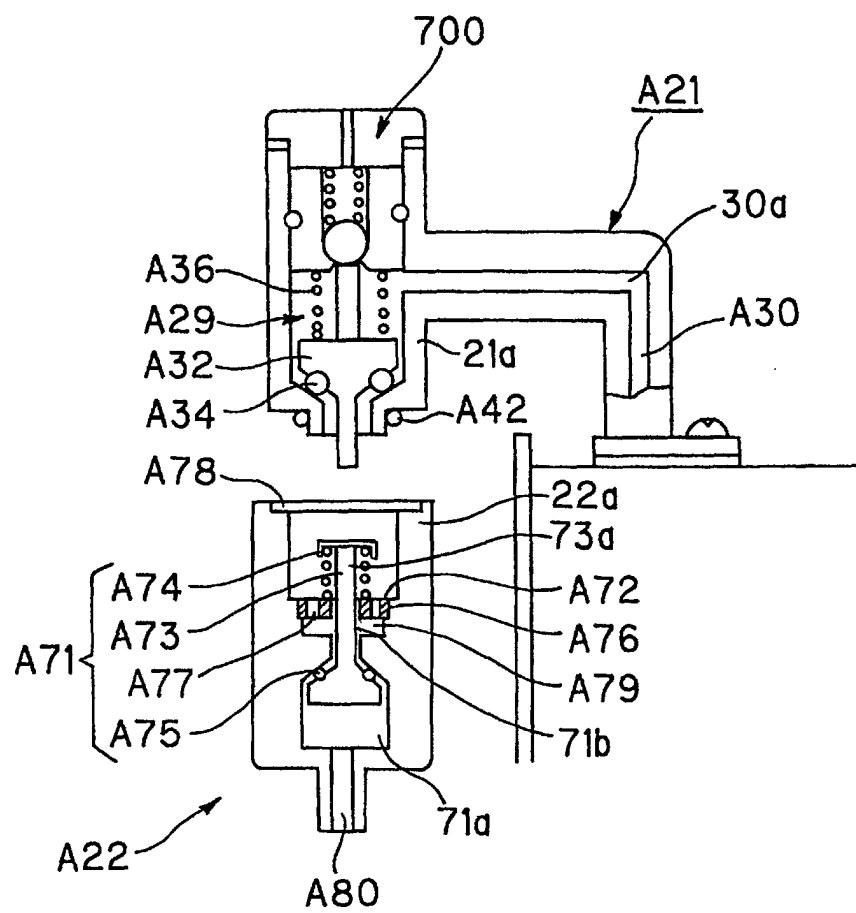


FIG. 30

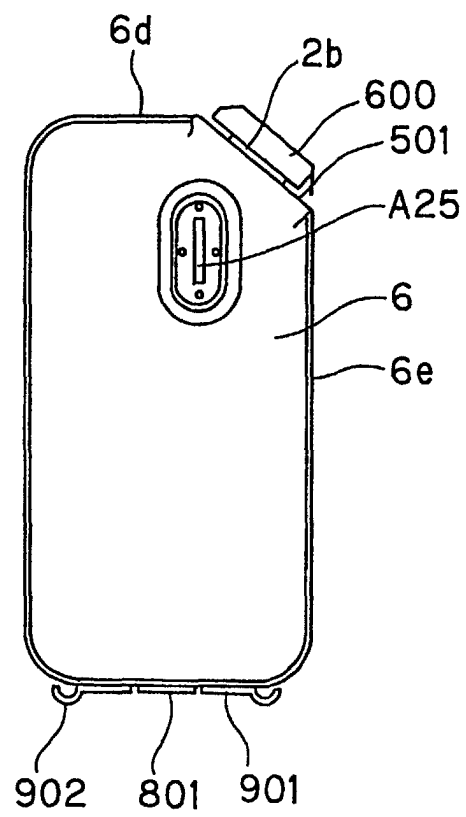


FIG. 31

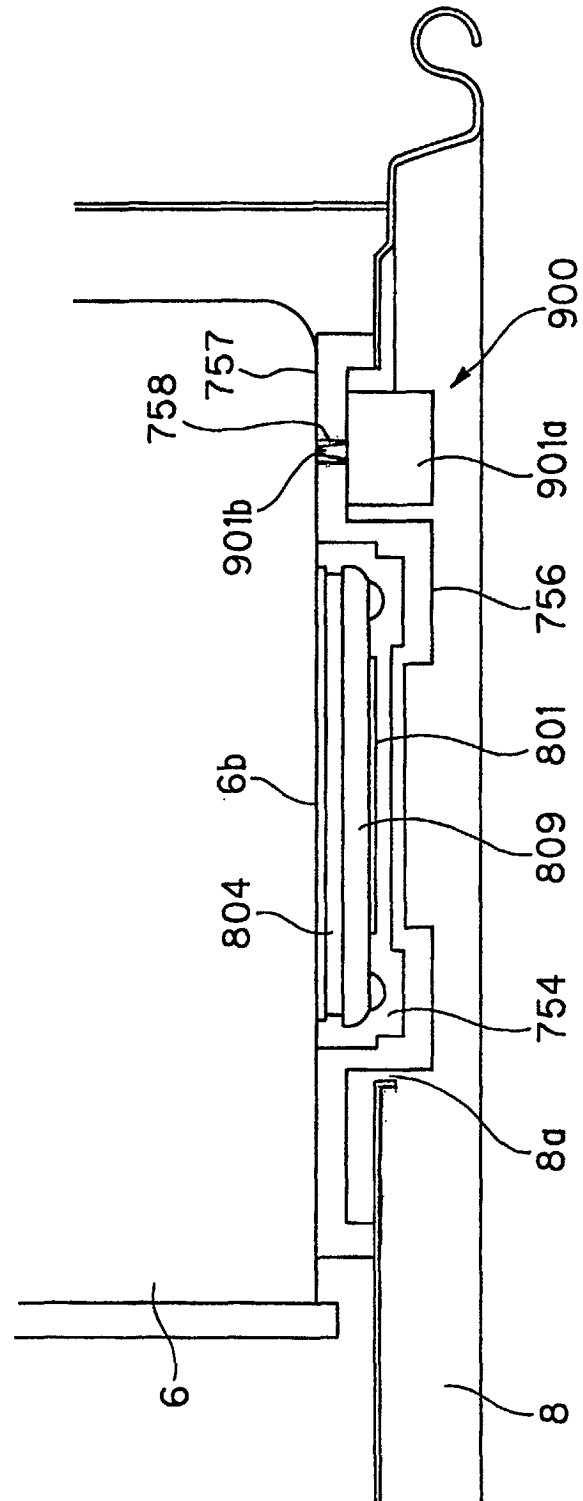


FIG. 32

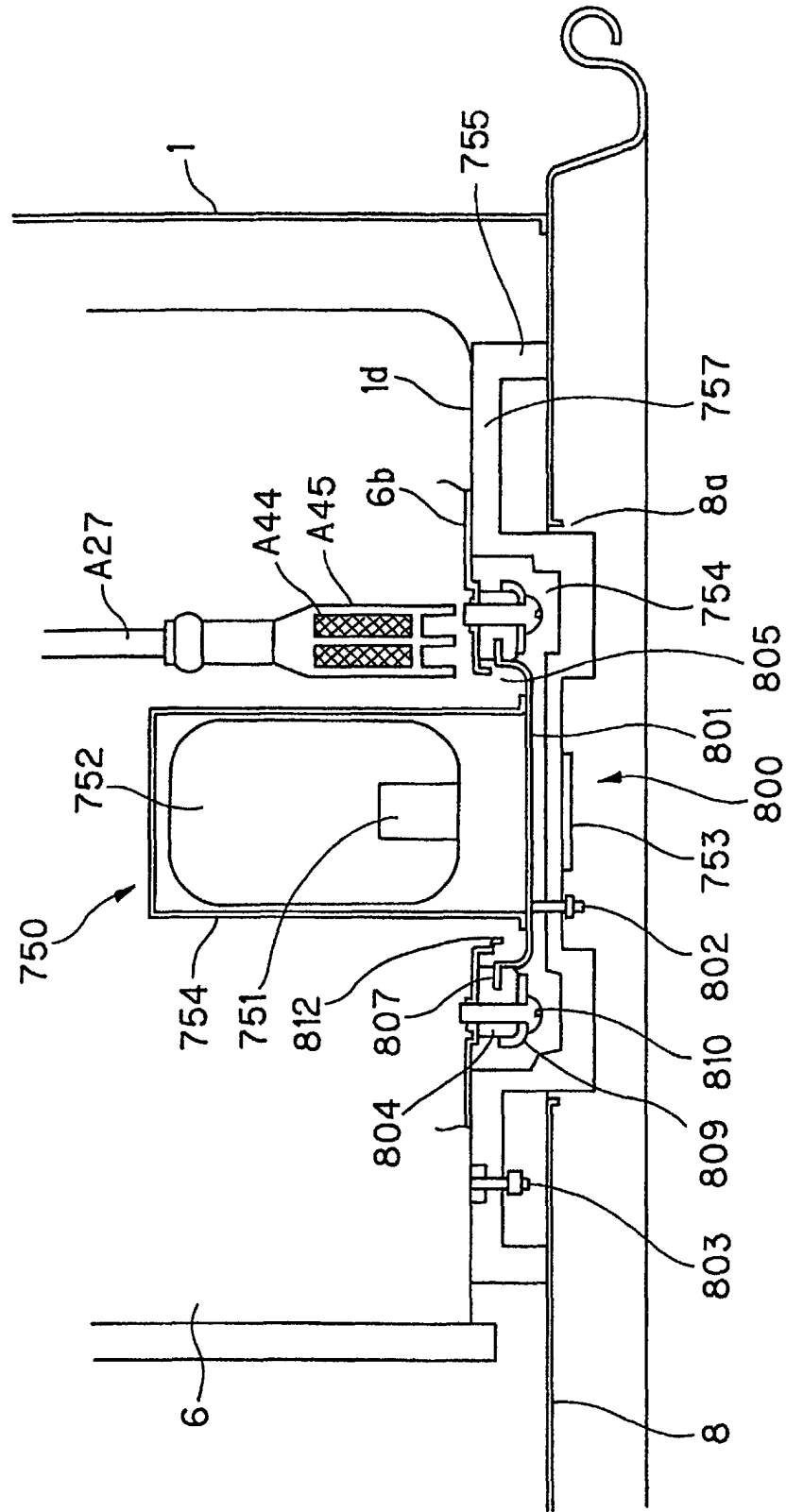


FIG. 33

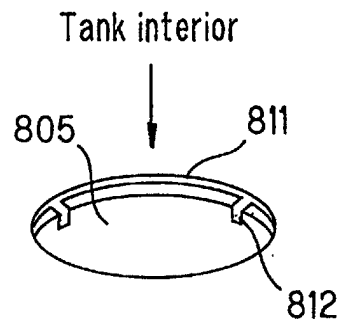


FIG. 34

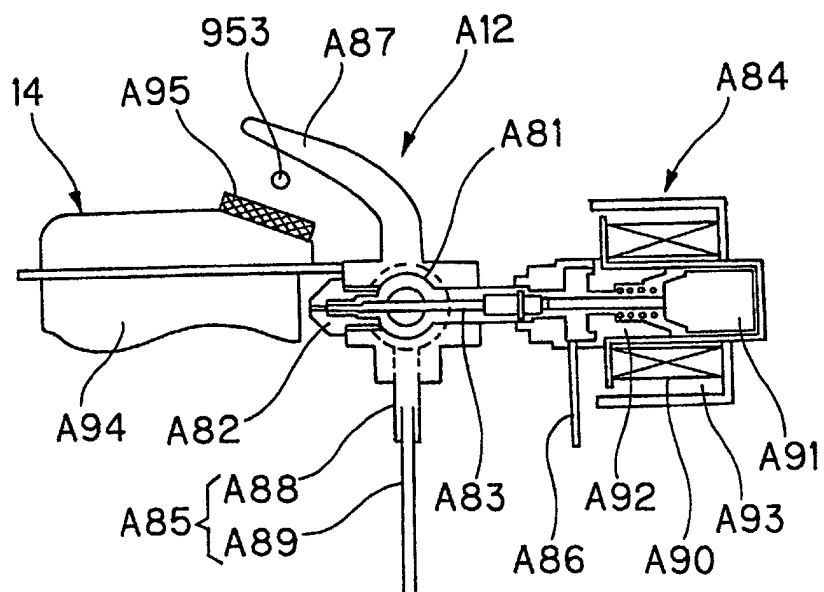


FIG. 35

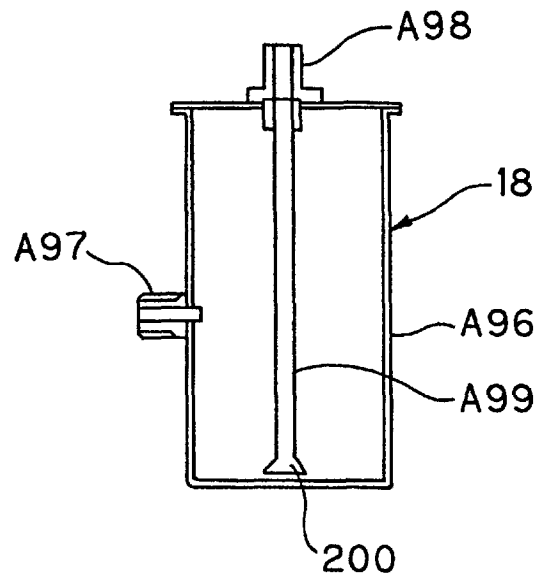


FIG. 36

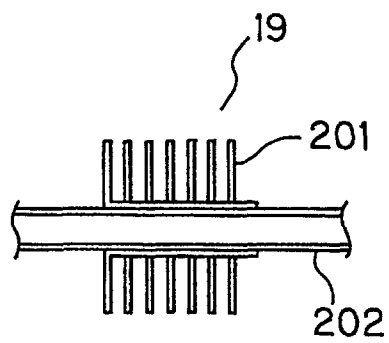


FIG. 37

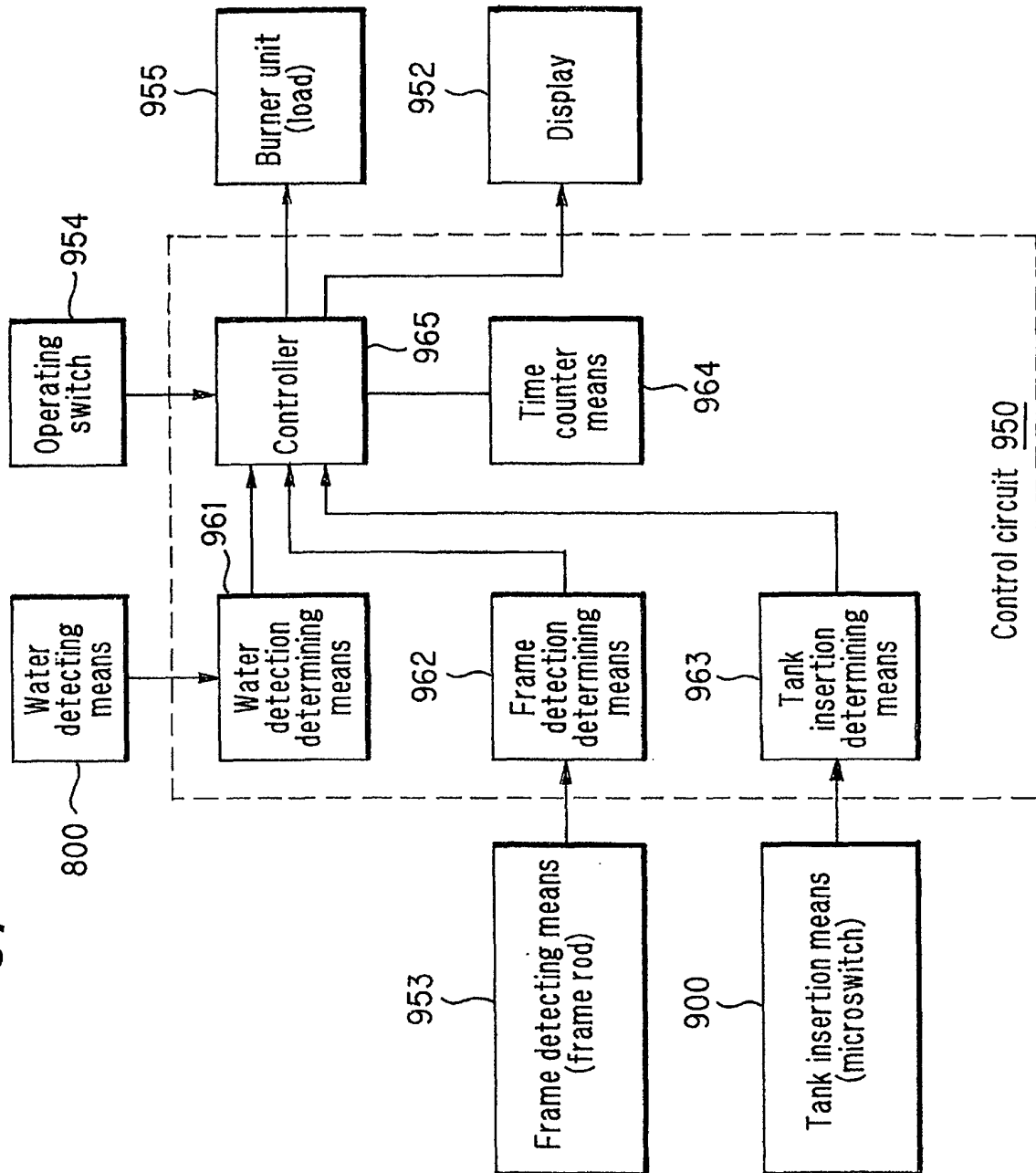


FIG. 38

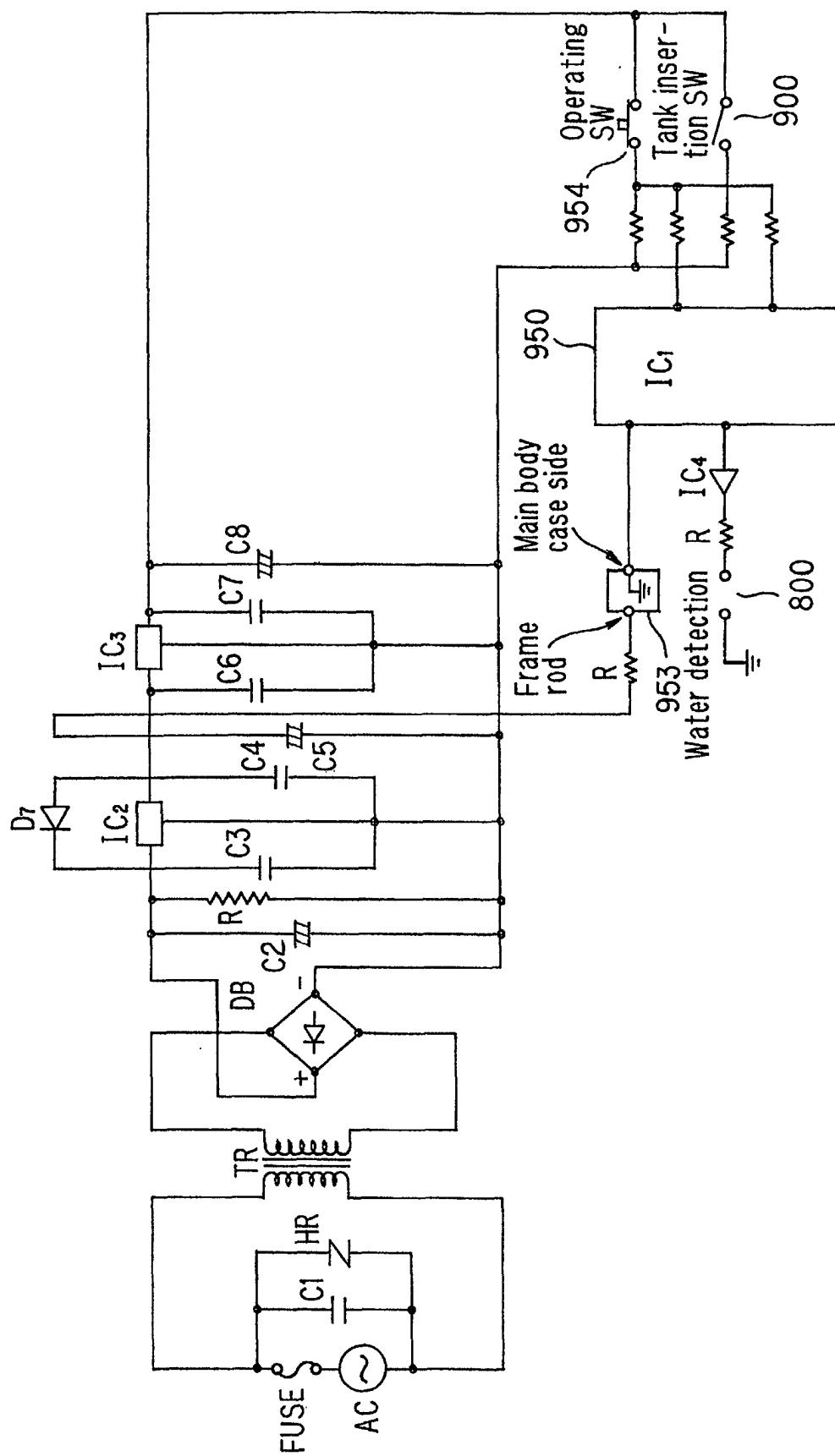


FIG. 39

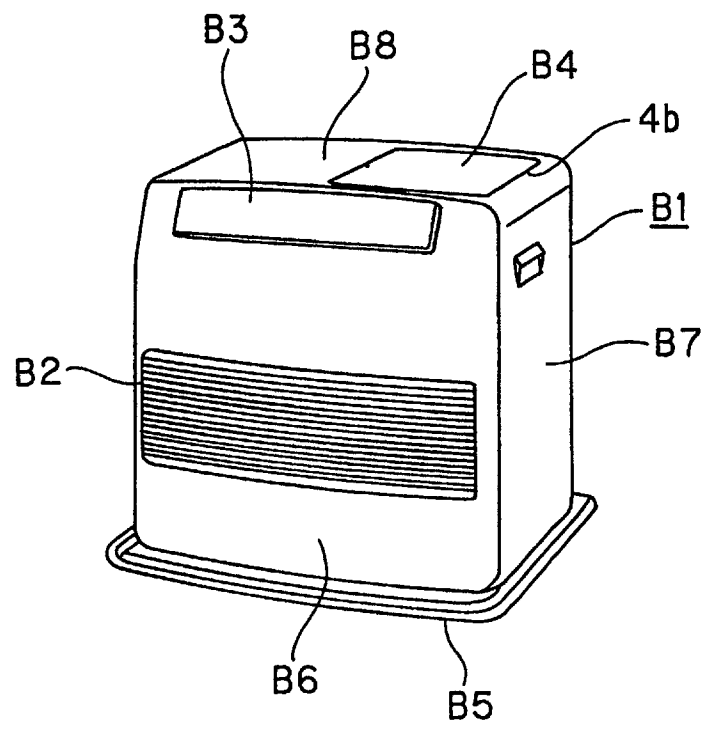


FIG. 40

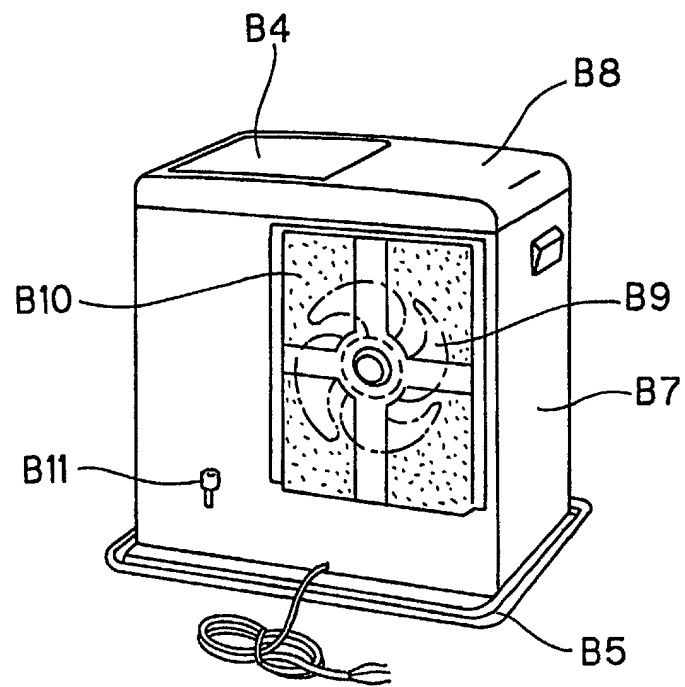


FIG. 41

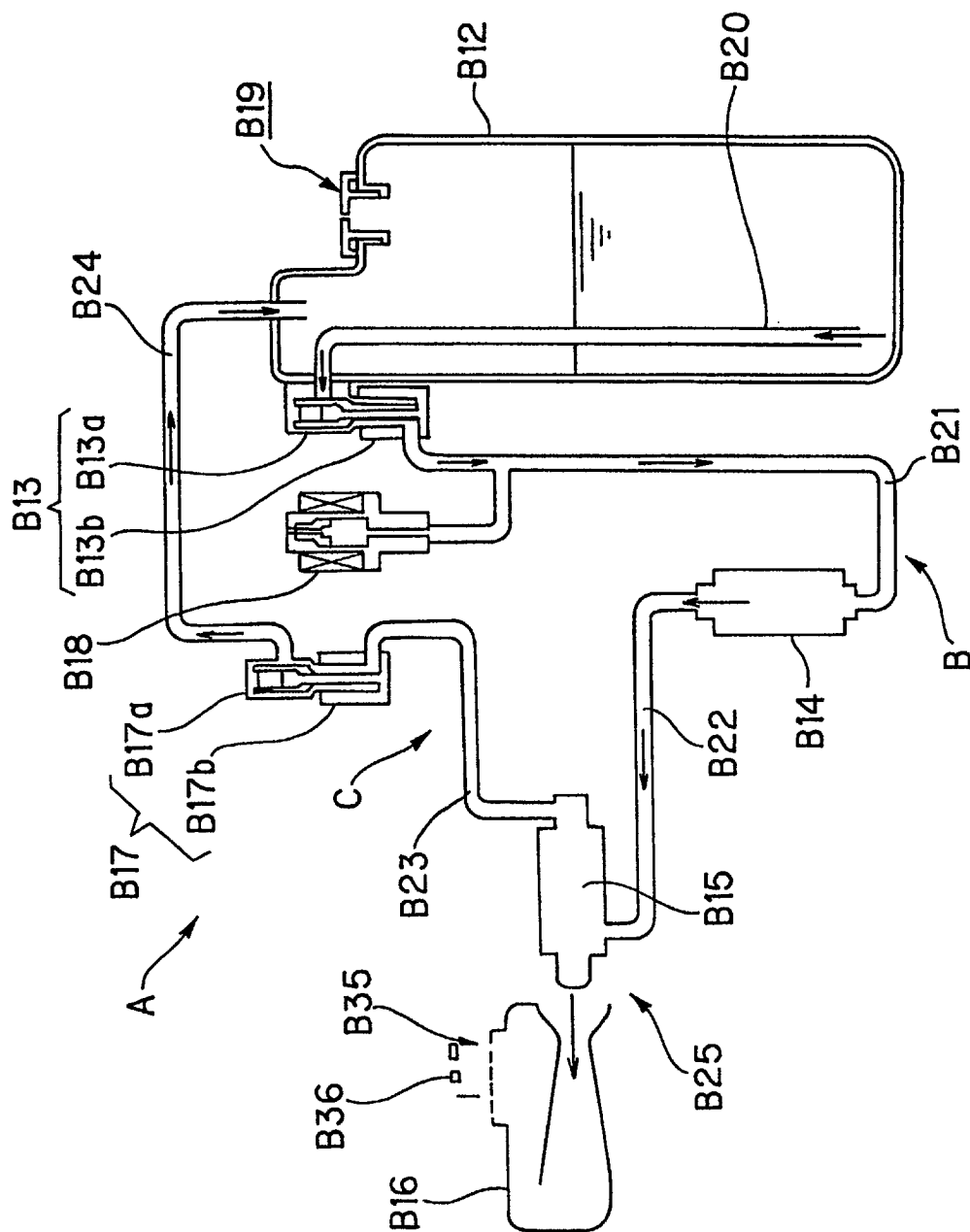


FIG. 42

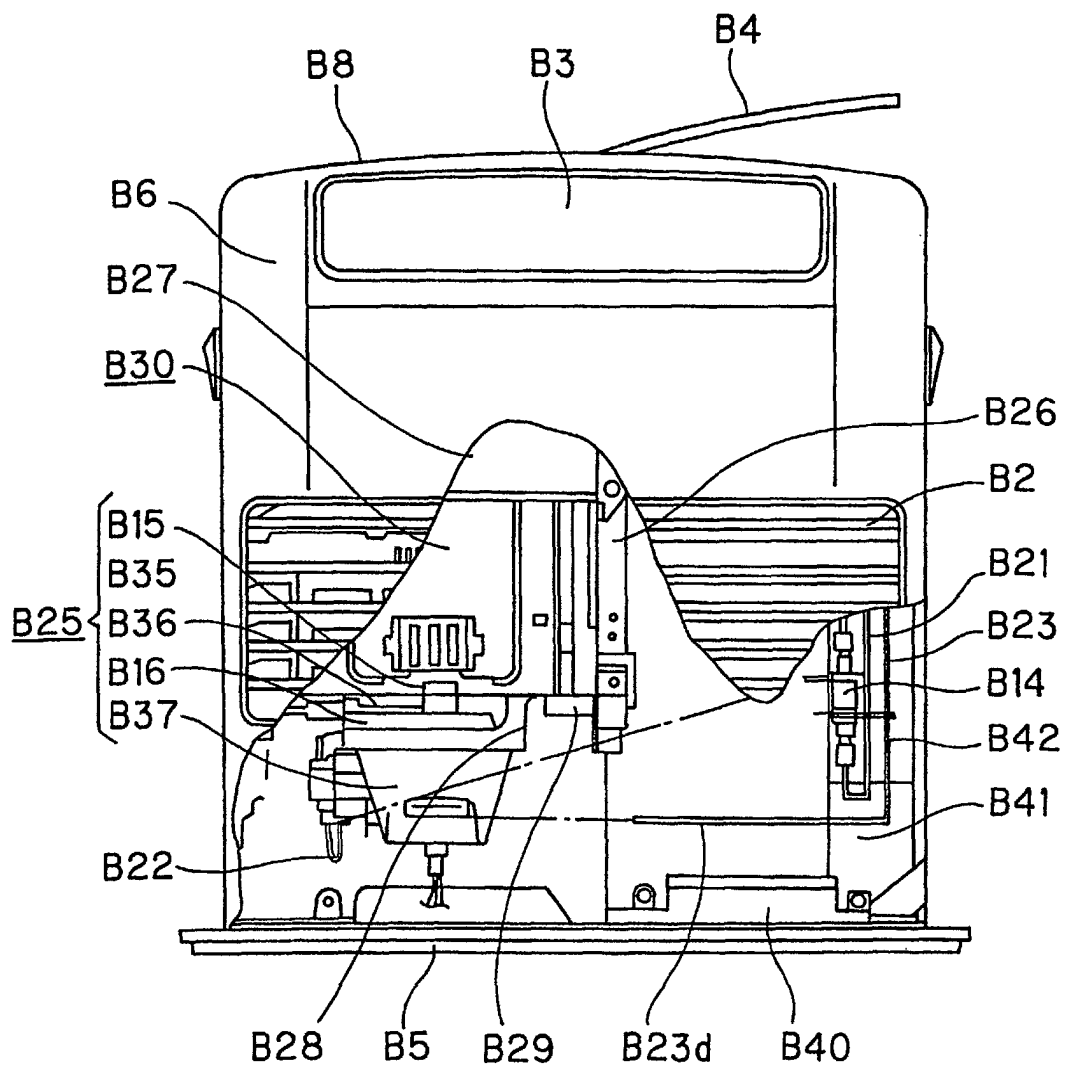


FIG. 43

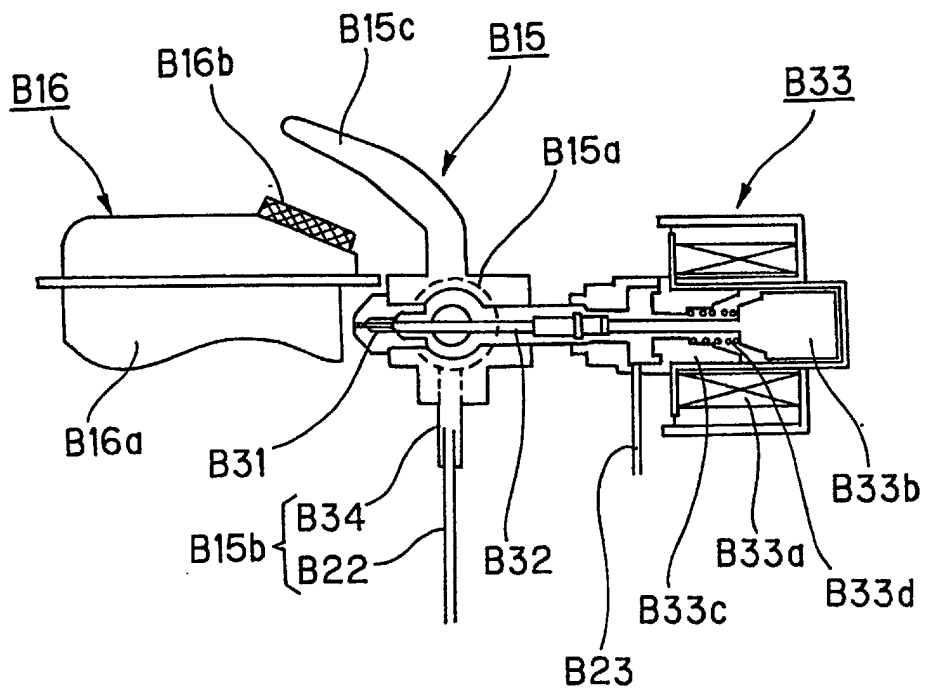


FIG. 44

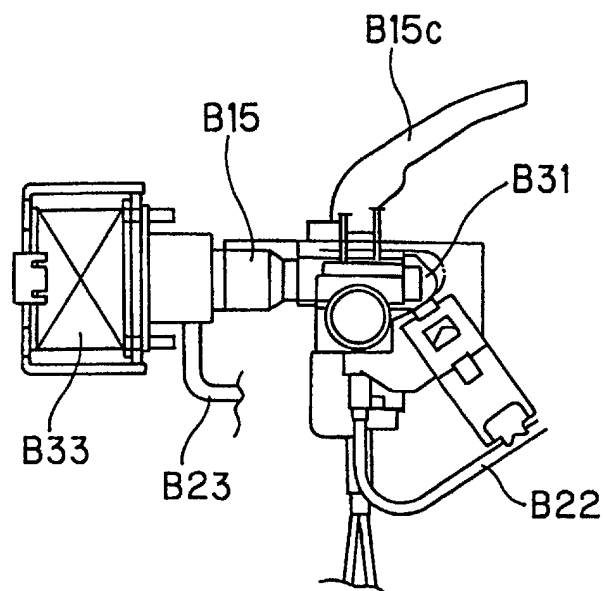


FIG. 45

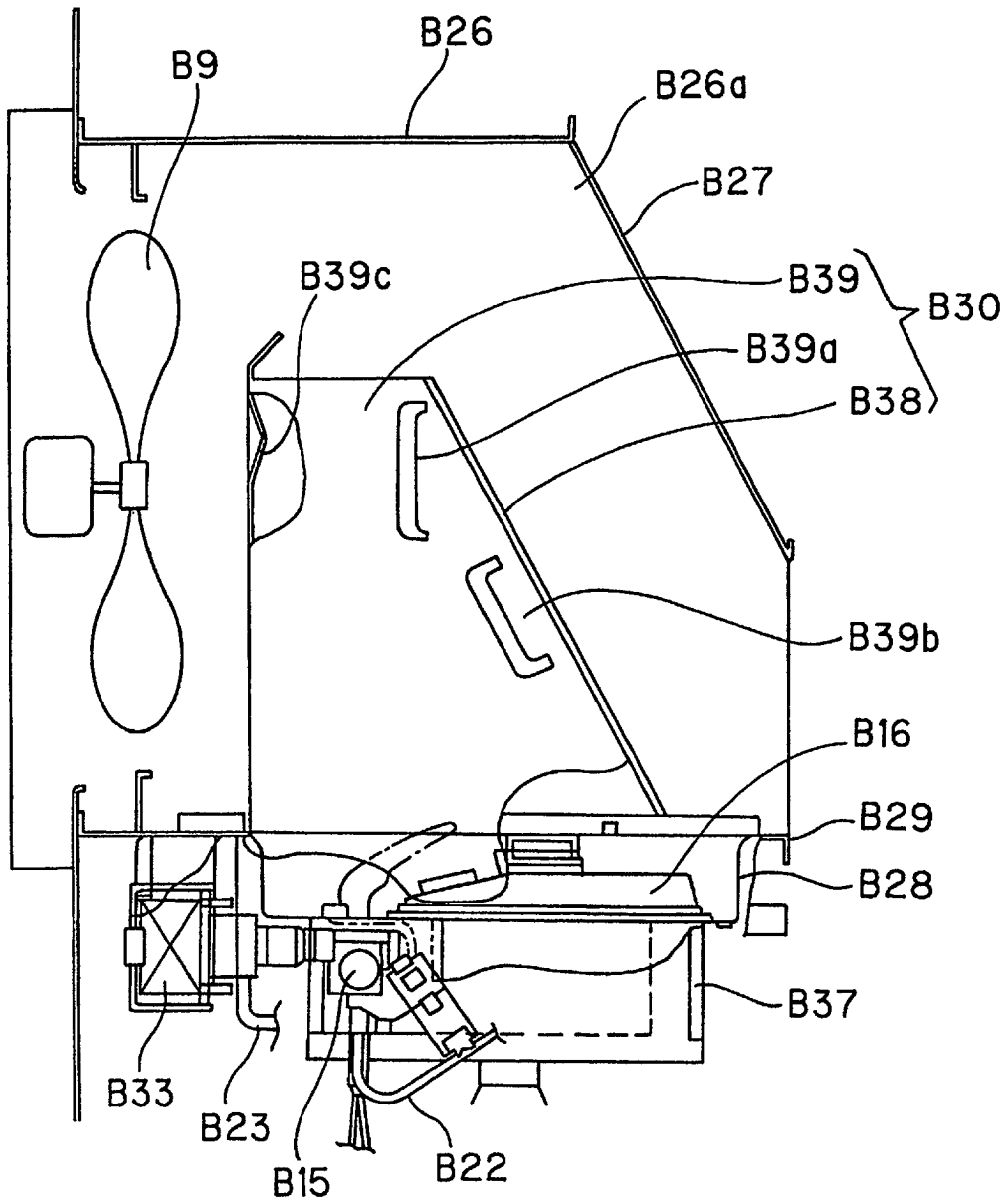


FIG. 46

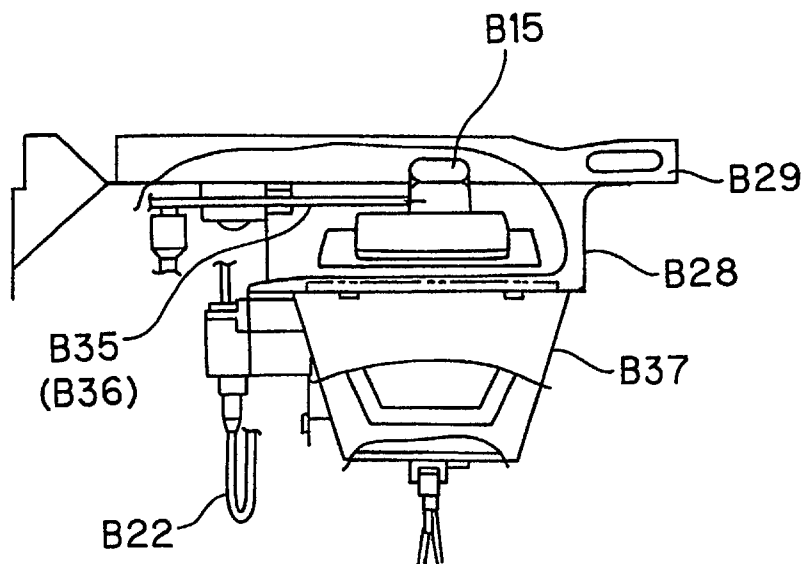


FIG. 47

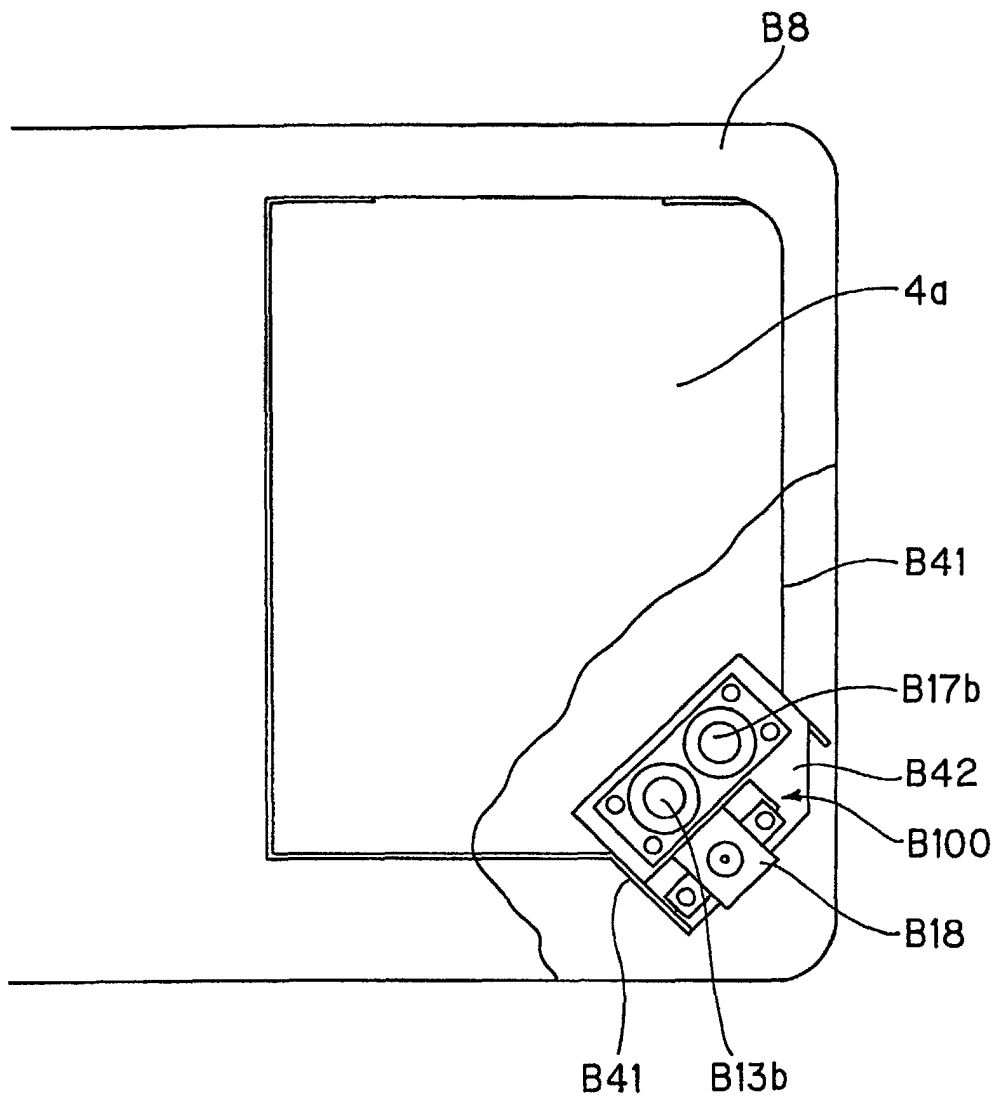


FIG. 48

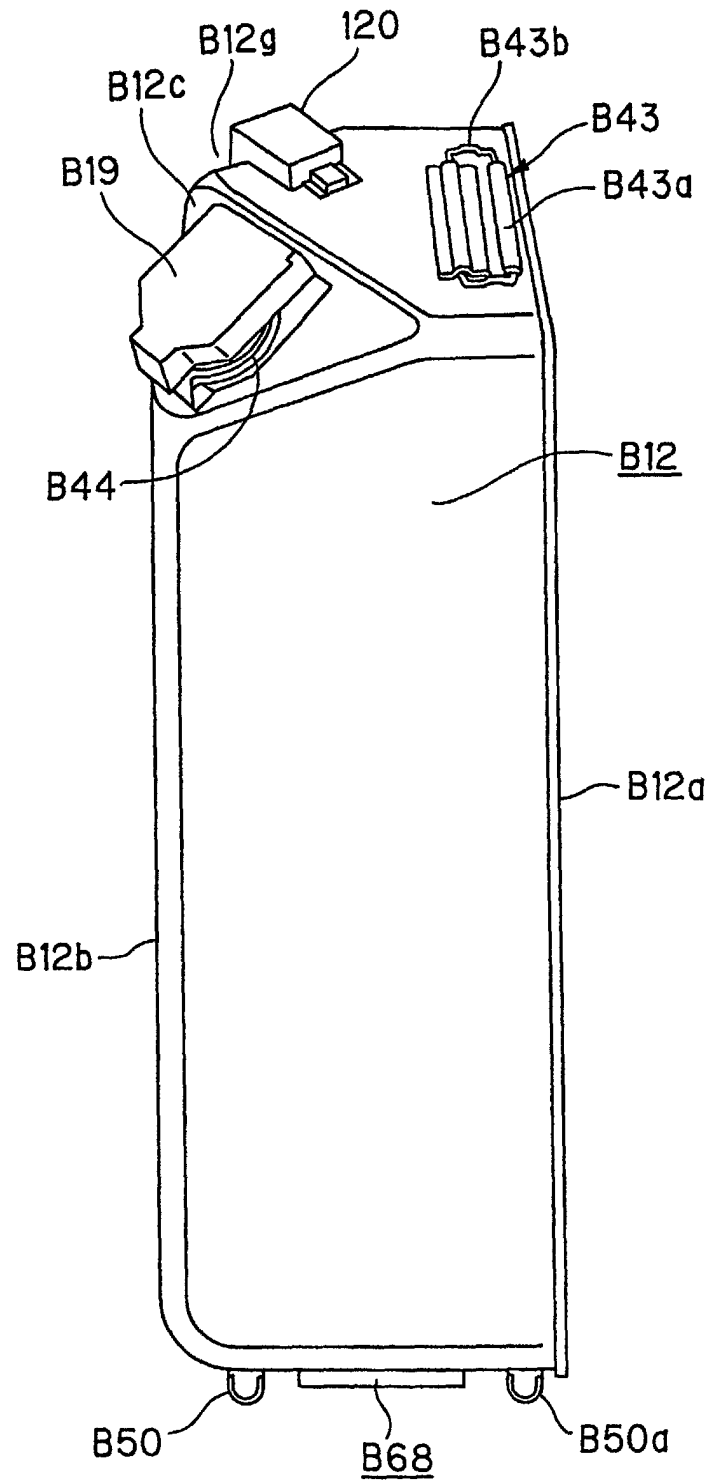


FIG. 49

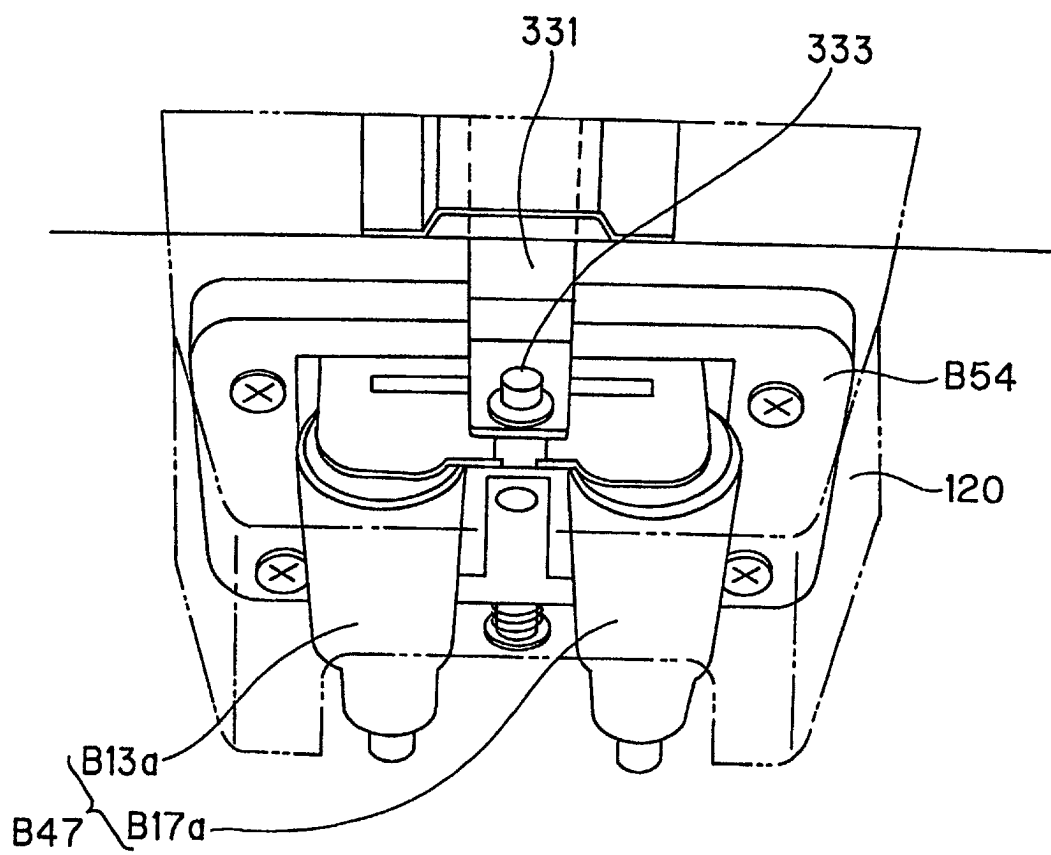


FIG. 50

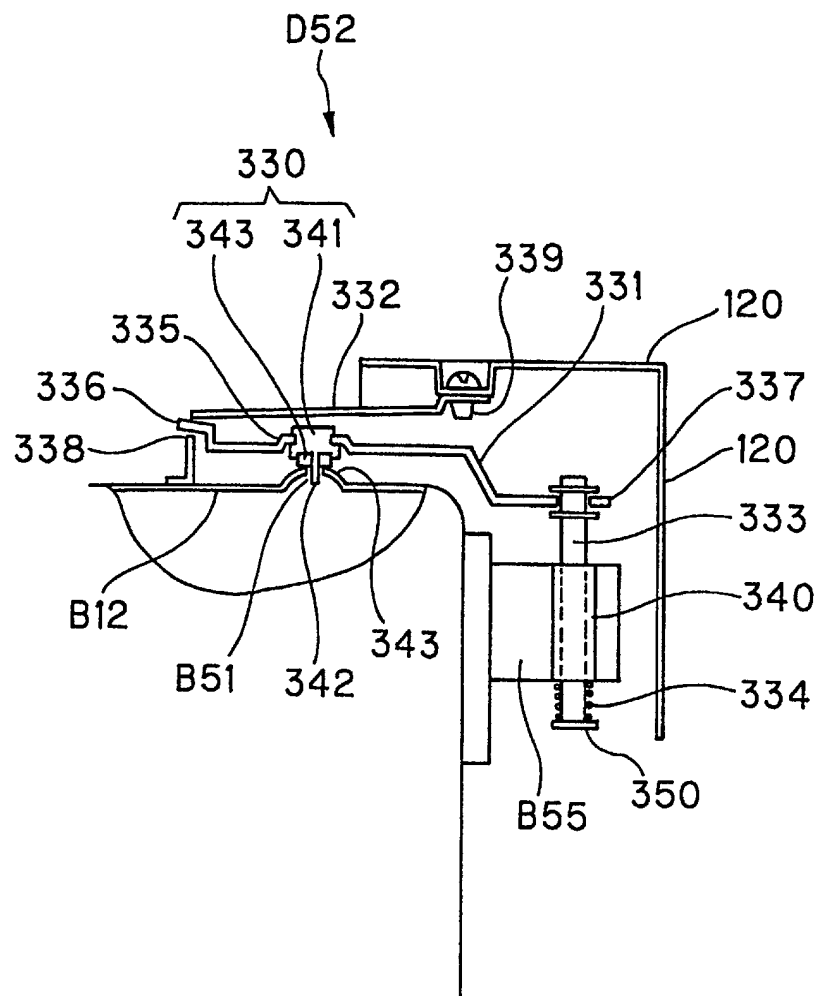


FIG. 51

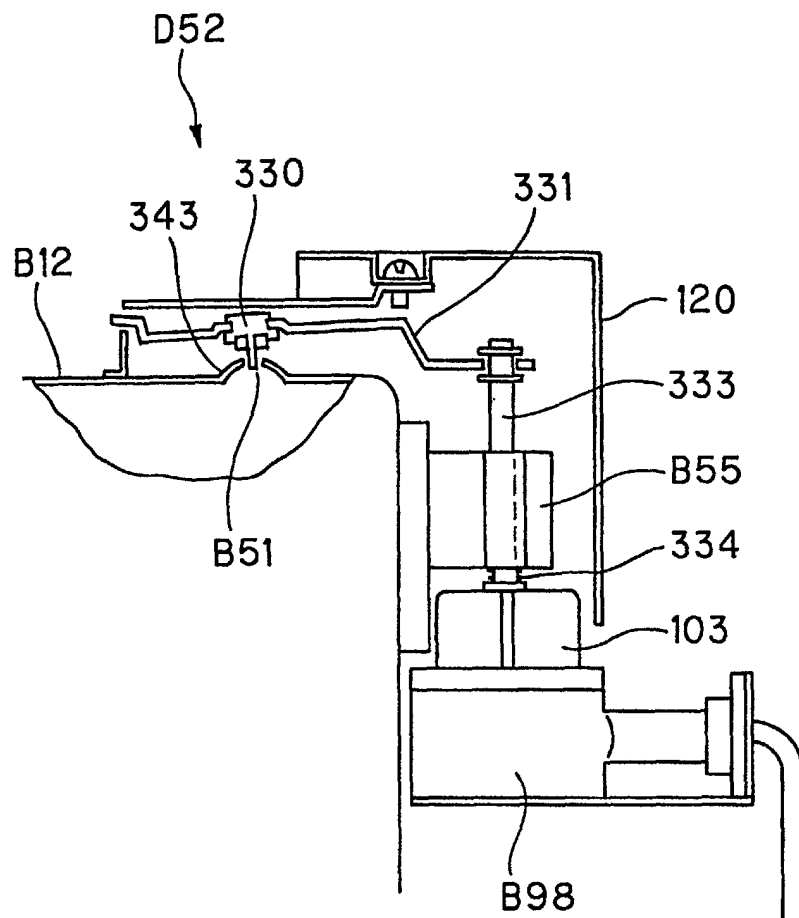


FIG. 52

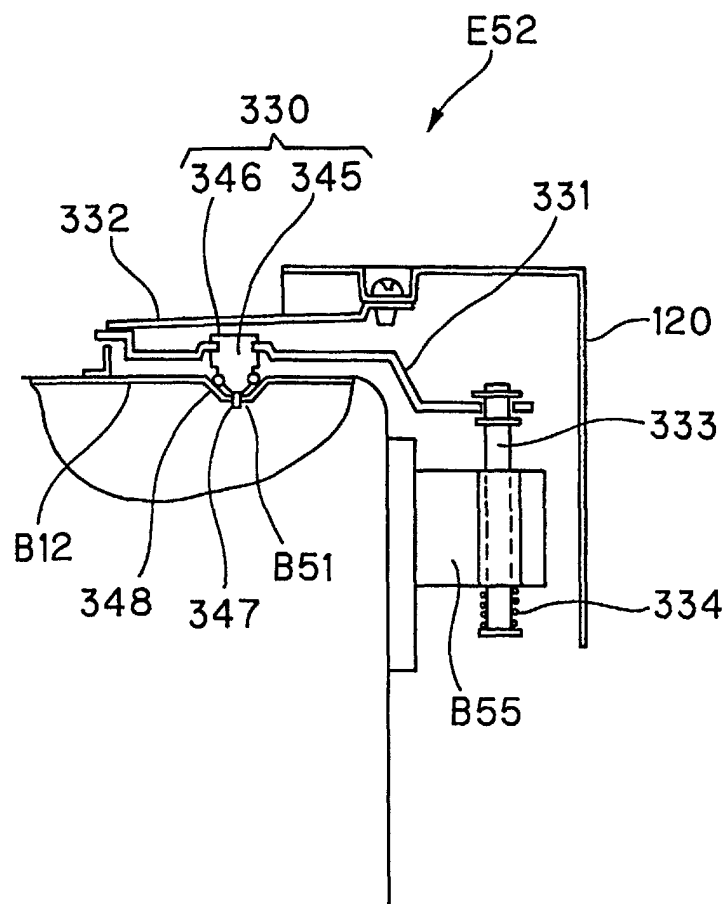


FIG. 53

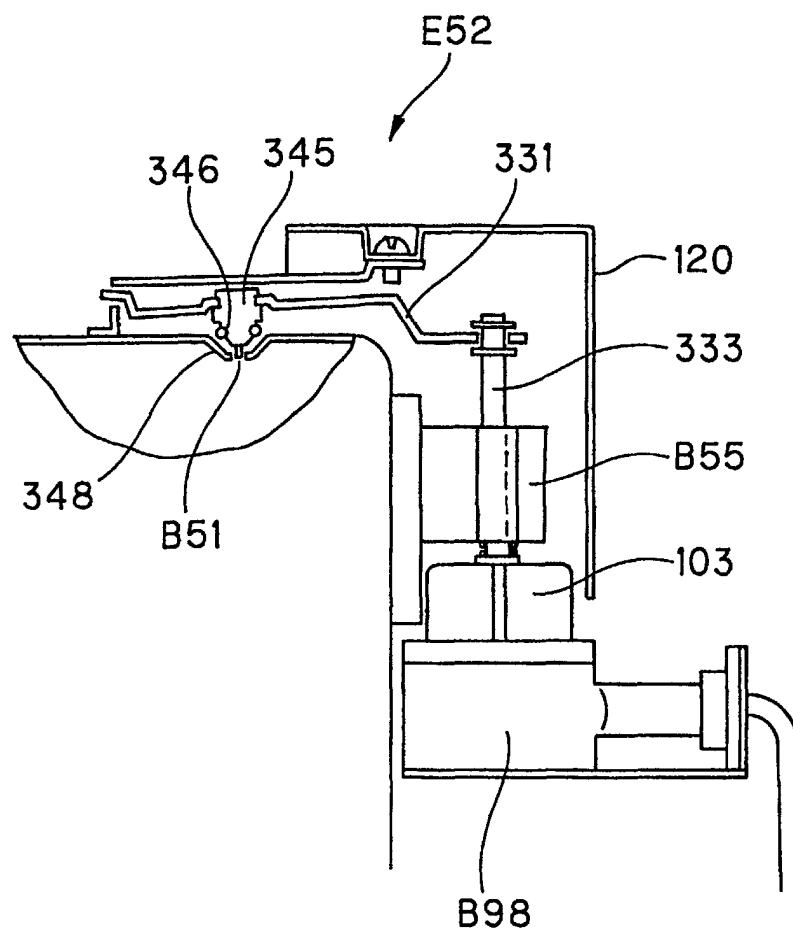


FIG. 54

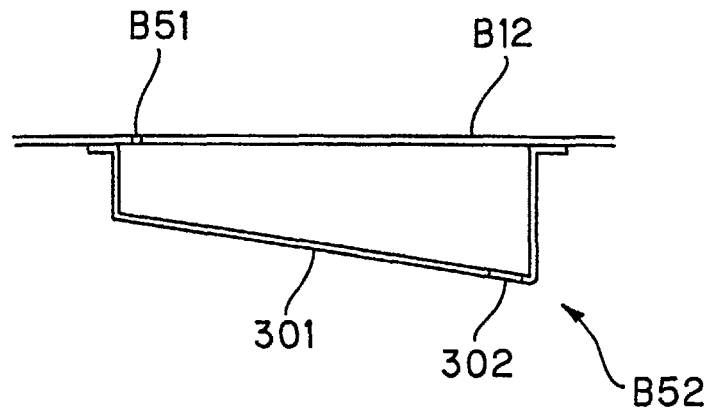


FIG. 55

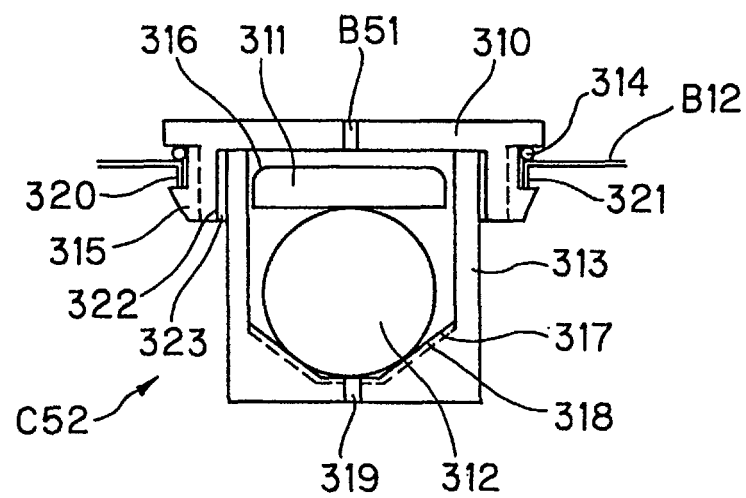


FIG. 56

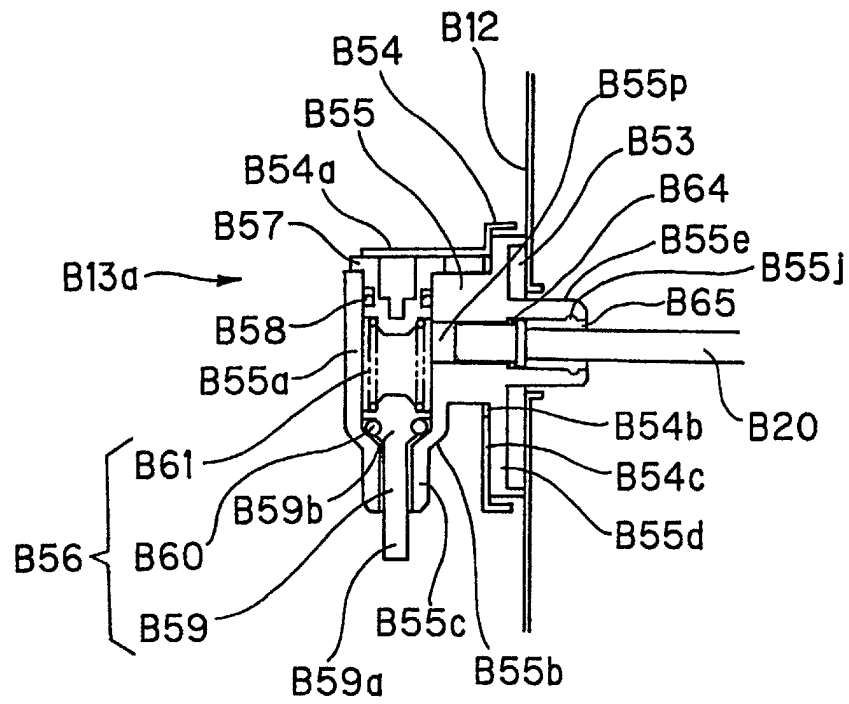


FIG. 57

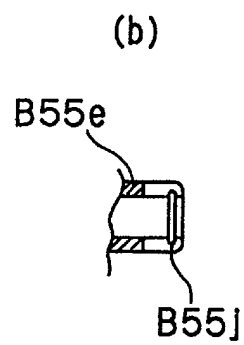
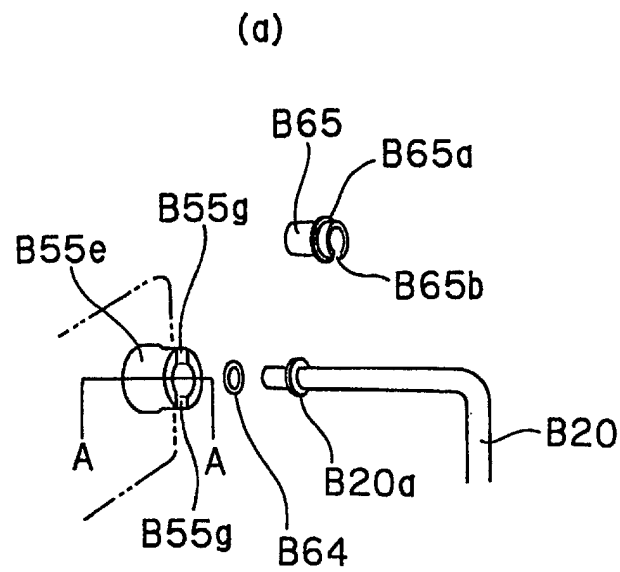


FIG. 58

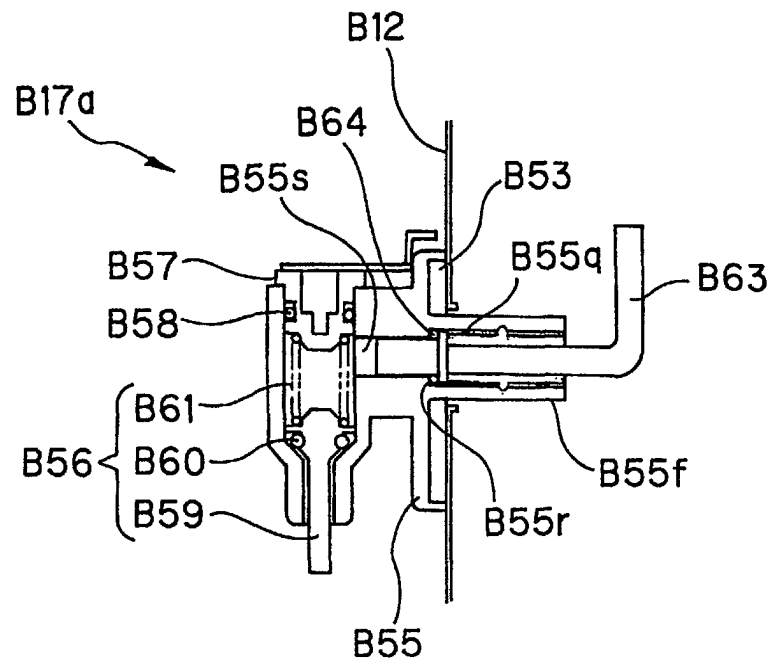
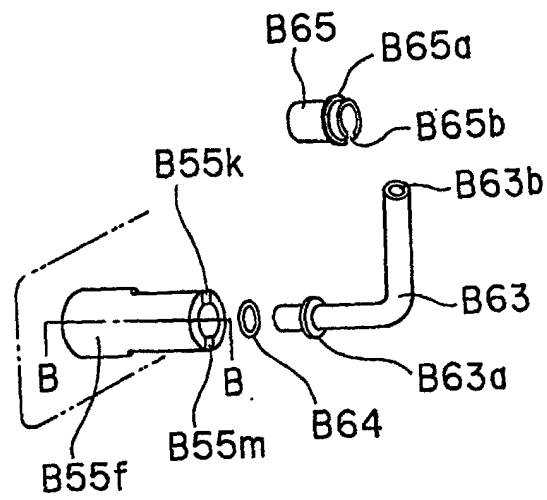


FIG. 59

(a)



(b)

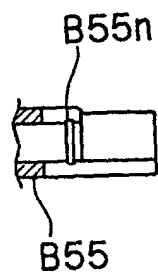


FIG. 60

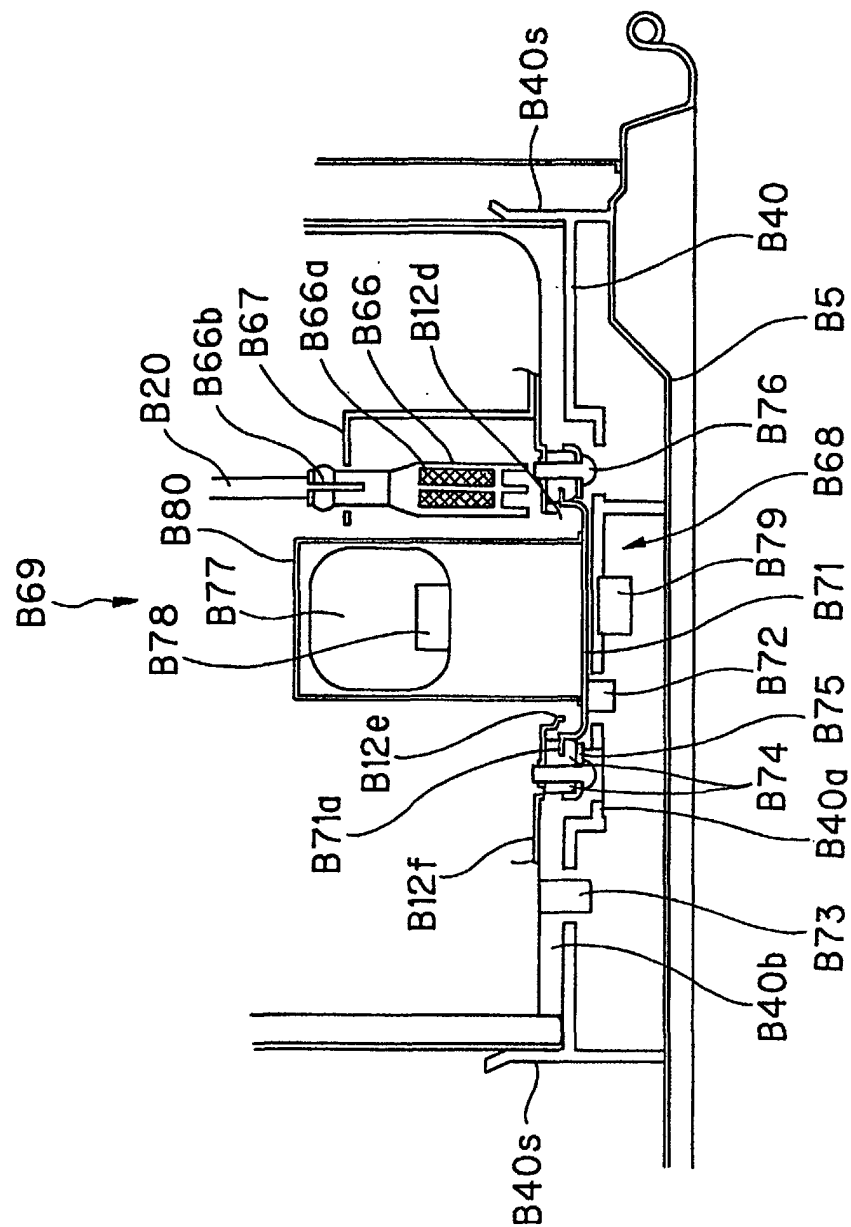


FIG. 61

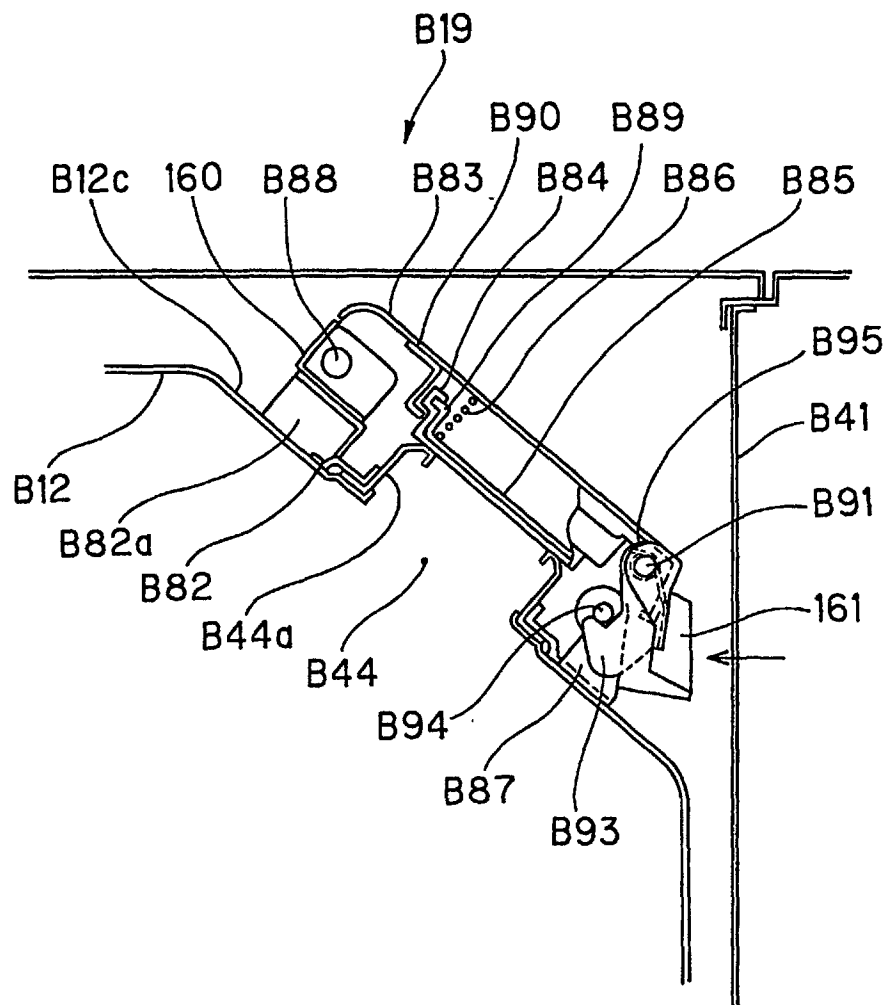


FIG. 62

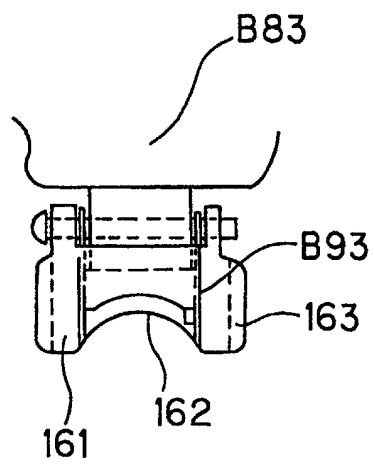


FIG. 63

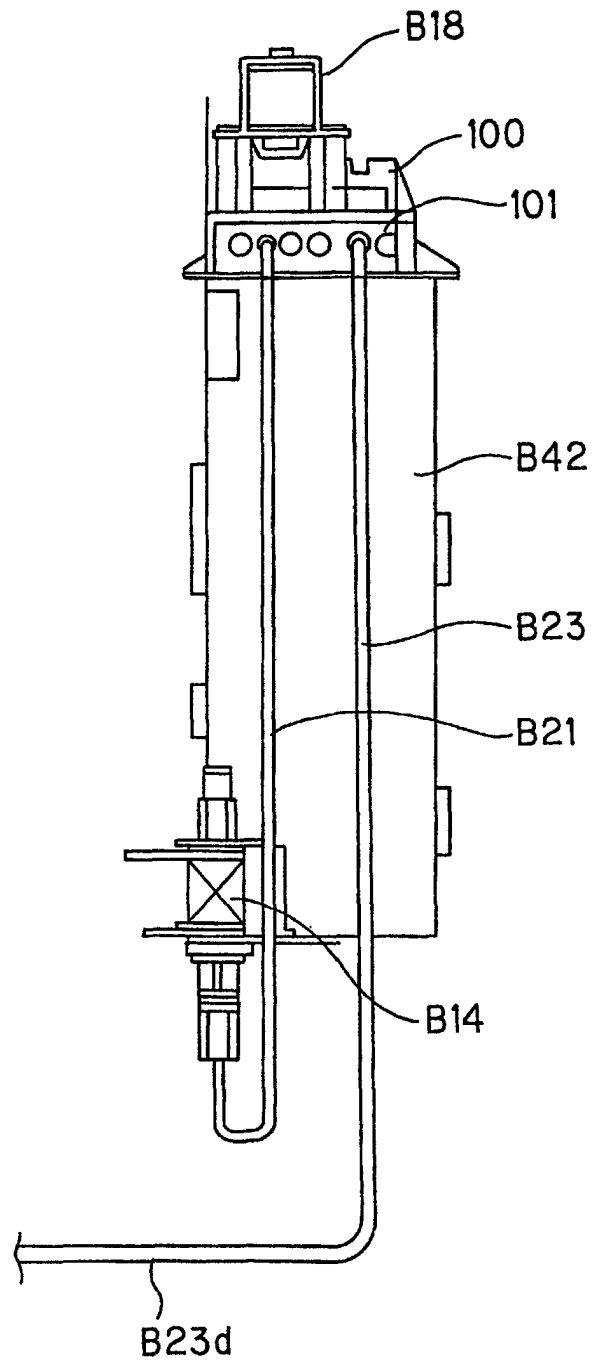


FIG. 64

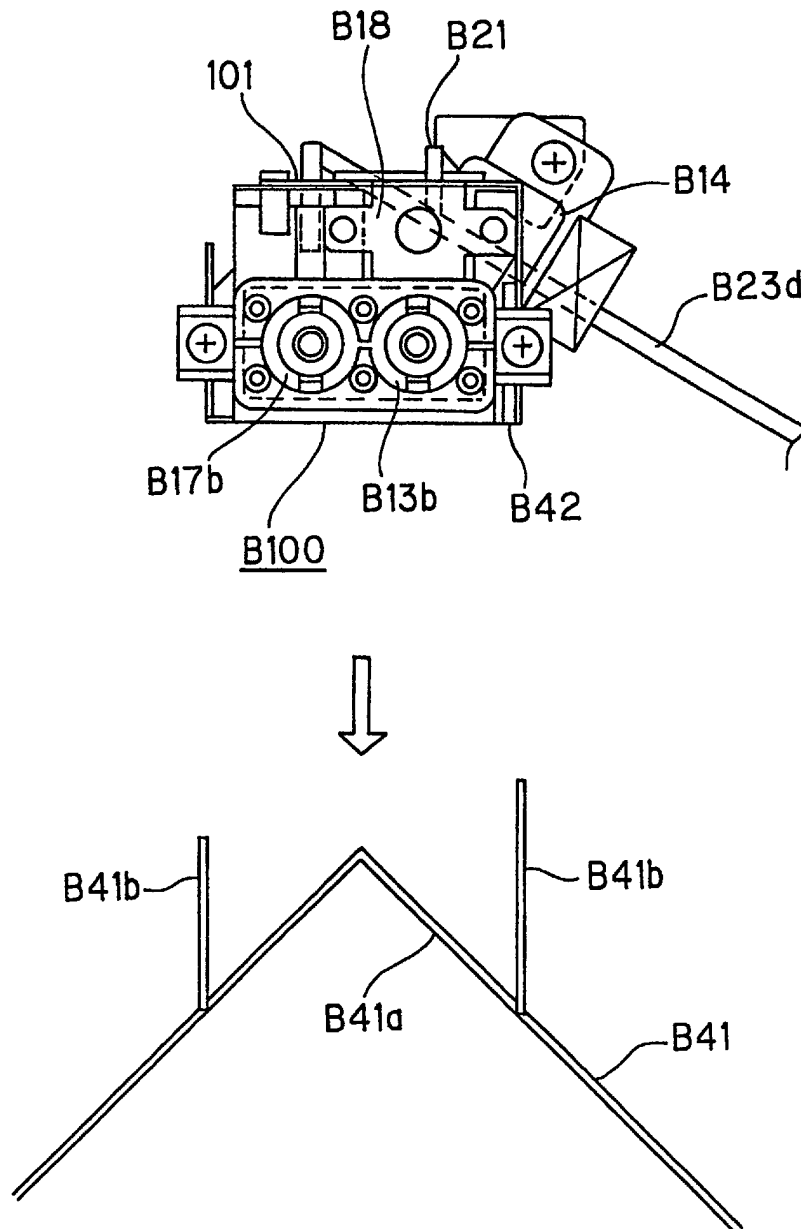


FIG. 65

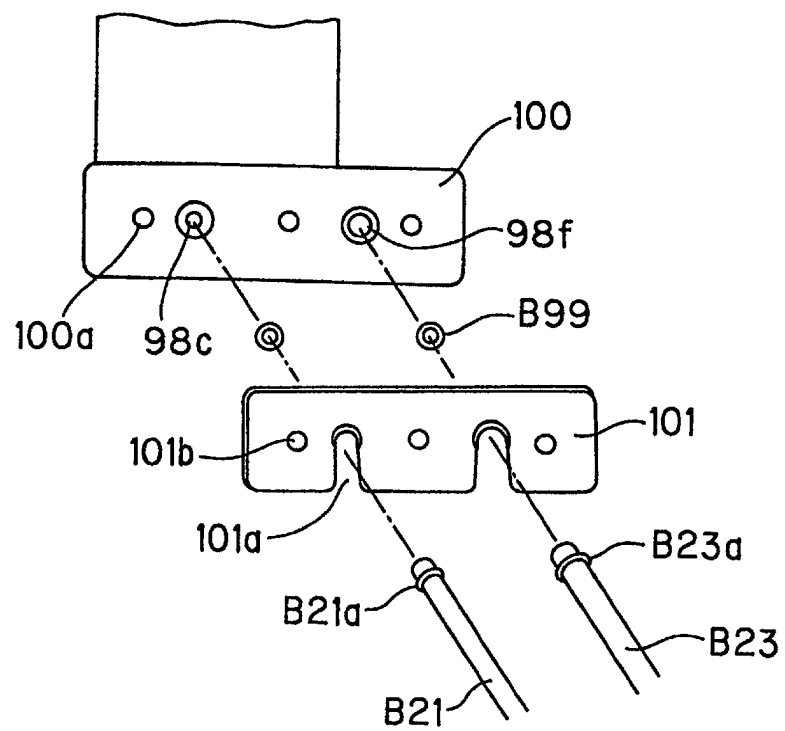


FIG. 66

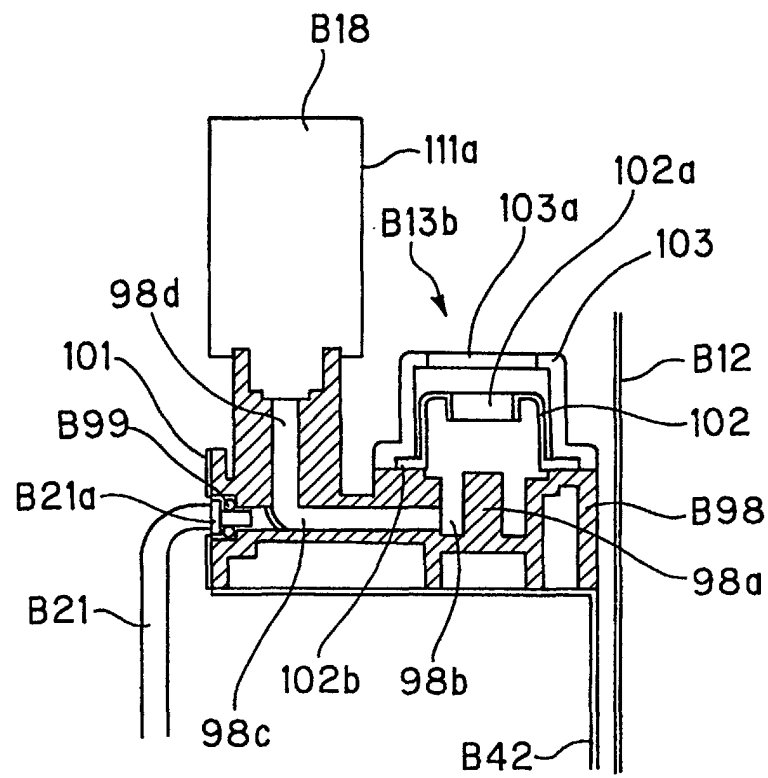


FIG. 67

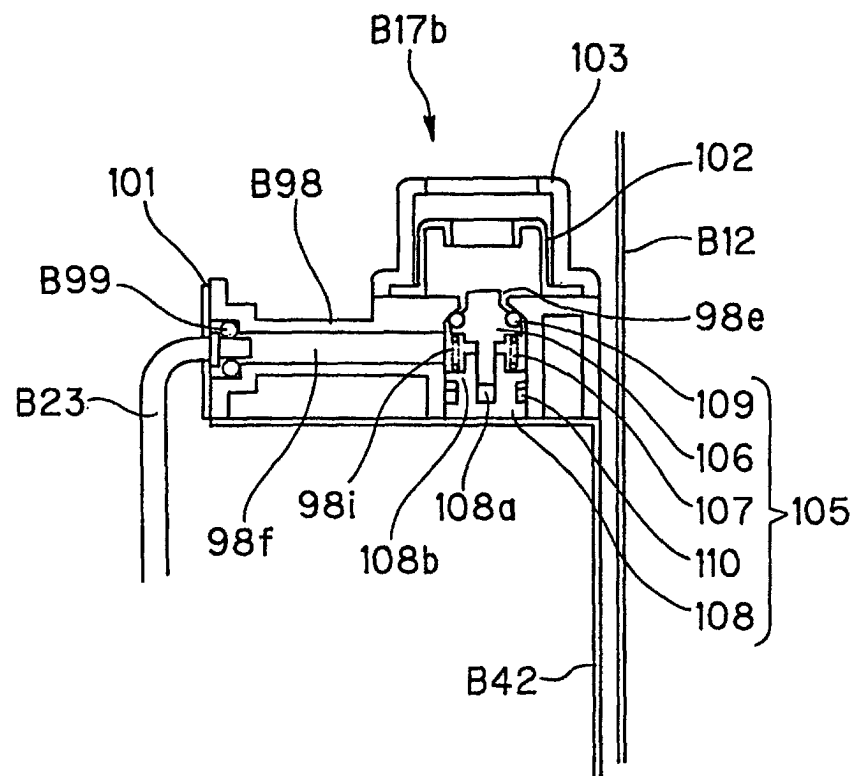


FIG. 68

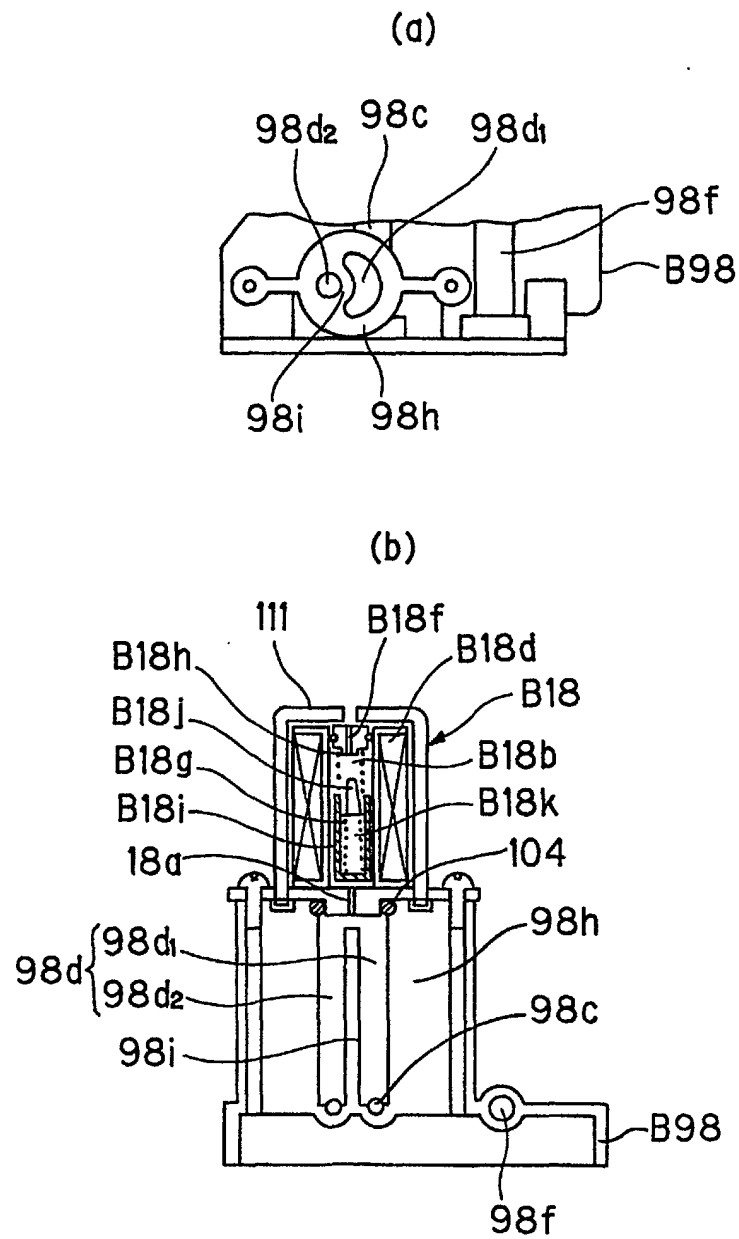


FIG. 69

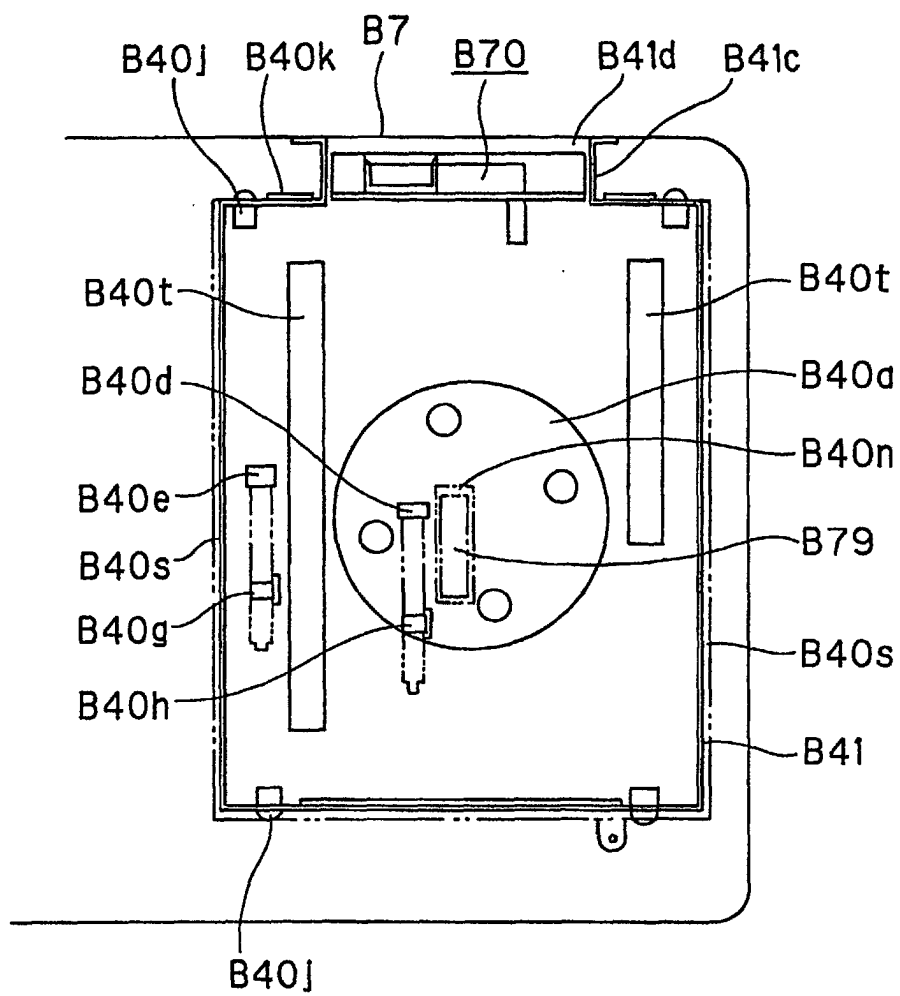


FIG. 70

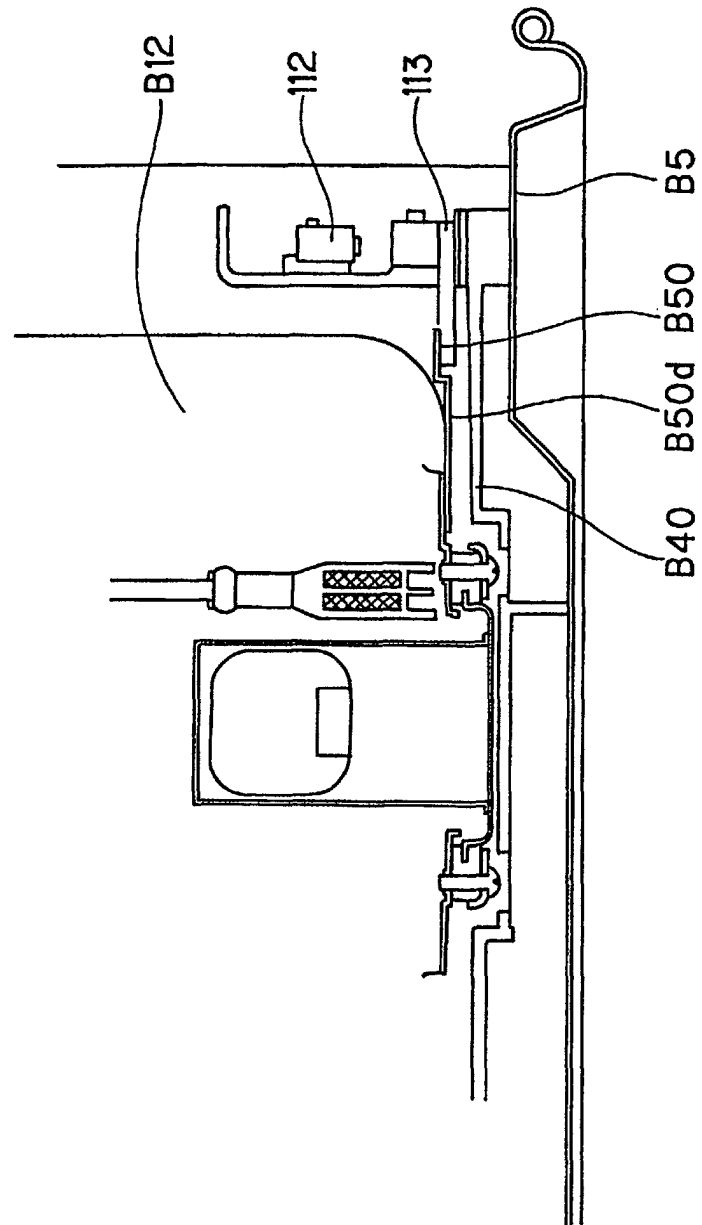


FIG. 71

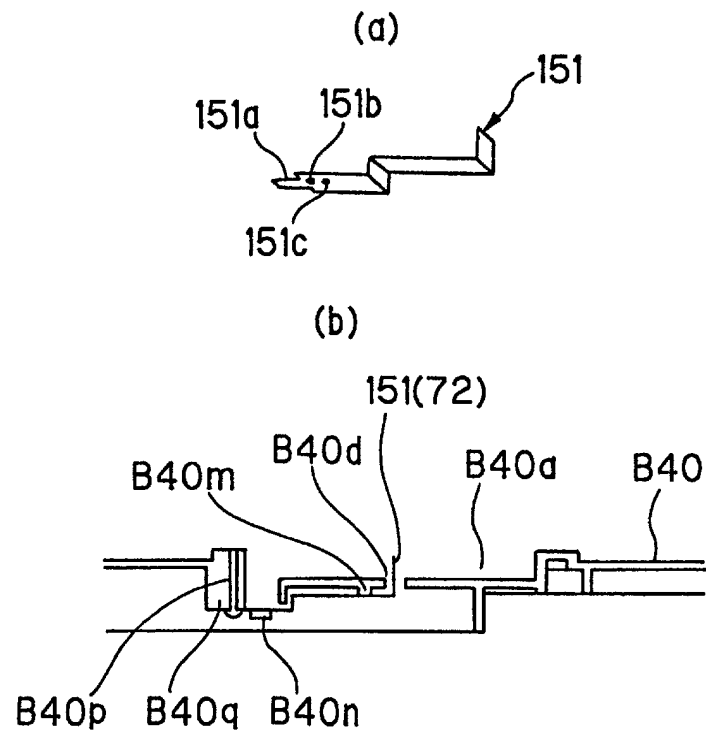


FIG. 72

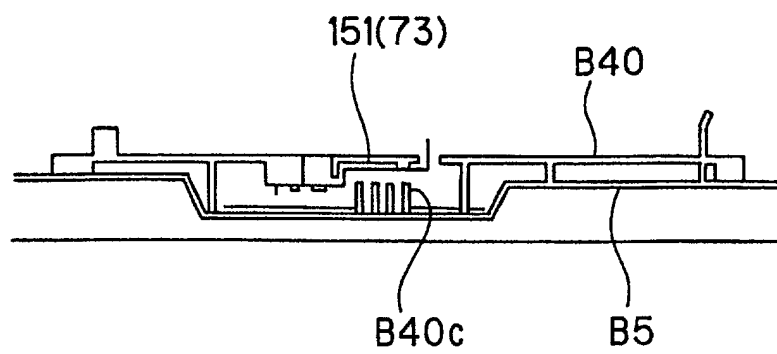


FIG. 73

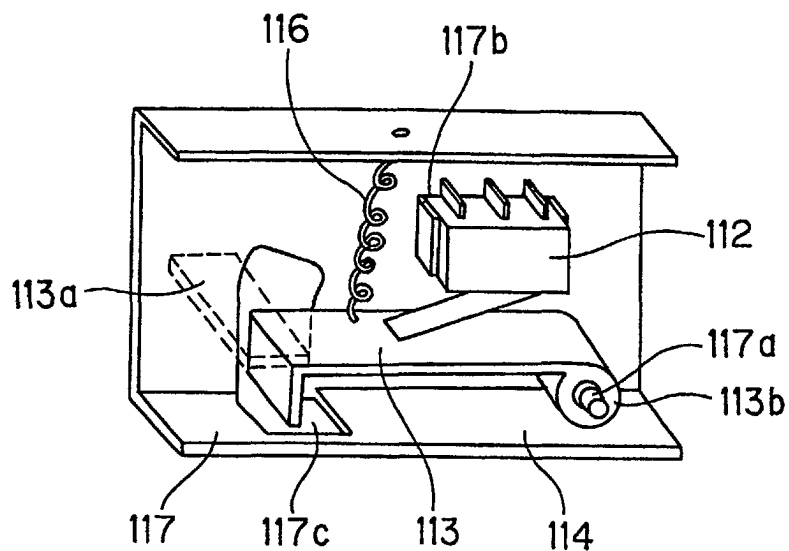


FIG. 74

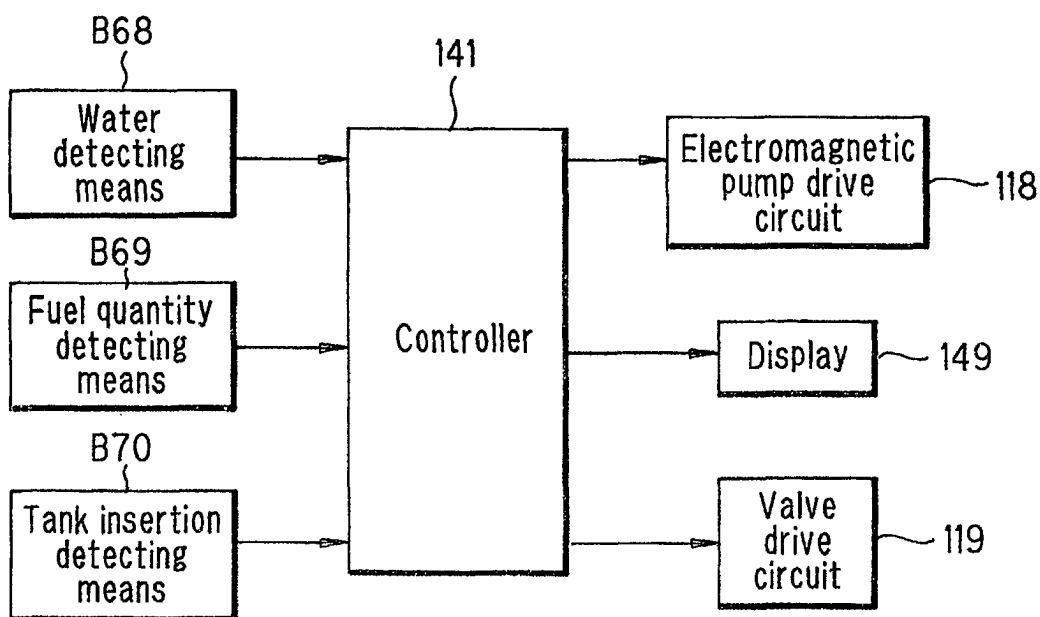


FIG. 75

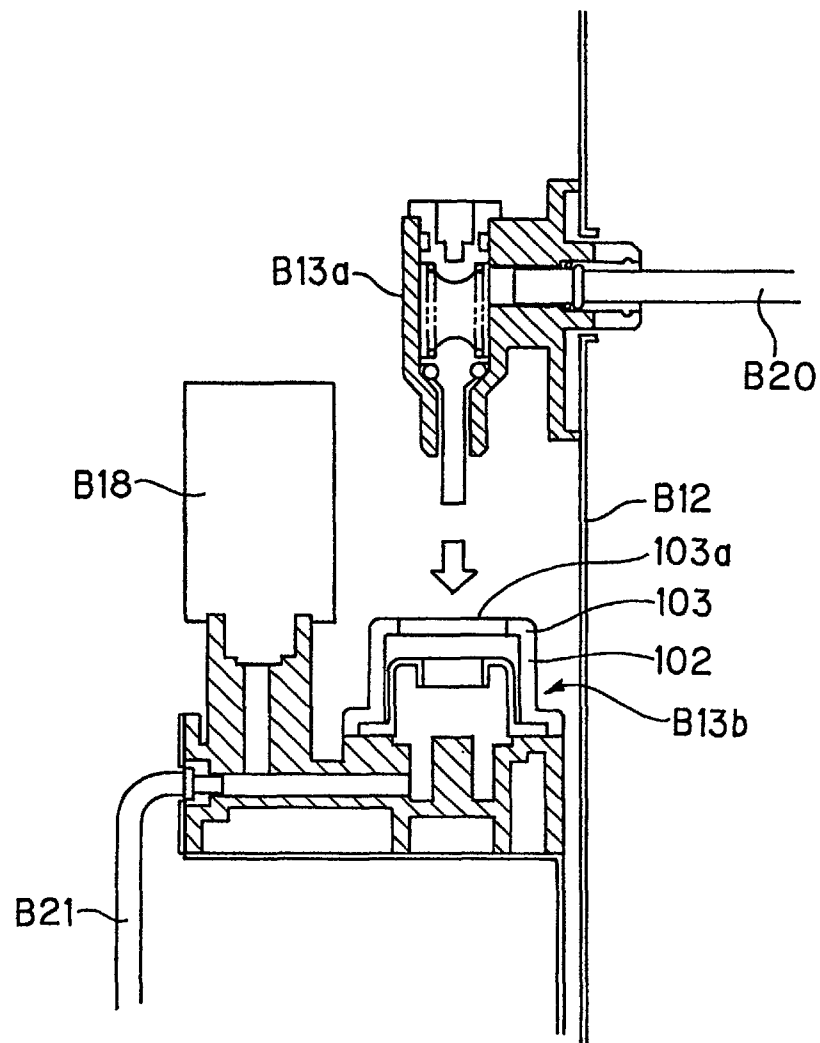


FIG. 76

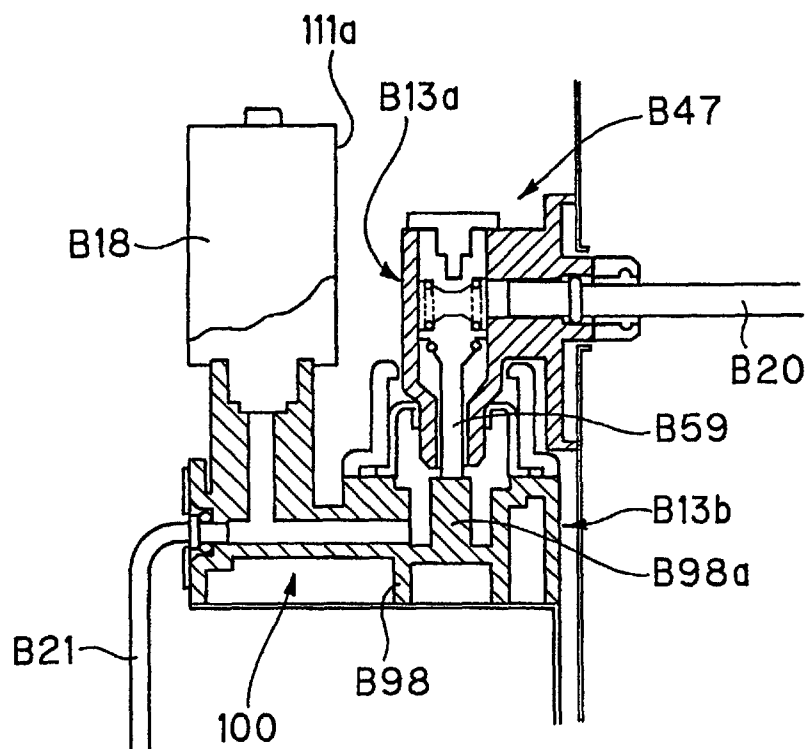


FIG. 77

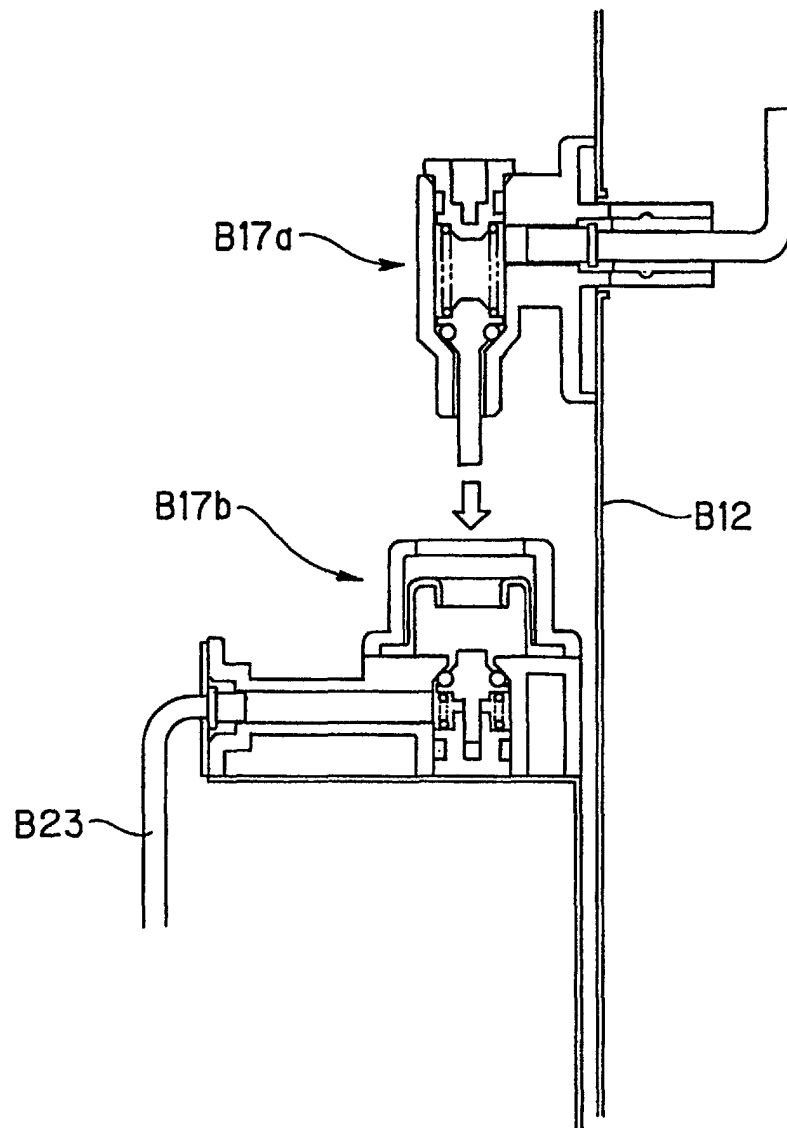


FIG. 78

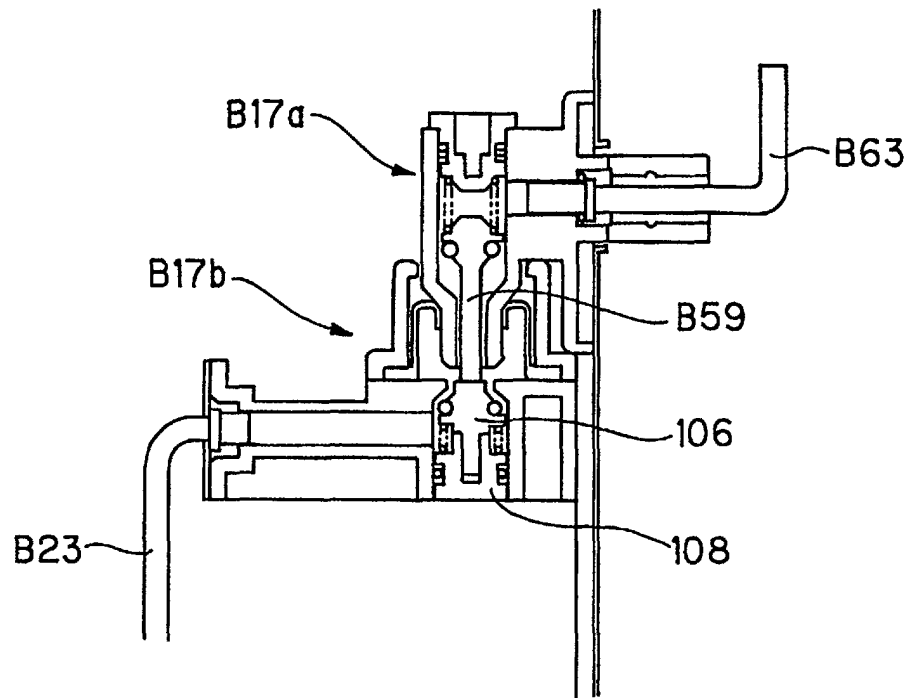


FIG. 79

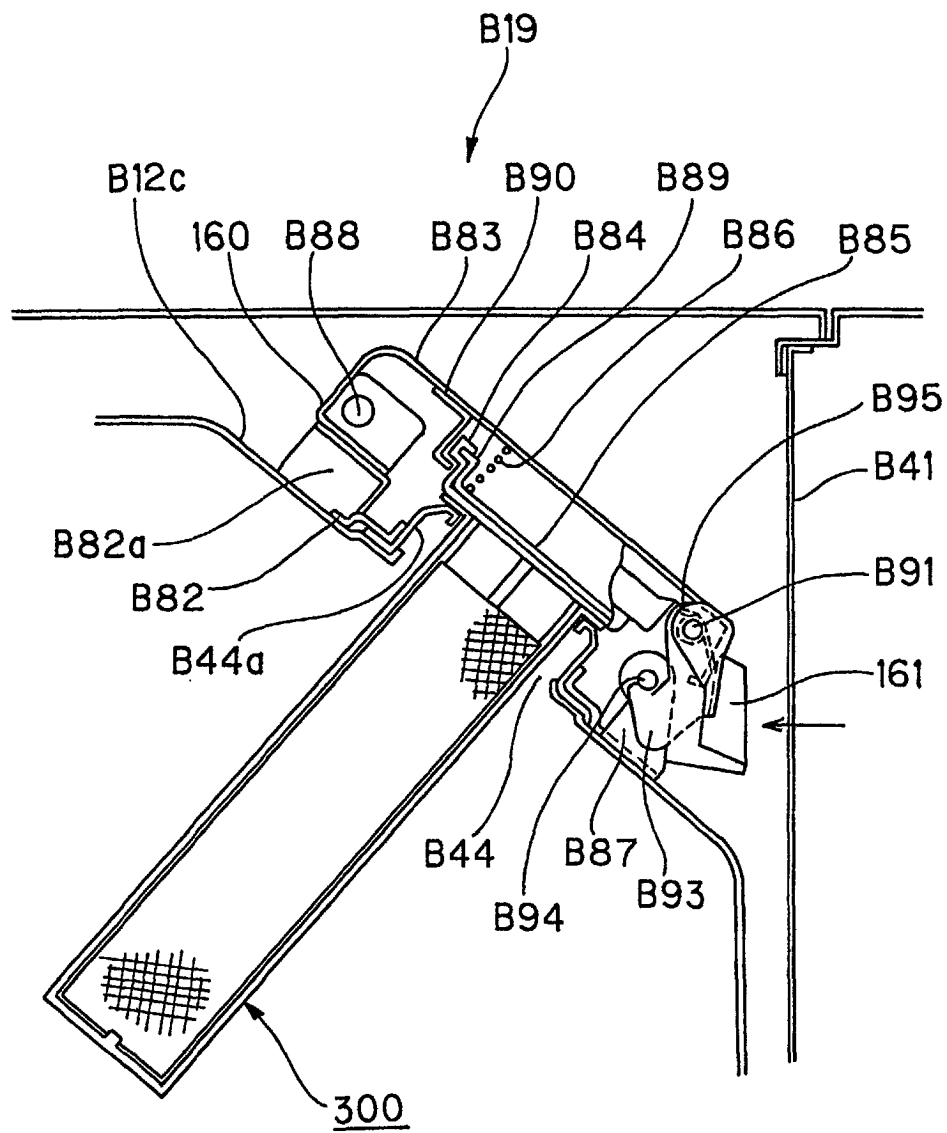


FIG. 80

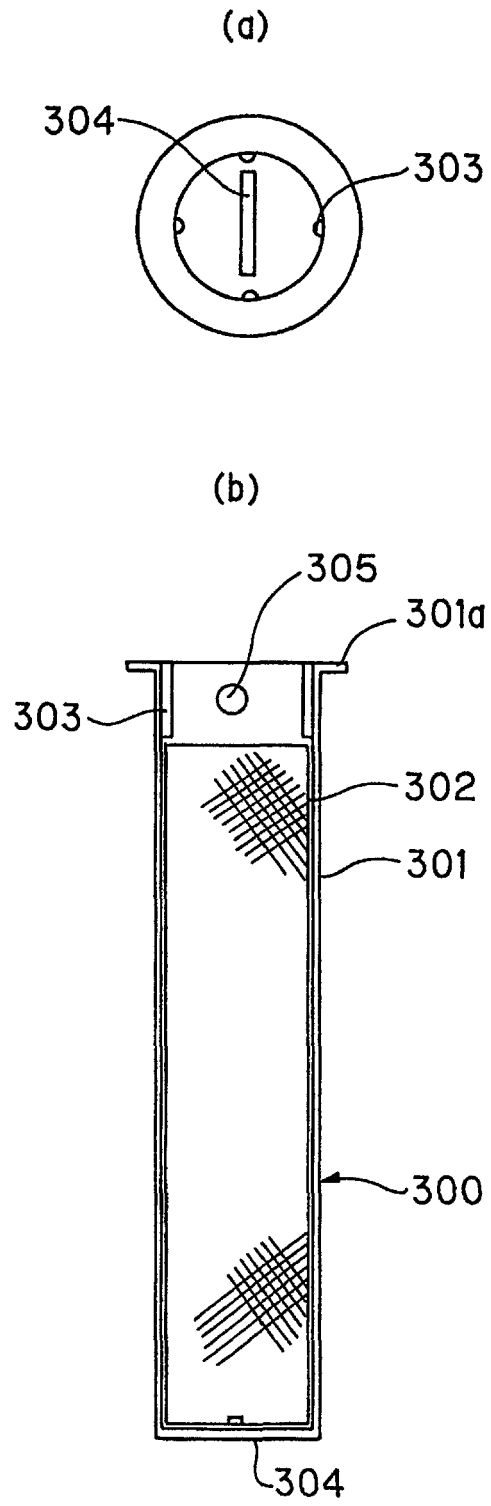


FIG. 81

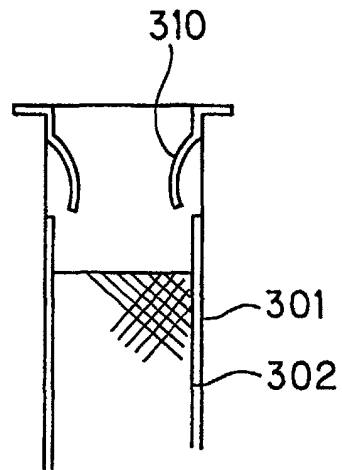


FIG. 82

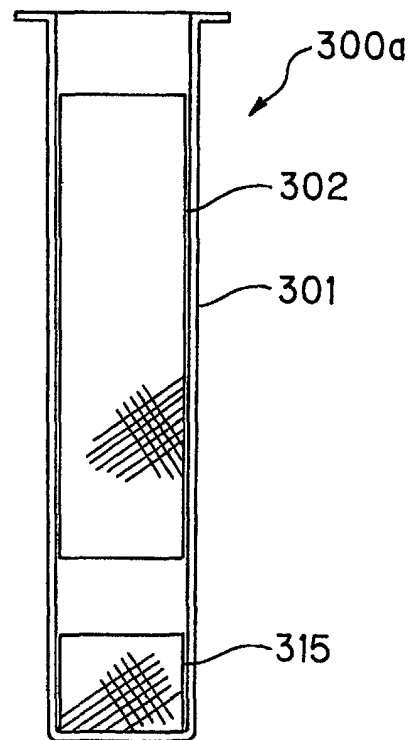


FIG. 83

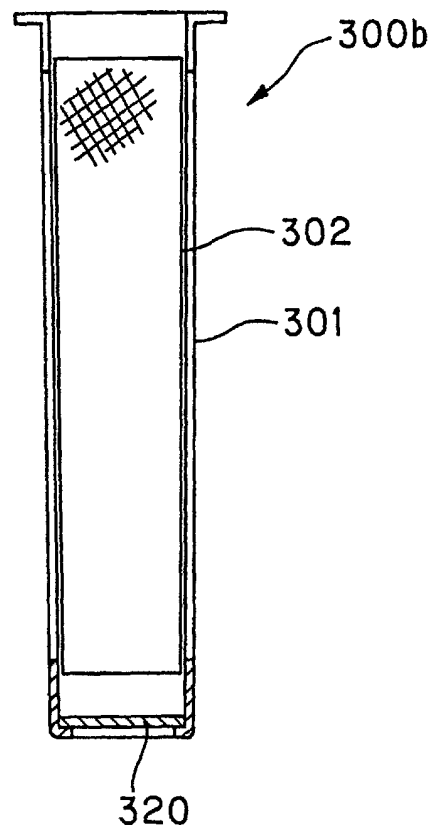


FIG. 84

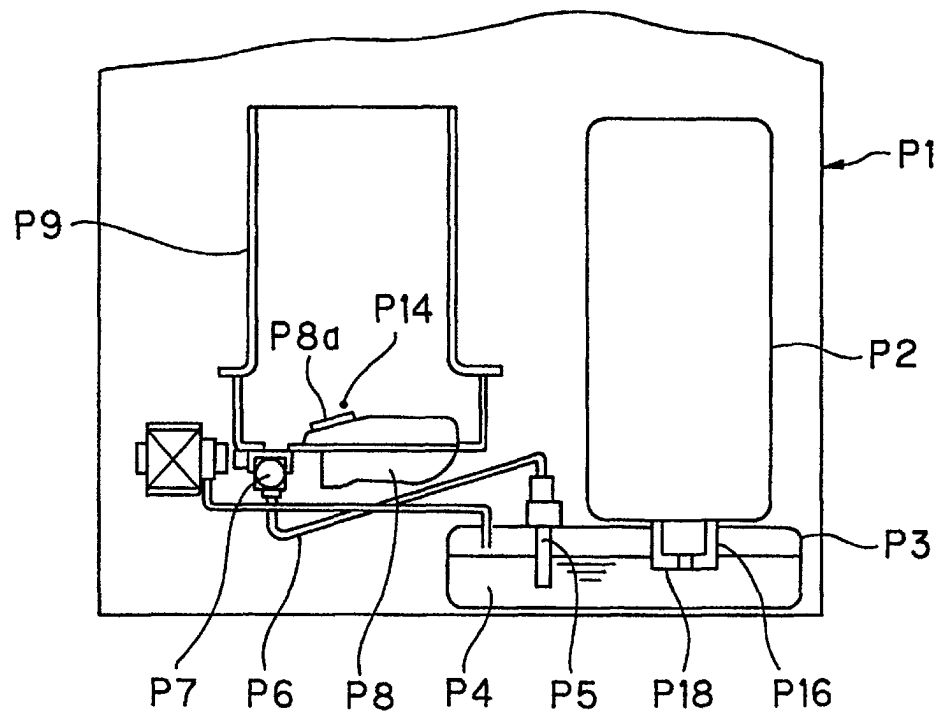


FIG. 85

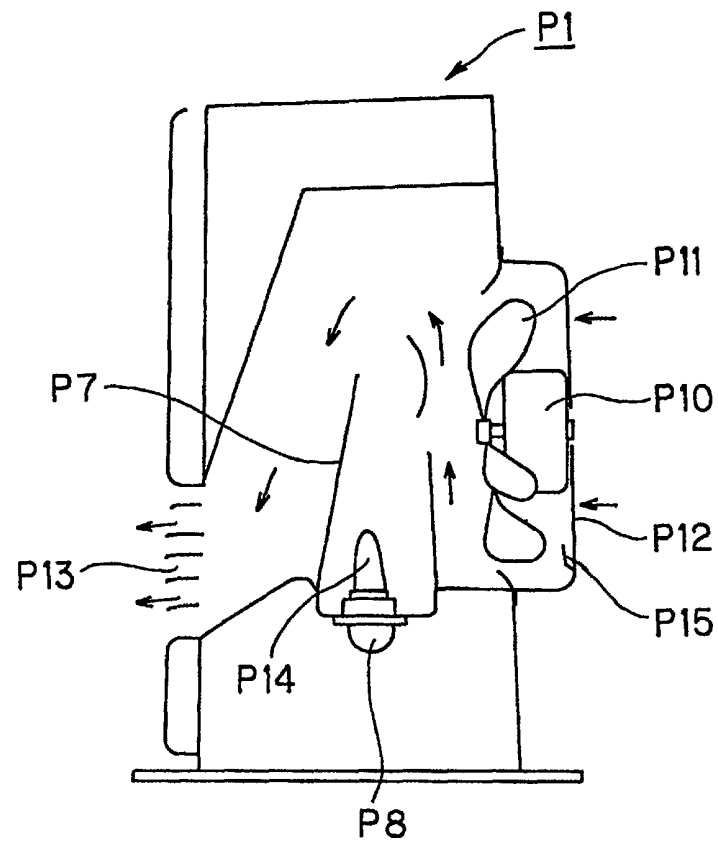
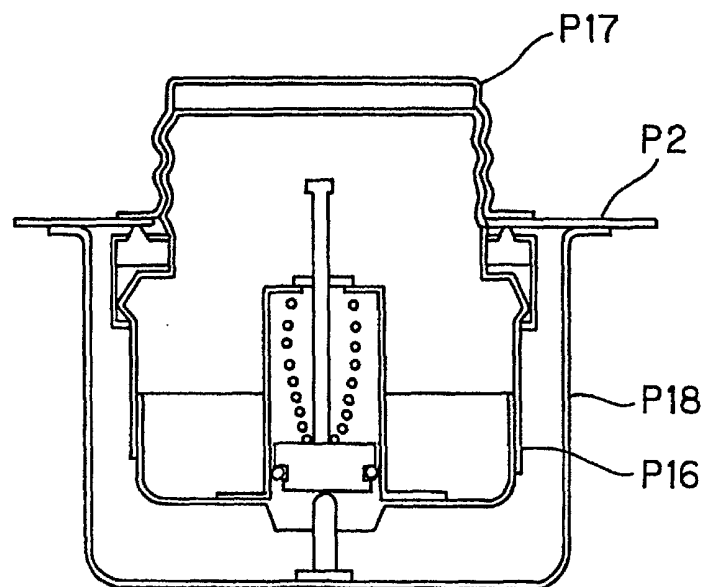


FIG. 86



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/00657

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F23K5/14		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁷ F23K5/14		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-2001 Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 123182/1976 (Laid-open No.40537/1978), (Hitachi Heating Appliance Co., Ltd.), 08 April, 1978 (08.04.78), Full text; Fig.2	13, 18, 19, 26-28, 38-42
A	Full text; Fig.2 (Family: none)	1-12, 14-17, 20-25, 29-37
Y	JP, 62-49117, A (Yamaha Motor Co., Ltd.), 03 March, 1987 (03.03.87), Full text; Figs. 1, 2 (Family: none)	13
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 48052/1981 (Laid-open No.162137/1982), (Mitsubishi Agricultural Machinery Co., Ltd.), 12 October, 1982 (12.10.82), Full text; Figs.2,3 (Family: none)	18, 19
Y	JP, 3-91613, A (Mitsubishi Electric Corporation),	26-28, 38-42
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 13 March, 2001 (13.03.01)		Date of mailing of the international search report 21 March, 2001 (21.03.01)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/00657

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	17 April, 1991 (17.04.91), Full text; Fig. 1 (Family: none)	

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