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(71) Applicant: **Sharp Kabushiki Kaisha**
Osaka-shi, Osaka 545-8522 (JP)

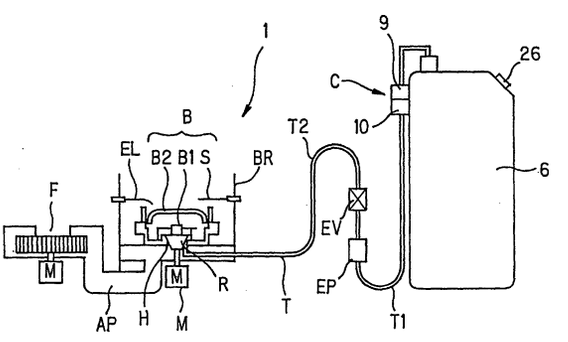
(72) Inventors:
- **TSUDA, Tsutomu**
  Kitakatsuragi-gun, Nara 635-0833 (JP)
- **YAMASAKI, Kazuo**
  Osaka 582-0003 (JP)
- **TANNO, Akemi**
  Nara 639-0223 (JP)
- **KITAGAITO, Hiroshi**
  Nara 636-0012 (JP)
- **SHIROUCHI, Toyokazu**
  Nara 638-0811 (JP)
- **GOTO, Masahiko**
  Osaka 585-0000 (JP)
- **KUWAHARA, Yasuaki**
  Yao-shi Osaka 581-0801 (JP)
- **MORIKAWA, Mamoru**
  Yamatokoriyama-shi, Nara 639-1024 (JP)

(74) Representative: **Brown, Kenneth Richard et al**
R.G.C. Jenkins & Co.
26 Caxton Street
London SW1H 0RJ (GB)

(54) LIQUID FUEL COMBUSTION DEVICE

(57) A liquid fuel burning apparatus comprising: a fuel supply tank(6) detachably mounted into the main body; a burner unit (B) having a vaporizer(B1) for vaporizing fuel by heating and a burner (B2) for burning the vaporized fuel; and an oil feed pump(EP) for sending fuel from the fuel supply tank to the vaporizer, further includes an oil feed joint (9) provided on the fuel supply tank side and an oil feed joint socket(10) provided on the main body side for detachably receiving the oil feed joint, in order to create connection of an oil feed passage from the fuel supply tank to the burner unit when the fuel supply tank is mounted to the main body while no container for temporarily holding fuel under the fuel supply tank is used.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to space heaters such as kerosene fan heaters and the like.

Background Art

[0002] Kerosene fan heaters have been widely used in typical homes as a space heater during the winter. Fig.119 is a partly abbreviated front sectional view schematically showing an example of a conventional kerosene fan heater. Fig.120 is a sectional side view of the same type. Fig.121 is a sectional view showing a filler cap and a socket of a fuel supply tank.

[0003] As shown in Fig.119, a kerosene fan heater body 101 incorporates a fuel supply tank 102 for being previously filled with a liquid fuel 104 such as kerosene as reserve fuel, at one side therein, so that an ample amount of liquid fuel 104 will be supplied to a fuel tank 103 connected under the fuel supply tank 102.

[0004] Liquid fuel 104 held in the fuel tank 103 is led by a fuel pressure-feed electromagnetic pump 105 to a vaporizer 107 by way of an oil feed pipe 106. The thus fed liquid fuel 104 is vaporized by a vaporizer heater (not shown) provided for vaporizer 107. Designated at 109 is a combustion chamber, which supports and fixes a burner 108 at the bottom of thereof.

[0005] The fuel vaporized through the vaporizer 107 is intensely jetted from a nozzle and led together with combustion air into the burner 108 and burns at a flame port 108a, whereby air inside combustion chamber 109 is heated. As indicated by the arrows in Fig.120, air is suctioned through a filter 112 from the room by a blower fan 111 attached to a fan motor 110 of a single-phase induction motor or the like arranged at the rear side of main body 101 and blown out together with the heated air and combustion gas inside combustion chamber 109, as warm air through an air outlet 113 to the room.

[0006] A flame sensor 114, arranged slightly above flame port 108a, 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 the fan motor 110 so that blower fan 111 starts rotating, whereby air sucked from the room is blown out as warm air through air outlet 113 to the room. At the same time, the room temperature is sensed by a room temperature thermistor 115, and based on the temperature difference between the room temperature and a set temperature, a controller (not shown) controls the drive of the fuel pressure-feed electromagnetic pump 105 (see Fig. 119), whereby the amount of liquid fuel 104 supplied to vaporizer 107 is regulated to control the power of the burning flame at burner 108.

[0007] For example, when a kerosene fan heater starts its operation when the room temperature is low, a large amount of liquid fuel 104 is supplied to vaporizer 107 so as to quickly raise the room temperature to the set level and thereafter the supplied amount of liquid fuel 104 is regulated so as to maintain the temperature at about the preset level.

[0008] As shown in Fig.121, fuel supply tank 102 is refueled by taking out fuel supply tank 102 from main body 101 and turning it upside down, removing a filler cap 116 having a valve element of fuel supply tank 102, charging fuel through a mouth 117, confirming the correct supply of fuel into fuel supply tank 102, then fixing filler cap 116 to the threaded portion of mouth 117, turning the tank upside down so that filler cap 116 is downside and inserting it into main body 101, and placing it on fuel tank 103 so that filler cap 116 fits into a socket 118 attached to the top face of fuel tank 103.

[0009] 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 its 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.

[0010] 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 or 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.

[0011] When fuel is supplied into the fuel tank, fuel is delivered into the fuel tank 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.

[0012] Further, to clean impurities in the vaporizer by baking, requires the tedious work of taking out the fuel supply tank from the main body and removing the remaining oil in the bottom of the fuel tank under the fuel supply tank using a pump etc., resulting dissatisfaction.

[0013] In view of the above problems, it is therefore an object of the present invention to provide a liquid fuel burning apparatus which allows refueling the fuel supply tank without turning the tank upside down and without any staining of the hands with fuel and which permits cleaning of the vaporizer by baking without the necessity of clearing fuel.

Disclosure of Invention

[0014] The present invention resides in a liquid fuel burning apparatus which comprises: a fuel supply tank detachably mounted into a main body of the liquid fuel

burning apparatus; 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 first joining portion for creating connection of oil feed passage from the fuel supply tank to the burner unit when the fuel supply tank is mounted to the main body, and is characterized in that the first joining portion comprises an oil feed joint provided on the fuel supply tank side and an oil feed joint socket provided on the main body side for detachably receiving the oil feed joint. This arrangement makes it possible to directly feed fuel from the fuel supply tank to the burner unit without providing any fuel tank for temporarily holding fuel which is conventionally disposed under the fuel supply tank. Thereby, the oil feed passage can be constituted of a reduced number of parts while the fuel supply tank can be made to be easy to handle without the necessity of turning the fuel supply tank upside down when the tank is refueled.

[0015] When the apparatus further includes a second joining portion for creating connection of return oil passage from the burner unit to the fuel supply tank and is configured so that the second joining portion comprises a return oil joint provided on the fuel supply tank side and a return oil joint socket provided on the main body side for detachably receiving the return oil joint, fuel can be returned to the fuel supply tank.

[0016] When the oil feed joint, or the oil feed joint, oil feed joint socket and return oil joint each incorporate a valve mechanism for opening and closing oil feed passage, it is possible to secure reliable oil feed to the burner unit.

[0017] Further, provision of a shutoff valve for shutting off fuel supply from the fuel supply tank to the burner unit, within the oil feed passage makes it possible to positively shut off fuel supply in accordance with shutoff valve control. The shutoff valve comprises an air valve which leads air into the oil feed passage so as to shut off fuel supply from the fuel supply tank to the burner unit.

[0018] Further, the path in the oil feed joint connected to the suction path inside the fuel supply tank is arranged above the liquid level of fuel in the fuel supply tank. This arrangement makes it possible to avoid the fuel spilling out even when the fuel supply tank is filled up with fuel.

[0019] The fuel path connecting the fuel supply tank and the oil feed pump is formed by an inverted U-shaped upturned path and the top end of the upturned path is located above the liquid level of fuel in the fuel supply tank. This arrangement makes it possible to avoid the fuel spilling out even when the fuel supply tank is filled up with fuel.

[0020] The upturned path is formed on the main body side while the shutoff valve is arranged at the top end of the upturned path. Therefore, this arrangement makes it possible to avoid the fuel spilling out even when the fuel supply tank is filled up with fuel.

[0021] The exit of the fuel path of the return oil joint on the fuel supply tank side is arranged above the liquid level of fuel in the fuel supply tank, or the exit of the fuel path of the return oil joint is upturned so that it is positioned above the liquid level of fuel in the fuel supply tank. Either of the above arrangement makes it possible to avoid the fuel spilling out even when the fuel supply tank is filled up with fuel.

[0022] The air intake port of the air valve is arranged above the liquid level of fuel in the fuel supply tank. This arrangement makes it possible to avoid the fuel spilling out even when the fuel supply tank is filled up with fuel.

[0023] Further, provision of an air hole on the top face of the fuel supply tank makes it possible to avoid increase the pressure in the fuel supply tank due to a temperature rise. Provision of a shutoff mechanism for closing the air hole when the tank falls down makes it possible to prevent fuel leakage from the air hole when the tank falls down.

[0024] Setting the inside diameter of the return oil passage so as to be greater than the inner diameter of the oil feed passage, makes it possible to quickly return the fuel inside the pipe to the fuel supply tank.

[0025] When insertion of the fuel supply tank into the main body is permitted only in such a way that the tank is oriented to one determined direction, this makes it possible to prevent other parts from being damaged when the fuel supply tank is inserted.

[0026] The oil feed joint and the return oil joint on the fuel supply tank side are integrated into a fuel supply tank side joint unit while the oil feed joint socket and the return oil joint socket on the main body side are integrated into a main body side joint socket unit. This arrangement makes the first and second joining means compact and enables them to be assembled by fewer steps.

[0027] The position and placement of this joint unit on the fuel supply tank side is not particularly limited as long as it is arranged in the upper part of the fuel supply tank. However, in the case where the joint unit is adapted to be connected to the joint socket unit on the burner unit side when the fuel supply tank is inserted from the top of the main body into the tank holding compartment, no functional parts can be laid out under the oil feed joint unit.

[0028] Therefore, the oil feed joint unit is, in effect, projected from the exterior of the fuel supply tank, so that the fuel supply tank has a large projection area. Generally, the fuel supply tank is formed by joining a U-shaped tank part, when viewed from top and a flat sheet tank part. Therefore, in order to reduce the projection area of the fuel supply tank, it is preferred that part of the inverted U-shaped tank part, on its side opposite to the joint-forming face of the fuel supply tank, is depressed inwards so as to allow the placement of the joint unit in the thus formed depressed portion.

[0029] It is necessary to connect the pipe for the suction path from the fuel supply tank and the return pipe for returning fuel into the tank. Means for positioning and connecting these pipes entering the fuel supply tank

may be provided in the joint unit, so that the pipes can be positioned easily without the necessity of a special jig.

[0030] In this case, the pipes may be fixed to the fuel supply tank side joint unit by the fastening means of the pipes in the fuel supply tank, so that connecting work of the pipes can be simply performed needing a smaller work space.

[0031] The main body side joint socket unit has a shutoff valve for shutting off fuel supply from the fuel supply tank to the burner unit and a protective cover for protecting the shutoff valve while the fuel supply tank side joint unit has a cushioning cover for protection against impacts so that, when the fuel supply tank is inserted into the main body, the two covers serve as tank insertion guides. Thus, the covers can provide both the protecting function and the function of insert guidance when fuel supply tank is inserted.

[0032] When, in order to detect water in the fuel supply tank, the apparatus includes a water detecting portion having a first electrode in contact with a water receptacle provided at the bottom of the fuel supply tank and a second electrode in contact with the fuel supply tank, and at least one of the electrodes is fixed at a point on the detector board and supported in a cantilevered manner on a fulcrum other the fixed point, it is possible to disperse the stresses acting on the electrodes.

[0033] It is possible to cool the return oil from the vaporizer, by providing a fuel container for ICHIJITEKINI holding fuel or a cooling portion for cooling fuel, within the return oil passage from the burner unit to the second joining portion.

[0034] Further, to mention the shape of the fuel supply tank, the first joining portion and/or the second joining portion on the fuel supply tank side to be used when the fuel supply tank is mounted into the main body is adapted to be positioned within the ridge-based contour in the top view of the fuel supply tank, it is possible to prevent the joining portions from being damaged if, for example, the tank falls down during its carriage. In the case where these joining portions are formed with an impact protecting means, it is preferred that the structure including the impact protecting means is laid out within the ridge-based contour in the top view of the fuel supply tank.

[0035] Here, the arrangement of the joining portions and the like within the ridge-based contour in the top view of the fuel supply tank means, for example, that an approximately triangular or rectangular space is formed within the ridge-based contour in the top view of the fuel supply tank, by setting back the outer shape of the fuel supply tank from the ridgeline formed by the intersection of two adjoining sides, toward the tank center, so that the joining portions and the like are arranged within this space. Alternatively, this means that a depressed portion is formed within the ridge-based contour in the top view of the fuel supply tank, by setting back the outer shape of the fuel supply tank from one side face thereof toward the tank center, so that joining portions and the like are arranged within this depressed portion.

[0036] The above joining portions and the like also include air valves and other parts which are provided for the fuel supply tank, and all these parts are preferably configured so as to be arranged within the ridge-based contour in the top view of the tank.

[0037] Provision of a fixture for fixing the suction passage of fuel toward the oil feed pump inside the fuel supply tank, makes it possible to prevent the suction passage from interfering with the inner wall of the oil feed pump during carriage and hence avoid damage to both.

[0038] The arrangement of the first joining portion and/or the second joining portion above the liquid surface of the fuel in the fuel supply tank will prevent the fuel in the fuel supply tank from spilling out.

[0039] Provision of a suction pipe for suctioning the fuel to be sent to the oil feed pump and positioning of the suction port of the suction pipe for suctioning fuel near the bottom of the fuel supply tank make efficient suction of fuel possible.

[0040] Provision of guide members, which can come into contact with and separate from each other, on the fuel supply tank side and on the burner unit side, in the first joining portion and the second joining portion, makes the connection of the tank to the main body smooth.

[0041] Specifically, according to the present invention, while no fuel tank for temporarily holding fuel is arranged under the fuel supply tank, fuel is directly supplied from the fuel supply tank to the burner so that the oil feed passage can be constituted by fewer components and the fuel supply tank can be handled easily. Further, since the tank has the joining means for joining itself to the oil feed passage reaching the burner unit, there is no necessity to turn the fuel supply tank upside down when the tank is refueled.

[0042] Concerning the burning system in this case, any of burning systems defined in JIS S3030, including pot type, pressure spraying type, rotary atomizing type, jet spraying type and vaporizing type can be used. The pot type indicates a means that evaporates fuel using a vaporizing pot, wherein the vaporizer for evaporating fuel by heating and the burner for burning the vaporized fuel are formed integrally. The pressure spraying type indicates a means that pressurizes fuel into a spray to burn it by evaporation, wherein the vaporizer and the burner are formed integrally. The rotary atomizing type indicates a means that atomizes fuel by centrifugal force to burn it by evaporation. The jet spraying type indicates a means that atomizes fuel by air jet to burn it by evaporation, wherein the vaporizer and burner are formed integrally. The vaporizing type indicates a means that evaporates fuel in a vaporizing compartment or vaporizer, wherein the vaporizer and burner are formed separately.

[0043] Among these, the pot type, pressure spraying type, rotary atomizing type and jet spraying type burning systems, which all have the vaporizer and burner inte-

grated, are preferably used. That is, the liquid fuel burning apparatus includes a fuel supply tank detachably mounted into the apparatus body, a burner unit integrally having a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel, and an oil feed pump for sending fuel from the fuel supply tank to the vaporizer. The fuel in the fuel supply tank is adapted to be directly fed to the burner unit, instead of providing a fuel tank for temporarily holding the fuel under the fuel supply tank.

[0044] Since the liquid fuel burning apparatus of the above direct oil feed types do not temporarily hold fuel in the fuel tank, which has been used conventionally, it is preferred that a shutoff valve for shutting off fuel supply is provided in the oil feed passage from the fuel supply tank to the burner unit so as to positively shut off fuel supply to the burner unit.

[0045] Since the burning system having a vaporizer and burner integrated does not need to return fuel from the vaporizer, provision of a joining means for connection with the fuel supply tank within the oil feed passage reaching to the burner works well enough. This joining means can be represented by a configuration made up of an oil feed joint on the fuel supply tank side and an oil feed joint socket on the burner unit side. Further, a valve mechanism which is adapted to open its valve when the fuel supply tank is mounted to the main body and close when the fuel supply tank is removed from the main body may be provided for the oil feed joint. This arrangement makes it possible to eliminate the risk of fuel leaking from the fuel supply tank when the tank is removed and also reliably open the oil feed passage when the tank is mounted.

[0046] This shutoff valve may be arranged in the oil feed passage, either at a position halfway along the path from the fuel supply tank to the oil feed pump, or at a position halfway along the path from the oil feed pump to the burner unit. Further, the shutoff valve may have any configuration as long as it provides the function of shutting off the oil feed passage. For example, an electromagnetic valve or an air valve may be used. Use of an electromagnetic valve integrated with an oil feed pump made of an electromagnetic pump or the like, also makes it possible to achieve space-saving and simplification of the forming step when the oil feed passage is joined.

[0047] The air valve is provided to take air into the oil feed passage so as to shut off fuel supply, and can be disposed at an appropriate position in the oil feed passage. However, if the air valve is combined with the oil feed joint socket of the joining means, it is possible to simplify the pipe joining step, compared to the case where the valve is laid out at other positions. Further, the air valve is preferably disposed at a position higher than the maximum liquid level of fuel in the tank, in order to prevent fuel from leaking through the air valve when the fuel supply tank is full.

[0048] The oil feed pump may be disposed at an appropriate position in the oil feed passage, for example, at a position closer to the burner unit side than the joint means is, or at a position closer to the fuel supply tank side than the joint means is.

[0049] The suctioning path for suctioning fuel from the fuel supply tank to the oil feed pump needs to be long enough to almost reach the bottom of the fuel supply tank, a fixing means may be provided inside the fuel supply tank so that the path will not move.

[0050] Further, since the fuel supply tank is configured so that fuel is charged without the necessity of turning the tank upside down, the filler port through which fuel is charged as well as a filler cap for closing the filler port, is preferably arranged at the top of the fuel supply tank. It is more preferable that a valve mechanism for releasing the pressure inside the tank is provided for the filler cap, so that no fuel will spill out due to increase in pressure inside the tank, which is caused by difference in temperature between the interior and exterior of the tank.

[0051] Specifically, the aspect of the present invention resides in a liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted into the main body; a vaporizer for vaporizing fuel by heating; an electromagnetic pump for sending fuel from the fuel supply tank; and a burner for burning the vaporized fuel, without having any receptacle for temporarily holding fuel under the fuel supply tank.

[0052] Another aspect resides in a liquid fuel burning apparatus comprising: a filler port through which fuel is charged into the fuel supply tank; a filler cap for closing the filler port; and a joining means that is to be connected to the suction passage of fuel to the electromagnetic pump when the fuel supply tank is mounted to the main body, whereby the joining means creates a fuel passage from the fuel supply tank to the vaporizer by way of the electromagnetic pump.

[0053] A feature resides in a liquid fuel burning apparatus which is characterized in that an air valve is disposed at a position halfway along the passage from the fuel supply tank to the electromagnetic pump.

[0054] A feature resides in a liquid fuel burning apparatus which is characterized in that a valve mechanism for shutting off the flow of fuel is provided for the joining means to be connected to the suction passage of fuel of the electromagnetic pump when the fuel supply tank is mounted to the main body.

[0055] A feature resides in a liquid fuel burning apparatus, comprising a joining means for connecting the vaporizer to the fuel supply tank, wherein a fuel return passage from the vaporizer to the fuel supply tank is created by the joining means.

[0056] A feature resides in a liquid fuel burning apparatus, comprising a joining means for connecting the vaporizer to the fuel supply tank and a valve mechanism for shutting off the flow of fuel, from the vaporizer to the fuel supply tank, created by the joining means.

[0057] A feature resides in a liquid fuel burning appa-

ratus, comprising a heat pump in the form of a receptacle for temporarily holding fuel, arranged at a position halfway along the return passage of fuel from the vaporizer to the fuel supply tank.

[0058] A feature resides in a liquid fuel burning apparatus which is characterized in that a filler cap which provides both the function of a valve mechanism for releasing pressure and the lid function is provided for the fuel supply tank.

[0059] A feature resides in a liquid fuel burning apparatus which is characterized in that a filler cap which provides both the function of a valve mechanism for releasing pressure and the lid function is provided for the fuel supply tank.

[0060] A feature resides in a liquid fuel burning apparatus wherein the fuel supply joint of the joining means is positioned above the liquid surface of fuel in the fuel supply tank.

[0061] A feature resides in a liquid fuel burning apparatus which is characterized in that a passage that communicates with the oil feed joint of the joining means is provided inside the fuel supply tank and a filter for dust removal is provided at the front end of the passage.

[0062] A feature resides in a liquid fuel burning apparatus which is characterized in that cleaning of impurities built up in the vaporizer is performed by baking the vaporizer with the air valve set open when the apparatus is not in operation.

[0063] A feature resides in a TAI fuel burning apparatus, comprising a means for cooling the fuel inside the fuel passage, arranged at a position halfway along the passage from the vaporizer to the heat pump.

[0064] 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.

[0065] The fuel supply tank in this case is provided with a filler port provided on the top for refueling, a filler cap for closing this filler port and a first joining means that is joined to the suction passage of fuel towards the oil feed pump when the fuel supply tank is mounted into the body and the tank is constructed such that an oil feed passage from the fuel supply tank to the vaporizer by way of the oil feed pump is completed by this joining means. This arrangement makes it possible for the fuel supply tank to be refueled and be inserted into the main body, without the necessity of turning the fuel supply tank upside down.

[0066] This first joining means is constructed of an oil feed joint on the fuel supply tank side and an oil feed joint socket on the burner unit side for detachably receiving the oil feed joint. When a valve mechanism which opens its valve when the fuel supply tank is mounted to the main body and closes when the fuel supply tank is taken out from the main body, is provided for the oil feed joint, it is possible to prevent fuel from leaking when the tank is taken from the main body. It is also possible to provide a configuration in which a similar valve mechanism is provided in the oil feed joint socket so that both valves will open when the tank is mounted to the main body.

[0067] Further, when a second joining means is provided for connection from the vaporizer to the fuel supply tank and a return oil passage of fuel from the vaporizer to the fuel supply tank is created through this second joining means, it is possible to return unburned gas from the vaporizer to the fuel supply tank.

[0068] This second joining means is constructed of a return oil joint on the fuel supply tank side and an return oil joint socket on the burner unit side for detachably receiving the return oil joint. When a valve mechanism which opens its valve when the fuel supply tank is mounted to the main body and closes when the fuel supply tank is taken out from the main body, is provided for the return oil joint, it is possible, in the same manner as the first joining means, to prevent fuel from leaking when the tank is taken from the main body. It is of course possible to provide a configuration in which a similar valve mechanism is provided in the return oil joint socket so that both valves will open when the tank is mounted to the main body.

[0069] Further, it is also possible to provide an impact protecting means for reducing impacts against the first joining means and/or second joining means so as to protect these joining means from impacts.

[0070] Furthermore, the first joining means and second joining means may be arranged above the liquid surface of the fuel in the fuel supply tank, so that it is possible to prevent fuel from spilling out when the tank is full.

[0071] It is also possible to provide a configuration which can positively shut off fuel supply by arranging a means for shutting off fuel supply at a position halfway along the oil feed passage from the fuel supply tank to the oil feed tank. As an example of this shutoff means, an electromagnetic valve and air valve can be used. An air valve is to take in air for shutting off fuel supply, and its position is not particularly limited. However, it is preferred that the air valve is arranged in the oil feed joint socket in the first joining means. As to this air valve, if the valve is arranged above the liquid surface of the fuel when the fuel supply tank is full, it is possible to prevent fuel from spilling out.

[0072] Further, when a pressure valve mechanism for adjusting the pressure inside the fuel supply tank is provided for the second joining means, it is possible to reduce the internal pressure in the tank and hence prevent fuel from spilling from the tank. When the pressure valve mechanism is configured so that it opens its valve when the fuel supply tank is inserted into the main body and connected thereto and opens its valve when the fuel supply tank is taken out from the main body, it is possible to adjust the internal pressure of the tank by automatically opening the valve upon insertion of the tank to the

main body while the mechanism automatically closes its valve when the tank is taken out from the main body. In this way, it is possible to prevent fuel leakage from the tank.

[0073] In connection with this, a means for fixing the suction passage from the fuel supply tank to the oil feed pump to the fuel supply tank interior may be provided so that the suction passage will not move.

[0074] Also, in the present invention, the apparatus includes a fuel supply tank for storing fuel, detachably mounted in the main body and a burner unit for burning fuel by heating. While no fuel tank for temporarily holding fuel is provided under the fuel supply tank, fuel in the fuel supply tank is directly fed to an oil feed pump which sends it to the burner unit, whereby the fuel passage is constructed by fewer components and the fuel supply tank can be easily handled.

[0075] A first joining means for creating a suctioning passage for sending fuel from the fuel supply tank to the oil feed pump when the fuel supply tank is mounted to the apparatus body is provided between the fuel supply tank to the oil feed pump, so as to eliminate the necessity of turning the fuel supply tank upside down when it is refueled. When an air valve is provided at a position halfway along the passage between this fuel supply tank and oil feed pump, the fuel path between the fuel supply tank and the oil feed pump is shut off by the function of the air valve. Further, a means for fixing the suctioning passage of fuel to the oil feed pump, inside the fuel supply tank may be provided so that the suctioning passage will not move inside the tank or will not be deformed therein.

[0076] An example of a burner unit is configured of a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel through this vaporizer. In this burning system using a vaporizer, no fuel leakage will take place from the fuel supply tank to the oil feed pump when a passage for returning fuel from the vaporizer to the fuel supply tank is formed while a second joining means connected to this passage is provided in the fuel supply tank. Further, when a heat pump for temporarily holding fuel or a cooling means for cooling the fuel within the passage is provided for this return passage, it is possible to cool and liquefy the fuel returned from the vaporizer.

[0077] Further, when the first joining means and second joining means are provided with valve mechanisms which shut off the flow of fuel when the fuel supply tank is removed from the apparatus body, no fuel will leak from the joining means of the fuel supply tank. It is also possible to integrate the first joining means and second joining means into a uni-body structure so as to reduce the size and the number of parts. It is also possible to provide means for reducing impacts so as to enclose the first joining means and second joining means.

[0078] Moreover, when the first joining means and/or the second joining means is arranged above the liquid surface of the fuel in the fuel supply tank, no fuel will spill out from the fuel supply tank. When guide members which can come into contact with and separate from each other are provided on both the fuel supply tank side and on the apparatus side, in the first joining means and the second joining means, the tank can be smoothly connected to the receiver side joining means on the main body.

[0079] A suction pipe for suctioning fuel to be sent to the oil feed pump is provided for the fuel supply tank. Positioning of the suction port of the suction pipe for suctioning fuel near the bottom in the fuel supply tank improves suction of fuel into the suction pipe. Further, provision of a filter for dust removal in the suction port of the suction pipe for suctioning fuel prevents suction of dust and dirt into the suction pipe.

[0080] The filler cap for closing the filler port through which fuel is charged into the fuel supply tank is adapted to have a valve mechanism for relieving air pressure in the fuel supply tank, whereby it is possible to eliminate the risk of fuel leakage due to a pressure rise or expansion of air caused by difference in temperature of the fuel supply tank.

[0081] The liquid fuel burning apparatus has the function of cleaning by baking, i.e., cleaning the vaporizer by baking impurities built up in the vaporizer by opening the air valve to send air, in place of fuel, to the vaporizer while no combustion is in operation. This function makes it possible to perform cleaning without removal of the fuel.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] An example of fuel quantity detecting means may be comprised of a float incorporating a magnet, disposed 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.

[0086] 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.

[0087] 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.

[0088] 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.

[0089] 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 between fuel and water collected between them. In this case, it is possible to improve the precision of water detection by forming needle portions of a narrow sharpened tip along part of the hole on the tank side to which water receptacle is attached so that these portions can function as the tank side front electrodes and also 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.

[0090] 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.

[0091] 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.

[0092] Further, a liquid fuel burning apparatus according to the present invention includes: a fuel supply tank detachably mounted into the main body; a burner unit having a vaporizer for vaporizing fuel by heating and a burner for burning the vaporized fuel; and an oil feed pump for sending fuel from the fuel supply tank to the vaporizer. In this apparatus, a first joining portion for connecting the fuel supply tank to an oil feed passage reaching the burner unit when the fuel supply tank is mounted to the main body is provided, without having any fuel tank for temporarily holding fuel under the fuel supply tank, so as to directly send fuel from the fuel supply tank to the burner unit.

[0093] In accordance with this configuration, it is possible to charge fuel into the fuel supply tank without turning the fuel supply tank upside down when the tank is refueled. Further, omission of the fuel tank makes it possible to enlarge the fuel supply tank by the volume equivalent to that of the fuel tank or reduce the size of the main body.

[0094] In addition to the above configuration, when the apparatus further includes a second joining portion for connecting the fuel supply tank to the return oil passage from the burner unit when the fuel supply tank is mounted to the main body, it is possible to return the fuel from the vaporizer to the fuel supply tank. In this case, setting the inside diameter of the pipe of the return oil passage to be greater than the inner diameter of the pipe of the oil feed passage, makes it possible to quickly return the fuel inside the pipe to the fuel supply tank.

[0095] When there are two paths, i.e., the oil feed passage and the return oil passages, for instance the first joining means may be constructed of an oil feed joint on the fuel supply tank side and an oil feed joint socket on the burner unit side for detachably receiving the former while the second joining means may be constructed of a return oil joint on the fuel supply tank side and a return oil joint socket on the burner unit side for detachably receiving the former.

[0096] The oil feed joint and the return oil joint on the fuel supply tank side may be integrated into a fuel supply tank side joint unit while the oil feed joint socket and the return oil joint socket on burner unit side may be inte-

grated into a burner unit side joint socket unit. This arrangement makes the joint unit and the joint socket unit compact and enables them to be assembled by fewer steps.

[0097] The position and placement of the joint unit on the fuel supply tank side is not particularly limited as long as it is arranged in the upper part of the fuel supply tank. However, in the case where the joint unit is adapted to be connected to the joint socket unit on the burner unit side when the fuel supply tank is inserted from the top of the main body into the tank holding compartment, no functional parts can be laid out under the oil feed joint unit.

[0098] Therefore, the oil feed joint unit is, in effect, projected from the exterior of the fuel supply tank, so that the fuel supply tank has a large projection area. Generally, the fuel supply tank is formed by joining a U-shaped tank part, when viewed from top and a flat sheet tank part. Therefore, in order to reduce the projection area of the fuel supply tank, it is preferred that part of the inverted U-shaped tank part, on its side opposite to the joint-forming face of the fuel supply tank, is depressed inwards so as to allow the placement of the joint unit in the thus formed depressed portion.

[0099] It is necessary to connect the pipe for the suction path from the fuel supply tank and the return pipe for returning fuel into the tank. Means for positioning and connecting these pipes entering the fuel supply tank may be provided in the joint unit, so that the pipes can be positioned easily without the necessity of a special jig.

[0100] In this case, the pipes may be fixed to the fuel supply tank side joint unit by the fastening means of the pipes in the fuel supply tank, so that connecting work of the pipes can be simply performed needing a smaller work space.

[0101] On the other hand, an oil feed pump is provided between the burner unit and the joint socket unit on the burner unit side. This oil feed pump may be fixed to the same member as, and approximately flush with, the joint socket unit on the burner unit side. This arrangement allows both the components to be easily assembled and inspected and managed as to dimensions.

[0102] Here, since an oil feed system to directly send fuel from the fuel supply tank to the burner unit is adopted, it is preferred that fuel is definitely shut off at the joint unit and the joint socket unit when the fuel supply tank is taken out. To achieve this, valve mechanisms may be included in the oil feed joint and return oil joint in the fuel supply tank side joint unit and valve mechanisms may be included in the burner unit side joint socket unit, so as to prevent fuel leakage from the oil feed passage and the return oil passage.

[0103] In this case, in the burner unit side joint socket unit, both the oil feed joint socket and the return oil joint socket may include a valve mechanism, or when an oil feed pump or a shutoff valve for shutting off fuel supply is present near the oil feed joint socket, only the return oil joint socket may include a valve mechanism without providing any valve element for the oil feed joint socket. Either of these configurations may be adopted.

[0104] When the valve mechanism is assembled into the fuel passage of the connecting joint unit or its joint socket unit, an opening into which the valve mechanism is fitted and a closing element (valve cap) for shutting off the opening should be provided. This closing element may be screw fitted to the opening or the valve element may be confined by another fixing element so that the valve element will not come off. As another configuration, since the connecting joint unit and its joint socket unit are fixed to the fuel supply tank and burner unit by a fixing means, this fixing means may be used to hold the valve element so that it will not come off. Use of this configuration has the advantages that no threading or no fixing element is needed and assembly can be simplified. This retention of the closing element using the fixing means may be used for either or both of the connecting joint unit and its joint socket unit.

[0105] Also, it is preferred that a shutoff valve for shutting off fuel supply from the fuel supply tank to the burner unit is provided at a position halfway along the oil feed path so that fuel will not be accidentally fed to the burner unit side. As this shutoff valve, either a valve mechanism that directly shuts off the oil feed passage or a valve mechanism that uses an air valve to release the oil feed passage to the atmosphere may be adopted. However, in view of the mechanical requirements, the configuration using an air valve is preferable.

[0106] In order to positively prevent fuel leakage from the oil feed passage, it is effective that the passage of the oil feed joint connected to the suction path in the fuel supply tank is positioned above the liquid level of fuel in the fuel supply tank, and that the air intake port of the air valve is positioned above the liquid level of fuel in the fuel supply tank.

[0107] Further, the fuel passage connecting between the fuel supply tank and the oil feed pump may be upturned in a U-shape and the top end of the passage may be positioned above the liquid level of fuel in the fuel supply tank. This arrangement makes it possible to prevent the fuel in the fuel supply tank from being accidentally delivered to the oil feed pump side.

[0108] This upturned passage can be disposed at an appropriate position along the pipe on the burner unit side. But when this may be formed in the joint socket unit on the burner unit side with a shutoff valve arranged at the top end of the path of the upturned passage, the space for curving the pipe becomes unnecessary, so that it is possible to reliably shut off fuel supply by the compact joint socket.

[0109] On the other hand, in order to prevent backward flow through the return oil passage due to a rise of the surface level of fuel in the fuel supply tank, caused by a temperature rise, it is preferred that the fuel passage of the return oil joint on the fuel supply tank side and the pipe exit on the fuel supply tank side are posi-

tioned above the liquid level of fuel in the fuel supply tank. As a specific configuration, the fuel supply tank side pipe exit of the return oil joint can be upturned so that it is located above the liquid level of fuel in the fuel supply tank.

[0110] Moreover, in order to avoid a fuel level rise due to a negative pressure inside the tank, an air hole is formed on the top face of the fuel supply tank. However, since there is a risk of fuel flowing out through the air hole when the tank falls down, a means for shutting off this air hole should be preferably provided so as to positively prevent fuel leakage.

[0111] When insertion of the fuel supply tank into the main body is permitted only when the tank is oriented to one determined direction, this makes it possible to prevent other parts from being damaged when the fuel supply tank is inserted.

[0112] With regards to the insertion of this fuel supply tank into the main body, a protecting cover for protecting the valve element integrally fixed to the joint socket on the burner unit side and an impact protecting cover for reducing impacts against the joint unit on the fuel supply tank side may be provided in such a manner that these two covers can be used as tank insertion guides. Thus it is possible to make the covers provide both the protecting function and the function of insert guidance when fuel supply tank is inserted.

[0113] When, in order to detect water in the fuel supply tank, the apparatus includes a water detecting portion having a first electrode in contact with a water receptacle provided at the bottom of the fuel supply tank and a second electrode in contact with the fuel supply tank, and at least one of the electrodes is fixed at a point on the detector board and supported to sway in a cantilevered manner on a fulcrum other the fixed point, it is possible to disperse the stresses acting on the electrodes.

Brief Description of Drawings

[0114]

Fig.1 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 1 of the first embodiment of the present invention;
Fig.2 is a partially sectional, front view showing a fuel supply tank;
Fig.3 is a sectional view showing a joining means of the same;
Fig.4 is a sectional view showing a fixing structure of the lower end of a suction pipe;
Fig.5 is a sectional view showing a filler cap with a built-in pressure valve for a fuel supply tank;
Fig.6 is a sectional view showing an integrated state of an electromagnetic pump and an electromagnetic valve;
Fig.7 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 2 of the first embodiment of the present invention;
Fig.8 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 3 of the first embodiment of the present invention;
Fig.9 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 4 of the first embodiment of the present invention;
Fig.10 is a sectional view showing an oil feed joint socket of the same;
Fig.11 is a structural sectional view showing an air valve of the same;
Fig.12 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 5 of the first embodiment of the present invention;
Fig.13 is a front, partly sectional view showing a kerosene fan heater in accordance with the second embodiment of the present invention;
Fig.14 is an outline view showing the liquid fuel burning apparatus of Fig.13;
Fig.15 is an outline view showing a fuel supply tank of Fig.14;
Fig.16 is a structural view showing attachment of an oil feed joint-in and oil feed joint-out of the fuel supply tank of Fig.14;
Fig.17 is a structural view showing the oil feed joint-in of Fig.14;
Fig.18 is a structural view showing suction pipes in the oil feed joint-in and fuel supply tank of Fig.14;
Fig.19 is a structural view showing the oil feed joint-out of Fig.14;
Fig.20 is a structural view showing an oil feed joint-out and fuel supply tank of Fig.14;
Fig.21 is a structural view showing a filler cap with a built-in pressure valve for the fuel supply tank of Fig.15;
Fig.22 is a structural view showing an oil feed joint-in socket and air valve of Fig.14;
Fig.23 is a structural view showing an oil feed joint-out socket of Fig.14;
Fig.24 is a structural view showing a burner and a vaporizer of Fig.14;
Fig.25 is a structural view showing a heat pump of Fig.14;
Fig.26 is a structural view showing a cooling fin assembly of Fig.14;
Fig.27 (a) is a view showing an oil feed joint-in and an oil feed joint-in socket with its air valve abbreviated in the inserted state of a fuel supply 1 tank of Fig.14, and (b) is a front view of a socket portion 61;
Fig.28 is a view showing an oil feed joint-out and an oil feed joint-out socket in the inserted state of a fuel supply 1 tank of Fig.14;
Fig.29 is a front, partly sectional view showing a ker-

osene fan heater in accordance with an example 1 of the third embodiment of the present invention;
Fig.30 is a structural view showing the same liquid fuel burning apparatus;
Fig.31 is an outline view showing a fuel supply tank of the same;
Fig.32 is a perspective view showing joining portions of the fuel supply tank of the same;
Fig.33 is a sectional view showing the structure of an oil feed joint of the same;
Fig.34 is a sectional view showing the structure of a return oil joint of the same;
Fig.35 is a sectional view showing the structure of an oil feed side joining means of the same;
Fig.36 is a sectional view showing the structure of an oil feed joint socket portion;
Fig.37 is a sectional view showing the structure of a return oil side joining means of the same;
Fig.38 is a plan view showing a joining means according to an example 2 of the third embodiment of the present invention;
Fig.39 is a front view of the same;
Fig.40 is a sectional view showing an oil feed joint side;
Fig.41 is a sectional view showing a return oil joint side;
Fig.42 is a sectional view showing a joint socket side;
Fig.43 is a front view of the same;
Fig.44 is a front, partly sectional view showing a kerosene fan heater in accordance with an example 1 of the fourth embodiment of the present invention;
Fig.45 is a structural view showing the operation of the same;
Fig.46 is a partly sectional view of a fuel supply tank of the same;
Fig.47 is a view cut along a plane B-B in Fig.46;
Fig.48 a partly sectional view showing a suction port of a fuel supply tank;
Fig.49 is a sectional view showing a filler cap with a pressure valve for a fuel supply tank;
Fig.50 is a sectional view showing an oil feed joint-in socket, oil feed joint-out socket and air valve;
Fig.51 is a sectional view showing an air valve;
Fig.52 is a view for explaining insertion of an oil feed joint-in of a fuel supply tank into an oil feed joint-in socket;
Fig.53 is a sectional view cut along a plane A-A in Fig.44;
Fig.54 is a top view of Fig.53;
Fig.55 is a view for illustrating a state where an oil feed joint-in of a fuel supply tank is about to fit into an oil feed joint-in socket;
Fig.56 is a view for illustrating a state where an oil feed joint-in of a fuel supply tank has fitted into an oil feed joint-in socket;
Fig.57 is a perspective view showing a fuel supply tank of an example 2 of the fourth embodiment of the present invention;
Fig.58 is a top view showing a fuel supply tank of the same;
Fig.59 is a top view showing the same equipped with an impact protecting means;
Fig.60 is a top view showing a fuel supply tank of an example 3 of the fourth embodiment of the present invention;
Fig.61 is a top view showing the same equipped with an impact protecting means;
Fig.62 is a top view showing a fuel supply tank of an example 4 of the fourth embodiment of the present invention;
Fig.63 is a top view showing the same equipped with an impact protecting means;
Fig.64 is a front, partly sectional view showing a kerosene fan heater in accordance with an example 1 of the fifth embodiment of the present invention;
Fig.65 is a structural view showing a liquid fuel burning apparatus of the same;
Fig.66 is an outline view showing a fuel supply tank of the same;
Fig.67 is a perspective view showing a joining portion of a fuel supply tank of the same;
Fig.68 is a sectional view showing the structure of an oil feed joint of the same;
Fig.69 is a sectional view showing the structure of a return oil joint of the same;
Fig.70 is a sectional view showing the structure of an oil feed side joining means of the same;
Fig.71 is a sectional view showing the structure of an oil feed joint socket portion;
Fig.72 is a sectional view showing the structure of a return oil side joining means of the same;
Fig.73 is a side view showing a fuel supply tank;
Fig.74 is a sectional view showing the structure of a filler port of the same;
Fig.75 is a sectional view showing the open state of a filler port of the same;
Fig.76 is a sectional view showing the relationship between a fuel supply tank and a placement board;
Fig.77 is a sectional view showing the bottom part of a fuel supply tank of the same;
Fig.78 is a perspective view showing a water receptacle attachment hole of a fuel supply tank of the same, viewed from the tank interior;
Fig.79 is a control circuit of a liquid fuel burning apparatus of the same;
Fig.80 is a perspective view showing a filler port and thereabout of a fuel supply tank according to an example 2 of the fifth embodiment of the present invention;
Fig.81 is a side view showing a fuel supply tank of an example 3 of the fifth embodiment of the present invention;
Fig.82 is a partly sectional view showing a fuel supply tank of an example 4 of the fifth embodiment of the present invention;

Fig.83 is a perspective view showing the main body of kerosene fan heater in accordance with the embodiment of the present invention;
Fig.84 is a perspective view showing the rear side of the kerosene fan heater shown in Fig.83;
Fig.85 is an outline view showing the structure of the liquid fuel burning apparatus shown in Fig.83;
Fig.86 is a front view of the main body shown in Fig. 83 with part of the front panel cut away;
Fig.87 is an outline view showing a burner unit and a vaporizer shown in Fig.83;
Fig.88 is an outline view showing the vaporizer shown in Fig.87;
Fig.89 is a sectional side view showing a burner unit in the main body shown in Fig.83;
Fig.90 is a front view showing a burner unit in the main body shown in Fig.83;
Fig.91 is an outline view showing a fuel supply tank in Fig.83;
Fig.92 is a top view showing the tank side of the main body shown in Fig.83;
Fig.93 is an outline view showing an air hole shutoff means of the fuel supply tank shown in Fig.91;
Fig.94 is an outline view showing a connecting joint unit of the fuel supply tank shown in Fig.91;
Fig.95 is a sectional view showing the oil feed side joint in Fig.94;
Fig.96 (a) is an exploded perspective view showing the assembled state of an oil feed side joint and a suction pipe, and (b) is a sectional view cut along a plane A-A in (a);
Fig.97 is a sectional view showing the return oil side joint in Fig.94;
Fig.98 (a) is an exploded perspective view showing the assembled state of an return oil side joint and a return pipe, and (b) is a sectional view cut along a plane B-B in (a);
Fig.99 is an outline view showing a filler port shutoff means of the fuel supply tank shown in Fig.91;
Fig.100 is an outline view showing a water detecting means and a fuel detecting means in the fuel supply tank shown in Fig.91;
Fig.101 is an outline view showing a tank insertion detecting means of a fuel supply tank;
Fig.102 is an outline view showing a detector board on the fuel supply tank side shown in Fig.86;
Fig.103 (a) is a perspective view showing an electrode lever on the water receptacle side in the detector board and (b) is a view showing the attached state of the same;
Fig.104 is a view showing the attached state of an electrode lever on the tank side in the detector board;
Fig.105 is an outline view showing a tank insertion detecting means;
Fig.106 is a top view showing a fuel supply tank holding compartment;
Fig.107 is an exploded perspective view showing assembly of a tank guide and a tank guide fixture;
Fig.108 is a front view showing a tank guide fixture;
Fig.109 is an exploded perspective view showing the connected state of a joint socket unit and pipes;
Fig.110 is an outline view showing an oil feed side joint socket and an air valve on the burner unit side;
Fig.111 is an outline view showing a return oil side joint socket on the burner unit side;
Fig.112 (a) is a top view showing a connecting joint socket portion viewed from the air valve side and (b) is an outline sectional view showing an air valve and a joint socket portion;
Fig.113 is a view showing the relationship as to the liquid level of fuel in the fuel supply tank, connecting joint unit, joint socket unit and air valve;
Fig.114 is a block diagram showing a controller provided in the main body shown in Fig.83;
Fig.115 is an outline view showing an oil feed side joint and its joint socket when the tank is inserted in Fig.86;
Fig.116 is an outline view showing an oil feed side joint and its joint socket when the tank has been fitted in Fig.86;
Fig.117 is an outline view showing a return oil side joint and its joint socket when the tank is inserted in Fig.86;
Fig.118 is an outline view showing a return oil side joint and its joint socket when the tank has been fitted in Fig.86;
Fig.119 is a partly abbreviated, front sectional view showing a conventional kerosene fan heater;
Fig.120 is an overall sectional side view showing the same kerosene fan heater; and
Fig. 121 is a partial sectional view showing a fuel supply tank and a socket of the same.

Best Mode for Carrying Out the Invention

[The first embodiment]

(Example 1)

[0115] Fig. 1 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with the present invention. As shown in the drawing, a liquid fuel burning apparatus 1 of the present embodiment is a liquid fuel burning apparatus of a rotary atomizing type including a vaporizer B1 for evaporating fuel by heating and a burner unit B integrally formed with a burner B2 for burning vaporized fuel, further including a separable fuel supply tank 6 attached to the apparatus body and an oil feed pump EP for feeding fuel from fuel supply tank 6 to vaporizer B1, wherein a joining means C is provided to join fuel supply tank 6, when it is mounted to the apparatus body, to an oil feed path T, reaching to burner unit B, so that fuel in fuel supply tank 6 can be directly fed from oil feed pump EP to burner unit B, instead of providing a fuel tank for temporarily holding the

fuel under fuel supply tank 6.

[0116] Since rotary atomizing burner unit B is of a well-known structure defined in JIS S3030, the configuration is only briefly described. Burner unit B is integrally formed of a vaporizer B1 of a cylinder with a bottom and a burner B2 that covers the top of vaporizer B1 and mixes vaporized fuel from vaporizer B1 with primary combustion air and burns the mixture. Vaporizer B1 includes a front-end piping nozzle of the oil feed path, exposed through a center hole H formed in the bottom face of vaporizer B1, and an atomizing motor M and rotor R for atomizing the fuel flowing out from the nozzle by centrifugal force. Further, a combustion air passage AP is connected to the center hole H at the bottom face of vaporizer B1 so that combustion air can be supplied through combustion air passage AP by a fan F.

[0117] Burner B2 is enclosed by a combustion chamber BR and is provided with an electrode EL for combustion gas ignition and a flame rod RD for detecting flame of burner B2 arranged over burner B2. Other than these components a convection fan, though it is not illustrated, is arranged over combustion chamber BR so that air suctioned into the kerosene fan heater from the room can be blown out together with heated air and combustion gas inside the combustion chamber BR as warm air from the air outlet on the front side of the main body.

[0118] Fig.2 is a partially sectional, front view showing a fuel supply tank and Fig.3 is a sectional view showing a joining means of the same. As illustrated, fuel supply tank 6 has a vertical box-shaped configuration capable of being inserted in and removable from the tank holding compartment in the kerosene fan heater body, and includes a handle 23 arranged on the top for carriage, a filler cap 24 with a built-in pressure valve, disposed on the same plane as the handle 23, an oil gauge 25 disposed near the filler cap 24 with a built-in pressure valve and extending vertically to make the supplied fuel visible, an oil feed joint 9 of joining means C for connection with oil feed path T when fuel supply tank 6 is mounted to the main body, and a filler port 26 from which filler cap 24 with a built-in pressure valve is loosened to allow refueling.

[0119] As shown in Fig.3, joining means C is composed of an oil feed joint 9 provided on the fuel supply tank side and an oil feed joint socket 10 provided for oil feed path T on the burner unit side. The oil feed joint 9 and oil feed joint socket 10 are arranged above the maximum fluid level of fuel in fuel supply tank 6 so as to avoid fuel spilling out of fuel supply tank 6.

[0120] Oil feed joint 9 is arranged along the side face of the top part of fuel supply tank 6 and enclosed by a protective cover 28 for protection against impacts, and is attached to an attachment plate 27 by the protective cover 28. Further, the oil feed joint incorporates a valve mechanism 30 of a spindle type therein and is connected to a suction pipe 31 for suctioning fuel from fuel supply tank 6 and sending fuel to electromagnetic pump EP for conveyance.

[0121] Suction pipe 31 has one end almost reaching the bottom of fuel supply tank 6 while the other side is formed so as to penetrate through the top face of fuel supply tank 6 and is bent in an approximately inverted U shape so that the distal end is connected to communicate with valve mechanism 30 of the oil feed joint. Protective cover 28 is formed so as to enclose the projected part of suction pipe 31 over the top face of fuel supply tank 6, i.e., the approximately, inverted U-shaped communicating portion of suction pipe 31, as well as protecting oil feed joint 9.

[0122] Valve mechanism 30 of oil feed joint 9 is comprised of a joint body 33, a valve element 34, an annular O-ring packing 35, a spring 36 and a joint body packing 37. Joint body 33 is formed in a funnel shape by enlarging a metallic pipe in diameter and formed at a partway position with a bead portion 33d which is extended in a flange-like manner for allowing joint body 33 to fit inside cover 28. That is, the joint body is continuously formed of a cylindrical barrel portion 33a, a tapered portion (sealing surface) 33b which gradually becomes smaller in diameter from the lower end of the barrel downwards, and a cylindrical portion 33c having a predetermined length with a constant diameter equal to the predetermined diameter at the lower end of the tapered portion 33b while the lower end of cylindrical portion 33c is tapered so as to be further smaller in diameter. Formed at the upper end of joint body 33 is an inward flange 33e. This flange fixes joint body packing 37, which in turn holds suction pipe 31 so that its front end is inserted into the joint body, establishing communication.

[0123] Here, the material of joint body 33 should not be limited to metal but may be a resin. Barrel portion 33a, tapered portion 33b, cylindrical portion 33c and other parts should not be limited to having circular shapes. Joint body packing 37 is molded and shaped from rubber, providing the sealing function for joint body 33 and the contact sealing function with suction pipe 31.

[0124] Valve element 34 has a shape approximately analogous to the inside shape of the funnel-like portion of joint body 33 and has a configuration which can reciprocate inside joint body 33. Specifically, the valve element is comprised of a plug portion (sealing surface) 34a having an approximately conical shape and an elongated column-like movable portion 34b which is extended from the lower end of plug portion 34a and is narrower and longer than cylindrical portion 33c. An annular O-ring packing 35 is provided at the tapered portion of plug portion 34a so that the packing will be able to come into sealing contact with tapered portion 33b of joint body 33.

[0125] In order to regulate contact and separation between plug portion 34a and tapered portion 33b of joint body 33, the length of movable portion 34b is designated so that its front end projects out from the cylindrical portion 33c when the valve is closed or when O-ring 35 of plug portion 34a is placed in sealing contact with the inner surface of tapered portion 33b.

[0126] The aforementioned spring 36 is interposed between the top inward flange 33e and plug portion 34a of valve element 34, inside barrel portion 33a of joint body 33, so as to urge valve element 34 in the valve closing direction.

[0127] Attachment plate 27 is welded to the side face of fuel supply tank 6 and is comprised of a box-like fixing portion 27a for fixing impact protective cover 28 and an insert guide portion 27b disposed at a lower position, serving as a guide means when fuel supply tank 6 is inserted.

[0128] Oil feed joint socket 10 includes: a cylindrical valve retainer body 62 having a projection 60 at the center thereof for engagement with the valve element 34 of oil feed joint 9 and an annular groove 69 around the projection for creating communication with oil feed path T; a cylindrical, bellows-like joint sealing element 63 formed of rubber in such a manner that it projects upwards from valve retainer body 62 and encloses the projection 60; a spring 64 interposed between the top part of the sealing element and valve retainer body 62 so as to urge the sealing element upwards to assist its flexibility; and a bracing plate 66 for fixing the bottom of sealing element 63 against valve retainer body 62. Formed at the top of sealing element 63 is a passage hole 70 into which valve element 34 on the oil feed joint side snugly fits.

[0129] Oil feed joint socket 10 is fixed by an oil feed joint support plate 72 to tank guide 71 which sections the tank holding compartment in the apparatus body. Oil feed joint support plate 72 is bent and formed in a U-shape with its top open and has oil feed joint socket 10 fixed to the bottom plate thereof and one side plate fixed to tank guide 71. Another side plate 73 of support plate 72, bent on the other side (tank side) is rounded at its front end so as to form a guide portion 74 for insertion of fuel supply tank 6 into the main body. Provided on the tank guide side of support plate 72 is an elastic guide abutment plate 75 which is rounded or convexed toward the fuel supply tank side. This guide abutment plate 75 is fixed at only its upper side and provides the guiding function of smoothing the connection between oil feed joint 9 and its joint socket 10 by its abutting protective cover 28 of oil feed joint 9 when fuel supply tank 6 is inserted into the main body.

[0130] Fig.4 is a sectional view showing a fixing structure of the lower end of a suction pipe. Suction pipe 31 almost reaches the bottom of fuel supply tank 6 opposite to that with handle 23 and has a suction opening 44 at its distal end. A filter 45 which blocks water and dust from permeating is fitted inside this suction opening 44. This suction opening 44 may be formed at the bottom face instead of the side portion of the distal part of suction pipe 31. This suction pipe 31 is assembled into fuel supply tank 6 in such a manner that, before the left and right parts of fuel supply tank 6 is Adrian-formed, filter 45 is fitted into suction opening 44 and suction pipe 31 is fitted through a cutout hole 46a formed in a crank-shaped, suction pipe fixing plate 46, and then the left and right parts of fuel supply tank 6 are joined by Adrian-forming. Since the thus configured suction pipe 31 is kept from moving during carriage of fuel supply tank 6 by suction pipe fixing plate 46, suction opening 44 of suction pipe 31 will not interfere with the inner wall of fuel supply tank 6 so that it is possible to avoid damage to it.

[0131] Fig.5 is a sectional view showing a filler cap with a built-in pressure valve for the fuel supply tank. Filler cap 24 with a built-in pressure valve is comprised of a cap 53 which is screw fitted on filler port 26 which is projectively formed on the top of fuel supply tank 6 with its outer periphery threaded and a pressure valve mechanism 54. The filler cap is screw fitted on filler port 26 with a rubber packing 55 interposed therebetween. This cap 53 has a pressure releasing hole 56 for relieving pressure, penetrating through the center thereof. The side of the cap is threaded and the brim is curled. Rubber packing 55 provides a sealing function between filler port 26 and cap 53 and has a pressure releasing hole 57 at the center thereof for relieving pressure.

[0132] Pressure valve mechanism 54 is composed of a valve element 58 disposed between rubber packing 55 and the ceiling of cap 53 and a spring 59 urging this valve element 58 so as to close pressure releasing hole 52. The reason why this pressure valve mechanism 54 is needed is as follows. Generally, fuel to be charged into fuel supply tank 6 is stored at a cool site, and after fuel supply tank 6 is refueled, it is used in a room where the temperature is higher. Therefore, the temperature around fuel supply tank 6 inside main body 1 is high so that the space of air other than the fuel inside fuel supply tank 6 will expand due to difference in temperature. Resultantly, the air pressure increases, causing the liquid surface of fuel in tank 6 to rise and producing a risk of fuel spilling out. To avoid this, pressure valve mechanism 54 is provided. On the contrary, in order to prevent occurrence of negative pressure in the fuel supply tank, through-holes 77 and 78 having a diameter equal to or smaller than 1.5 mm are formed in rubber packing 55 and the ceiling of cap 53.

[0133] As shown in Fig.1, arranged along oil feed path T from oil feed joint socket 10 to the burner unit are electromagnetic pump EP as an oil feed pump for feeding the fuel to burner unit B and electromagnetic valve EV as a shutoff valve for shutting off fuel supply. Solenoid pump EP and electromagnetic BEN 80 may be provided separately, though the two are integrally arranged in oil feed path T, in the case of the present embodiment.

[0134] Fig.6 is a sectional view showing an integrated state of electromagnetic pump EP and electromagnetic valve EV. As illustrated, electromagnetic valve EV is comprised of a cylindrical valve body EV1, a cylindrical valve piece EV4 incorporated in a valve chamber EV2 of valve body EV1 and having an O-ring or rubber sheet EV7 at the end for opening and closing a communication path EV3 with electromagnetic pump EP, a solenoid coil

EV5 arranged around valve body EV1 for causing valve piece EV4 to move in the valve opening direction and a coil spring EV6 interposed between the exit side of valve chamber EV2 and valve piece 42 for urging valve piece EV4 to move in the valve closing direction.

[0135] A mating hollow EV8 which receives electromagnetic pump EP is formed so as to be connected to the entrance side of valve chamber EV1 by way of communication passage EV3. An exit side projection P of electromagnetic pump EP is adapted to tightly fit this hollow EV8 with an O-ring OR therebetween. A pipe connecting port TC1 is formed on the exit side of the valve chamber of electromagnetic valve EV while another pipe connecting port TC2 is formed on the entrance side of electromagnetic pump EP.

[0136] An oil feed pipe T1 connecting this electromagnetic pump EP with oil feed joint socket 10 and another oil feed pipe T2 connecting the connecting port TC1 of electromagnetic valve EV with vaporizer B1 are formed of copper pipes, thereby forming oil feed path T. Oil feed pipe T1 connecting oil feed joint socket 10 and electromagnetic pump EP may be of a resin pipe.

[0137] In the kerosene fan heater thus configured, when fuel in fuel supply tank 6 has run out, fuel is charged into fuel supply tank 6 through filler port 26 by opening the lid of main body 1, taking out fuel supply tank 6 by holding handle 23, releasing and removing filler cap 24 with a pressure valve with the handle 23 side up. In this case, since refueling is done while fuel supply tank 6 is placed on a flat site with the handle 23 side up, it is no longer necessary to turn fuel supply tank 6 upside down. Accordingly, it is possible to easily and reliably perform refueling without the filler cap of fuel supply tank 6 being stained with fuel.

[0138] When refueling is completed, the fuel supply tank 6 filled up with fuel is set into the predetermined position inside main body 1 after opening the lid of main body 1. Upon this setting, insert guide portion 27a extended downwards of attachment plate 27 is guided between insert guide 74 extended upwards of oil feed joint support plate 72 and valve retainer body 62, and protective cover 28 of fuel supply tank 6 is pushed by guide abutment sheet 75 so that valve element 34 of oil feed joint 9 is lead and inserted into passage hole 70 of oil feed joint socket 10. As the valve element is inserted, the bellows of sealing element 63 contracts, whereby valve element 34 of oil feed joint 9 comes into contact with projection 60 of valve retainer body 62.

[0139] When fuel supply tank 6 is further inserted into main body 1, valve element 34 of oil feed joint 9 moves upwards, pressurizing spring 36, whereby valve element 34 becomes open. That is, the oil feed path from suction pipe 31 of fuel supply tank 6 to the electromagnetic pump EP side of oil feed path T by way of joining means C becomes open.

[0140] When, in this tank inserted state, the operation switch (not shown) of the kerosene fan heater is actuated so as to turn the power on, solenoid EV5 of electromagnetic valve EV is magnetized so that valve piece EV4 moves in the valve opening direction, whereby the oil feed path T from electromagnetic pump EP to the vaporizer B1 side is opened and fuel is sent by electromagnetic pump EP to the vaporizer B1 side.

[0141] At vaporizer B1, fuel fed from electromagnetic pump EP is atomized and evaporated by rotor R of centrifugal atomizer, the vapor is ejected from the flame port of burner B2 located above, and ignited at the flame port and burns in the combustion chamber. At the same time, based on the difference in temperature between the room temperature detected by the room temperature thermistor and the set temperature designated through the control portion, an unillustrated controller controls drive of electromagnetic pump EP to vary the amount of liquid fuel fed to vaporizer B1, whereby the heat generation rate of the burning is controlled appropriately.

[0142] When combustion starts and the flame sensor detects a flame current equal to or greater than the preset current value, an unillustrated 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 obtained in combustion chamber BR and is blown out together with the combustion gas as warm air through the air outlet to the room, whereby the temperature in the room rises and is controlled.

[0143] When the operation of main body 1 is stopped, drive of electromagnetic pump EP is deactivated and electromagnetic valve EV is demagnetized so as to close the valve, whereby fuel supply can be shut off in a positive manner.

(Example 2)

[0144] Fig.7 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 2. In this example, an electromagnetic valve EV for shutting off fuel supply is disposed closer to the oil feed joint socket 10 side than electromagnetic pump EP is. Also in this case, it is possible to achieve space-saving and simplification of the pipe connecting process by integrating electromagnetic valve EV and electromagnetic pump EP. Other configurations are the same as those in example 1, so that the description is omitted.

(Example 3)

[0145] Fig.8 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 3. In this example, an electromagnetic pump EP is arranged on the suction pipe 31 side upstream of oil feed joint 9 of fuel supply tank 6 and is fixed to the top face of fuel supply tank 6 by screws or the like. The suctioning side of this electromagnetic pump EP is connected for communication to suction pipe 31 while the ejection side is connected for communication to oil feed joint 9 by a pipe. Electromagnetic valve EV is arranged

halfway along oil feed path T between oil feed joint socket 10 and vaporizer B1 similarly to the first embodiment.

[0146] Also in the above configuration, once fuel supply tank 6 is set in place into the main body, oil feed joint 9 and joint socket 10 are connected establishing the oil feed path from fuel supply tank 6 to vaporizer B1, whereby it is possible for electromagnetic pump EP to feed fuel to the vaporizer.

[0147] Here, concerning electric power supply to the electromagnetic pump, an unillustrated connecting plug can be used to be connected to the main body side when detachable fuel supply tank 6 is set into the main body. Other configurations are the same as those in example 1, so that the description is omitted.

(Example 4)

[0148] Fig.9 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 4; Fig.10 is a sectional view showing an oil feed joint socket of the same; and Fig.11 is a structural sectional view showing an air valve of the same. In this example, as a shutoff valve for shutting off fuel supply, an air valve 110 is used in place of the electromagnetic valve EV used in the above embodiments 1 to 3. This air valve 110 is arranged in oil feed joint socket 10.

[0149] Air valve 110 is to take in air to feed air for shutting off the oil feed path of fuel from fuel supply tank 6 to electromagnetic pump 13, and is disposed in a communication passage 112, which is branched off from oil feed path T connected for communication from groove 69 of oil feed joint 9b and the burner unit B·side. Further, similarly to oil feed joint socket 10, air valve 110 is arranged above the maximum liquid surface of fuel in fuel supply tank 6, so as to prevent fuel from spilling out of fuel supply tank 6.

[0150] As shown in Fig.11, the structure of air valve 110 is composed of a cylindrical valve body 115 having an opening 113 on one side thereof which opens to the atmosphere and a valve chamber 114 on the other side which is connected to the communication passage 112, an approximately conical valve piece 116 for opening and closing the opening 113 arranged in valve chamber 114 of valve body 115, a solenoid coil 117 arranged around valve body 115 to move the valve piece 116 in the valve opening direction, a coil spring 118 interposed between the opening side of valve chamber 114 and valve piece 116 for urging valve piece 116 in the valve closing direction, and an O-ring 119 disposed on the sealing side of valve piece 116.

[0151] This air valve 110 is closed by activation of solenoid coil 117 while kerosene fan heater is being operated, under control of an unillustrated controller. While the kerosene fan heater is not in operation, solenoid coil 117 is demagnetized so that the valve is opened by the repulsive force of spring 118, whereby air for shutting off fuel in oil feed path T from fuel supply tank 6 to electromagnetic pump EP is taken in to oil feed path T. Here, control, or opening and closing of air valve 110 may be done mechanically or manually other than the above electric control.

[0152] Similarly to the above examples 1 and 2, electromagnetic pump EP is arranged closer to the burner unit B side downstream of oil feed joint 9b.

[0153] In the above configuration, when oil feed tank 6 is mounted to the main body, oil feed joint 9 and joint socket 10 mate each other creating an oil feed path from fuel supply tank 6 to vaporizer B1, whereby it is possible to feed fuel to vaporizer B1 by electromagnetic pump EP. When fuel supply needs to be shut off, air valve 110 is opened so that air can be taken in to oil feed path T, whereby it is possible to stop fuel supply from fuel supply tank 6. Other configurations and operations are the same as those in example 1, so that the description is omitted.

(Example 5)

[0154] Fig.12 is an outline view showing the structure of a liquid fuel burning apparatus in accordance with an example 5. In this example, similarly to example 3, an electromagnetic pump EP is disposed close to suction pipe 31 upstream of oil feed joint 9 on the fuel supply tank 6 side and similarly to embodiment 4, an air valve 110 is used as a shutoff valve for shutting off fuel supply and is arranged in oil feed joint socket 10. The configurations and operations are same as those in examples 3 and 4 so that the description is omitted.

(Other examples)

[0155] 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, though description of the above embodiment was made referring to the oil supply system in a rotary atomizing type liquid fuel burning apparatus, the present invention can of course be applied to other burning types than this, such as pot type, pressure spraying type, jet spraying type burners and others.

[0156] Concerning the oil feed pump, it should not be limited to electromagnetic pumps, but pumps of other types can be used as long as it can feed fuel. As an example of the closing means for closing the filler opening of the fuel supply tank, a filler cap screw-fitted on the filler opening was mentioned, but a rotational shutoff type filler cap may be used. Further, the above embodiment was described referring to a configuration that uses a filler cap with a built-in pressure valve, but the pressure valve mechanism may be provided in the oil feed joining portion, not limited to the filler cap.

[0157] In the above embodiment, the valve mechanism that opens its valve when the fuel supply tank is set in the main body and closes the valve when the tank is removed is provided in the oil feed joint only. However,

a similar valve mechanism may also be provided on the oil feed joint socket side.

[0158] As described heretofore, according to the present invention, in a liquid fuel burning apparatus of a rotary atomizing type, pot type, pressure spraying type, jet spraying type, or other burning types, a joining means for connecting the fuel supply tank to the oil feed path reaching the burner when the fuel supply tank is set into the apparatus body is provided without providing a fuel tank for temporarily holding fuel under the fuel supply tank, so that fuel is directly fed from the fuel supply tank to an oil feed pump which feeds the fuel to the burner unit. Accordingly, it is possible to construct the fuel passage with fewer components. Further, since setting and refueling of the fuel supply tank can be done without turning the fuel supply tank upside down, the fuel supply tank becomes easy to handle.

[The second embodiment]

[0159] The embodiment of the present invention will be described with reference to the drawings. Fig.13 is a front overall view showing a kerosene fan heater including a liquid fuel burning apparatus in accordance with the embodiment. Fig.14 is an outline view showing the liquid fuel burning apparatus.

[0160] 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. As shown in Figs.13 and 14, main body 1 incorporates detachable fuel supply tank 6 for temporarily storing fuel, a vaporizer 12 for vaporizing the liquid, 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, 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 and a cooling fin assembly 19 located between vaporizer 12 and heat pipe 18 to cool fuel.

[0161] The fuel supply tank 6 includes, as shown in Fig.15, a handle 23 for carriage, a filler cap 24 with a built-in pressure valve, an oil gauge 25, a filler port 26, an oil feed joint 9A having avalve for opening and closing the passage connected to a pipe for suctioning fuel, and an oil feed joint-out 21A for transporting the return fuel from the vaporizer, from heat pipe 18 to fuel supply tank 6. Fig.16 is a structural view of the fuel supply tank 6 viewed in perspective from a higher point. This fuel supply tank 6 is configured so as to be attached and detached. The oil feed joint-in 9A and the oil feed joint-out 21A are configured so as to be attached to and detached from the oil feed joint-in socket 10A and the oil feed joint-out socket 22A, respectively.

[0162] As shown in Figs.15 and 18, the oil feed joint-in 9A is provided with a spindle type valve mechanism 28A and a suction pipe 27A for suctioning fuel from the fuel supply tank 6 while the oil feed joint-out 21A is provided with a spindle type valve mechanism 29A and a return pipe 30A for returning the liquefied fuel into the fuel supply tank 6. The oil feed joint-in 9A is fixed to the fuel supply tank 6 with a rubber packing 50A interposed therebetween by a screw bolt inserted into an attachment hole 47A formed on the oil feed joint 9 in the fuel supply tank 6.

[0163] As shown in Fig. 17, the valve mechanism 28A is comprised of a valve element 31A having a projection, an annular O-ring packing 33A and a spring 35A, and is fitted into the hollow of a guard 300A that has a passage hole at the hollow bottom, and covered by a lid nut 39A which is fixed to the guard with a seal packing 37A therebetween. The projected part of valve element 31A is fitted in the passage hole formed at the hollow bottom of the guard 300A with the aforementioned O-ring packing 33A held therebetween. Spring 35A is interposed in a space 302A between the top part of the valve element 31A and the lid nut 39A. A passage 43A for supplying fuel to the space 302A is provided and connected to the suction pipe 27A for suctioning fuel from fuel supply tank 6.

[0164] As shown in Fig.18, the suction pipe 27A is extended to almost the bottom of the fuel supply tank 6, penetrating through a fitting hole 46A formed on the top face of the fuel supply tank 6, and has a suction opening 44A and a filter 45A at its distal end. This suction opening 44A may be formed at the side portion other than the front end part of the suction pipe 27A.

[0165] As shown in Figs.19 and 20, the valve mechanism 29A is comprised of a valve element 32A having a projection, an annular O-ring packing 34A and spring 36A, and is fitted in the hollow of a guard 301A with a passage hole at the hollow bottom and is covered by a lid nut 40A which is fixed to the guard with a seal packing 38A therebetween. The projected part of valve element 32A is fitted in the passage hole formed at the hollow bottom of the guard 301A with the aforementioned O-ring packing 34A held therebetween. The spring 36A is interposed in a space 303A between the top part of the valve element 32A and the lid nut 40A. Further, the aforementioned return pipe 30A for returning fuel into the fuel supply tank 6 is disposed so as to communicate with the space 303A. The oil feed joint-out 21A is fixed to the fuel supply tank 6 with a rubber packing 51A therebetween by a screw bolt inserted into an attachment hole 49A formed on the oil feed joint 21 side in the fuel supply tank 6. Further, a fitting hole 48A through which the return pipe 30A is inserted is formed in the fuel supply tank 6.

[0166] Filler cap 24 with a built-in pressure valve (Fig.

13) arranged on the top face of fuel supply tank 6 is composed of, as shown in Fig.21, a filler port 26 of which the outer periphery is threaded, a cap 53 screw fitted on the filler port 26 with a rubber packing 55 providing a sealing function interposed therebetween and a pressure valve mechanism 54. The aforementioned filler port 26 is comprised of a hole 306A opening on the same plane as that to which the oil feed joint-out 21A is attached and a wall portion 26a projected outwards from the rim of the hole 306A. The cap 53 is fitted on the projected filler port 26 and engaged with wall portion 26a. Here, the side face of the cap 53 and the wall portion 26a are shaped so as to mesh each other. Fig.21 shows a particular example in which they are shaped in a wavy form. The pressure valve mechanism 54 is comprised of a valve element 58 and a spring 59, and the rubber packing 55 and the cap 53 have, at their center, pressure relieve holes 56 and 57 for releasing pressure, respectively.

[0167] The oil feed joint-in socket 10A (Fig.13) is comprised of, as shown in Fig.22, a valve mechanism 60A for receiving the valve element 31A of the valve mechanism 28A (Fig.17), a guard 68A and a valve support 61A having a grating hole 66A fitted in the guard. The valve mechanism 60A is composed of a valve element 62A, a spring 63A and a sealing O-ring 64A. The aforementioned valve support 61A serves as a stopper for valve element 62A. That is, when the oil feed joint-in 9A (Fig.16) is fitted to the oil feed joint-in socket 10A, side part 62a of the valve element 62A is supported by a valve abutment 65A of the valve support 61A. Further, oil feed joint-in socket 10A includes a sealing surface 67A creating a seal with valve mechanism 28A of oil feed joint-in 9A, a passage 69A extending from grating hole 66A of valve support 61A to electromagnetic pump 13 and a passage 70A which branches off at a position partway along the passage and communicates with air valve 20 formed of an electromagnetic coil and other components.

[0168] The oil feed joint-out socket 22A (Fig.16) is comprised of, as shown in Fig.23, a valve mechanism 71A for receiving the valve element 32A of the valve mechanism 29A (Fig.20), a guard 79A and a valve support 72A having a grating hole 77A fitted in the guard 79A. The valve mechanism 71A is composed of a valve element 73A, a spring 74A and a sealing O-ring 75A. The aforementioned valve support 72A serves as a stopper for valve element 73A. That is, when the oil feed joint-out 21A (Fig.16) is fitted into the guard 79A of the oil feed joint-out socket 22A, the side part 73a of the valve element 73A is supported by a valve abutment 72a of the valve support 72A.

[0169] When the fuel supply tank 6 is set to the main body 1 by the above structure, the joining means, namely the valve mechanism 28A of the oil feed joint-in 9A and the valve mechanism 29A of the oil feed joint-out 21A are set in place to oil feed joint-in socket 10A and oil feed joint-out socket 22A, respectively. The external O-rings 41A (Fig.17) and 42A (Fig.19) of the valve mechanisms 28A and 29A abut the sealing surface 67A (Fig.22) of the oil feed joint-in socket 10A and the sealing surface 78A (Fig.23) of the oil feed joint-out socket 22A, creating sealing contact.

[0170] The air valve 20 (Fig.22) is closed during operation, whereby the electromagnetic pump 13 (Figs.13 and 14) feeds liquid fuel from the fuel supply tank 6 to the vaporizer 12. It is opened when the apparatus is not in operation. Further, when the vaporizer 12 is to be baked for cleaning, the air valve 20 is opened and the electromagnetic pump 13 is actuated so as to send air to the vaporizer 12.

(Vaporizer and burner configuration)

[0171] Fig.24 is a structural view showing a vaporizer and a burner portion. As illustrated, vaporizer 12 is comprised of a vaporizing element 81 for vaporizing the fuel existing therein by heating, anozzle 82 for ejecting the fuel evaporated by this vaporizing element 81, a needle 83 that reciprocates back and forth through the hole of the nozzle 82 so as to open and close it, a solenoid valve 84 that is coupled with this needle 83 for moving needle 83, a fuel entrance 85 for supplying fuel to vaporizing element 81, a return circuit 86 for returning the fuel inside vaporizer 12 when the operation stops and a heat collector 87 for collecting combustion heat from burner 14.

[0172] Vaporizing element 81 is a sintered cylinder made of fine ceramic particles, and tar generated when fuel evaporates accumulates inside vaporizing element 81 from its surface inwards. Fuel entrance 85 to vaporizer 12 has a double pipe structure of an outer stainless pipe 88 and an inner copper pipe 89. Stainless pipe 88 is used to reduce heat conduction from vaporizer 12 and suppress temperature rise of fuel entering vaporizer 12. Further, stainless pipe 88 is made greater in diameter than the copper pipe so as to further inhibit heat conduction from stainless pipe 88 to the copper pipe. The end of copper pipe 89 is located at a position outside vaporizer 12.

[0173] Solenoid valve 84 is mainly composed of an electromagnetic coil 90 made up of wire wound in a coil, a moving piece 91 which is located inside the coil and axially movable together with the needle, an attracting piece 92 and a pressure spring 93. As electric current through electromagnetic coil 90 is turned on or cut off, moving piece 91 is attracted to or departs from attracting piece 92, so as to cause needle 83 linked with moving piece 91 to move whereby the hole of nozzle 82 of vaporizer 12 is made open or closed.

[0174] Burner 14 is composed of a mixing tube 94 for mixing the combustion gas evaporated through vaporizer 12 with primary combustion air and a flame port 95 for burning the mixed combustion gas.

(Configurations of the electromagnetic pump, collecting container, cooling fin assembly)

[0175] As shown in Fig.14, electromagnetic pump 13 suctions fuel from fuel supply tank 6 to send it toward the vaporizer 12 while the ejected amount of fuel and the like are controlled by the controller.

[0176] Fig.25 is a sectional view showing a collecting container. A collecting container 18 is configured as illustrated, and is provided to temporarily retain and cool the fuel, which remains inside vaporizer 12 upon a halt of electromagnetic pump 13 and shutoff of nozzle 82 of vaporizer 12 because of room temperature control from the start to end of operation and needs to be returned to fuel supply tank 6.

[0177] A container body 96 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 12 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 unburned fuel per day amounts to about 3 to 5 cc. Accordingly, container body 96 has a large enough volume (about 20 cc) to collect the amount of returned fuel.

[0178] Formed on the side face of this container body 96 is an entrance 97 of combustion gas from vaporizer 12 while an exit 98 for the fuel collected in container body 96 is formed on the top of container body 96. A pipe 99 almost reaching the bottom inside container body 96 is arranged through this exit 98 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.

[0179] Fig.26 is a sectional view showing a cooling fin assembly 19 provided halfway along the passage between vaporizer 12 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 partly evaporated fuel, which is returned from vaporizer 12.

[0180] In the above configuration, oil feed pipes 203, 204, 205, 206 and 207, which each connect the oil feed joint-in socket 10A and the electromagnetic pump 13, the electromagnetic pump 13 and the vaporizer 12, the vaporizer 12 and the cooling fin assembly 19, the cooling fin assembly 19 and the heat pipe 18, and the heat pipe 18 and the oil feed joint-in socket 10A, respectively, are formed of steel pipes.

[0181] Concerning the above configuration, its operation will be described.

[0182] When fuel in the fuel supply tank 6 (Fig.13) has run out, fuel is charged into fuel supply tank 6 through the filler port 26 by opening the lid 7 of the main body 1, taking out the fuel supply tank 6 by holding the handle 23, releasing and removing the filler cap 24 with a pressure valve with the handle 23 side up. When refueling is completed, the fuel supply tank 6 filled up with fuel is set into the predetermined position inside the main body 1 after opening the lid 7 of the main body 1. Upon this setting, when, as shown in Figs.27 and 28, the valve element 31A in the valve mechanism 28A of the oil feed joint-in 9A and the valve element 32A in the valve mechanism 29A of the oil feed joint-out 21A, as the joining means of the fuel supply tank 6, respectively press the valve element 62A of the valve mechanism 60A of the oil feed joint-in socket 10A and the valve element 73A of the valve mechanism 71A of the oil feed joint-out socket 22A, as the joining means, the valve elements 62A and 73A move down so that the side parts 62a and 73a of the valve elements 62A and 73A abut bearing portions 65A and 72a of valve supports 61A and 72A. Then the valve element 31A of the valve mechanism 28A of the oil feed joint-in 9A and the valve element 32A of the valve mechanism 29A of oil feed joint-out 21A move upwards so that the urging springs 35A and 36A become compressed, whereby the O-ring packings 33A and 34A forming sealing surfaces of valve elements 31A and 32A depart from the respective sealing surfaces of the oil feed joint-in 9A and the oil feed joint-out 21A, creating clearances. Thus, these clearances establish the passage of fuel into the electromagnetic pump 13 side and the passage from the heat pump 18 to the fuel supply tank 6.

[0183] Next, electric power is turned on by actuating the operating switch (not shown) of the kerosene fan heater, the vaporizer heater (not shown) attached to the vaporizer 12 heats the vaporizer 12. During heating, a vaporizer thermistor (not shown) detects the temperature of vaporizer 12. When the vaporizer 12 is heated to a predetermined temperature, the electromagnetic pump 13 is driven so as to suction the liquid fuel inside the fuel supply tank 6 through the suction pipe 27A and sends it to the vaporizer 12 by way of the oil feed joint-in 9A and the oil feed joint-in socket 10A. The liquid fuel is gasified by the heated vaporizer 12 and the gas is ejected from the flame port 95 of the burner 14, ignited at the flame port 95 and burns in the combustion chamber. At the same time, based on the difference in temperature between the room temperature detected by the room temperature thermistor and the set temperature designated through the control portion, a controller controls drive of the electromagnetic pump 13 to vary the amount of liquid fuel fed to vaporizer 12, whereby the heat generation rate of the burning is controlled appropriately.

[0184] When combustion starts and the flame sensor 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 the aforementioned 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 the air outlet 5 to the outside (the room of main body 1), whereby the temperature in the room will rise.

[0185] Next, when the operation of main body 1 is stopped, the drive of electromagnetic pump 13 is deactivated and electric current through the vaporizer heater is stopped. At the same time, the solenoid valve 84 is deactivated so as to release the moving piece 91 and the attracting piece 92, whereby the hole of the nozzle 82 is shut off by the needle 83. As the hole is closed, partially evaporated fuel remaining inside the vaporizer 12 passes through the return channel 86 (Fig.24) and oil feed pipe 205 (Fig.14) to the heat pump 18, where the fuel is stored. The partly evaporated fuel, elevated in temperature, is cooled through the cooling fin assembly 19 provided between the oil feed pipe 205 and the oil feed pipe 206 and sent to the heat pipe 18. The partly evaporated fuel fed into the heat pipe 18 reduces in temperature with the passage of time, whereby the gas is liquefied and stored therein. Upon ignition, the nozzle 82 is closed (for about one to two minutes) until the fuel changes from liquid to gas inside the vaporizer 12, whereby the internal pressure in the vaporizer 12 rises to about 0.2 kg/cm. This pressure acts on the interior of the heat pipe 18 so as to push up the liquid inside the heat pipe 18 and send it out from the funnel shaped port 200 at the lower end of the pipe 99 (Fig.25) arranged inside the heat pipe 18 through the oil feed pipe 207 (Fig.14), the passage 80A (Fig.23) of the oil feed joint-out socket 22A and the return pipe 30A (Fig.20) of oil feed joint-out 21A into the fuel supply tank 6.

[0186] When liquid fuel is heated and evaporated in the vaporizer 12, it leaves some impurities therein. The impurities build up inside the vaporizer 12 after long-term operation, whereby the amount of gas emitted from the nozzle 82 of the vaporizer 12 lowers and it becomes necessary to remove the impurities built up inside the vaporizer 12. For this purpose, the vaporizer 12 is cleaned by baking in the following manner. When the switch for cleaning by baking is turned on with the fuel supply tank 6 set in the main body 1, the temperature of vaporizer 12 is raised automatically to a temperature for cleaning by baking. At the same time, the air valve 20 (Fig.14) is activated so as to open itself and electromagnetic pump 13 starts to be driven. In this situation, since the pressure of air entering through the air valve 20 is higher than that inside the fuel supply tank 6, air is suctioned through the air valve 20 and is sent by the electromagnetic pump 13 to the vaporizer 12. Thus, the impurities in vaporizer 12 can be baked for a predetermined time together with air sent by the vaporizer 12 and removed. Accordingly, this method makes it possible to easily clean the interior of the vaporizer 12 without the necessity of any tedious work of removing fuel because air is suctioned in by the electromagnetic pump 13.

[0187] As has been described heretofore, according to the present invention, cleaning of the vaporizer by baking impurities built up in the vaporizer with the air valve set open during non-operation, makes it possible to easily clean the vaporizer without removing the fuel supply tank from the main body.

[0188] It is also possible to shut off fuel in the fuel passage by the air valve.

[0189] No fuel will spill if the apparatus falls down.

[0190] It is possible to change the partly evaporated fuel to liquid and return it to the fuel supply tank.

[0191] Provision of a filler cap functioning as a pressure release valve mechanism and a lid for the fuel supply tank prevents the fuel from spilling when a temperature variation occurs.

[0192] Since the oil feed joint as the joining means is arranged above the liquid level of fuel in the fuel supply tank, no fuel will spill out of the fuel supply tank.

[0193] Since the passage connected to the oil feed joint as the joining means is provided inside the fuel supply tank with a dust removal filter attached at the end of the passage, neither water nor dirt will be suctioned.

[0194] Since means for cooling fuel inside the passage is provided halfway along the fuel passage for return fuel from the vaporizer to the heat pump, it is possible to lower the temperature of the fuel returning from the vaporizer.

[The third embodiment]

(Example 1)

[0195] Fig.29 is a front overall view showing a kerosene fan heater including a liquid fuel burning apparatus in accordance with the third embodiment of the present invention. Fig.30 is an outline view showing the liquid fuel burning apparatus.

[0196] 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 6A 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.

[0197] As shown in Figs.29 and 30, 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 6A, a functional part compartment 1b for accommodating a vaporizer 12, electromagnetic pump 13 and the like and a burner unit compartment 1c including a burner 14 and a combustion chamber 15.

[0198] Arranged in tank holding compartment 1a are fuel supply tank 6A of a cartridge type which temporarily stores fuel and is detachable, oil feed side joining means

9A and 10A that create a detachable connection between fuel supply tank 6A and an oil feed passage 300 for transferring fuel from fuel supply tank 6A to the vaporizer side, and oil return side joining means 21B and 22A that create a detachable connection between fuel supply tank 6A and an oil return passage 301 for returning fuel from the vaporizer 12 side to fuel supply tank 6A. A cushioning mount base 1d for absorbing and relieving impacts acting on joining means 9A, 10A, 21B and 22A 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 9A and 10A and oil return side joining means 21B and 22A will reliably fit to each other when fuel supply tank 6A is inserted.

[0199] The oil feed side joining means is composed of an oil feed joint 9A incorporating a valve for opening and shutting off the passage to the suction pipe and an oil feed joint socket 10A for receiving the valve of the oil feed joint 9A. Connected to oil feed joint socket 10A 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 6A to electromagnetic pump (oil feed pump) 13. This oil feed joint socket 10A 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.

[0200] The functional part compartment 1b is located between tank holding compartment 1a and burner unit compartment 1c and includes vaporizer 12 for evaporating fuel from fuel supply tank 6A, electromagnetic pump 13 for feeding fuel from fuel supply tank 6A to vaporizer 12, a collecting container 18 for temporarily holding partly evaporated fuel from vaporizer 12 and a cooling fin assembly 19 arranged between vaporizer 12 and collecting container 18 for cooling the partly evaporated fuel.

[0201] Burner unit compartment 1c is defined by partitioning plate 16 and incorporates burner 14 that mixes the evaporated fuel through vaporizer 12 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 12, burner 14 and other parts.

[0202] Oil feed passage 300 is composed of a pipe 203 connecting oil feed joint socket 10A and electromagnetic pump 13 and a pipe 204 connecting electromagnetic pump 13 and vaporizer 12. Return oil passage 301 is composed of a pipe 205 connecting vaporizer 12 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 10A. These pipes 203 to 207 are all formed of copper pipes. The pipe from fuel supply tank 6A to electromagnetic pump 13 and pipe 207 may be formed of resin pipes or others, instead of copper pipes.

[0203] Fig.31 is an outline view showing a fuel supply tank, Fig.32 is a perspective view showing a joining portion of the fuel supply tank, Fig.33 is a sectional view showing the connected state of an oil feed joint and a suction pipe in the fuel supply tank, and Fig.34 is a structural view showing a return oil joint.

[0204] As illustrated, fuel supply tank 6A is formed in a vertical box-shaped configuration made up of a metallic material presenting conductivity (e.g., galvanized steel sheet), having a handle 23 on the top face of the tank for carriage with fuel therein, a filler port 26 arranged on the same top face as the handle 23, a filler cap 24 with a built-in rubber packing for closing the filler port 26, an oil gauge 25 disposed on the side face near the filler port 26 to make the supplied fuel visible, oil feed joint 9A and return oil joint 21B arranged on the side opposite to filler port 26, on the same top face as handle 23.

[0205] As shown in Fig.33, oil feed joint 9A is comprised of a side-facing L-shaped connecting pipe 43A projected from the top of fuel supply tank 6A and extended sidewards of the tank and a joint body 9Aa with a built-in spindle type valve mechanism 28A, arranged at the distal end of the connecting pipe 43A.

[0206] Joint body 9Aa is formed of a vertical cylinder having a small-diametric projective cylinder 9Ab shaped at the bottom end thereof so as to be fitted into the oil feed joint socket 10A side. Further, an O-ring 41A for connection sealing is tightly fitted on the outer periphery of the cylinder 9Ab. An openable and closable lid nut 38A is screw fitted on the top opening of joint body 9Aa so as to allow valve mechanism 28A to be inserted.

[0207] Valve mechanism 28A inside joint body 9Aa is composed of a center valve hole 9Ac in small-diametric projective cylinder 9Ab of joint body 9Aa, a spindle-like valve element 31A which can fit on and separate from an inverted conical valve seat 9Ad formed in the lower part of the joint body, a spring 35A interposed between the top of valve element 31A and lid nut 38A for urging valve element 31A in the valve closing direction and an O-ring 33A for sealing fitted on the peripheral side of valve element 31A so as to oppose the valve seat. When the valve mechanism is in the closed state, the lower end of valve element 31A is set so as to project out and downwards from small-diametric projective cylinder 9Ab.

[0208] Connecting pipe 43A has a suction passage 43a formed therein which communicates with the valve chamber inside joint body 9Aa and the end that is extended sidewards of the tank is integrally connected to the side part of joint body 9Aa. The lower end of connecting pipe 43A is inserted into the tank through an insert hole 46A formed on the top face of fuel supply tank 6A. The connecting pipe has a flange 43b formed in the lower part thereof so that the flange is fastened to a hole 47A on the top face of fuel supply tank 6A by a screw with a rubber packing 50A interposed therebetween. The outer peripheral side at the lower end of connecting

pipe 43A is incised with a male thread, on which the upper end of a suction pipe 27A inside the fuel supply tank is screw fitted.

[0209] Suction pipe 27A almost reaches the bottom of fuel supply tank 6A and has a suction opening 44A on the side at its lower end, to which a filter 45A that blocks water and dust from permeating is fitted. This suction opening 44A may be formed at the bottom face of suction pipe 27A.

[0210] This suction pipe 27A is assembled into fuel supply tank 6A in such a manner that, before the left and right parts of fuel supply tank 6A is Adrian-formed, filter 45A is fitted into suction opening 44A and suction pipe 27A is fitted through a cutout hole 50a formed in a crank-shaped, suction pipe fixing plate 50, and then the left and right parts of fuel supply tank 6 are joined by Adrian forming. Since suction pipe 27A is fixed by fixing plate 50, it will be constrained during carriage of fuel supply tank 6A hence suction opening 44A of suction pipe 27A will not interfere with the inner wall of fuel supply tank 6A, thus making it possible to avoid damage to it.

[0211] On the other hand, return oil joint 21B is arranged on the top face of fuel supply tank 6A at the side of oil feed joint 9A as illustrated in Fig.34 and has basically the same structure as that of oil feed joint 9A except in that no suction pipe 27A is connected and a pressure valve mechanism 700 is provided for fuel supply tank 6A. Accordingly, description will be made briefly except for the above differences.

[0212] As shown in Fig.34, return oil joint 21B is comprised of a side-facing L-shaped connecting pipe 30A projected from the top of fuel supply tank 6A and extended sidewards of the tank and a joint body 21a with a built-in spindle type valve mechanism 29A, arranged at the distal end of the connecting pipe 30A.

[0213] 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 22A side. Further, an O-ring 42A for connection sealing is tightly fitted on the outer periphery of the small-diametric cylinder. An openable and closable lid nut 40A is screw fitted on the top opening of joint body 21a so as to allow valve mechanism 29A and pressure valve mechanism 700 to be inserted.

[0214] Valve mechanism 29A 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 32A which can fit on and separate from an inverted conical valve seat 21d formed in the lower part of the joint body, a spring 36A for urging valve element 32A in the valve closing direction and an O-ring 34A for sealing which is fitted on the peripheral side of valve element 32A so as to oppose the valve seat.

[0215] When valve element 32A 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 36A is interposed between the top face of valve element 32A and the bottom face of a valve seat element 702 of pressure valve mechanism 700 which is to be described later.

[0216] Connecting pipe 30A has a return passage 30a formed therein which communicates with the valve chamber inside joint body 21a and the end that is extended sidewards of the tank is integrally connected to the side part of joint body 21a. The lower end of connecting pipe 30A is inserted into the tank through an insert hole 48A formed on the top face of fuel supply tank 6A. The connecting pipe has a flange 30b formed in the lower part so that the flange is fastened to a hole 49A on the top face of fuel supply tank 6A by a screw with a rubber packing 51 interposed therebetween.

[0217] In the present embodiment, pressure valve mechanism 700 is provided for return oil joint 21B 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 6A.

[0218] This pressure valve mechanism 700 is comprised of valve seat element 702 with a cylindrical valve hole 701, located over valve element 32A, 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 40A for positioning the valve seat element 702 inside joint body 21a.

[0219] Lid nut 40A has a pressure release hole 705 formed at the center thereof. Spring 704 is held between ball valve piece 703 and lid nut 40A. Valve hole 701 has a diameter adequate enough to allow pushing rod 709 of valve element 32A to pass therethrough. When return oil joint 21B is fitted and connected to return oil joint socket 22A (Fig.32) and valve element 32A 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 40A by way of connecting pipe 30A.

[0220] In both the aforementioned oil feed joint 9A (Fig.32) and return oil joint 21B, valve elements 31A and 32A 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 10A and return oil joint socket 22A which are arranged upwards so as to oppose them. Accordingly, just the insertion of fuel supply tank 6A into tank compartment 1a from above makes it possible to establish smooth connection between joining means 9A and 21B and between joining means 10A and 22A, both. The first joining means on the oil feed side and the second joining means on the return oil side are configured so as to be positioned at a level higher than the liquid level of fuel in the fuel supply tank full of fuel when the fuel supply tank is mounted in the main body, whereby fuel can be prevented from

spilling out from the tank, which is full.

[0221] Fig.35 is a structural view showing oil feed side joining means 9A and 10A. Fig.36 is a structural view showing an oil feed joint socket. Fig.37 is a structural view showing a return oil side joining means. As illustrated, in tank holding compartment 1a (Fig.29), oil feed joint socket 10A and return oil joint socket 22A (Fig.32) are arranged under, and opposing, oil feed joint 9A and return oil joint 21B, respectively when fuel supply tank 6A is mounted in place.

[0222] As shown in Fig.35, oil feed joint socket 10A is comprised of a hollow socket portion 61A that has a circular cross-section, opens to the top of a cylindrical socket body 10Aa to receive the small-diametric projective cylinder 9Ab at the lower end of oil feed joint 9A, and a valve mechanism 60A that is disposed in the hollow socket portion 61A and opens and closes as valve element 31A of valve mechanism 28A of oil feed joint 9A is abutted against, and separated from, socket portion 61A.

[0223] Formed at the top of hollow socket portion 61A is an annular sealing surface 67A which can make hermetic contact with the periphery of small-diametric projective cylinder 9Ab of oil feed joint 9A. Further, a valve support holder 68A is indented in the bottom of socket portion 61A. A valve support 65A is fitted in this valve support holder 68A. Valve support 65A is formed with a valve hole 60b which communicates with a valve chamber 60a formed in the lower part of socket body 10Aa while grating channels 66A for allowing fuel to flow are formed around the valve hole.

[0224] Valve mechanism 60A is composed of a valve element 62A 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 61A side, a spring 63A interposed between the head of the valve element 62A and valve support 65A so as to urge valve element 62A in the valve closing direction, and an O-ring 64A tightly fitted on valve element 62A on its valve chamber 60a side to seal against the valve seat. This valve mechanism 60A is adapted to open the valve when valve element 33A of oil feed joint 9A comes into pressure contact with the head of valve element 62A on the socket side and close the valve when it separates from the head of valve element 62A.

[0225] Formed in the lower part of valve chamber 60a of socket body 10Aa is a conduit 69A (Fig.36) communicating with pipe 203 which is connected to electromagnetic pump 13 (Fig.30). A conduit 70A for air valve 20 is formed on the side part of valve chamber 60a. This air valve 20 and conduit 70A are positioned at a level higher than the liquid level of fuel in the fuel supply tank when it is full, so that fuel can be prevented from spilling out from the tank.

[0226] 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 6A 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 70A when it is magnetized and a spring 20c urging valve piece 20a in the valve opening direction.

[0227] 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 12 by actuation of electromagnetic pump 13.

[0228] On the other hand, return oil joint socket 22A basically has the same configuration as that of oil feed joint socket 10A except in that it does not have any air valve 20. Accordingly, briefly explaining the structure, return oil joint socket 22A, as shown in Fig.37, is comprised of a hollow socket portion 72A formed on the top face of a socket body 22a and a valve mechanism 71A that is disposed in this socket portion 72A and opens and closes as a valve element 32A of a valve mechanism 29A of return oil joint 21B is abutted against it and separated from it.

[0229] Formed at the top of socket portion 72A is an annular sealing surface 78A. Further, a valve support holder 79A is indented in the bottom of socket portion 72A. A valve support 76A is fitted in this valve support holder 79A. Valve support 76A 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 77A for allowing fuel to flow are formed around the valve hole.

[0230] Valve mechanism 71A is composed of a valve element 73A 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 72A side, a spring 74A interposed between the head of the valve element 73A and valve support 72 so as to urge valve element 73A in the valve closing direction, and a sealing O-ring 75A tightly fitted on valve element 73A on its valve chamber 71a side. This valve mechanism 71A is adapted to open the valve when valve element 32A of return oil joint 21B comes into pressure contact with the head of valve element 73A on the socket side and close the valve when it separates from the head of valve element 73A. Formed in the lower part of valve chamber 71a of socket body 22a is a conduit 80A communicating with pipe 207 which is connected to collecting container 18.

[0231] In the above configuration of the fuel supply tank 6A, joining means 9A, 10A, 21B and 22A, when fuel supply tank 6A is set into tank holding compartment 1a of main body 1 from above, oil feed joint 9A and return oil joint 21B as the joining means are fitted to the predetermined positions of oil feed joint socket 10A and return oil joint socket 22A, so that O-rings 41A and 42A

on their sides of small-diametric projective portions 9Ab and 21b (Figs.33 and 34) of joint bodies 9Aa and 21a abut against sealing surface 67A of oil feed joint socket 10A and sealing surface 78A of return oil joint socket 22A, forming hermetic states. At the same time, in each joint, valve mechanism 28A or 29A is mated with socket side valve mechanism 60A or 71A, so that mating valve elements push each other, forming a valve-open state.

[0232] Further, on the return oil joint 21B side, valve element 32A 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 703 upwards hence valve hole 701 opens. Accordingly, a communication passage is formed from the tank to valve hole 701 and pressure release hole 705 in joint body 21a by way of connecting pipe 30A, 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.

[0233] The configurations of vaporizer 12 and burner 14, electromagnetic pump 13, collecting container 18 and cooling fin assembly 19 are the same as ZENKI so that description is omitted.

(The operation of the kerosene fan heater)

[0234] The operation of the kerosene fan heater will be described. Fuel is charged into fuel supply tank 6A through filler port 26 by opening lid 7 of main body 1, taking out the empty fuel supply tank 6A by holding handle 23, releasing and removing filler cap 24 with the handle 23 side up.

[0235] When refueling is completed, the fuel supply tank 6A 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.35 and 37, valve element 31A in valve mechanism 28A of oil feed joint 9A and valve element 32A in valve mechanism 29A of the return oil joint 21B, of fuel supply tank 6A, press valve element 62A of valve mechanism 60A of oil feed joint socket 10A and valve element 73A of valve mechanism 71A of the return oil joint socket 22A, respectively, and the valve elements 62A and 73A move down.

[0236] As the head parts 62a and 73a of these valve elements 62A and 73A abut the respective top faces of valve supports 61A and 72A, valve element 31A of valve mechanism 28A of oil feed joint 9A and valve element 32A of valve mechanism 29A of return oil joint 21B move upwards so that urging springs 35A and 36A which have urged in the valve closing direction become compressed, whereby the O-rings 33A and 34A forming sealing surfaces of valve elements 31A and 32A depart from the respective sealing surfaces of oil feed joint 9A and return oil joint 21B, forming clearances, which open oil feed passage 300 for fuel to flow to the electromagnetic pump 13 side and return oil passage 301 from collecting container 18 to fuel supply tank 6A.

[0237] 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 vaporizer thermistor (not shown) detects the temperature of the vaporizer 12. When vaporizer 12 is heated to a predetermined temperature, electromagnetic pump 13 is driven so as to suction liquid fuel inside fuel supply tank 6A through suction pipe 27A and sends it to vaporizer 12 by way of oil feed joint 9A and oil feed joint socket 10A. The liquid fuel is gasified by the heated vaporizer 12 and the gas is ejected from flame port 95 of burner 14, ignited at the flame port 95 to burn in combustion chamber 15.

[0238] 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 controller 950 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.

[0239] When combustion starts and the flame sensor 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 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), whereby the temperature in the room rises and is regulated at an optimal temperature.

(Example 2)

[0240] Fig.38 is a plan view showing a joining means of an example 2; Fig.39 is its front view; Fig.40 is a sectional view showing the oil feed joint side; Fig.41 is a sectional view showing the return oil joint side; Fig.42 is a sectional view showing the joint socket side; and Fig. 43 is its front view.

[0241] As illustrated, this embodiment is made different from example 1 in that, in the joining means on the oil feed side and in the joining means on the return oil side, oil feed joint 9A and return oil joint 21C are integrated, oil feed joint socket 10A, return oil joint socket 22A and air valve 20 are integrated, a protective cover 800 is provided as an impact protecting means for oil feed joint 9A and return oil joint 21C, the shape of a ball valve piece 702a of return oil joint 21C is made different and the valve mechanism of oil feed joint socket 10A is omitted, and basically has the same configuration as example 1 in other respects. Therefore, only the differences will be described in detail.

[0242] As illustrated, oil feed joint 9A and return oil joint 21C are laid out side by side, on the side of, and in

the upper part of fuel supply tank 6A. These joint bodies 9Aa and 21a are integrated on the fuel supply tank side by a connecting plate 801, which is fixed by screws to the side wall of fuel supply tank 6A with a sealing element 802 in between.

[0243] A reinforcing plate 804 having an approximately U-shape, viewed from top, so as to enclose oil feed joint 9A and return oil joint 21C on the three sides and is fixed to connecting plate 801. Further, a protecting cover 800 made of resin is arranged so as to fit in contact with the outer faces of reinforcing plate 804 and is fixed thereto by a screw 806, whereby impacts acting on oil feed joint 9A and return oil joint 21C will be reduced. Accordingly, it is possible to protect the joining portion from impacts when fuel supply tank 6A is carried or when fuel supply tank 6A is inserted into the main body.

[0244] Oil feed joint socket 10A and return oil joint socket 22A are also laid out side by side on the compartment wall of the tank holding compartment. These joint bodies 10Aa and 22a are also integrated by a connecting plate 810. Further, an air valve 20 which is connected to communicate with the valve chamber of oil feed joint socket body 10Aa by way of a communication passage 70A is also integrally joined to socket body 10Aa.

[0245] Here, oil feed joint socket 10A is comprised of a hollow socket portion 61A that has a circular cross-section, opens to the top of cylindrical socket body 10Aa to receive a small-diametric projective cylinder 9Ab at the lower end of oil feed joint 9A, and a projection 812 which is projected upwards at the center of this socket portion 61A so as to abut valve element 31A of valve mechanism 28A of oil feed joint 9A and open the valve of valve mechanism 28A of oil feed joint 9A. A communication passage 70A to air valve 20 and a communication passage (not shown) to electromagnetic pump 13 are formed in connection with an annular groove 813 formed around this projection 812.

[0246] Return oil joint socket 22A basically has the same configuration and function as that of the first embodiment. A notable difference is that, among valve mechanism 71A incorporated in socket body 22a of return oil joint socket 22A, spring 63A that urges valve element 62A in the valve closing direction is arranged in valve chamber 60a of socket body 22a between its bottom wall and valve element 62A. This valve mechanism 71A is provided so that unburned fuel from vaporizer 12 will not leak out when fuel supply tank 6A is taken out from the main body. This prevents generation of odor.

[0247] In the configuration of the fuel supply tank 6A, joining means 9A, 10A, 21C and 22A, when fuel supply tank 6A is set into tank holding compartment 1a of main body 1 from above, oil feed joint 9A and return oil joint 21C as the joining means are fitted to the predetermined positions of oil feed joint socket 10A and return oil joint socket 22A, so that O-rings 41A and 42A on their outer sides of small-diametric projective portions 9Ab and 21b of joint bodies 9Aa and 21a abut against sealing surface 67A of oil feed joint socket 10A and sealing surface 78A of return oil joint socket 22A, respectively, forming hermetic states. At the same time, valve mechanism 28A of oil feed joint 9A and the valve element of valve mechanism 60A on the socket side press each other to open their respective valves. Valve mechanism 29A of return oil joint 21C and the valve element of valve mechanism 71A on the socket side press each other to create a valve-open state.

[0248] Further, on the return oil joint 21C side, valve element 32A moves upwards as it opens so that upper pushing rod 709 moves upwards through valve hole 701 of pressure valve mechanism 700 and pushes ball valve piece 703 upwards and valve hole 701 opens. Accordingly, a communication passage is formed from the tank to valve hole 701 and pressure release hole 705 in joint body 21a by way of connecting pipe 30a, 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. Further, this also prevents occurrence of a negative pressure inside the tank. Other configurations and operating effects are the same as the first embodiment, so that description is omitted.

(Other examples)

[0249] The present invention should not be limited to the above embodiments and many changes and modifications can be added within the scope of the present invention. For example, in the above description of the embodiment, the oil feed joint and the return oil joint are extended sidewards from the top face of the fuel supply tank, but the present invention should not be limited to this. It is also possible to provide a configuration in which the joints are projected from the side as in example 2. Further, the filler port of the fuel supply tank does not need to be provided on the top. It may be arranged in the side faces of the tank as long as it is located in the upper part of the tank.

[0250] As has been described heretofore, according to the present invention, since fuel in the fuel supply tank is directly fed to the oil feed pump while no fuel tank for temporarily holding the fuel is provided, there is no need for the filler port of the fuel supply tank to be set to the fuel tank, hence there is no possibility of the filler port cap being wetted with fuel from the fuel tank. Particularly, since no fuel tank is needed, the number of constituent parts can be reduced.

[0251] Moreover, joining means are provided for the oil feed passage for feeding fuel from the fuel supply tank to the burner unit and/or for the return oil passage for allowing fuel to return from the burner unit to the fuel supply tank and these joining means are provided with valve mechanisms which open their valves when the fuel supply tank is mounted to the main body and close the valves when the fuel supply tank is taken out from the main body. As a result, no fuel leakage will occur

when the tank is taken out from the main body.

[0252] Further, since the air valve for taking air into the oil feed passage so as to shut off fuel supply is provided, it is possible to reliably shut off fuel supply. Since the pressure valve mechanism for adjusting the tank internal pressure using the return oil joint as the second joining means is provided, it is possible to cancel a pressure difference between the interior and exterior of the tank if it arises due to difference in temperature between the interior and exterior of the tank. It is also possible to prevent variation in fuel suction and the suctioning amount, without causing a negative pressure inside the tank.

[The fourth embodiment]

(Example 1)

[0253] The embodiment of the present invention will be described with reference to the drawings. Fig.44 is a partly cutaway outline view showing the front of a kerosene fan heater 1 including a liquid fuel burning apparatus in accordance with the present invention. Fig.45 is an outline view showing the operative configuration of a liquid fuel burning apparatus. Fig.46 is a partially sectional front view showing a fuel supply tank 6. Fig.47 is a sectional view cut along a plane B-B in Fig. 46. Fig. 48 is a partly sectional illustrative view showing a suction port 44 and the like. Fig.49 is a sectional view showing a filler cap 24 with a built-in pressure valve of fuel supply tank 6. Fig.50 is a sectional view showing an oil feed joint socket.

[0254] As shown in Fig.44, 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, 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.

[0255] As shown in Figs.44 and 45, the kerosene fan heater main body 1 incorporates detachable fuel supply tank 6 for temporarily storing fuel, an oil feed joint-in 9a as a joining means, an oil feed joint-in socket 10a connectable to the valve of the oil feed joint-in 9a, an air valve 20 (Fig.45) for shutting off the fuel passage between fuel supply tank 6 and an aftermentioned electromagnetic pump 13 (Fig.45), a tank guide 11 for positioning and holding oil feed joint-in socket 10a at a predetermined position, a vaporizer 12 for evaporating fuel from fuel supply tank 6, electromagnetic pump 13 for feeding fuel from fuel supply tank 6 to vaporizer 12, a burner 14 for mixing evaporated fuel through vaporizer 12 with primary combustion air and burning the mixture, a combustion chamber 15 enclosing burner 14 where combustion occurs, a partition 16 for partitioning burner 14 and combustion chamber 15 from the other parts, a burner box 17 for holding the burner 14, a heat pipe 18 (Fig.45) for retaining partly evaporated fuel from the vaporizer 12 and a cooling fin assembly 19 (Fig.45) located between vaporizer 12 and heat pipe 18 for cooling partly evaporated fuel, an oil feed joint-out 9b (Fig.45) as a joining means for sending the return fuel from the vaporizer, from heat pipe 18 to fuel supply tank 6, and an oil feed joint-out socket 10b as a joining means of the fuel supply tank 6.

[0256] Fig.46 is a front, partly sectional view showing fuel supply tank 6. Fig.47 is a sectional view taken along a plane B-B in Fig.46.

[0257] Box-shaped fuel supply tank 6 for storing fuel includes a handle 23 arranged on the top face thereof for carriage, a filler cap 24 with a built-in pressure valve, disposed on the same top side as the handle 23, an oil gauge 25 disposed near the filler cap 24 with a built-in pressure valve and extending vertically to make the supplied fuel visible, a joining means 9 for establishing an oil feed passage when fuel supply tank 6 is mounted to the main body, and a filler port 26 from which filler cap 24 with a built-in pressure valve is released to allow refueling.

[0258] As shown in Figs.46 and 47, joining means 9 has a fuel suction pipe 31a which almost reaches the bottom of fuel supply tank 6 at its one end and is formed in an inverted, approximate U-shape at the other end, oil feed joint-in 9a connected to the inverted, approximate U-shaped side of fuel suction pipe 31a, oil feed joint-out 9b as a joining means for the return fuel passage from vaporizer 12, an inverted, approximately U-shaped return pipe 31b for communication between the oil feed joint-out 9b and fuel supply tank 6, and a protective cover 28 for holding the oil feed joint-in 9a, oil feed joint-out 9b, fuel suction pipe 31a and return pipe 31b at predetermined positions relative to fuel supply tank 6 and covering these to protect them against impacts.

[0259] Protective cover 28 is positioned on the side face of fuel supply tank 6 by means of an attachment plate 27.

[0260] Oil feed joint-in 9a and oil feed joint-out 9b are of an identical configuration as shown in Fig.47, whereby both have a spindle type valve mechanism. Suction pipe 31a for suctioning and transferring fuel from fuel supply tank 6 to electromagnetic pump 13 is connected to the oil feed joint-in 9a side while return pipe 31b for sending return fuel from vaporizer 12 (Figs.44 and 45) to fuel supply tank 6 is connected to the other side, or the oil feed joint-out 9b side.

[0261] As shown in Fig.47, each valve mechanism in oil feed joint-in 9a and oil feed joint-out 9b is comprised of a joint body 33, a valve element 34, an annular O-ring packing 35, a spring 36 and a joint body packing 37.

[0262] As illustrated, joint body 33 is formed into a funnel shape by enlarging a metallic pipe in diameter and also formed at a partway position with a bead portion 33d which is extended in a flange-like manner for allow-

ing joint body 33 to fit inside cover 28. That is, joint body 33 is formed of a cylindrically formed barrel portion 33a, a tapered portion (sealing surface) 33b which gradually becomes smaller in diameter from the end of barrel portion 33a to the distal side and a cylindrical portion 33c having a predetermined length with a constant diameter equal to the predetermined diameter at the lower end of the tapered portion 33b while the distal end of cylindrical portion 33c is tapered so as to be further smaller in diameter. Formed at the other end of joint body 33 is an opening portion 33d for hermetically holding suction pipe 31a or return pipe 31b with a joint body packing 37. The aforementioned bead portion 33d which is extended in a flange-like manner is formed at a position close to tapered portion 33b in barrel portion 33a.

[0263] Here, the material of joint body 33 should not be limited to metal but may be a resin. Barrel portion 33a, tapered portion 33b, cylindrical portion 33c and other parts should not be limited to having cross sectional circular shapes. Joint body packing 37 is molded and shaped from rubber, providing sealing against joint body 33 and contact sealing with the pipe for oil feed passage.

[0264] Valve element 34 has a shape approximately analogous to the inside shape of the funnel-like portion of joint body 33 and has a configuration which can reciprocate inside joint body 33. Specifically, the valve element is comprised of a plug portion (sealing surface) 34a having an approximately conical shape and a column-like movable portion 34b which is extended from the end of plug portion 34a and is narrower and longer than the cylindrical portion 33c. The aforementioned spring 36 is connected to the side opposite to plug portion 34a. An annular O-ring packing 35 is provided at the tapered portion of plug portion 34a so that it will be able to come into sealing contact with funnel-shaped tapered portion 33b of joint body 33.

[0265] Since contact and separation between O-ring packing 35 and tapered portion 33b of joint body 33 are actuated by movable portion 34b, the length of actuator 34b is designated so that its front end will project out from the cylindrical portion 33c when O-ring 35 of plug portion 34a is set in tight contact with the inner surface of tapered portion 33b.

[0266] The aforementioned spring 36 is arranged with its one end resting on opening portion 33d of joint body 33 and the other end resting on plug portion 34a, so that it provides repulsive force so as to keep O-ring packing 35 of plug portion 34a in contact with the inner surface of tapered portion 33b. That is, spring 36 is in its expanded state.

[0267] Accordingly, if no external force acts, O-ring packing 35 and the inner portion of tapered portion 33b are pressed in hermitic contact with each other by the repulsive force of spring 36.

[0268] Assembly of oil feed joint-in 9a and oil feed joint-out 9b is performed by fitting annular O-ring packing 35 at the predetermined position of valve element 34, fitting spring 36 to valve element 34, inserting the valve element into joint body 33 from the opening portion 33d side, fitting joint body packing 37 into joint body 33 and fixing it with adhesives.

[0269] Attachment plate 27 provided for fuel supply tank 6 is welded to fuel supply tank 6 and is comprised of a box-like fixing portion 27a for fixing an impact protective cover 28 and an insert guide portion 27b disposed at a lower position, serving as a guide means when fuel supply tank 6 is inserted.

[0270] Impact protective cover 28 is composed of a rear cover 39, front cover 40 and top cover 41, as shown in Fig. 46.

[0271] Rear cover 39 has ahollowed structure so as to accommodate oil feed joint-in 9a and oil feed joint-out 9b with their length supported vertically and is formed with a groove 39a for receiving bead portion 33d of joint body 33 and three bolt holes 39b for fixture to attachment plate 27.

[0272] Front cover 40 also has a hollowed structure similarly to the rear cover 39 so as to accommodate oil feed joint-in 9a and oil feed joint-out 9b and is formed with a groove for receiving bead portion 33d of joint body 33, bolt holes for fixture of attachment plate 27 of fuel supply tank 6 and a fixing catch 42 of top cover 41.

[0273] Front cover 40 and rear cover 39 are assembled with their hollowed supporting structures opposed to each other and the corresponding bolt holes aligned so as to hold oil feed joint-in 9a and oil feed joint-out 9b therebetween and be fixed to the attachment plate 27 by common screw bolts.

[0274] Top cover 41 has a number of unillustrated guide pins for preventing displacement of suction pipe 31a for transporting fuel to oil feed joint-in 9a and oil feed joint-out 9b and return pipe 31b for returning fuel to fuel supply tank 6. Further, the top cover is also formed with a fixture hook 43 which engages catch 42 of front cover 40 and a bolt hole 41a for fixture to attachment plate 27.

[0275] Suction pipe 31a for suctioning fuel from fuel supply tank 6 almost reaches the bottom opposite to that with handle 23 of fuel supply tank 6, as shown in Fig.46 and has a suction opening 44 at its distal end (Figs.46 and 48). A filter 45 which blocks water and dust from permeating is fitted inside the suction opening 44. This suction opening 44 may be formed at the side portion other than the bottom face at the distal end of suction pipe 31a.

[0276] This suction pipe 31a is assembled into fuel supply tank 6 in such a manner that, before the left and right parts of fuel supply tank 6 is Adrian-formed, filter 45 is fitted into suction opening 44 and suction pipe 31a is fitted through a cutout hole 46a formed in a crank-shaped, suction pipe fixing plate 46, and then the left and right parts of fuel supply tank 6 are joined by Adrian-forming. Since the suction pipe 31a is fixed during carriage of fuel supply tank 6 by suction pipe fixing plate 46, suction opening 44 of suction pipe 31a will not interfere with the inner wall of fuel supply tank 6 so that it is

possible to avoid damage to it.

[0277] For assembly of the joining means of fuel supply tank 6 or oil feed joint-in 9a and oil feed joint-out 9b, a connecting packing 47 is fitted on suction pie 31a and set into the predetermined position of fuel supply tank 6.

[0278] Further, bead portions 33d of oil feed joint-in 9a and oil feed joint-out 9b are fitted into respective grooves 39a of rear cover 39. Similarly, front cover 40 is fitted so as to hold oil feed joint-in 9a and oil feed joint-out 9b between itself and rear cover 39 and fixed to attachment plate 27 by multiple screw blots. Then suction pipe 31a and return pipe 31b are inserted into the centers of respective joint packings 37 of two joint bodies 33.

[0279] Fixing hook 43 of top cover 41 is fitted into fixing catch 42 of front cover 40 and top cover 41 is fixed to attachment plate 27 by a screw bolt fitted through bolt hole 41a.

[0280] As illustrated heretofore, since cover 28 as a means for reducing impacts acting on oil feed joint-in 9a and oil feed joint-out 9b as the joining means of fuel supply tank 6 is provided, it is possible to reduce impacts by the cover 28 if an external impulsive force acts. Accordingly, it is possible to eliminate the risk of fuel supply tank 6, oil feed joint-in 9a and oil feed joint-out 9b being damaged.

[0281] As shown in Figs.46 and 49, filler cap 24 with a built-in pressure valve is comprised of a cap 53 which is screw fitted on filler port 26 which is projectively formed on the top face of fuel supply tank 6 with its outer periphery threaded, and a pressure valve mechanism 54. The filler cap is screw fitted on filler port 26 with a rubber packing 55 interposed therebetween.

[0282] This cap 53 has a pressure releasing hole 56 for relieving pressure, penetrating through the center thereof. The side of the cap is threaded and the brim is curled.

[0283] This rubber packing 55 provides a sealing function between filler port 26 and cap 53 and has a pressure releasing hole 57 for reliving pressure at the center thereof.

[0284] Pressure valve mechanism 54 is composed of a valve element 58 and a spring 59.

[0285] Generally, fuel to be charged into fuel supply tank 6 is stored at a cool site, and after fuel supply tank 6 is refueled, it is used in a room where the temperature is higher. Therefore, the temperature around fuel supply tank 6 inside main body 1 is high so that the space of air other than the fuel inside fuel supply tank 6 will expand due to difference in temperature. Resultantly, the air pressure increases, causing the liquid surface of fuel in fuel supply tank 6 to rise and producing a risk of fuel spilling out. To avoid this, the pressure valve mechanism 5 4 is provided. Further, in order to prevent occurrence of negative pressure in fuel supply tank 6, through-holes 97 and 98 having a diameter equal to or smaller than 1.5 mm are formed in rubber packing 55 and the ceiling of cap 53. These holes 97 and 98 may be formed on the top face of the fuel supply tank.

[0286] As shown in Fig.45, oil feed joint-in socket 10a as the joining means on the socket side is arranged under oil feed joint-in 9a while oil feed joint-out socket 10b as the joining means on the socket side is arranged under the valve mechanism of oil feed joint-out 9b. When fuel supply tank 6 is mounted to the main body, the associated joints are coupled providing the function of joining means for the fuel passages.

[0287] The arrangement of the oil feed joint-in socket 10a and oil feed joint-out socket 10b side will be described with reference to Fig.50.

[0288] In the oil feed joint-in socket 10a and oil feed joint-out socket 10b side, each socket is composed of a valve socket body 62 including a projective valve retainer 60 engaging valve element 34, a surrounding upright wall 61 and a fuel passage formed therein, a bellows joint-in receiver 63 for sealing between oil feed joint-in socket 10a or oil feed joint-out socket 10b and valve socket body 62, a spring 64 for supporting expansion of bellows joint-in receiver 63, a spring rest 65 for receiving spring 64 and a bracing plate 66 for pressing joint-in receiver 63. The two socket pieces are integrally formed and arranged side by side, a predetermined distance apart from each other.

[0289] An abutment 67 of valve retainer 60 is formed to be greater than the contact area of the front end 68 of valve element 34 as a part of the valve mechanism of oil feed joint-in 9a so as to secure its engagement. A depressed groove 69 is formed around valve retainer 60 and is connected by a passage 71a to electromagnetic pump 13 or by a passage 71b to heat pipe 18.

[0290] Air valve 20 as a valve for taking air in in order to shut off the flow of fuel (see Figs.45, 50 and 51) is connected to fuel passage 71a on the oil feed joint-in socket 10a side, by providing a hole 71c communicating with fuel passage 71a. Here, communication hole 71c should be disposed above the level of fuel when the fuel supply tank is full.

[0291] Since the valve retainers 60 for oil feed joint-in 9a and oil feed joint-out 9b are formed into a uni-body structure as stated above, it is possible to make the structure including attachment of valve socket body 62 compact.

[0292] Joint receiver 63 is to seal oil feed joint-in socket 10a and valve socket body 62 and is made up of resilient multi-folded rubber on the side thereof so as to obtain improved contraction and expansion. The base 63a of joint receiver 63 in contact with valve socket body 62 is formed with a projected rib 63b for attachment. The joint receiver further has a flange 63c folded inwards on the side to which valve element 34 is inserted, so as to provide a passage hole 70 which comes into hermetic contact with valve element 34.

[0293] Arranged between the lower part of joint receiver 63 and valve socket body 62 is spring rest 65 for supporting one end of spring 64. Spring rest 65 has an upright rim around the abutment on which spring 64 rests and a hole 65a at the center thereof for allowing

fuel passage.

[0294] Bracing plate 66 is to brace joint receiver 63 against valve socket body 62 and holds base 63a of joint receiver 63 against valve socket body 62 by its being fixed with screws.

[0295] Air valve 20 (Figs.45, 50 and 51) is provided to take air in to shut off the fuel inside oil feed passage from fuel supply tank 6 to electromagnetic pump 13. While the kerosene fan heater is in operation air valve 20 is in the closed state, whereas the valve is released when the kerosene fan heater is not in operation, so as to take air in to shut off fuel inside oil feed passage 71a from fuel supply tank 6 to electromagnetic pump 13.

[0296] Air valve 20 suctions air into oil feed passage 71a by opening itself during cleaning by baking of vaporizer 12 and also sends air to vaporizer 12 by actuating electromagnetic pump 13. As shown in Fig.51, air valve 20 may be given in any configuration such as a solenoid valve as long as it can create an air hole 71c that communicates with oil feed passage 71a in accordance with a control signal from an unillustrated controller. Also, air valve 20 may be actuated to open and close its air hole, mechanically or manually other than the aforementioned electric control.

[0297] The above-described oil feed joint-in socket 10a can be assembled by inserting spring rest 65 into a predetermined position of valve socket body 62, fitting spring 64 inside spring rest 65, fitting bellows joint-in receiver 63 over spring 64 and fixing it to the predetermined depressed portion of valve socket body 62, and fixing bracing plate 66 to valve socket body 62 with screws. Oil feed joint-out socket 10b is assembled in the same manner as oil feed joint-in socket 10a, using the other part of valve-socket body 62. At the end of assembly, air valve 20 is attached and fixed to hole 71c portion located at a position partway along passage 71.

[0298] The integration of oil feed joint-in socket 10a and oil feed joint-out socket 10b in valve socket body 62 is fixed to an oil feed joint support plate 72 so that it can be fixed to a tank guide 11 as shown in Fig.52.

[0299] Oil feed joint support plate 72 is formed with a surrounding upright wall 73 which is higher than the oil feed joint-in socket 10a and oil feed joint-out socket 10b and the front end of the wall on the tank 6 side is rounded forming a guide portion 74 which will guide fuel supply tank 6 when it is inserted into the main body.

[0300] Provided on the fixed side of oil feed joint support plate 72, i.e., on the tank guide 11 side, is an elastic guide abutment sheet 75 which is rounded or convex toward the fuel supply tank side and is fixed at the upper side only. This sheet provides the guiding function of bringing fuel supply tank 6 to the side opposite to combustion chamber 15 when fuel supply tank 6 is inserted into main body 1.

[0301] Fig.53 is a sectional view of Fig.44 cut along a plane A-A. Fig.54 is a top view of Fig.53, viewed from the direction C, with top cover 28 removed.

[0302] Vaporizer 12, burner 14, heat pump 18 and cooling fin assembly 19 have the same configurations as those described above so that description is omitted.

[0303] Next, the operation of the kerosene fan heater having the above configuration will be described.

[0304] Fuel is charged into fuel supply tank 6 through filler port 26 by opening lid 7 of main body 1, taking out the empty fuel supply tank 6 by holding handle 23, releasing and removing filler cap 24 with a built-in pressure valve with the handle 23 side up.

[0305] When refueling is completed, the fuel supply tank 6 filled up with fuel is set into place after opening lid 7 of main body 1. Upon this setting, as shown in Figs. 52, 55 and 56, an insert guide 38 extending downward from attachment plate 27 is guided between an insert guide 74 extending upwards from oil feed joint support plate 72 and valve socket body 62 while guide abutment sheet 75 pushes front cover 40 of the joining means of fuel supply tank 6 so as to bring fuel supply tank 6 to the side opposite to combustion chamber 15, whereby valve elements 34 are inserted into respective passage holes 70 of the joint receivers 63 of oil feed joint-in socket 10a and oil feed joint-out socket 10b. As each valve element is inserted, the bellows of joint receiver 63 contracts and valve element 34 comes into contact with valve retainer 60 of valve socket body 62. As fuel supply tank 6 is further inserted into main body 1 as shown in Fig.56, valve elements 34 in oil feed joint-in 9a and oil feed joint-out 9b move upwards while springs 36 become compressed, whereby O-rings 35 arranged at the sealing surfaces of valve elements 34 depart from the sealing surfaces of joint bodies 33, forming clearances S, which individually establish fuel passage to the electromagnetic pump 13 side and return fuel passage from heat pump 18 to fuel supply tank 6.

[0306] When electric power is turned on by actuating the operating switch (not shown) of the kerosene fan heater, a vaporizer heater (not shown) attached to vaporizer 12 heats vaporizer 12. At the same time, a vaporizer thermistor (not shown) detects the temperature of the vaporizer 12. When vaporizer 12 is heated to a predetermined temperature, electromagnetic pump 13 is driven so as to suction the liquid fuel inside fuel supply tank 6 through suction pipe 31a and sends it to the vaporizer 12 by way of oil feed joint-in 9a and oil feed joint-in socket 10a.

[0307] The liquid fuel is gasified by the heated vaporizer 12 and the gas is emitted from flame port 95 of burner 14, ignited at the flame port 95 to burn in combustion chamber. At the same time, based on the difference in temperature between the room temperature detected by a room temperature thermistor and the set temperature designated through control portion 4, an unillustrated controller controls drive of the electromagnetic pump 13 to vary the amount of liquid fuel fed to vaporizer 12, whereby the heat generation rate of burning is controlled appropriately.

[0308] 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 aforementioned controller.

[0309] The air suctioned from the room absorbs the radiated heat generated 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.

[0310] 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 84 is deactivated so as to release moving piece 91 of solenoid valve 84 from attracting piece 92, whereby the hole of nozzle 82 in vaporizer 12 is shut off by needle 83 attached to attracting piece 92.

[0311] Partially evaporated fuel remaining inside the vaporizer 12 passes through the gap between the sealing surfaces of solenoid valve 84 body and needle 83, and proceeds through the oil feed pipe to the heat pump 18, where the fuel is stored. The partly evaporated fuel elevated in temperature, as it passes through the pipe 202, radiates heat through cooling fin assembly 19 which is arranged partway along the oil feed pipe, so that partly evaporated fuel is cooled and sent to heat pipe 18.

[0312] Partly evaporated fuel in the heat pipe 18, is present in gas when it is fed therein, but reduces in temperature with the passage of time, whereby the gas is liquefied and stored therein.

[0313] Upon ignition, nozzle 82 is closed by needle 83 for about one to two minutes until fuel is heated to change from liquid to gas inside vaporizer 12 and is emitted from nozzle 82. The internal pressure in vaporizer 12 rises to about 0.2 [kg/cm^2] due to the hole of nozzle 82 of vaporizer 12 being closed. This pressure acts on the interior of heat pipe 18 by way of the oil feed pipe, applying pressure on the surface of the liquefied fuel in a container 96 of heat pipe 18 to push down the oil surface and send the liquefied fuel out from a funnel shaped port 200 at the lower end of a pipe 99 arranged inside heat pipe 18 through oil feed pipe 202b, passage 71b of oil feed joint-out socket 10b and return pipe 31b of oil feed joint-out 9b to fuel supply tank 6.

[0314] When liquid fuel is heated and evaporated, it leaves some impurities. Since impurities build up inside vaporizer 12 after long-term operation and lower the amount of gas emitted from nozzle 82 of vaporizer 12, it becomes necessary to remove the impurities built up inside the vaporizer 12 in order to recover the original amount of gas. For this purpose, vaporizer 12 needs to be cleaned by baking.

[0315] Cleaning of vaporizer 12 by baking is performed in the following manner.

[0316] First, when the switch for cleaning by baking is turned on with fuel supply tank 6 set in main body 1, the temperature of vaporizer 12 is raised automatically to a temperature for cleaning by baking. Air valve 20 is opened and electromagnetic pump 13 starts to be driven. Since the pressure of air entering through air valve 20 is higher than that inside fuel supply tank 6, air is suctioned through air valve 20 into passage 71a and further sent by the electromagnetic pump 13 to vaporizer 12. The impurities in vaporizer 12 are removed by raising the temperature in vaporizer 12 and baking them together with air, for a predetermined period of time.

[0317] Since air is suctioned by electromagnetic pump 13 as used previously, no means is needed to remove fuel from the oil feed passage and it is possible to easily clean vaporizer 12 without the necessity of tedious work of removing fuel from the oil feed passage.

[0318] 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 23 side up, cap 24 with a built-in pressure valve which is present on the same side as handle 23 is loosened and removed and fuel is charged from filler port 26 of fuel supply tank 6 using a refueling pump. 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 easily and reliably perform refueling without the filler cap of fuel supply tank 6 being stained with fuel, as used to be the case.

[0319] Further, fuel to be charged therein is often stored at a cool place outside the room and so the temperature of the fuel is low. Since the ambient temperature around fuel supply tank 6 inside main body is high, air inside fuel supply tank 6 expands and the pressure rises due to temperature difference. The air pressure thus increased pushes up valve element 58 of filler cap 24 with a built-in pressure valve to release air through pressure relieve hole 56 of cap 53 so as to restore the original air pressure in fuel supply tank 6, whereby no fuel will spill out from fuel supply tank 6.

[0320] Since oil feed joint-in 9a and oil feed joint-out socket 10a are arranged above the maximum liquid surface level in fuel supply tank 6, fuel is prevented from spilling out from fuel supply tank 6.

(Example 2)

[0321] Fig.57 is a perspective view showing a fuel supply tank in accordance with an example 2 of the embodiment. Fig.58 is a top view showing the same fuel supply tank. This example is aimed at preventing the joining means such as oil feed joint-in 9a, oil feed joint-out 9b, etc., from being damaged even if a fuel supply tank 6B falls down. That is, as oil feed joint-in 9a, oil feed joint-out 9b are arranged within a ridge-based contour 600 in the top view of fuel supply tank 6B.

[0322] Specifically, as shown in Figs.57 and 58, in fuel supply tank 6B of an approximate parallelepiped, sides 6B1 and 6B2 which should adjoin to each other are bev-

eled toward the tank center from the ridgeline 6B3 formed between sides 6B1 and 6B2, so as to create an approximately triangular space 6B4 within ridge-based contour 6B0, in the top view of fuel supply tank 6B. Oil feed joint-in 9a and oil feed joint-out 9b are disposed on the thus formed tank wall side 6B5 in space 6B4 so that they are located within the space 6B4.

[0323] Tank wall side 6B5 of space 6B4 is extended from the top to the bottom of fuel supply tank 6B, and oil feed joint-in 9a and oil feed joint-out 9b, formed individually, are fixed to this tank wall side by means of an attachment plate 27. Here, although not illustrated, joint-in 9a and joint-out 9b are connected with a fuel suction pipe 31a and fuel return pipe 31b, respectively. Further, similar to first embodiment, each joint incorporates a spindle type valve mechanism so as to constitute part of the oil feed passage or return oil passage.

[0324] Further, a bevel 6B9 is formed by cutting off a volume defined by the tank top face and two adjoining sides 6B2 and 6B8 from a partway point on a ridgeline 6B7 of the fuel supply tank adjacent to ridgeline 6B3 based on which space 6B4 is formed. A filler port 26 is formed on this bevel. A filler cap 24 is provided to cover this filler port in a rotationally openable and closable manner. This filler cap 24 is also disposed within ridge-based contour 6B0 in the top view of fuel supply tank 6, so as to be able to prevent cap 24 from being damaged in case the tank falls down.

[0325] Fig.59 is a top view showing a configuration further including an impact protecting means, wherein a protective cover 28 for impact reduction is arranged outside oil feed joint-in 9a and oil feed joint-out 9b, in addition to the configuration shown in Figs.57 and 58. In this case, protective cover 28 having an approximately U-shaped cross-section, viewed from top, is arranged within the approximately triangular space 6B4 inside ridge-based contour 6B0 in the top view of fuel supply tank 6B.

[0326] In this configuration, since the joining means, including oil feed joint-in 9a, oil feed joint-out 9b and protective cover 28, are all arranged within the approximately rectangular space 6B4 inside ridge-based contour 6B0 in the top view of fuel supply tank 6B, it is possible to avoid oil feed joint-in 9a and oil feed joint-out 9b directly hitting the floor if the tank, wrongly, falls down during carriage of the tank while sides 6B1, 6B2 and 6b8 of tank 6 hit the floor, instead. Accordingly, it is possible to prevent damage to these joining parts. Since other configurations are the same as the above first embodiment, the description is omitted.

(Example 3)

[0327] Fig.60 is a top view showing a fuel supply tank in accordance with an example 3 of the present embodiment. In this example, instead of creating the approximately triangular space as in example 2, an approximately rectangular space 6C4 is created so as to dispose an oil feed joint-in 9a and oil feed joint-out 9b therein. Specifically, a fuel supply tank 6C is constructed by creating a depressed portion from a ridgeline 6C3 which is defined by an intersection between two adjoining sides 6C1 and 6C2, towards the center of the tank so as to form an approximately rectangular space 6C4 within a ridge-based contour 6C0 in the top view of fuel supply tank 6C, wherein oil feed joint-in 9a and oil feed joint-out 9b are arranged and fixed to a tank wall side 6C5 by means of an attachment plate 27. Other configurations and operations are the same as in example 2.

[0328] Fig.61 is a top view showing a variation of the example shown in Fig.60, in which a protective cover 28 for impact protection having a shape curved along ridge-based contour 6C0 is added. The protective cover 28 is arranged inside the ridge-based contour 6C0. In either example, the same operations and effects as in the above example 2 are obtained so that prevention of damage to the joining parts can be achieved.

(Example 4)

[0329] Fig.62 is a top view showing a fuel supply tank in accordance with an example 4 of the embodiment. Fig.63 is a top view showing a case in which a protective cover 28 for impact protection is added. In this example, a side 6D1 of a fuel supply tank 6D is depressed toward the center of the tank, creating a depressed portion 6D4 within a ridge-based contour 6D0 in the top view of fuel supply tank 6D, wherein oil feed joint-in 9a and oil feed joint-out 9b are disposed and attached to the bottom of the depressed portion 6D4 or tank wall surface 6D5 by means of an attachment plate 27. The configuration shown in Fig.63 additionally has a protective cover 28 having a U-shaped section for protecting oil feed joint-in 9a and oil feed joint-out 9b, arranged within ridge-based contour 6D0. Also in this embodiment, it is possible to prevent damage to the joining parts, similarly to the ways used in embodiments 2 and 3.

(Other examples)

[0330] The present invention should not be limited to the above examples and many changes and modifications can of course be added within the scope of the present invention. For example, though in the above examples, a filler cap with a pressure valve built in was described, a pressure valve mechanism may be provided in the oil feed joining portion, instead of the filler cap. Further, in examples 2 to 4, air valve 20 shown in example 1 may also be arranged within the ridge-based contour.

[0331] As has been described heretofore, according to the present invention, fuel in the fuel supply tank is directly fed to the oil feed pump which transfers fuel to the burner unit while no fuel tank for temporarily holding the fuel is provided. Accordingly, the fuel passage can be constituted by fewer constituent parts while handling

of the fuel supply tank can be improved.

[0332] Since there is no need to temporarily hold the fuel under the fuel supply tank, design flexibility of the fuel supply tank is improved. Since the position of the fuel discharge port of the fuel supply tank is not limited to the lower part thereof and it is not necessary for the filler cap to also provide the fuel delivery function, the exterior of the filler cap will not be in contact with fuel. Accordingly, the hands will never be stained with fuel when the filler cap is opened and closed for refueling. Further, there is no concern of fuel spilling out if the filler cap becomes loose.

[0333] Moreover, since the joining means of the fuel supply tank and its impact protecting cover are arranged within the ridge-based contour in the top view of the fuel supply tank, no impacts will act on the joining means, etc., whereby it is possible to prevent damage to it.

[The fifth embodiment]

[0334] Fig.64 is a front overall view showing a kerosene fan heater including a liquid fuel burning apparatus in accordance with the fifth embodiment of the present invention. Fig.65 is an outline view showing the liquid fuel burning apparatus.

[0335] 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 6E 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.

[0336] As shown in Figs.64 and 65, 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 6E, a functional part compartment 1b for accommodating a vaporizer 12, electromagnetic pump 13 and the like and a burner unit compartment 1c including a burner 14 and a combustion chamber 15.

[0337] Arranged in tank holding compartment 1a are fuel supply tank 6E of a cartridge type which temporarily holds fuel and is detachable, oil feed side joining means 9A and 10A that create a detachable connection between fuel supply tank 6E and an oil feed passage 300 for transferring fuel from fuel supply tank 6E to the vaporizer side, and oil return side joining means 21C and 22A that create a detachable connection between fuel supply tank 6E and an oil return passage 301 for returning fuel from the vaporizer 12 side to fuel supply tank 6E. A cushioning mount base 1d for absorbing and relieving impacts acting on joining means 9A, 10A, 21C and 22A 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 9A and 10A and oil return side joining means 21C and 22A will reliably fit to each other when fuel supply tank 6E is inserted.

[0338] The oil feed side joining means is composed of an oil feed joint 9A incorporating a valve for opening and shutting the passage to the suction pipe and an oil feed joint socket 10A for receiving the valve of the oil feed joint 9A. Connected to oil feed joint socket 10A 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 6E to electromagnetic pump (oil feed pump) 13. This oil feed joint socket 10A 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.

[0339] The functional part compartment 1b is located between tank holding compartment 1a and burner unit compartment 1c and includes vaporizer 12 for evaporating fuel from fuel supply tank 6E, electromagnetic pump 13 for feeding fuel from fuel supply tank 6E to vaporizer 12, a collecting container 18 for temporarily holding partly evaporated fuel from vaporizer 12 and a cooling fin assembly 19 arranged between vaporizer 12 and collecting container 18 for cooling partly evaporated fuel.

[0340] Burner unit compartment 1c is defined by partitioning plate 16 and incorporates burner 14 that mixes evaporated fuel through vaporizer 12 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 12, burner 14 and other parts.

[0341] Oil feed passage 300 is composed of a pipe 203 connecting oil feed joint socket 10A and electromagnetic pump 13 and a pipe 204 connecting electromagnetic pump 13 and vaporizer 12. Return oil passage 301 is composed of a pipe 205 connecting vaporizer 12 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 10A. These pipes 203 to 207 are all formed of copper pipes. The pipes from fuel supply tank 6E to electromagnetic pump 13 may be formed of resin pipes or others, instead of copper pipes.

(Fuel supply tank configuration)

[0342] Fig.66 is an outline view showing a fuel supply tank, Fig.67 is a perspective view showing a joining portion of the fuel supply tank, Fig.68 is a sectional view showing the connected state of an oil feed joint and a suction pipe in the fuel supply tank, and Fig.69 is a structural view showing a return oil joint.

[0343] As illustrated, fuel supply tank 6E is formed in a vertical box-shaped configuration made up of a metallic material presenting conductivity (e.g., galvanized

steel sheet), having a handle 23 on the top face of the tank for carriage with fuel therein, a bevel 501 formed between the top face with handle 23 thereon and one side adjacent to the top face, a filler port 26 for refueling arranged on bevel 501, a shutoff means 600 for closing the filler port 26 in a rotationally openable and closable manner, an oil gauge 25 disposed on the side surface near the filler port 26 to make the supplied fuel visible, oil feed joint 9A and return oil joint 21C arranged on the side opposite to filler port 26, on the same top face as handle 23.

[0344] As shown in Fig.68, oil feed joint 9A is comprised of an inverted L-shaped connecting pipe 43A projected from the top of fuel supply tank 6E and extended sidewards of the tank and a joint body 9Aa with a built-in spindle type valve mechanism 28A, arranged at the distal end of the connecting pipe 43A.

[0345] Joint body 9Aa is formed of a vertical cylinder having a small-diametric projective cylinder 9Ab shaped at the bottom end thereof so as to be fitted into the oil feed joint socket 10A side. Further, an O-ring 41A for connection sealing is tightly fitted on the outer periphery of the cylinder 9Ab. An openable and closable lid nut 38A is screw fitted on the top opening of joint body 9Aa so as to allow valve mechanism 28A to be inserted.

[0346] Valve mechanism 28A inside joint body 9Aa is composed of a center valve hole 9Ac in small-diametric projective cylinder 9Ab of joint body 9Aa, a spindle-like valve element 31A which can fit on and separate from an inverted conical valve seat 9Ad formed in the lower part of the joint body, a spring 35A interposed between the top of valve element 31A and lid nut 38A for urging valve element 31A in the valve closing direction and an O-ring 33A for sealing fitted on the peripheral side of valve element 31A so as to oppose the valve seat. When the valve mechanism is in the closed state, the lower end of valve element 31A is set so as to project out and downward from small-diametric projective cylinder 9Ab.

[0347] Connecting pipe 43A has a suction passage 43a formed therein which communicates with the valve chamber inside joint body 9Aa and the end that is extended sidewards of the tank is integrally connected to the side part of joint body 9Aa. The lower end of connecting pipe 43A is inserted into the tank through an insert hole 46A formed on the top face of fuel supply tank 6E. The connecting pipe has a flange 43b formed in the lower part thereof so that the flange is fastened to a hole 47A on the top face of fuel supply tank 6E by a screw with a rubber packing 50A interposed therebetween. The outer peripheral side at the lower end of connecting pipe 43A is incised with a male thread, on which the upper end of a suction pipe 27A inside the fuel supply tank is screw fitted.

[0348] Suction pipe 27A almost reaches the bottom of fuel supply tank 6E and has a suction opening 44B on the side at its lower end, to which a filter 45B that blocks water and dust from permeating is fitted. This suction opening 44B may be formed at the bottom face of suction pipe 27A (see Fig.82).

[0349] Return oil joint 21C is arranged on the top face of fuel supply tank 6E at the side of oil feed joint 9A as illustrated in Fig.69 and has basically the same structure as that of oil feed joint 9A except in that no suction pipe 27A is connected and a pressure valve mechanism 700 is provided for fuel supply tank 6E. Accordingly, description will be made briefly except for the above differences.

[0350] As shown in Fig.69, return oil joint 21C is comprised of a side facing L-shaped connecting pipe 30A projected from the top of fuel supply tank 6E and extended sidewards of the tank and a joint body 21a with a built-in spindle type valve mechanism 29A, arranged at the distal end of the connecting pipe 30A.

[0351] 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 22A side. Further, an O-ring 42A for connection sealing is tightly fitted on the outer periphery of the small-diametric cylinder. An openable and closable lid nut 40A is screw fitted on the top opening of joint body 21a so as to allow valve mechanism 29A and pressure valve mechanism 700 to be inserted.

[0352] Valve mechanism 29A 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 32A which can fit on and separate from an inverted conical valve seat 21d formed in the lower part of the joint body, a spring 36A for urging valve element 32A in the valve closing direction and an O-ring 34A for sealing which is fitted on the peripheral side of valve element 32A so as to oppose the valve seat.

[0353] When valve element 32A is in its closed position, its lower end projects out and downwards from the small-diametric projective cylinder 21b. Further, this valve element is integrally has a pushing rod 709 on top which can press a ball valve piece 703 of pressure valve mechanism 700. Spring 36A is interposed between the top face of valve element 32A and the bottom face of a valve seat element 702a of pressure valve mechanism 700 which is to be described later.

[0354] Connecting pipe 30A has a return passage 30a formed therein which communicates with the valve chamber inside joint body 21a and the end that is extended sidewards of the tank is integrally connected to the side part of joint body 21a. The lower end of connecting pipe 30A is inserted into the tank through an insert hole 48A formed on the top face of fuel supply tank 6E. The connecting pipe has a flange 30b formed in the lower part so that the flange is fastened to a hole 49A on the top face of fuel supply tank 6E by a screw with a rubber packing 51A interposed therebetween.

[0355] In the present embodiment, pressure valve mechanism 700 is provided for return oil joint 21C 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 6E and in order to prevent occurrence of a negative pressure in the tank.

[0356] This pressure valve mechanism 700 is comprised of valve seat element 702a with a cylindrical valve hole 701 located over valve element 32A, 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 702a, a spring 704 for urging this ball valve piece 703 in the direction it is seated and lid nut 40A for positioning the valve seat element 702a inside joint body 21a.

[0357] Lid nut 40A has a pressure release hole 705 formed at the center thereof. Spring 704 is held between ball valve piece 703 and lid nut 40A. Valve hole 701 has a diameter adequate enough to allow pushing rod 709 of valve element 32A to pass therethrough. When return oil joint 21C is fitted and connected to return oil joint socket 22A and valve element 32A 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 40A by way of connecting pipe 30A.

[0358] In both the aforementioned oil feed joint 9A and return oil joint 21C, valve elements 31A and 32A 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 10A and return oil joint socket 22A which are arranged upwards so as to oppose them. Accordingly, just the insertion of fuel supply tank 6E into tank compartment 1a from above makes it possible to establish smooth connection between joining means 9A and 21C and between joining means 10A and 22A, both.

[0359] Fig.70 is a structural view showing oil feed side joining means 9A and 10A. Fig.71 is a structural view showing an oil feed joint socket. Fig.72 is a structural view showing a return oil side joining means. As illustrated, in tank holding compartment 1a, oil feed joint socket 10A and return oil joint socket 22A are arranged under, and opposing, oil feed joint 9A and return oil joint 21C, respectively when fuel supply tank 6E is mounted in place.

[0360] As shown in Fig.71, oil feed joint socket 10A is comprised of a hollow socket portion 61A that has a circular cross-section, opens to the top of a cylindrical socket body 10Aa to receive the small-diametric projective cylinder 9Ab at the lower end of oil feed joint 9A, and a valve mechanism 60A that is disposed in the hollow socket portion 61A and opens and closes as valve element 33A of valve mechanism 28A of oil feed joint 9A is abutted against, and separated from, socket portion 61A.

[0361] Formed at the top of hollow socket portion 61A is an annular sealing surface 67A which can make hermetic contact with the periphery of small-diametric projective cylinder 9Ab of oil feed joint 9A. Further, a valve support holder 68A is indented in the bottom of socket portion 61A. A valve support 65A is fitted in this valve support holder 68A. Valve support 65A is formed with a valve hole 60b which communicates with a valve chamber 60a formed in the lower part of socket body 10Aa while grating channels 66A for allowing fuel to flow are formed around the valve hole.

[0362] Valve mechanism 60A is composed of a valve element 62A 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 61A side, a spring 63A interposed between the head of the valve element 62A and valve support 65A so as to urge valve element 62A in the valve closing direction, and an O-ring 64A tightly fitted on valve element 62A on its valve chamber 60a side to seal against the valve seat. This valve mechanism 60A is adapted to open the valve when valve element 33A of oil feed joint 9A comes into pressure contact with the head of valve element 62A on the socket side and close the valve when it separates from the head of valve element 62A.

[0363] Formed in the lower part of valve chamber 60a of socket body 10Aa is a conduit 69A communicating with pipe 203 which is connected to electromagnetic pump 13. A conduit 70A for air valve 20 is formed on the side part of valve chamber 60a. This conduit 70A is positioned at a level higher than the liquid level of fuel in the fuel supply tank when it is full.

[0364] 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 6E 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 70A when it is magnetized and a spring 20c urging valve piece 20a in the valve opening direction.

[0365] 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 12 by actuation of electromagnetic pump 13.

[0366] On the other hand, return oil joint socket 22A basically has the same configuration as that of oil feed joint socket 10A except in that it does not have any air valve 20. Accordingly, briefly explaining the structure, return oil joint socket 22A, as shown in Fig.72, is comprised of a hollow socket portion 72A formed on the top face of a socket body 22a and a valve mechanism 71A that is disposed in this socket portion 72A and opens and closes as a valve element 32A of a valve mechanism 29A of return oil joint 21C is abutted against it and separated from it.

[0367] Formed at the top of socket portion 72A is an annular sealing surface 78A. Further, a valve support

holder 79A is indented in the bottom of socket portion 72A. A valve support 76A is fitted in this valve support holder 79A. Valve support 76A 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 77A for allowing fuel to flow are formed around the valve hole.

[0368] Valve mechanism 71A is composed of a valve element 73A 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 72A side, a spring 74A interposed between the head of the valve element 73A and valve support 72A so as to urge valve element 73A in the valve closing direction, and a sealing O-ring 75A tightly fitted on valve element 73A on its valve chamber 71a side. This valve mechanism 71A is adapted to open the valve when valve element 32A of return oil joint 21C comes into pressure contact with the head of valve element 73A on the socket side and close the valve when it separates from the head of valve element 73A. Formed in the lower part of valve chamber 71a of socket body 22a is a conduit 80A communicating with pipe 207 which is connected to collecting container 18.

[0369] In the above configuration of the fuel supply tank 6E, joining means 9A, 10A, 21C and 22A, when fuel supply tank 6E is set into tank holding compartment 1a of main body 1 from above, oil feed joint 9A and return oil joint 21C as the joining means are fitted to the predetermined positions of oil feed joint socket 10A and return oil joint socket 22A, so that O-rings 41A and 42A on their sides of small-diametric projective portions 9Ab and 21b of joint bodies 9Aa and 21a abut against sealing surface 67 of oil feed joint socket 10A and sealing surface 78A of return oil joint socket 22A, forming hermetic states. At the same time, in each joint, valve mechanism 28A or 29A is mated with socket side valve mechanism 60A or 71A, so that mating valve elements push each other, forming a valve-open state.

[0370] Further, on the return oil joint 21C side, valve element 32A 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 703 upwards, and valve hole 701 opens. Accordingly, a communication passage is formed from the tank to valve hole 701 and pressure release hole 705 in joint body 21a by way of connecting pipe 30A, 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 as well as to prevent occurrence of a negative pressure inside the tank.

(Filler port configuration)

[0371] Fig.73 is a side view showing a fuel supply tank; Fig. 74 is a sectional view showing a filler port and thereabout when the fuel supply tank is set in the main body; and Fig.75 is a sectional view showing a filler port and thereabout when the fuel supply tank is taken out from the main body.

[0372] As illustrated, in fuel supply tank 6E, a bevel 501 that extends at a predetermined angle downwards from the top face 6d to the side 6E which should adjoin to the top face, is formed. Filler port 26 is located on this bevel 501. The angle of inclination of bevel 501 is designated so that the volume reduction of the fuel supply tank is minimal, and yet filler port 26 cannot be opened and closed when the tank is mounted in the main body.

[0373] Filler port 26 is shut off by a pivotal lid component. Specifically, a shutoff means 600 of filler port 26, as shown in Fig.74, is composed of a fixing plate 601 which has an opening fitted to the filler port 26 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 26a of filler port 28A, 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 26a of filler port 26, and an engaging means 607 for keeping moving plate 603 in its filler port closed position.

[0374] Fixing plate 601 extends from bevel 501 to the tank top face and has a shaft support (not shown), in that extended part, which pivotally supports handle 21C 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.

[0375] 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 26a. Spring element 606 is disposed in the inner space between moving plate 603 and lid part 605.

[0376] 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.

[0377] 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.

[0378] Engaging hold 616 has a space for permitting engaging piece 614 to enter between itself and the side wall of mouth 26a and opens to the mouth 26a side, so as to engage engaging piece 614, in a detachable manner.

[0379] 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.

[0380] 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 is released. However, since the filler port is provided on bevel 501 and since engaging lever 615 is formed with extended part 620, if engaging lever 615 is tried to be rotated and released, engaging lever 615 is hidden by moving plate 603 when tank 6E 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. Therefore, no refueling is allowed unless fuel supply tank 6E is taken out from the main body. Thus, fuel will never spill into the main body when refueled. 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.

(Tank bottom arrangement)

[0381] Fig.76 is a sectional view showing an arrangement of the tank bottom; Fig.77 is a sectional view showing the interior of the same tank; and Fig.79 is a perspective view showing a water receptacle attachment hole in the tank bottom. As illustrated, fuel supply tank 6E of this embodiment has, at its bottom, a fuel quantity detecting means 750 (Fig.77) for detecting the amount of fuel in the fuel supply tank, a water detecting means W for detecting condensation of water arising in the fuel supply tank, and a tank insertion detecting means 900 for detecting whether the fuel supply tank is mounted in the main body.

[0382] Tank placement board 1d 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 W1 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 fitted in a hollow 8a of the base.

[0383] Water detecting means W is comprised of a conductive water receptacle W1 which is arranged at the conductive tank bottom to collect condensation of water, an electrode W2 in contact with the water receptacle W1, an electrode W3 in contact with the bottom of fuel supply tank 6E and an insulating water-tight packing W4 which provides electric insulation between water receptacle W1 and fuel supply tank 6E, and is adapted to detect water based on the difference in electric resistance between fuel and water collected in water receptacle W1.

[0384] Water receptacle W1 is formed of a stainless steel sheet, separately from tank 6E, in order to prevent rust, and has an upper side concave similar to a dish and a peripheral flange W7 extending radially outwards, and is attached to the bottom of fuel supply tank 6E with the flange W7 fixed to a bottom-side attachment hole W5 with rubber packing W4 interposed therebetween.

[0385] Packing W4 is a resilient non-conductive member interposed between the peripheral wall of bottom-side attachment hole W5 of fuel supply tank 6E and peripheral flange W7 of water receptacle W1, and holds water receptacle W1 so as to grip flange W7 between its upper and lower parts. Packing W4 is fixed around tank attachment hole W5 by means of an annular bracing member W9 disposed at the underside thereof, with screws W10. Thus, water receptacle W1 is fixed in a water-tight manner to attachment hole W5.

[0386] This rubber packing W4 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 6E 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.

[0387] Electrode W2 on the water receptacle W1 side and electrode W3 on the tank side are both attached to the tank placement board 1d outside the fuel supply tank. Water receptacle W1 side electrode W2 is anee-

dle-like electrode which is projected from the bottom wall of water receptacle depressed holder 754 to the tank side and in contact with the external surface of water receptacle W1 when the tank is set in place. Tank side electrode W3 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 W2, water receptacle W1, fuel or water on the inner surface, tank bottom surface 6b, tank side electrode W3, 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 W1.

[0388] In order to enhance the accuracy of water detection, the opening wall of attachment hole W5 on the tank side, which water receptacle W1 fits, is bent downwards forming a bent portion W11 while a multiple number of needle portions W12 of a narrow sharpened tip are projected downwards at intervals along the circumference of the bent portion W11. These needle portions W12 function as the tank side front electrodes and are electrically connected through the tank bottom to tank side electrode W3. Suction port 44B for suctioning fuel from the tank is positioned above needle portions W12 so that it will not directly suction water from the water pool in the water receptacle W1. Further, the areas other than the inner side and outer side of the bottom of water receptacle W1 are coated with a non-conductive paint or the like, whereby malfunction is prevented even if water is left covering packing W4 and metal parts of fuel supply tank 6E.

[0389] Further, when the inner surface of fuel supply tank 6E above the suction port 44B for suctioning fuel from the tank is coatedwith 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.

[0390] A tank die 901 for guarding water receptacle W1 is welded around conductive water receptacle W1 in the bottom face of fuel supply tank 6E. 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 6E, has a height greater than that of water receptacle W1, and is formed at the periphery. Therefore, if, upon refueling fuel supply tank 6E 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 6E or water receptacle W1, it is possible to prevent the tank bottom face and water receptacle W1 from being damaged or pitted, whereby it is possible to prevent malfunction in water detection.

[0391] Fuel quantity detecting means 750 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.

[0392] 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 W1 of water detecting means W. 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 6E. Therefore, if this guide 754 is of metal, it should be machined so as not to form burrs inside.

[0393] Accordingly, when the surface of fuel reaches a certain level as the fuel inside fuel supply tank 6E is used, lead switch 753 detects magnetism from the magnet in float 752 and sends the detection to controller 950, so that warnings of the end of fuel and the like can be given through a display 952.

[0394] Tank insertion detecting means 900 is constituted of a micro-switch 901 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 6E is set on the placement surface 757, moving contact 901b is pressed down by the tank so as to retract actuating the switch.

[0395] Fig.79 is a block diagram showing a control circuit for controlling various modes of operation in accordance with the signals from fuel quantity detecting means 750, water detecting means W and tank insertion detecting means 900. As illustrated, controller 950 is constituted of a microcomputer incorporating a CPU, ROM and RAM, and connected on its input side to fuel quantity detecting means 750, water detecting means W and tank insertion detecting means 900 while the output side is connected to an electromagnetic pump driver circuit 951, display 952 and a valve drive circuit 953, so that it can control the operation in accordance with various input signals.

[0396] For example, when tank insertion detecting means 900 is turned off (no tank) by removal of the fuel supply tank during operation, the controller receives the signal and outputs an electromagnetic pump cutoff signal to pump driver circuit 951 and also outputs an open signal for air valve 20 to valve drive circuit 953 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 12 when tank insertion detecting means 900 is on.

[0397] Cleaning by baking refers to baking of impurities built up in the vaporizer by sending air instead of fuel to vaporizer 12 by opening air valve 20 while the apparatus is not in operation. The cleaning by baking is performed such that, when the bake-cleaning switch

(not shown) is turned on, the temperature of vaporizer 12 is heated up to the bake-cleaning temperature and then air valve 20 is opened while electromagnetic pump 13 is actuated to send air into the vaporizer side.

[0398] Under the above control, air is suctioned from air valve 20 because the atmospheric pressure of air entering through air valve 20 is higher than the pressure inside fuel supply tank 6E, and is sent to the vaporizer 12 side so that impurities can be baked together with air in vaporizer 12 at an elevated temperature for a predetermined period of time, whereby vaporizer 12 is cleaned. In this cleaning operation by baking, no means of removing fuel from the oil feed passage is needed, so that no tedious work of removing fuel from the oil feed passage is required.

[0399] Controller 950 is also able to perform control of driving electromagnetic pump 13 to start the operation in accordance with the operation command from the operation switch (not shown) when tank insertion detecting means 900 is in the ON state and the fuel quantity detecting means for detecting the amount of fuel is in the OFF state (fuel present). Further, it is also possible to perform control of stopping the operation when tank insertion means 900 is in the ON state(the tank inserted) during the burning operation 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 display 952 when the ON state of the fuel quantity detecting means 750 (no fuel present) is detected.

[0400] The configurations of the vaporizer, burner, electromagnetic pump, collecting container, cooling fin assembly are the same as those described above so that the description is omitted.

(The operation of the kerosene fan heater)

[0401] The operation of the kerosene fan heater will be described. When fuel supply tank 6E is empty, fuel is charged into fuel supply tank 6E through filler port 26 by opening lid 7 of main body 1, taking out the fuel supply tank by holding handle 23 and releasing shutoff means 600 with the handle 23 side up.

[0402] When refueling is completed, the fuel supply tank 6E 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.71 and 73, valve element 31A in valve mechanism 28A of oil feed joint 9A and valve element 32A in valve mechanism 29A of the return oil joint 21C, of fuel supply tank 6E, press valve element 62A of valve mechanism 60A of oil feed joint socket 10A and valve element 73A of valve mechanism 71A of the return oil joint socket 22A, respectively, and the valve elements 62A and 73A move down.

[0403] As the head parts 62a and 73a of these valve elements 62A and 73A abut the respective top faces of valve supports 61A and 72A, valve element 31A of valve mechanism 28A of oil feed joint 9A and valve element 32A of valve mechanism 29A of return oil joint 21C move upwards so that urging springs 35A and 36A which have urged in the valve closing direction become compressed, whereby the O-rings 33A and 34A forming sealing surfaces of valve elements 31A and 32A depart from the respective sealing surfaces of oil feed joint 9A and return oil joint 21C, forming clearances, which open oil feed passage 300 for fuel to flow to the electromagnetic pump 13 side and return oil passage 301 from collecting container 18 to fuel supply tank 6E.

[0404] 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 vaporizer thermistor (not shown) detects the temperature of the vaporizer 12. When vaporizer 12 is heated to a predetermined temperature, electromagnetic pump 13 is driven so as to suction liquid fuel inside fuel supply tank 6E through suction pipe 27A and sends it to vaporizer 12 by way of oil feed joint 9A and oil feed joint socket 10A. The liquid fuel is gasified by the heated vaporizer 12 and the gas is ejected from flame port 95 of burner 14, ignited at the flame port 95 to burn in combustion chamber 15.

[0405] 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 controller 950 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.

[0406] When combustion starts and the flame sensor 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 controlled at an optimal temperature.

(Example 2)

[0407] Fig. 80 is a perspective view showing an example 2 relating to the position of a filler port formed at the top of a fuel supply tank. In this example, a bevel 501 cut at a fixed inclination is formed straddling top face 6d of the fuel supply tank and two adjacent sides 6e and 6e so that a filler port 26 and a shutoff means 600 for closing the port in a pivotally openable and closable manner. An oil gauge 25 for allowing visible indication of a full state is arranged together with and near filler port 26 on the bevel.

[0408] In the above configuration, bevel 501 is formed

at a fixed angle such that it cuts a minimum volume of the tank. Since oil gauge 25 is laid out near oil port 26 in bevel 501, refueling can be done whilst oil gauge 25 is being checked. Therefore, it is possible to prevent fuel from overflowing. Further, oil gauge 25 can be viewed at an easy angle compared to configurations where the oil gauge is arranged on the tank side. Other configurations and operations are the same as those in the first embodiment.

(Example 3)

[0409] Fig.81 shows an example 3 of a fuel supply tank. In this example, a filler port 26 is formed on the upper side face of a fuel supply tank 6F with a filler cap 24 screw fitted to this filler port 26, so that filler port 26 cannot be opened when the tank is mounted in the main body.

[0410] Arranged at the bottom of tank 6F are a tank insertion detecting means 900a, a water detecting means W and a fuel quantity detecting means 750. Tank insertion detecting means 900a is comprised of a magnet 910 disposed in the depressed portion in the bottom of tank 6F and a lead switch 911 disposed on the tank placement board 1d side, opposing this magnet 910.

[0411] Water detecting means W has the same configuration as that in the above first embodiment. Fuel quantity detecting means 750 includes a guide rod 760 fixed upright on a water receptacle W1 and a magnet float 761 guided so as to vertically move along the guide rod as the liquid surface of fuel varies. Similarly to the first embodiment, a lead switch is arranged on the tank placement board 1d side opposing this float 761, so that the end of fuel can be detected by actuation of the lead switch in accordance with the vertical movement of the float. Other configurations are the same as in the above first embodiment, so that description is omitted.

(Example 4)

[0412] Fig.82 is a sectional view showing an example 4 of a fuel quantity detecting means. In the above first and second embodiments, as a fuel quantity detecting means 750, float 761 is arranged in water receptacle W1, but as shown in Fig. 82, the float may be arranged at the lower part of a suction pipe 27A. Specifically, a cylindrical float 761 incorporating a magnet 763 on the inner surface thereof may be externally fitted so as to move vertically with respect to a cylindrical suction port body 766 which is externally fixed at the bottom end of suction pipe 27A while a lead switch 753 is incorporated in suction port body 766 so as to detect the magnet to sense the end of fuel. Other configurations are the same as in the above embodiments, so that description is omitted.

(Other examples)

[0413] The present invention should not be limited to the above embodiments and many changes and modifications can be added within the scope of the present invention. For example, in the above description of the embodiment, the oil feed joint and the return oil joint are extended sidewards from the top face of the fuel supply tank, but the present invention should not be limited to this. These joints may be projected from the side instead of the top face, as long as they are arranged in the upper part of the fuel supply tank.

[0414] Further, though the above embodiments include all of the tank insertion detecting means, fuel quantity detecting means and water detecting means, one or combination of the two means from these alone may be used to configure the system. Similarly, concerning the control operation by the controller, control of the operation may be made based on input signals from one or combination of two means selected from the tank insertion detecting means, fuel quantity detecting means and water detecting means.

[0415] As has been described heretofore, according to the present invention, since fuel in the fuel supply tank is directly fed to the oil feed pump while no fuel tank for temporarily holding the fuel is provided, there is no need for the filler port of the fuel supply tank to be set to the fuel tank, hence there is no possibility of the filler port cap being wetted with fuel from a fuel tank. Particularly, since no fuel tank is needed, the number of constituent parts can be reduced.

[0416] Moreover, since at least one device of tank insertion detecting means, fuel quantity detecting means and water detecting means, is provided on the bottom face of the fuel supply tank so as to control the operation state based on the input signals from these, it is possible to improve the operativity.

[The sixth embodiment]

[0417] Fig.83 is a perspective view showing a kerosene space heater in accordance with the present invention, viewed from the front side of the body. Fig.84 is a perspective view showing the same kerosene space heater, viewed from the back side of the body. As shown in Figs.83 and 84, in this kerosene space heater, the external housing of a main body A1 for accommodating a burner unit and a fuel supply tank is formed of a box with the bottom open, composed of a front panel A6 for covering the front side, a side/rear panel A7 for covering the sides and backside and a top plate A8 for covering the top face, and this main body A1 is set on a base board A5.

[0418] Formed in the lower part of front panel A6 is an air outlet A2 for blowing warm air to the room. A control portion A3 including switches for changing operational states is disposed in the upper part of front panel A6. An output port A4b for a fuel supply tank is formed

on the top plate A8 and the output port A4b is covered with an openable tank lid A4.

[0419] Provided on the backside of the side/rear panel A7 (Fig.84) is a convection fan A9 for suctioning air from the room. This convection fan A9 is covered with a convection guard A10 of mesh so as to prevent dirt from being suctioned. Further, a temperature sensor A11 for detecting the room temperature is disposed on the backside of side/rear panel A7.

[0420] Fig.85 is an outline view showing a liquid fuel burning apparatus and its fuel paths in a kerosene space heater shown in Fig.83. A liquid fuel burning apparatus A comprises: a fuel supply tank A12 which is detachable from main body A1; a first joining means A13 and second joining means A17 for making connection between fuel supply tank A12 and a vaporizer A15 of a burner unit A25 when fuel supply tank A12 is inserted into the main body; an electromagnetic pump A14 as an oil feed pump for transferring fuel from fuel supply tank A12; vaporizer A15 for heating fuel from electromagnetic pump A14 to gasify it; a burner A16 for emitting gasified fuel from vaporizer A15 from a nozzle, mixing it with combustion air and burning the mixture; and an air valve A18 as a shutoff valve for shutting off fuel supply to the electromagnetic pump A14 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 A12 to vaporizer A15 and a return oil passage C for returning partly evaporated fuel from vaporizer A15 to fuel supply tank A12 are created.

[0421] In oil feed passage B, a pipe A21 is provided to make connection between the first joining means A13 on the oil feed side in the fuel supply tank and electromagnetic pump A14 while a pipe A22 is provided to complete the connection between electromagnetic pump A14 and vaporizer A15. In return oil passage C, a return oil pipe A23 is provided to make connection between vaporizer A15 and the second joining means A17 on the return oil side.

[0422] Joining means A13 and A17 for joining fuel supply tank A12 and burner unit A25 is composed of the first joining means A13 arranged halfway along the oil feed passage B from fuel supply tank A12 to electromagnetic pump A14 and the second joining means A17 arranged halfway along the return oil passage C for returning partly evaporated fuel from vaporizer A15 to fuel supply tank A12. Each of joining means A13 and A 17 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 A13a and A17a of the first and second joining means A13 and A17 are integrated on the fuel supply tank A12 side, forming a joint unit A47 while connecting joint sockets A13b and A17b of the first and second joining means A13 and A17 are integrated on the burner side, forming a joint socket unit A100 (Fig.107). Thus, the joining means is provided in a compact configuration.

[0423] Fig.86 is a view showing a state of the main body shown in Fig.83 with its front panel partially cut away. As illustrated, in the front view of main body A1, burner unit A25 is disposed on the left side, and fuel supply tank A12 and electromagnetic pump A14 are on the right side. The left side of main body A1 is comprised of burner unit A25 incorporating burner A16 and vaporizer A15, a burner unit frame A26 for enclosing burner unit A25 and a burner unit front frame A27 for covering the front and upper part of burner unit frame A26.

[0424] Burner unit A25 includes vaporizer A15, burner A16, a burner box A28 for accommodating burner A16, a burner partition board A29 for fixing burner box A28 and a combustion chamber A30 enclosing flame from burner A16.

[0425] Figs.87 and 88 are structural views showing vaporizer A15 and burner A16. As illustrated, vaporizer A15 is comprised of a vaporizing element A15a for vaporizing the fuel existing therein by heating, a nozzle A31 for ejecting the evaporated fuel by the vaporizing element A15a, a needle A32 that opens and closes the hole of the nozzle A31, a solenoid valve A33 that is linked to this needle A32 for moving needle A32, a fuel entrance A15b for supplying fuel to vaporizing element A15a, a return oil pipe A23 for returning the fuel inside vaporizer A15 when the operation stops and a heat collector A15c for collecting combustion heat from burner A16.

[0426] Vaporizing element A15a is a sintered cylinder made of fine ceramic particles, and tar generated when fuel evaporates accumulates inside vaporizing element A15a from its surface inwards.

[0427] Fuel entrance A15b to vaporizer A15 has a double pipe structure of an outer stainless pipe A34 and an inner copper pipe A22. Outer stainless pipe A34 is used to reduce heat conduction from vaporizer A15 and suppress temperature rise of the fuel entering vaporizer A15. Further, stainless pipe A34 is made greater in diameter than the copper pipe so as to further inhibit heat conduction from stainless pipe A34 to the copper pipe. The end of copper pipe A22 is located at a position outside vaporizer A15.

[0428] Solenoid valve A33 is composed of an electromagnetic coil A33a made up of wire wound in a coil, a moving piece A33b which is located inside the coil and axially movable together with needle A32, an attracting piece A33c for attracting moving piece A33b to move in the nozzle closing direction by magnetization of electromagnetic coil A33a and a pressing spring A33d for urging moving piece A33b in the nozzle opening direction.

[0429] In the thus configured solenoid valve A33, activation and deactivation of electromagnetic coil A33a causes moving piece A33b to be attracted to and separated from attracting piece A33c, so that needle A32 linked with moving piece A33b moves to thereby open and close the hole of nozzle A31 of vaporizer A15.

[0430] Burner A16 is composed of a mixing tube A16a for mixing the combustion gas evaporated through va-

porizer A15 with primary combustion air and a flame port A16b for burning the mixed combustion gas.

[0431] As shown in Figs.89 and 90, burner box A28 has a top-open box configuration capable of accommodating burner A16, with an approximately rectangular hole formed in the bottom for attaching a flange of the mixing tube of burner A16 and with attachment holes for an ignition heater A35 and flame sensor A36 formed on one side face.

[0432] Attached to the underside of burner box A28 is a burner cover A37. This burner cover A37, having an inverted triangular shape and being arranged under burner A16, has a sound absorbing and heat insulating material applied on the inner side thereof and is fixed to burner box A28, so as to absorb flame noise and prevent reduction of the temperature of the burner itself.

[0433] As shown in Figs.89 and 90, burner partition board A29 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 A28 is fixed, so that combustion flame from burner A16 passes through the rectangular hole. Further, partition board A29 has at its periphery a number of attachment holes for combustion chamber A30.

[0434] As shown in Fig.89, combustion chamber A30 surrounds the combustion flame from burner A16 on all sides, having an opening on the upper and front side. This chamber is composed of a combustion chamber front A38 and a combustion chamber rear A39.

[0435] Combustion chamber front A38 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 A29. Further combustion chamber front A38 is made of a heat-resisting material so that it will not be incinerated in case abnormal combustion occurs.

[0436] Combustion chamber rear A39 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 A38. The upper part of the backside wall of combustion chamber rear A39 is inclined inwards while the lower part is bent outwards and fixed to partition board A29. Cut and upturned pieces A39a and A39b are formed in each of the left and right sides of combustion chamber rear A39, so that part of air flow from convention fan A9 can be introduced into combustion chamber A30 as secondary combustion air to improve the flammability and reduce the burning temperature.

[0437] The upper part of the backside portion of combustion chamber rear A39 is cut and press formed so as to be projected inwards in an open-V shape forming air holes A39c, whereby part of air from convection fan A9 located on the rear side thereof is flowed into combustion chamber A30 as secondary combustion air, thus suppressing the combustion flame from emerging. Combustion chamber front A38 and rear A39 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.

[0438] As shown in Fig.89, burner unit frame A26 is configured of an inverted U-shaped box so as to surround combustion chamber A30 and create air flow passage, through which air suctioned from the room by convention fan A9 will pass, absorbing heat from combustion chamber A30. This burner unit frame A26 is fixed to the left side and backside of side/rear panel A7 of main body A1 and base board A5 by claws and screws. Burner unit frame A26 has a bevel A26a 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 A2 is fixed. A burner unit frame front A27 can be attached to bevel A26a after mounting burner unit A25 including burner A16 and vaporizer A15 into burner unit frame A26, obliquely from the upper and front part of main body A1.

[0439] Burner unit frame A27 is to guide air suctioned by convention fan A9 toward air outlet A2 on the front side of main body A1, and has an overheat protector on the front side thereof in order to protect the main body when the air rate of the convention fan decreases for some reason or other. Further, burner unit frame front A27 has a double-fold configuration so as to avoid local thermal influence.

[0440] As shown in Fig.92, main body A1 has, on its right side, a holding portion A4a for accommodating fuel supply tank A12 in a detachable manner by opening and closing tank lid A4 on the top face of main body A1 and a detector board A40 (Fig. 86) arranged at the bottom of the holding portion A4a having parts of the aftermentioned fuel quantity detecting means A69 and water detecting means A70. Further, joint socket unit A100 (Fig. 107) on the burner unit side is arranged inside holding portion A4a, to detachably receive connecting joint unit A47 on the fuel supply tank side when fuel supply tank A12 is mounted into the main body.

[0441] Tank holding compartment A4a is partitioned by a tank guide A41 (Fig.86) for guiding fuel supply tank A12 when the tank is mounted and removed. The right front part of this tank guide A41 is cut obliquely, and a tank guide fixture A42 for fixing joint socket unit A100 is attached to this part. Here, since no fuel tank, as used conventionally, exits in holding compartment A4a, 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.

[0442] The configuration of the insertion port including tank output port A4b (Fig.92) of holding portion A4a is formed as shown in Fig.92 in an approximately similar manner to, but marginally greater than, the top view of fuel supply tank A12, and its left side is substantially perpendicular to the front and rear sides of main body A1

while the right side is substantially perpendicular to the front and rear sides of main body A1 with two corners, front and rear, rounded. As shown in Fig.101, in the front right corner, tank guide fixture A42 for supporting connecting joint socket unit A100 on the burner unit side is disposed at a lower position a predetermined distance away from top face A8 of main body A1.

(Fuel supply tank configuration)

[0443] Fig.91 is a perspective view showing fuel supply tank A12 from the backside. Fig.92 is a plan view showing the fuel supply tank in its inserted state in tank holding compartment A4a. As illustrated, fuel supply tank A12 has a roughly parallelepiped configuration, made up of a substantially flat, fuel supply tank left part A12a and a fuel supply tank right part A12b 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.

[0444] Therefore, upon insertion of fuel supply tank A12 into holding compartment A4a, if the tank is attempted to be inserted into holding compartment A4a with its right-side left as indicated by the two-dot chain line in Fig.92, the front and rear corners of fuel supply tank right A12b collide with the front and rear rounded corners on the right side of the tank output port A4b, so that tank A12 is prohibited from being inserted.

[0445] Provided on the fuel supply tank right part A12b side are a handle A43 composed of a metal ring A43b attached to the tank top face so as to be upright and laid down and a resin grip A43a fixed at the center, a filler port A44 for refueling, formed on a bevel A12c extending over three faces, i.e., the two neighboring sides and the top face, and a shutoff means A19 for closing this filler port A44.

[0446] An oil gauge for visible indication of the liquid level of fuel in fuel supply tank A12 is provided on one side face adjacent to closing means A19. 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 A12d set back and inwards so that connecting joint unit A47 on the fuel supply tank side is fixed in this depressed portion A12d. This connecting joint unit A47 is fixed to depressed portion A12d 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 A4a.

[0447] A water receptacle A71 as a part of a water detecting means A68 (Fig.91) for detecting water in tank A12 is projected on the underside of fuel supply tank A12. In order to protect this water receptacle A71, a tank leg portion A50 projected downwards is welded around it.

[0448] A small air hole A51 (of about 1.5 mm in diameter) is formed on the top face of fuel supply tank A12 so as to prevent a negative pressure state from occurring inside fuel supply tank A12. This air hole A51 is formed with an air hole shutoff means A52 (Fig.93) for closing air hole A51 so that no fuel inside tank A12 will leak through air hole A51 in case fuel supply tank A12 falls down.

[0449] Fig.93 is a sectional view showing air hole shutoff means A52. As illustrated, air hole shutoff means A52 is of a bellow type, and is composed of a bellow A48 provided on the interior side of air hole A51 and an annular bellow guide A49 for supporting the bellow therein. Bellow A48 is made of elastic rubber with its circumference A48b and central part A48c thick while other parts are formed to be thin and a small hole A48a is formed in the thin part. Bellow guide A49 has a Z-shaped section so as to press and brace the circumference A48b of bellow A48 and has a hole A49a formed in the center thereof.

[0450] With the above arrangement, in case fuel supply tank A21 falls down, fuel in fuel supply tank A12 comes into contact with bellow A48 inside bellow guide A49 and moves bellow A48 toward air hole A51, so that the central thick portion A48c of bellow A48 shuts off air hole A51, whereby fuel will not leak out from fuel supply tank A12 through air hole A51. In the ordinary state, air can be exchanged through small hole A48a of bellow A48.

(The connecting joint configuration)

[0451] Fig.94 is a perspective view showing the structure of the connecting joint unit; Fig.95 is a sectional view showing joint A13a on the oil feed side; Fig.96 is an exploded perspective view showing its connection with suction pipe A20 on the tank side; Fig.97 is a sectional view showing joint A17a on the return oil side; and Fig.98 is an exploded perspective view showing its connection with a pipe A63 on the tank side.

[0452] As shown in Fig.94, connecting joint unit A47 on the tank side is an integrated structure of connecting joint A13a on the oil feed side and connecting joint A17a on the return oil side. Each of connecting joints A13a and A17a is comprised of a joint body A55, a valve mechanism A56 and a valve bracing A57. Each proximal flange A55d of body A55 is connected to the other so as to be integrated. This connecting joint unit A47 is arranged in depressed portion A12d formed at the right front corner on the side part of fuel supply tank A12 and is fixed to the bottom of depressed portion A12d of fuel supply tank A12 with a packing A53 therebetween, by a joint bracing plate A54 being fixed by screws A54f.

[0453] Each joint body A55 is made up of synthetic resin and is comprised, as shown in Fig.95, of a cylindrical barrel A55a on the front end side, a projected pipe portion A55e or A55f, projected from barrel body A55a towards the fuel supply tank side and a proximal flange 55d extended radially outwards from a mid portion of the

projected portion A55e. These joint bodies are integrated by joining proximal flanges A55d of two connecting joints A13a and A17a to each other.

[0454] Barrel portion A55a is continuously integrated with a tubular tapered portion (sealing surface) A55b which gradually becomes smaller in diameter from the lower end of the barrel downwards and a cylindrical portion 55c having a predetermined length with a constant diameter equal to the predetermined diameter at the lower end of the tapered portion A55b. This integration incorporates a valve mechanism A56 therein.

[0455] Each valve mechanism A56 incorporated in cylindrical barrel portion A55a is to shut off oil feed path B from fuel supply tank A12 to electromagnetic pump A14 (Fig.85) or a return oil path C from vaporizer A15 to fuel supply tank A12 in an openable and closable manner, and is composed of a valve element A59, an O-ring A60 fitted on the valve element and a spring A61 for the valve element.

[0456] Valve element A59 has a shape approximately analogous to the inside shape of the funnel-like portion made up of barrel portion A55a, tapered portion A55b and tubular portion A55c of joint body A55, and has a configuration which can reciprocate inside joint body A55. Specifically, valve element A59 is comprised of a plug portion (sealing surface) A59b having an approximately conical shape and a column-like movable portion A59a which is extended from the lower end of plug portion A59b and is narrower and longer than the cylindrical portion A55c. An annular O-ring packing A60 is provided at the tapered portion of plug portion A59b so that the packing will be able to come into sealing contact with tapered portion A55b of joint body A55.

[0457] In order to regulate contact and separation between plug portion A59b and tapered portion A55b of joint body A55, the length of movable portion A59a is designated so that its front end projects out from the cylindrical portion A55a when the valve is closed or when O-ring A60 of plug portion A59b is placed in sealing contact with the inner surface of tapered portion A55b.

[0458] Valve bracing A57 hermetically confines the top hole of barrel cylinder A55a with an O-ring A58 interposed therebetween and has an annular groove formed on its underside for easily receiving valve element spring A61.

[0459] Valve element spring A61 is held within barrel portion A55a, being interposed between valve bracing A57 at the top and plug portion A59b of valve element A59 so as to urge valve element A59 in the valve closing direction.

[0460] Each proximal flange A55d is extended radially outwards, forming an approximately rectangular plate in order to integrally join the two joints A13a and A17a. Annular joint packing A53 is externally fitted inside this flange A55d so as prevent fuel leakage from the boundary of projected portion A55e or A55f.

[0461] Each of projected portions A55e and A55f on the tank side is formed to be tubular, and the proximal extension beyond proximal flange A55d is inserted into fuel supply tank 12 through an opening A64 formed in the tank wall, so that the end part of suction pipe A20 or return pipe A63 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 A55a side.

[0462] As shown in Fig.97, the interior passage of projected portion A55e or A55f is composed of a portion having a diameter to snugly hold suction pip A20 or return pipe A63 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 A55r formed between the large-diametric passage A55q and the small-diametric passage A55s on the distal side is adapted to position a bead portion A20a of suction pipe 20A or A63a (Fig.98) of return pipe A63. Small-diametric passage A55s (Fig.97) is made to communicate with the valve chamber in barrel portion A55a (Fig.95).

[0463] Slit gaps A55g (Fig.96) and A55m (Fig.98) penetrating through in the radial direction are formed on the proximal side of projected portions A55e (Figs.95 and 96) and A55f (Fig.97), respectively, so as to allow the projected portions to spread in diameter by elasticity. Insertion grooves A55J or 55n (Fig.96(b), Fig.98(b)), which are engageable with a bead portion A65a of a stopper element A65 for suction pipe A20 or return pipe A63, are formed on the interior surface of the pipe, between the slit gaps A55g or A55m.

[0464] As shown in Fig.96, the interior part of projected portion A55e on the oil feed side is set to be shorter than that of projected portion A55f (Fig.98) on the return oil side so as to facilitate connection of suction pipe 20.

[0465] Suction pipe A20 is formed in an inverted L-shape with its upper horizontal portion connected to oil feed joint A13a (Fig.95) while the lower end of the vertical portion reaches almost the bottom of fuel supply tank A12 and connected to a suction port A66 (Fig.100) in order to suction fuel in fuel supply tank A12. A flange-like bead portion A20a (Fig.96) is formed at the distal end of the horizontal portion of suction pipe A20 for positioning an O-ring when the pipe is connected to connecting joint A47.

[0466] The projected portion A55f (Fig.98) on the return oil side is longer than projected portion A55e on the oil feed side and formed with upper and lower slit gaps A55k and A55m. Of the upper and lower slit gaps A55k and A55m, the upper slit gap A55k is formed greater than the lower slit gap A55m. This projected portion has an inside diameter slightly greater than the outside diameter of return pipe A63, and has a bore therein to which return pipe A63 is inserted and a bead fitting groove A55n formed outwards on the interior surface of the bore for mating a bead portion A65a on a pipe fixing member A65.

[0467] Return pipe A63 is to return partly evaporated fuel from vaporizer A12 to fuel supply tank A12, and is

bent in an L-shape inside fuel supply tank A12 so that its pipe outlet A63b is oriented upwards. With this arrangement, the pipe outlet A63b can be kept projected upward above the liquid level of fuel in fuel supply tank A12 even in case the liquid level of fuel in fuel supply tank A12 abnormally rises due to temperature difference, to thereby prevent incidental fuel leakage toward the burner unit side.

[0468] As the means for fixing suction pipe A20 and return pipe A63 to respective projected portions A55e and 55f, in a fall preventative manner, a pipe fixing member A65 having a C-shaped section as shown in Figs. 96 and 98 is provided. Formed on the peripheral side of pipe fixing member A65 is a flange-like bead portion A65a which can engage fitting groove A55j or A55n formed in the inner surface of projected portion A55e or A55f while a slit gap A65b is cut through. The inside diameter is formed to be slightly smaller the outside diameter of suction pipe A20 or return pipe A63.

[0469] The material of joint body A55 (Fig.95) is not limited to resins, but may be made of metal. The cross-sections of barrel portion A55a, tapered portion A55b and cylindrical portion A55c and others should not be limited to being circular.

[0470] Joint bracing plate A54 for fixing connecting joint unit A47 to fuel supply tank A12 is formed by cutting a central part of a metal sheet and bending it forming a cut and upturned piece A54a, as shown in Fig.94. This cut and upturned piece A54a is adapted to hold valve bracings A57 of SETSUJITU joints A13a and A17a by bracing them from the top so that the bracings will not come out from barrel portions A55a. The central part, from which cut and upturned piece A54a is removed, is shaped to be a relief opening A54b through which projected portions A55e and A55f of connecting joints A13a and A17a pass. The peripheral part of this relief opening A54b is formed to be a peripheral bracing A54d with a rib A54c for bracing the peripheral part of connecting joint unit A47 while a center bracing A54e is extended from the center bottom of relief opening A54b to and between the two connecting joints A13a and A17a.

[0471] Peripheral bracing A54d and center bracing A5 4e are fixed together with proximal flange A55d of connecting joint unit A47 to fuel supply tank A12 with screws A54f. Combination of relief opening A54b and center bracing A54e prevents bilateral offset of connecting joint unit A47.

[0472] This connecting joint unit A47, as shown in Figs.92 and 94, is protected from the top face of fuel supply tank A12 by a cushioning cover A120 having an L-shaped section, in order to keep connecting joint unit A47 out of the way of other components when fuel supply tank A12 falls down. The outer face of this cushioning cover A120 is formed to be a flat guide surface A120a, opposing and in contact with, a guide surface A111a which is formed opposing a protective cover A111 enclosing air valve A18 (Fig.85) of connecting joint socket unit A100, and functions to be the guide when the fuel supply tank is inserted into the main body.

[0473] The connecting portion on the side of suction port A66 (Fig.100) at the lower end of the vertical portion of suction pipe A20 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 A66. Suction port A66 is formed of an approximately cylindrical configuration with multiple feet at its bottom. A mesh filter A66a of stainless steel is concurrently formed in the lower part while a pair of slit gaps A66b opposing each other for joining suction pipe A20 is formed in the upper part, so that suction pipe A20 can be connected to the top end.

[0474] As shown in Fig.100, suction port A66 is fitted in the hole of a suction port fixing plate A67 of fuel supply tank A12 so as not to move, whereby suction port A66 will not interfere with the inner wall of fuel supply tank A12.

[0475] In the above configuration, assembly of connecting joint unit A47, suction pipe A20 and return pipe A63 to fuel supply tank A12 is performed by press forming fuel supply tank left and right parts A12a and A12b and fixing connecting joint unit A47 at the predetermined position of fuel supply tank right part A12b with a packing A53 (Fig.97) interposed therebetween, using joint bracing plate A54 (Fig.95) and screws, before Adrian forming for joining fuel supply tank left part A12a and right part A12b.

[0476] At the same time, valve bracings A57 of the joints are braced from above by cut and upturned piece A54a of joint bracing plate A54 (Fig.95). Therefore, each valve bracing A57 is held by cut and upturned piece A54a of joint bracing plate A54, so that it will not spring out from the connecting joint unit A47.

[0477] The method of inserting suction pipe A20 and return pipe A63 from the interior side of fuel supply tank right part A12b and fixing them to projected portions A55e (Fig.95) and A55f (Fig.97) of joint bodies A55, respectively is performed as follows: That is, suction port A66 is assembled into suction pipe A20, then O-ring A64 is fitted at the front side of bead portion A20a (Fig.96) of suction pipe A20 and the pipe is fitted into projected portion A55e of joint body A55. This is followed by fitting pipe fixing member A65 through its slit A65b onto suction pipe A20 so that it is positioned to be closer to the suction port than bead portion A20a is, and pushing it into the connecting joint unit A47 side until bead portion A65a of pipe fixing member A65 fits into bead fitting groove A55J on the inner side of projected portion A55e. During pushing, pipe fixing member A65 is contracted inwards in diameter so that suction pipe 20 is fixed to projected portion A55e, whereby it is possible to prevent the suction pipe from coming off from connecting joint unit A47.

[0478] For the method of fixing return pipe A63, as shown in Fig.98, O-ring A64 is fitted at the front side of bead portion A63a of return pipe A63. When the pipe is fitted into projected portion A55f of joint body A55, by

fitting return pipe A63 through the greater slit A55k of projected portion A55f of joint body A55, the return pipe A63 can be oriented upward. This is followed by fitting pipe fixing member A65 from above the pipe, through its slit A65b onto return pipe A63 and pushing it into projected portion A55f until bead portion A65a of pipe fixing member A65 fits into bead fitting groove A55n on the inner side of projected portion A55f. During pushing, pipe fixing member A65 is contracted inwards in diameter so that return pipe A63 is fixed to projected portion A55f, whereby it is possible to prevent the return pipe from coming off from connecting joint unit A47.

[0479] In the above way, it is possible to simply join suction pipe A20 and return pipe A63 to connecting joint unit A47 using pipe fixing members A65 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 dissembled, the cost for maintenance is reduced.

(Tank filler port configuration)

[0480] Fig.99 is a sectional view showing a tank filler port. As illustrated, in fuel supply tank A12, bevel A12c 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 A44 is provided on this bevel A12c. Filler port A44 has a mouth A44a projected outwards from the bevel and the opening of this mouth A44a is covered in an openable and closable manner by a pivotal lid member.

[0481] Specifically, a filler port shutoff means A19 of filler port A44 is composed of a fixing plate A82 which has an opening fitted to mouth A44a of filler port A44 and is spot-welded integrally with bevel A12c, a moving plate A83 which is pivotally supported by an upturned piece A82a formed on this fixing plate A82 on the top handle side, a lid part A85 which has a packing A84 and is disposed on the inner side of moving plate A83 for closing mouth A44a of filler port A44, a coil spring element A86 interposed between this lid part A85 and the inner side of moving plate A83 for pressing lid part A85 toward mouth A44a of filler port A44, and an engaging means A87 for keeping moving plate A83 in its filler port closed position.

[0482] Fixing plate A82 is formed extending from the lower part of bevel A12c to the vicinity of the tank top face. Moving plate A83 is supported on the tank top face side at a pivot A88 while engaging means A87 is provided at the free end side. The length of the moving plate is designed so that when moving plate A83 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 A41.

[0483] Lid part A85 is formed like a dish and has an outer flange A89, which is engaged by an annular stopper part A90 formed in the inner face of moving plate A83, so as not to slip off and so as to move in a direction perpendicular to the plate surface of moving plate A83. Packing A84 is an annular part and fitted to the underside projected portion of lid part A85 so that it will be pressed against the brim of mouth A44a. Spring element A86 is disposed in the inner space between moving plate A83 and lid part A85.

[0484] Engaging means A87 is disposed on the side opposite to pivot A88 of moving plate A83 or the free end side thereof, in other words, on the lower end side of bevel A12c close to tank guide A41 of the tank holding compartment. The engaging means is composed of an engagement lever A93 with a pin-like engaging piece A92 rotationally supported on a shaft A96 on the free end side of moving plate A83, a hook-like engaging hold A94 provided on fixing plate A82 for meshing engaging piece A92 to hold moving plate A83 in its closed position and a lever spring A95 for urging engaging piece A92 in the direction it becomes engaged with engaging hold A94.

[0485] Lever spring A95 is a coil spring element which is wound on a rotary axle A96 of engaging lever A93, with one end hooked on a cut and upturned piece A93a of the engaging lever and the other end engaged by stopper part A90 of moving plate A83. This spring is arranged on the inner face side of engaging lever A93 so as to urge engaging lever A93 more to the outside than moving plate A83.

[0486] Engaging hold A94 has a space for permitting engaging piece A92 to enter between itself and the side wall of mouth A44a and opens to the mouth A44a side, so as to engage engaging piece A92, in a detachable manner.

[0487] Engaging lever A93 is so formed that its outer edge partly extends A97, forming an approximately triangular shape, and when engaging lever A93 is in the engaged position, the lever is positioned so that its back opposes, and is spaced only a slight gap from, tank guide A41, prohibiting a finger, for releasing engaging lever A93, from being inserted into the gap. Further, when engaging lever A93 is in the engaged position, it does not protrude outside beyond the tank side face. If engaging lever A93 is tried to be rotated so as to release when the tank is mounted in the main body, the extended part A97 of engaging lever A93 interferes with tank guide A41 of the wall of the tank holding compartment to thereby prohibit rotation and release of engaging lever A93.

[0488] In the above configuration, when engaging lever A93 is pushed toward the mouth while engaging lever A93 is in its engaged state, engage piece 92 comes off engaging hold A93, and the engagement of filler port shutoff means A19 is released. However, since the filler port A44 is provided on bevel A12c and since engaging lever A93 is formed with extended part A97, if engaging lever A93 is tried to be rotated and released, engaging lever A93 is hidden by moving plate A83 when tank A12 is mounted in the main body. Further, since, in this situation, the back of engaging lever A93 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 A93.

[0489] Even if, in order to release engaging lever A93, a releasing member is forcibly inserted into the gap between engaging lever A93 and tank guide A41 and thereby if the engagement of engaging lever A93 is released, extended portion A97 of engaging lever A93 and the free end of moving plate A83 abut the wall surface (tank guide) A41 of the tank holding compartment, so as to prohibit moving plate A83 from being released. Therefore, unless fuel supply tank A12 is taken out from the main body, no refueling will be allowed, hence it is possible to prohibit filling fuel into main body A1. 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.

(The arrangement of the fuel supply tank bottom)

[0490] Fig.100 is sectional view showing the bottom of fuel supply tank 12. Fig.101 is a sectional view showing a tank insertion detecting means. As illustrated in Fig.100, fuel supply tank A12 has, at its bottom, a water detecting means A68 for detecting water arising in the fuel supply tank, a fuel quantity detecting means A69 for detecting the amount of fuel in fuel supply tank A12, and a tank insertion detecting means A70 for detecting whether fuel supply tank A12 is mounted in the main body.

[0491] Water detecting means A68 is comprised of a conductive water receptacle A71 which is arranged at the conductive tank bottom to collect water, an electrode A72 in contact with the water receptacle A71, an electrode A73 in contact with the bottom of fuel supply tankAl2 and an insulating water-tight packing A74 which provides electric insulation between water receptacle A71 and fuel supply tank A12, and is adapted to detect water based on the difference in electric resistance between fuel and water collected in water receptacle A71.

[0492] Water receptacle A71 is formed of a stainless steel sheet, separately from tank A12, 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 A71a formed around it extending radially outwards, and is attached to a bottom-side attachment hole A12d with the flange A71a fixed to the bottom face of fuel supply tank A12 with rubber packing A74 therebetween. Further, both the interior and exterior of water receptacle A71 from the outside of the contact portion with electrode A72 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.

[0493] Packing A74 is a resilient non-conductive member interposed between the peripheral wall of bottom-side attachment hole A12d of fuel supply tank A12 and peripheral flange A71a of water receptacle A71, and holds water receptacle A71 so as to grip flange A71a between its upper and lower parts. Packing A74 is fixed around tank attachment hole A12d by means of an annular bracing member A75 disposed at the underside thereof, with screws A76. Thus, water receptacle A71 is fixed in a water-tight manner to attachment hole A12d.

[0494] This rubber packing A74 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 A74 is poor in water repellence, water may pool and be left covering packing A74 and the metal portion of fuel supply tank A12 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.

[0495] Electrode A72 on the water receptacle A71 side and electrode A73 on the tank side are both attached to detector board A40 outside the fuel supply tank A12. Water receptacle A71 side electrode A72 is a needle-like electrode or a line-contact type electrode which is projected from the bottom wall of water receptacle depressed holder A40a to the tank A12 side and in contact with the external surface of water receptacle A71 when tank A12 is set in place.

[0496] Tank side electrode A73 is a needle-like electrode which is exposed on peripheral placement board A40b of detector board A40 and is in contact with the bottom face A12f of the tank A12 when tank A12 is set in place. Connecting these two electrodes A72 and A73 to a power supply constitutes a closed electric circuit, starting from the power supply, by way of water receptacle electrode A72, water receptacle A71, fuel or water on the inner surface, tank bottom surface A12f, tank side electrode A73, 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 A71.

[0497] In order to enhance the accuracy of water detection, the opening wall of attachment hole A12d on the tank side, which water receptacle A71 fits, is bent downwards forming a bent portion A12d while a multiple number of needle portions A12e of a narrow sharpened tip are projected downwards at intervals along the circumference of the bent portion A12d. These needle portions A12e function as the tank side front electrodes and are electrically connected through the tank bottom to tank side electrode A73.

[0498] Suction port A66 for suctioning fuel from tank A12 is positioned above needle portions A12e so that it will not directly suction water from the water pool in the water receptacle A71. Further, the areas other than the inner and outer sides of the bottom of water receptacle A71 are coated with a non-conductive paint or the like, whereby malfunction is prevented even if water is left

covering packing A74 and metal parts of fuel supply tank A12. Further, when the inner surface of fuel supply tank A12 above the suction port A66 for suctioning fuel from tank A12 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.

[0499] As shown in Fig.91, tank leg portion A50 for guarding water receptacle A71 are welded at the periphery of water receptacle A71 in the bottom face of fuel supply tank A12. This tank leg portion A50 is made up of rib-like or U-shaped feet A50a which are higher than the tank bottom surface that is welded to fuel supply tank A12, have a height greater than that of the water receptacle and are formed at both left and right ends.

[0500] Therefore, if, upon refueling fuel supply tank A12 with the filler port A24 side up after being taken out from main body A1, there are some foreign bodies present on the surface that is in contact with the bottom of fuel supply tank A12 or water receptacle A71 side, it is possible to avoid damage or pitting, whereby it is possible to prevent malfunction in water detection.

[0501] As shown in Fig.100, fuel quantity detecting means A69 is comprised of a float A77 incorporating a magnet A78 functioning as a detection portion disposed inside tank A12 and a lead switch A79 which is disposed on the detector board A40 side, opposing float A77 so as to turn on and off as magnet A78 moves closer and away.

[0502] Float A77 has its magnet at the bottom thereof and is held inside a transparent, canopied cylindrical guide A80 in such a manner that it can move vertically as the fuel level varies. The bottom face of guide A80 is integrally fixed to the inner side of water receptacle A71 of water detecting means A68.

[0503] Lead switch A79 is fixed to the underside of the central depressed portion A40a of detector board A40 so as to oppose float A77. Guide A80 is to prevent float A77 from coming into contact with a typical refueling hose as sold on the market when fuel is drawn off from fuel supply tank A12. Therefore, if this guide A80 is of metal, it is machined so as not to form burrs inside.

[0504] Accordingly, when the surface of fuel reaches a certain level as the fuel inside fuel supply tank A12 is used, lead switch A79 detects magnetism from the magnet in float A77 and sends the detection to a controller A80, so that warnings of the end of fuel and the like can be given through a display A81.

[0505] Tank leg portion A50 is press formed from a sheet material, having a relief opening for water receptacle A71 in the center with U-shaped feet A50a which are extended front to rear at both the left and right ends. Further, a tank side abutment A50d against which a lever of tank insertion detecting means A70 abuts is formed in an approximately Z-shape, at the corresponding site on the backside of the main body. This tank leg portion A50 is welded to the bottom face of fuel supply tank A12.

(Peripheral arrangement of the tank holding portion)

(The detector board structure)

[0506] Arranged at the bottom of holding compartment A4a is detector board A40 on which fuel supply tank A12 rests. This detector board A40 is attached to base board A5 located under fuel supply tank A12, as shown in Figs.100 to 102, including tank insertion detecting means A70 for detecting whether fuel supply tank A12 is inserted and a structure for attachment of the electrodes of water detecting means A68.

[0507] Detector board A40 has upright walls A40s arranged at both left and right ends, extending upwards and downwards. Each upright wall A40s is bent outwards at its top end. In the approximate center of detector board A40, a depressed holder portion A40a for water receptacle A71 that is concave downwards is formed. On both left and right sides of depressed holder portion A40a, two holding hollows A40t extended front to rear for receiving tank leg portion A50 on the underside of fuel supply tank A12 are formed. In the lower upright wall on the right side of detector board A40, a number of V-grooves A40c (Fig.104) for supporting and fixing lead wires are formed.

[0508] Provided in depressed holder portion A40a and placement surface A40b (Fig.100) on the left side of holding hollow A40t are two rectangular holes A40d and A40e (Fig.102) through which the contacts of electrodes A72 and A73 of water detecting means A68 move up and down and two lever supports A40h and A40g functioning as the electrodes.

[0509] Four attachment bosses A40J for fixing tank guide A41 are provided at positions front and rear on both the left and right sides in detector board A40 while guide rails A40k for guiding tank guide A41 when it is fixed to the side/rear panel A7 are arranged near the rear-side attachment bosses.

[0510] Attached to a depressed portion A40n (Fig. 103(b)) formed on the underside of depressed holder portion A40a of detector board A40 is a lead switch A79 as a proximity switch for fuel quantity detecting means A69.

[0511] Each of electrodes A72 and A73 of water detecting means A68 (Fig.100) is comprised of an electrode lever A115 (Fig.103(a)). As shown in Fig.103(a), this electrode lever A151 is formed of an elastic stainless steel sheet bent in a step-like manner. An insert receiver A151a for a lead wire connector at the proximal portion of the lever is formed with a screw hole A151b for its fixture to the detector board and a receiving hole A151c formed at a position more frontwards while the front end of the lever is bent upwards in an L-shape.

[0512] Formed on the detector board A40 side to which this electrode lever A151 is attached is a lever attachment boss A40q projected downwards. This boss has a fixing hole A40p formed therein. Further, a circular projected support A40h serving as a fulcrum on which

lever A151 pivots up and down is projectively formed in the vicinity of this attachment portion.

[0513] Assembly of electrode lever A151 is performed by fitting support A40h of detector board A40 into receiving hole A151c of electrode lever A151, aligning screw hole A151b of lever A151 to attachment hole A40q of detector board A40, and fastening it to boss A40p with a screw. By this arrangement, the distal part of electrode lever A151 is set so as to come out through rectangular hole A40d or A40e above the obverse side. In order to regulate the projected height, a rib A40m is projectively formed on the underside of detector board A40. In this way, since electrode lever A151 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.

[0514] Tank insertion detecting means A70 is arranged on the rear side of detector board A40, and is comprised of, as shown in Fig.105, a tank detector plate A117 fixed on the rear side of detector board A40, a lever A113 which is attached to this detector plate A117 so as to pivot vertically and come into contact with the fuel supply tank bottom when fuel supply tank A12 is inserted into the main body, a microswitch A112 which is fixed to detector plate A117 so that it turns on and off as the lever moves up and down and a lever spring A116 for urging lever A113 when it is movable.

[0515] Lever A113 has an L-shaped configuration of a small width when viewed from top. A boss A113b functioning as a pivoting fulcrum is formed at one end thereof while a tank abutment A113a to be in contact with the fuel supply tank is formed on the other end and projected from tank detector plate A117 to the detector board A40 side.

[0516] Tank detector plate A117 is formed in a side-facing U-shape by bending sheet material, having an axle A117a, on its upright wall, to which the lever is fitted, a holding hollow A117b for attachment of microswitch A112 and a rectangular hole A117c having a size approximately equal to the moving distance of the tank abutment of lever A113 when it moves up and down.

[0517] Lever spring A116 is hooked between the top plate of tank detector plate A117 and lever A113 and urges lever A113 in the direction microswitch A112 is turned on.

[0518] Assembly of the insertion detecting means A70 is performed by fitting and engaging lever spring A116 to lever A113, inserting tank abutment A113b of lever A113 through rectangular hole A117c of tank detector plate A117, then fitting boss A113b formed at one end of lever A113 onto axle A117a of tank detector plate A117 and fixing it with a stopper ring. This assembly is completed by fitting microswitch A112 onto the pin of holding hollow A117b of tank detector plate A117 and fixing it with a stopper ring.

[0519] Referring to the operation of tank insertion means A70, when fuel supply tank A12 is inserted into main body A1, tank abutment A113a of lever A113 is pressed downwards by fuel supply tank A12, so that microswitch A112 is opened and the circuit becomes activated. Conversely, when fuel supply tank A12 is not mounted in the main body, fuel supply tank A12 does not rest on tank abutment A113a of lever A113. Therefore, the lever is pushed up by lever spring A116, where by microswitch A112 is closed and the circuit becomes deactivated.

[0520] In the above way, microswitch A112 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 A12 when microswitch A112 is operated, and occurrence of problems can be reduced.

(Tank guide structure)

[0521] Next, the arrangement of the fuel supply tank and its periphery will be described. Fig.106 is a top view showing tank holding compartment A4a; Fig.107 is an exploded plan view showing the relationship between a tank guide and connecting joint socket unit; Fig.108 is a front view showing a tank fixing member; Fig.109 is a perspective exploded view showing the state of connection of an oil feed pipe and return oil pipe to the joint socket unit; Fig.110 is a sectional view showing an oil feed joint socket; Fig.111 is a section view showing a return oil joint socket; Fig.112 (a) is a plan view showing an upturned passage; and (b) is a vertical section of an air valve.

[0522] As shown in Figs.102 and 106, the peripheral four sides of holding portion A4a for fuel supply tank 12 is enclosed by tank guide A41. This tank guide A41 is formed 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 A41c. The top parts of bent portions A41c are hooked by claws on the backside face of side/rear panel A7 of the main body while the lower side is fixed with screws. Tank insertion detecting means A70 is disposed under this backside opening A41d.

[0523] The lower part of tank guide A41 is arranged along the inner side of the left and right upright walls A40s (Fig.102) of detector board A40. The front part of the lower part of the tank guide is located along the outer side of the front wall and bosses A40j of detector board A40 while the rear side is arranged between bosses A40j and upright walls A40k. The lower parts on the front and rear sides are fastened to detector board A50 by screws.

[0524] Tank guide A41 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 A41a. Tank guide fixture A42 is fixed between the unfolded tabs A41b of the opening portion A41a with claws and

screws.

[0525] Tank guide fixture A42 is to hold joint socket unit A100 and electromagnetic pump A14, having a U-shaped box-like configuration. Specifically, connecting joint socket unit A100 is fixed with screws at the predetermined position on the top while electromagnetic pump A14 is fixed on the underside with screws. The inner side of fixture A42 is projected into the tank holding compartment A4a to such a degree that it will not come into contact with depressed portion A12d (Fig.100) in which connecting joint unit A47 of the fuel supply tank is mounted and so that joint socket unit A100 on the top face and connecting joint unit A47 on the tank side can be joined to each other.

[0526] Connecting joint socket unit A100 is an integrated structure of oil feed joint side socket A13b and return oil joint side socket A17b, and copper-made outward pipe A21 is connected for communication to oil feed joint side socket A13b while copper-made return pipe A23 is connected for communication to return oil side joint socket A17b.

[0527] Coupling of outward pipe A21 and return oil pipe A23 with this connecting joint socket unit A100 is done as shown in Fig.109. That is, sealing O-rings A99 are fitted at the front side of flange-like bead portions A21a and A23a formed at the front ends of pipes A21 and A23, and these pipes are inserted into predetermined holes A98c and A98f, respectively, of connecting joint socket unit A100. With U-shaped slots A101a formed on the bottom side of a pipe fixing plate A101 fitted from above onto pipes A21 and A23 outside their bead portions A21a and A23a, fixing plate A101 and joint socket unit A100 are fixed to each other with screws passing through screw holes A101b and A100a formed on respective members.

[0528] Outward pipe A21 and return oil pipe A23 are formed of copper material. As to the inside diameter of outward pipe A21 and return oil pipe A23, the former is formed so as to be smaller in diameter than the latter. Specifically, the inside diameter of outward pipe A21 is set at 1.5 mm and the inside diameter of return oil pipe A23 is set at 3 mm. If the inside diameter of outward pipe A21 is greater than 1.5 mm, a greater amount of fuel is left over in outward pipe A21 upon extinguishment, and it takes time to return the remaining fuel from vaporizer A14 to fuel supply tank A12 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 A23 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 A12, 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 A12 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.

(Connecting joint socket unit configuration)

[0529] Connecting joint socket unit A100 is comprised of a socket body A98 fixed with screws to the top face of tank guide fixture A42, oil feed side joint socket A13b and return oil joint socket A17b, arranged side by side in this socket body, and air valve A18 as a shutoff valve disposed with socket body A98.

[0530] As shown in Fig.110, oil feed joint side socket A13b is comprised of a rod-like valve retainer A98a, projected upwards from the center of a depressed portion formed from the top face of socket body A98, an approximately cylindrical connection packing A102 of rubber placed on the top face of socket body A98 so as to enclose the valve retainer and an approximately cylindrical packing bracing A103 which covers the periphery of this packing A102 and fixes the bottom flange A102b of packing A102 to the top face of socket body A98 with screws. Formed around valve retainer A98a in socket body A98 is a groove A98b, from which a horizontal tubular passage A98c is formed to communicate with the electromagnetic pump A14 side.

[0531] As shown in Fig.112 (b), the passage A98c turns upwards along the way forming an inverted U-shaped upturned passage A98d which is higher than passage 98c. This upturned passage A98d is formed inside a cylindrical portion A98h which is integrally formed on the top face of socket body A98. Air valve A18 is fixed using screws to the depressed portion at the top of this cylindrical portion A98h with a packing A104 interposed therebetween. The exit A18a of air valve A18 is set to be open to the top end of inverted U-shaped passage A98d.

[0532] Further, as shown in Fig. 112 (a), upturned passage A98d is composed of a vertical upward passage A98d1, having a crescent cross-section, connected to the joint retainer A13b side and a vertical downward passage A98d2, having a circular cross-section, connected to outward pipe A21 on the electromagnetic pump A14 side, with a partitioning wall A98i in-between. These two passages A98d1 and A98d2 are formed so as to communicate with each other at their top ends over partitioning wall A98i.

[0533] As to the sectional areas of these two passages A98d1 andA98d2, the area of passage A98d2 is designated to be smaller than that of passage A98d1. 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.

[0534] Connection packing A102 (Fig.110) is used to reduce the impacts and create sealing when valve ele-

ment A59 on the oil feed joint A13a side is inserted into the oil feed joint socket A13b side, and has an approximately cylindrical configuration with a hole A102a formed on top of the cylinder so as to allow cylindrical portion A55c and valve element A59 of the oil feed joint A13a side to access thereto.

[0535] Packing bracing A103 presses connecting packing A102 from thereabove to improve sealability and also functions as a guide when connecting joint unit A47 fits in from above. This has an approximately cylindrical configuration with a hole A103a formed on top of the cylinder so as to allow barrel portion A55a and tapered portion A55b of the connecting joint A13a side to access thereto.

[0536] Air valve A18 takes air into the oil feed passage from fuel supply tank A12 to electromagnetic pump A14, from the outside of the passage to shut off the fuel supply through the oil feed passage, and is comprised, as shown in Fig.112(b), of an electromagnetic coil A18d located at the periphery of a valve chamber A18b, a valve element 18g which can move in the valve chamber by demagnetization of the electromagnetic coil A18d to open and close an air hole A18f formed in a valve bracing A18e above the valve element, a coil spring A18h which urges valve element A18g in the direction air hole A18f is opened, and a communication exit A18a formed under the valve chamber to communicate with inverted U-shaped passage A98d on the oil feed side. Valve element A18g moves as electromagnetic coil A18d is magnetized so as to close air hole A18f while it opens air hole A18f by virtue of repulsive force of coil spring A18h when electromagnetic coil A18d is demagnetized, whereby air passes through the clearance around valve element A18g to be supplied from communication exit A18a into the upturned passage A98d side.

[0537] Valve element A18g is constructed of a closed bottomed cylinder A18i, a valve piece A18j fitted inside the cylinder so as to project out and retract with respect to the top opening, and a spring A18k urging this valve piece A18j in the projected direction, to thereby alleviate collision with valve bracing A18e when air hole A18f is closed.

[0538] An air valve cover A111 for covering the air valve A18 to protect it is fastened together with socket body 98 of connecting joint socket unit A100. This air valve cover A111 is so formed that at least the oil feed joint socket A13b side forms a vertical surface A111a, opposing protective cover A120 of connecting joint unit A47 so as to provide the guide function for guiding the joint unit when fuel supply tank A12 is inserted into the main body.

[0539] On the other hand, as shown in Fig.111, socket body A98 of return oil side joint socket A17b of the second joining means has a valve chamber A98i which is located under a valve hole A98e formed on the top thereof, accommodates a valve mechanism A105 and is formed on its side wall with a horizontal passage A98f from vaporizer A14.

[0540] Valve mechanism A105 comprised of a receiver valve element A106 which shuts off valve hole A98e in an openable manner, a receiver valve element cap A108 for closing the bottom of valve chamber A98i, a receiver valve element spring A107 interposed between this cap A108 and receiver valve element A106 to urge receiver valve element A106 in the direction the valve hole is closed, an O-ring A109 fitted on the sealing surface of receiver valve element A106 and a cap O-ring A110 for sealing receiver valve element cap A108.

[0541] Receiver valve element A106 is provided in order to receive valve element A59 of joint A17a on the return oil side as the second joining means and to prevent odor leakage when fuel supply tank A12 is taken out.

[0542] Receiver valve element spring A107 becomes compressed by pressing of connecting joint A17a on receiver valve element A106 when fuel supply tank A12 is set into the main body. Receiver valve element cap A108 includes a hollowed receiver A108a for guiding the lower part of receiver valve element A106 when receiver valve element A106 is moved a predetermined distance by valve element A59 of connecting joint A17a and a rest A108b for receiver valve element spring A107, formed around that hollow.

[0543] This receiver valve element cap A108 is inserted from the opening of the fuel passage on the underside of connecting joint socket unit A100. When this connecting joint socket unit A100 is fixed to the predetermined position of the tank guide fixture A42 by screws, tank guide fixture A42 braces that part. That is, the inserted receiver valve element cap A108 is prevented from falling off by connecting joint socket unit A100.

[0544] Connecting joint socket A17b has a connection packing A102 in socket body A98 and is covered above the connection packing A102 by a packing bracing A103, similarly to the first connecting joint socket.

[0545] Fixed at the predetermined position under tank guide fixture A42 is electromagnetic pump A14 as an oil feed pump. Coupling of outward pipe A21 from this electromagnetic pump A14 and return oil pipe A23 from vaporizer A15 with connecting joint socket unit A100 may be performed, in the aforementioned manner, by fitting O-rings A99 to bead portions A21a and A23a on outward pipe A21 and return oil pipe A23, inserting these pipes into the predetermined holes, respectively, of socket body A98, then fitting pipe fixing plate A101 with its U-shaped slots A101a onto pipes A21 and A23 and fixing the plate with screws.

[0546] In the above configuration, fuel in fuel supply tank A12 flows from connecting joint A13a to connecting joint socket A13b when electromagnetic pump A14 is driven so as to suction the fuel inside fuel supply tank A12 through suction pipe A20. Thereby, fuel flows sidewards into connecting joint unit A47, passing through the gap opened in valve mechanism A56 between the main body cylindrical portion A55c and body A59 to connecting joint socket A13b. The fuel further proceeds

from groove A98b through passage A98c, flowing through upturned passage A98d under air valve A18. Then the fuel is sent from electromagnetic pump A14 to vaporizer A15.

(The positional relationship between the liquid level in the fuel supply tank and joining means)

[0547] Fig.113 shows a view showing the positional relationship of each joining means with respect to the liquid level of fuel in fuel supply tank A12. As illustrated, in the connecting joint unit A47 of fuel supply tank A12, passage A55p through which fuel suctioned from fuel supply tank A12 passes is arranged above the indicated maximum fluid level L0 of fuel supply tank A12, so as to avoid fuel leakage at the tank joining portion in connecting joint unit A47.

[0548] In connecting joint socket unit A100, the upper end of partitioning wall A98i of upturned passage A98d under air valve A18 is positioned to be higher than the fuel level LO in fuel supply tank A12. Here, the fuel level in the fuel supply tank means the fluid level of the maximum fuel indication at the ordinary state.

[0549] Since pipe outlet A63b of return oil pipe A63 from the vaporizer A15 side into fuel supply tank A12, in connecting joint unit A47 is positioned so as to be higher than the abnormal fluid level L1 of fuel in fuel supply tank A12, fuel is prevented from flowing backwards, from the fuel supply tank side to the vaporizer A15 side through the return oil passage even when the fluid level of fuel in fuel supply tank A12 rises abnormally due to difference in temperature. In this case, if some fuel is sent from connecting joint unit A47 to the electromagnetic pump A14 side, no fuel will be sent further forwards because pump A14 is deactivated. Further, air hole A18f in air valve A18 is set at such a position as to be always higher than the abnormal fluid level L1, so that no fuel will leak from fuel supply tank A12 to the outside by way of air valve A18.

[0550] In connecting joint socket unit A100, the upper end of partitioning wall A98i of upturned passage A98d under air valve A18 is located so as to be always higher than the normal fluid level L0 of fuel supply tank A12. Accordingly, when air valve A18 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 A98d1 on the fuel supply tank side of upturned passage A98d is greater than the other. Thus, it is possible to reliably shut off fuel supply.

(Controller configuration)

[0551] Fig.114 is a block diagram showing a control circuit for controlling various modes of operation in accordance with the signals from fuel quantity detecting means A69, water detecting means A68 and tank insertion detecting means A70. As illustrated, controller 140 is constituted of a microcomputer incorporating a CPU, ROM and RAM, and connected on its input side to fuel quantity detecting means A69, water detecting means A68 and tank insertion detecting means A70 while the output side is connected to an electromagnetic pump driver circuit A118, display A143 and a valve drive circuit A119, so that it can control the operation in accordance with various input signals.

[0552] For example, when tank insertion detecting means A70 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 A14 to pump driver circuit A118 and also outputs an open signal for air valve A18 to valve drive circuit A119 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 A15 when tank insertion detecting means A70 is on.

(The operation of the kerosene fan heater)

[0553] Next, the operation of the kerosene fan heater will be described. When fuel in fuel supply tank A12 has run out, fuel is charged into fuel supply tank A12 through filler port A44 by opening lid A4 of main body A1, taking out the fuel supply tank A12 by holding handle A43, and releasing shutoff means A19 with the handle A43 side up. In this case, since refueling is done while fuel supply tank A12 is placed on aflat site with the handle A43 side up, it is no longer necessary to turn fuel supply tank A12 upside down. Accordingly, it is possible to easily and reliably perform refueling without the filler cap of fuel supply tank A12 being stained with fuel, as used to be the case.

[0554] When refueling is completed, the fuel supply tank A12 filled up with fuel is set into the predetermined position after opening lid A4 of main body A1. Upon this setting, as shown in Figs.115 through 118, the lower part of cushioning cover A120 attached to connecting joint unit A47 of fuel supply tank A12 is lead to the lower part of connecting joint socket unit A1 along the outside of air valve protective cover A111 of connecting joint socket unit A100 on the burner unit side, so that connecting joint unit A47 on the fuel supply tank A12 side becomes connected to the joint socket unit A100 on the burner unit side.

[0555] At the same time, in oil feed side joint A13a of connecting joint unit A47, the valve element A59 is guided and inserted into hole A103a of packing bracing A103 of oil feed side joint socket A13b and enters hole A102a of connection packing A102 to abut valve retainer A98a. In this situation, hole A102a of connection packing A102 is hermetically sealed by HON ITA cylindrical portion A55c of connecting joint unit A47 so as to eliminate the risk of fuel leakage from this connection.

[0556] As fuel supply tank A12 is further inserted into main body A1, valve retainer A98a pushes valve element A59 of oil feed joint A13a upward while valve element spring A61 becomes compressed to set valve el-

ement A59 open. Thus, oil feed passage B for flow of fuel from suction pipe A20 of fuel supply tank A12 to the electromagnetic pump A14 side via connecting joint A13a becomes open.

[0557] Similarly, return oil side joint A17a of fuel supply tank A12 moves in the same manner. That is, the valve element A59 of connecting joint A17a is lead and inserted into hole A103a of packing bracing A103 of connecting joint socket unit A100 and enters hole A102a of connection packing A102, so that valve element A59 of return oil side joint A13a abuts valve element A106 in valve mechanism A105 of socket body A98. In this situation, connection packing A102 is hermetically sealed with main body cylindrical portion A55c of connecting joint unit A47 so as to eliminate the risk of fuel leakage.

[0558] As fuel supply tank A12 is further inserted into main body A1, receiver valve element A106 of valve mechanism A105 moves downwards and abuts the bottom of hollowed receiver A108a of receiver valve element cap A108. Then, valve element A59 of return oil joint A17a is pushed upwards by receiver valve element A106 while valve element spring A61 becomes compressed to set valve element A59 open. Thus, return oil passage C for flow of fuel from vaporizer A15 to the fuel supply tank A12 side via pipe A23 becomes open.

[0559] When fuel supply tank A12 is inserted into main body A1 and the bottom of fuel supply tank A12 reaches detector board A40 at the bottom of holding compartment A4a, rear side lever abutment A50d of tank leg portion A50 of fuel supply tank A12 presses down lever tank abutment A113a of lever A113 of tank insertion detecting means A70 so as to turn on microswitch A112 on the circuit.

[0560] 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 A14 is driven, air is taken in from air hole A18f of air valve A18 and sent to oil feed passage B because air valve A18 is in demagnetized state and hence is open. Therefore, no fuel in fuel supply tank A12 is suctioned through suction pipe A20, whereas fuel remaining in oil feed passage B is sent to vaporizer A15 and then it is returned together with the fuel partly vaporized and remaining in vaporizer A15 to fuel supply tank A12 by way of return oil passage C so that no fuel will remain in the passage.

[0561] In vaporizer A15, the vaporizer heater is heated as the operation switch is turned on so that vaporizer A15 is preheated to the predetermined temperature. When it reaches the predetermined preheat temperature, air valve A18 is actuated and electromagnetic coil A18d is magnetized so that valve element A18g moves so as to close air hole A18f and stop taking air from air hole A18f. As a result, oil feed passage B is made to communicate from fuel supply tank A12 to electromagnetic pump A14 by way of the joining means, and fuel is sent from fuel supply tank A12 to oil feed passage B.

[0562] At vaporizer A15, the fuel sent by electromagnetic pump A14 is evaporated into gaseous fuel in vaporizer A15 so that it is blown out from nozzle A31 of vaporizer A15 and mixed with combustion air in the burner. This mixture is emitted from flame port A16b of burner A16, and ignited at flame port A16b and made to burn in combustion chamber A30. At the same time, based on the temperature difference between the room temperature detected by room temperature thermistor A1 and a set temperature designated through control portion A3, controller 140 controls the drive of electromagnetic pump A14, whereby the amount of liquid fuel supplied to vaporizer A15 is varied to appropriately control the power of heating from burning.

[0563] When combustion starts and flame sensor A36 detects a flame current equal to or greater than the preset current value, an unillustrated fan motor is activated so that blower fan A9 starts rotating to suction air from the room. The rotational rate of the fan motor is controlled by controller 140. The air suctioned from the room absorbs the radiated heat obtained in combustion chamber A30 and is blown out together with the combustion gas as warm air through air outlet A2 to the room, whereby the temperature in the room rises and is regulated.

[0564] When the operation of main body A1 is stopped, drive of electromagnetic pump A14 is deactivated and air valve A18 is opened so that air flows into the passage from the outside, whereby supply of fuel is reliably shut off.

[0565] 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 eliminate the fuel tank and enlarge the fuel supply tank by the volume corresponding to the fuel tank or make the apparatus small and compact, providing the advantage of saving space.

[0566] In liquid fuel burning apparatus of this type, integration of the first joining means for connecting the fuel supply tank to the oil feed path reaching to the burner unit and the second joining means for connecting the fuel supply tank to the fuel return path from the burner unit, makes the joining means compact, reduces the number of the steps of assembly and manufacture and simplifies the structure, thus providing a totally compact configuration.

[0567] Each of the above configurations described in the embodiments and examples described heretofore can of course be applied to other embodiments within the scope of their applicability.

Industrial Applicability

[0568] 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 comprising:

   a fuel supply tank detachably mounted into a main body of the liquid fuel burning apparatus;
   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 first joining portion for creating connection of oil feed passage from the fuel supply tank to the burner unit when the fuel supply tank is mounted to the main body,

   characterized in that the first joining portion comprises an oil feed joint provided on the fuel supply tank side and an oil feed joint socket provided on the main body side for detachably receiving the oil feed joint.

2. The liquid fuel burning apparatus according to Claim 1, further comprising a second joining portion for creating connection of return oil passage from the burner unit to the fuel supply tank, **characterized in that** the second joining portion comprises a return oil joint provided on the fuel supply tank side and a return oil joint socket provided on the main body side for detachably receiving the return oil joint.

3. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the oil feed joint incorporates a valve mechanism for opening and closing the oil feed passage.

4. The liquid fuel burning apparatus according to Claim 2, wherein the oil feed joint, oil feed joint socket and return oil joint each incorporate a valve mechanism for opening and closing the oil feed passage.

5. The liquid fuel burning apparatus according to Claim 1 or 2, wherein a shutoff valve for shutting off fuel supply from the fuel supply tank to the burner unit is provided in the oil feed passage.

6. The liquid fuel burning apparatus according to Claim 5, wherein the shutoff valve comprises an air valve which leads air into the oil feed passage so as to shut off fuel supply from the fuel supply tank to the burner unit.

7. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the path in the oil feed joint connected to the suction path inside the fuel supply tank is arranged above the liquid level of fuel in the fuel supply tank.

8. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the fuel path connecting the fuel supply tank and the oil feed pump is formed by an inverted U-shaped upturned path and the top end of the upturned path is located above the liquid level of fuel in the fuel supply tank.

9. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the upturned path is formed on the main body side while the shutoff valve is arranged at the top end of the upturned path.

10. The liquid fuel burning apparatus according to Claim 2, wherein the exit of the fuel path of the return oil joint on the fuel supply tank side is arranged above the liquid level of fuel in the fuel supply tank.

11. The liquid fuel burning apparatus according to Claim 10, wherein the exit of the fuel path of the return oil joint is upturned so that it is positioned above the liquid level of fuel in the fuel supply tank.

12. The liquid fuel burning apparatus according to Claim 6, wherein the air intake port of the air valve is arranged above the liquid level of fuel in the fuel supply tank.

13. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the fuel supply tank has an air hole on the top face and a shutoff mechanism for closing the air hole when the tank falls down.

14. The liquid fuel burning apparatus according to Claim 2, wherein the inside diameter of the return oil passage is greater than the inner diameter of the oil feed passage.

15. The liquid fuel burning apparatus according to Claim 1 or 2, wherein insertion of the fuel supply tank into the main body is permitted only when the tank is oriented to one determined direction.

16. The liquid fuel burning apparatus according to Claim 1 or 2, wherein the oil feed joint on the fuel supply tank side is disposed on the side opposite to the butted side of the fuel supply tank.

17. The liquid fuel burning apparatus according to Claim 2 or 4, wherein the oil feed joint and the return oil joint on the fuel supply tank side are integrated into a fuel supply tank side joint unit while the oil feed joint socket and the return oil joint socket on the main body side are integrated into a main body

side joint socket unit.

18. The liquid fuel burning apparatus according to Claim 17, wherein the fuel supply tank side joint unit is disposed on the side opposite to the butted side of the fuel supply tank.

19. The liquid fuel burning apparatus according to Claim 17, wherein the fuel supply tank side joint unit has a positioning means for positioning the pipes which are extended into the fuel supply tank.

20. The liquid fuel burning apparatus according to Claim 17, wherein the fuel supply tank side joint unit is constructed so as to be fixed by the fastening means of the pipes in the fuel supply tank.

21. The liquid fuel burning apparatus according to Claim 17, wherein the main body side joint socket unit has a shutoff valve for shutting off fuel supply from the fuel supply tank to the burner unit and a protective cover for protecting the shutoff valve while the fuel supply tank side joint unit has a cushioning cover for protection against impacts so that, when the fuel supply tank is inserted into the main body, the two covers serve as tank insertion guides.

22. The liquid fuel burning apparatus according to Claim 1 or 2, further comprising a water detecting portion having a first electrode in contact with a water receptacle provided at the bottom of the fuel supply tank and a second electrode in contact with the fuel supply tank for detecting water in the supply tank, wherein at least one of the electrodes is fixed at a point on a detector board and supported in a cantilevered manner on a fulcrum other the fixed point.

23. The liquid fuel burning apparatus according to Claim 2, wherein a fuel container for temporarily holding fuel is provided within the return oil passage from the burner unit to the second joining portion.

24. The liquid fuel burning apparatus according to Claim 2, wherein a cooling portion for cooling fuel is provided within the return oil passage from the burner unit to the second joining portion.

25. A liquid fuel burning apparatus comprising: a fuel supply tank detachably mounted to a tank holding compartment in the main body; a burner unit for burning fuel; and an oil feed pump for transferring fuel from the fuel supply tank to the burner unit and being constructed so as to directly feed fuel from the fuel supply tank to the oil feed pump without having any fuel tank for temporarily holding fuel under the fuel supply tank,
further comprising: a first joining portion that creates connection of suctioning passage of fuel to the oil feed pump when the fuel supply tank is mounted to the apparatus body, wherein the joining portion on the fuel supply tank side is arranged within the ridge-based contour in the top view of the fuel supply tank.

26. The liquid fuel burning apparatus according to Claim 25, wherein a second joining portion joining to the return path of fuel from the burner unit to the fuel supply tank when the fuel supply tank is mounted to the tank holding compartment is provided for the fuel supply tank, and the second joining portion is arranged within the ridge-based contour in the top view of the fuel supply tank.

27. The liquid fuel burning apparatus according to Claim 25 or 26, wherein an approximately triangular space is formed within the ridge-based contour in the top view of the fuel supply tank, by setting back the outer shape of the fuel supply tank from the ridgeline formed by the intersection of two adjoining sides, toward the tank center, so that the first joining portion and/or the second joining portion is arranged within the space.

28. The liquid fuel burning apparatus according to Claim 25 or 26, wherein an approximately rectangular space is formed within the ridge-based contour in the top view of the fuel supply tank, by setting back the outer shape of the fuel supply tank from the ridgeline formed by the intersection of two adjoining sides of the fuel supply tank, toward the tank center, so that the first joining portion and/or the second joining portion is arranged within the space.

29. The liquid fuel burning apparatus according to Claim 25 or 26, wherein a depressed portion is formed within the ridge-based contour in the top view of the fuel supply tank, by setting back the outer shape of the fuel supply tank from one side face thereof toward the tank center, so that the first joining portion and/or the second joining portion is arranged within the depressed portion.

30. The liquid fuel burning apparatus according to Claim 25 or 26, wherein a fixture for fixing the suction passage toward the oil feedpump inside the fuel supply tank is provided.

31. The liquid fuel burning apparatus according to Claim 25 or 26, wherein the first joining portion and/or the second joining portion is arranged above the liquid surface of the fuel in the fuel supply tank.

32. The liquid fuel burning apparatus according to Claim 25 or 26, wherein the fuel supply tank is provided with a suction pipe for suctioning the fuel to

be sent to the oil feed pump, the suction port of the suction pipe for suctioning fuel is arranged near the bottom of the fuel supply tank.

33. The liquid fuel burning apparatus according to Claim 25 or 26, wherein in the first joining portion and the second joining portion, guide members which can come into contact with and separate from each other are provided on the fuel supply tank side and on the burner unit side.

FIG. 1

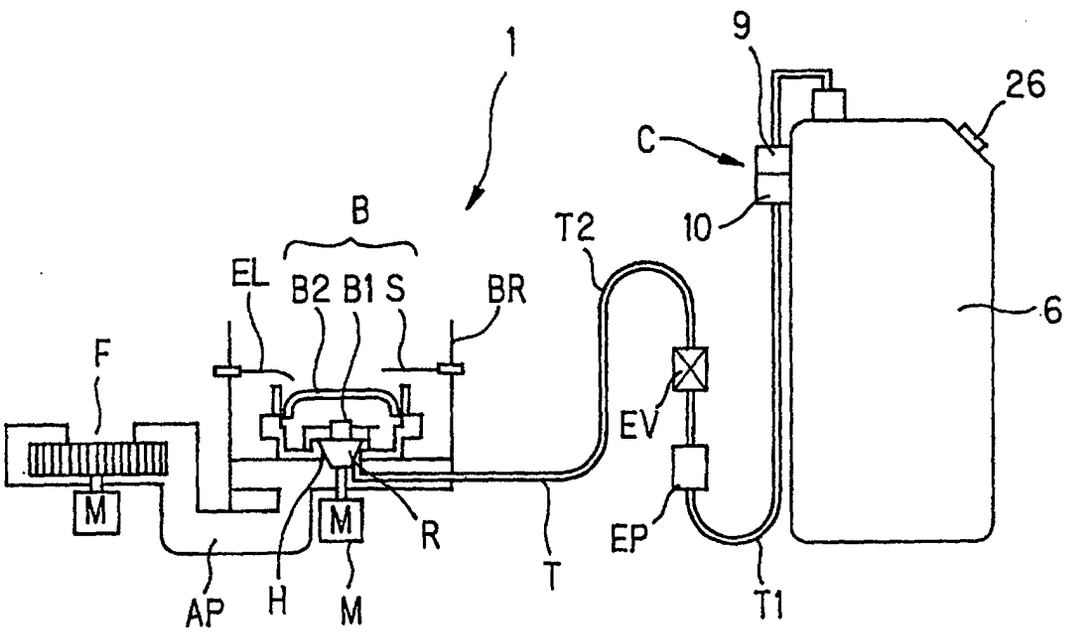

FIG. 2

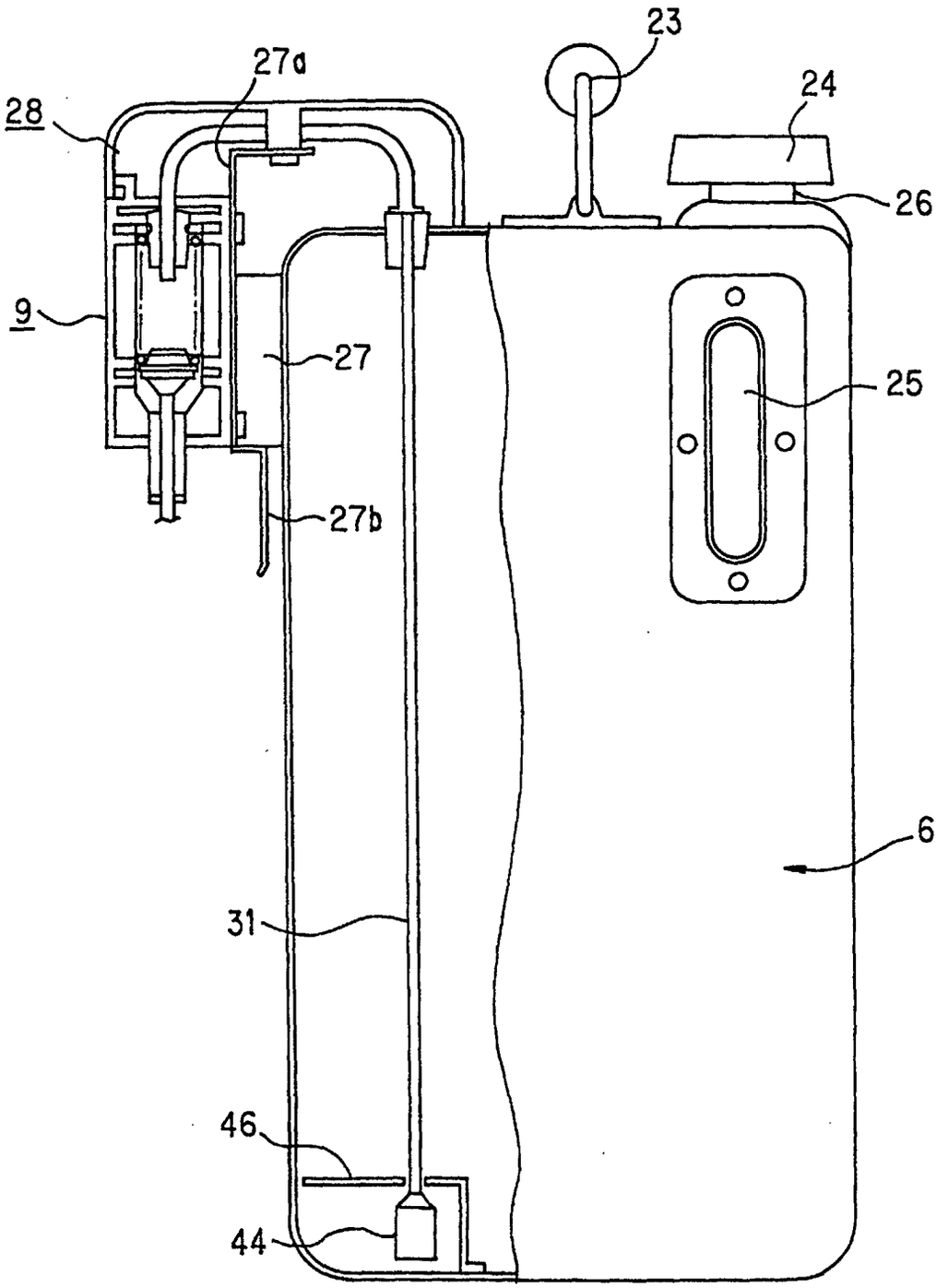

FIG. 3

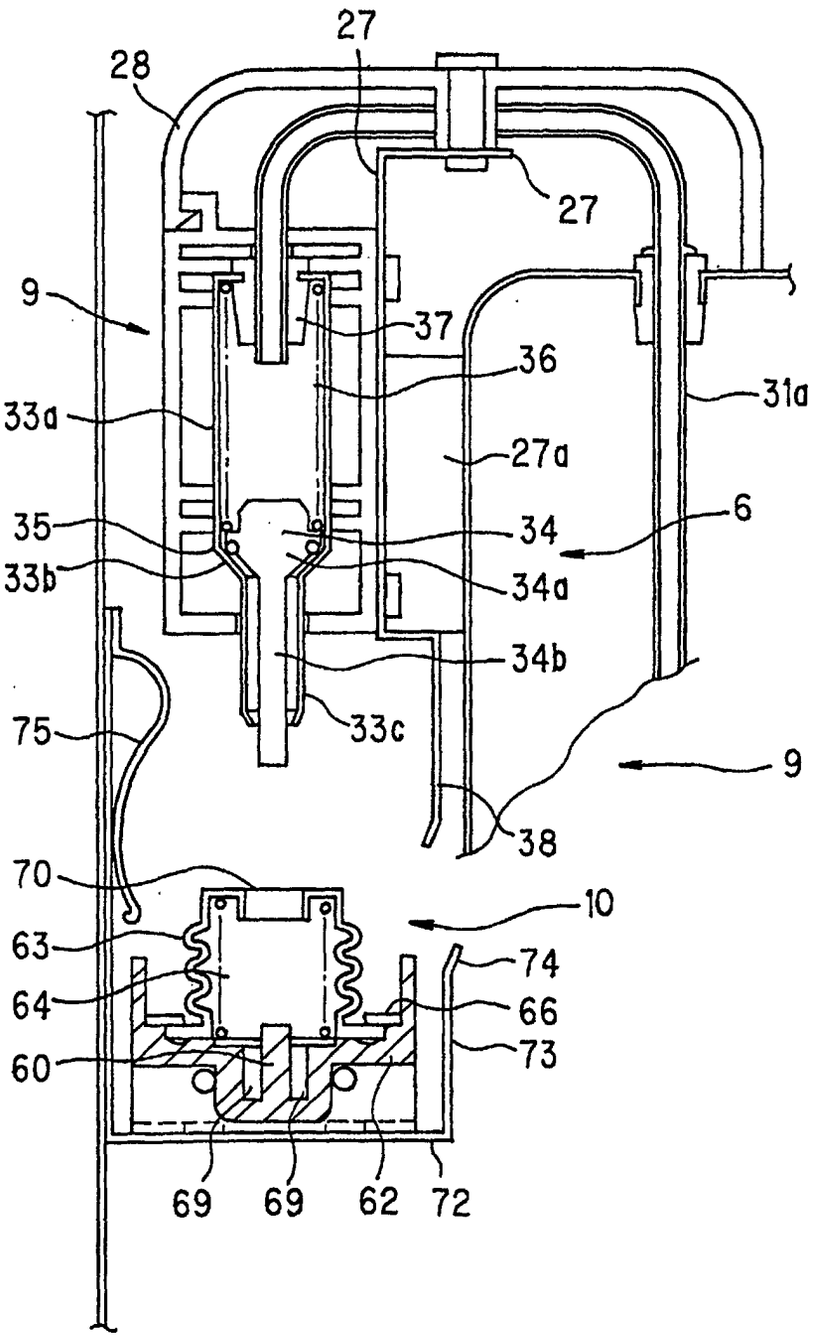
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FIG. 4

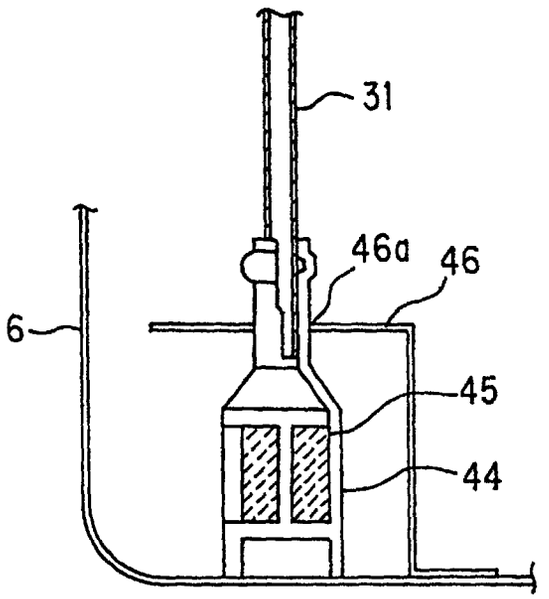


FIG. 5

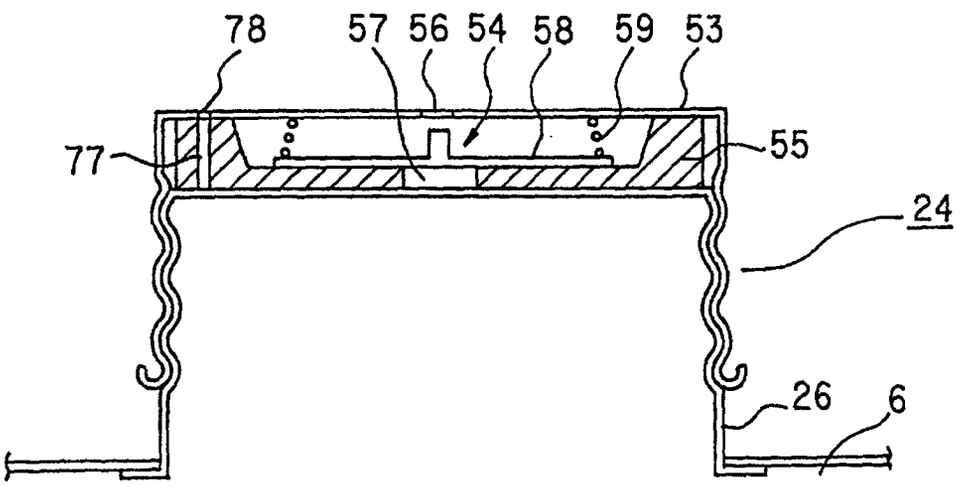


FIG. 6

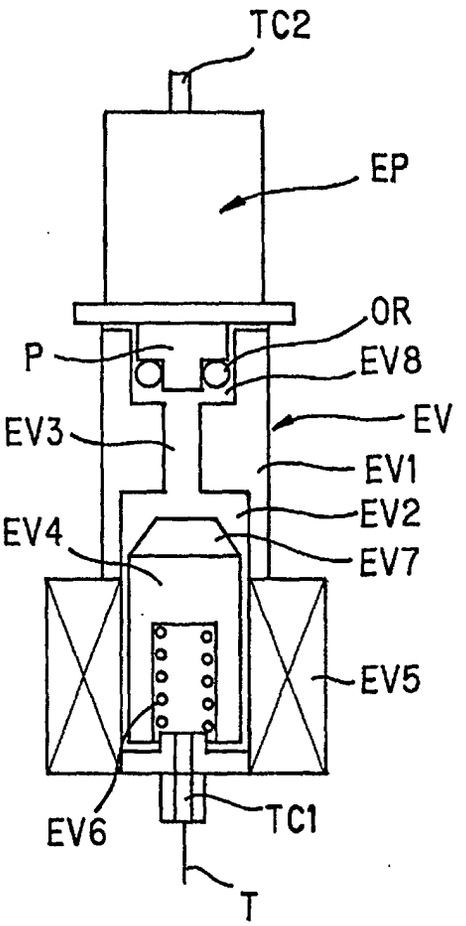


FIG. 7

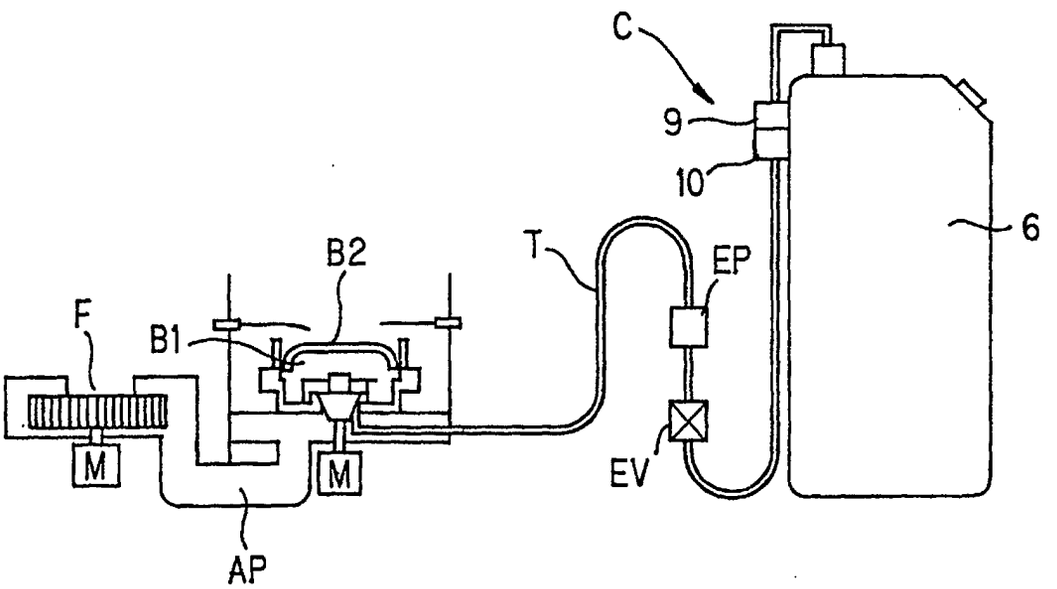


FIG. 8

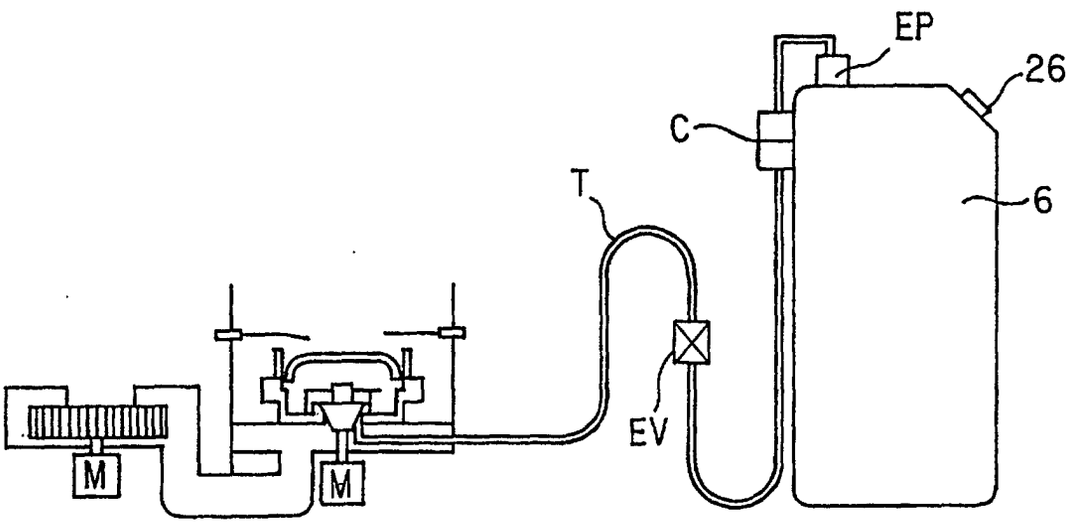


FIG. 9

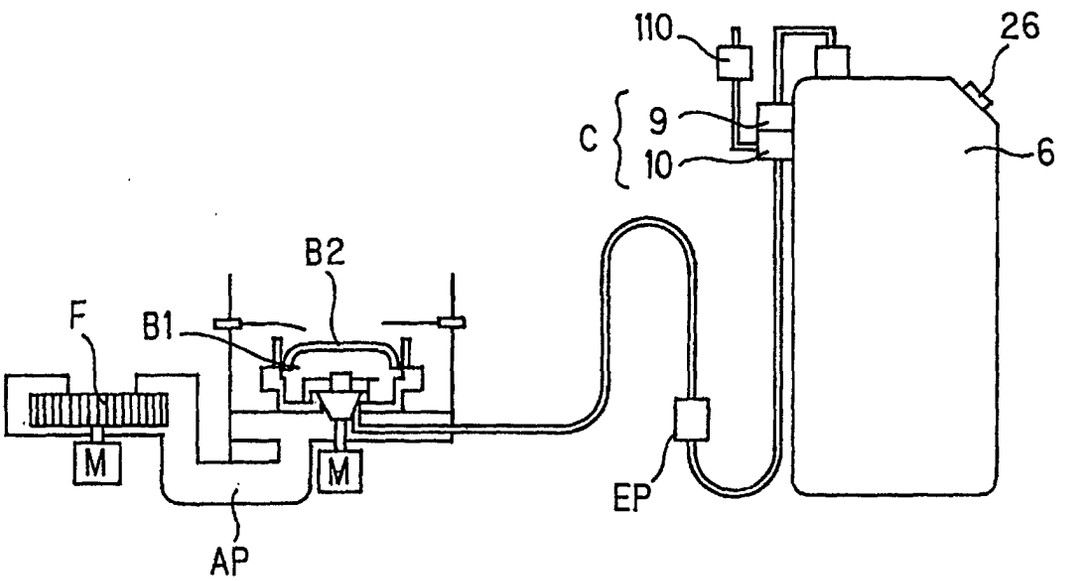


FIG. 10

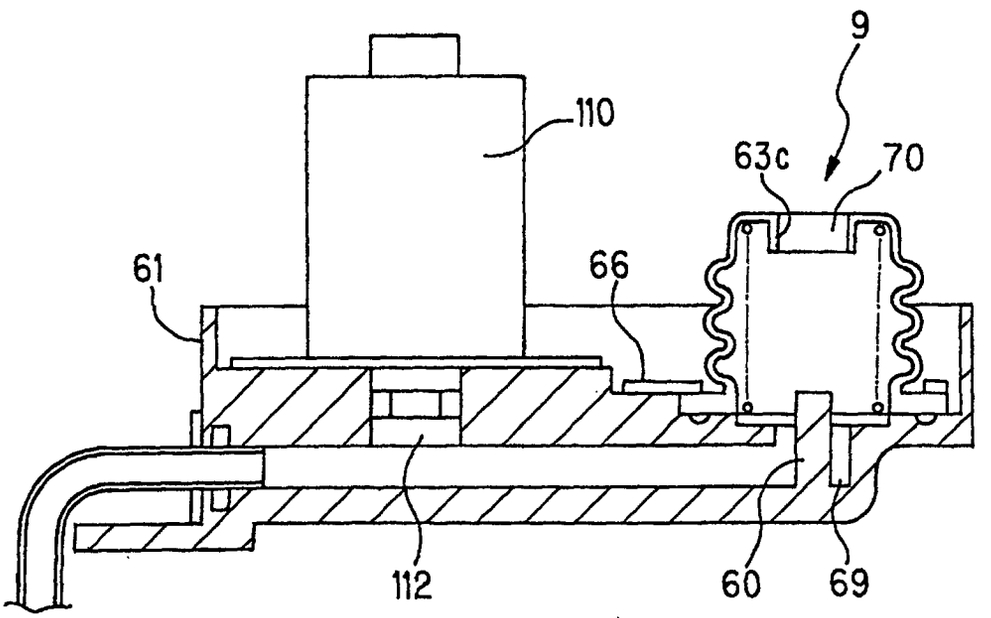


FIG. 11

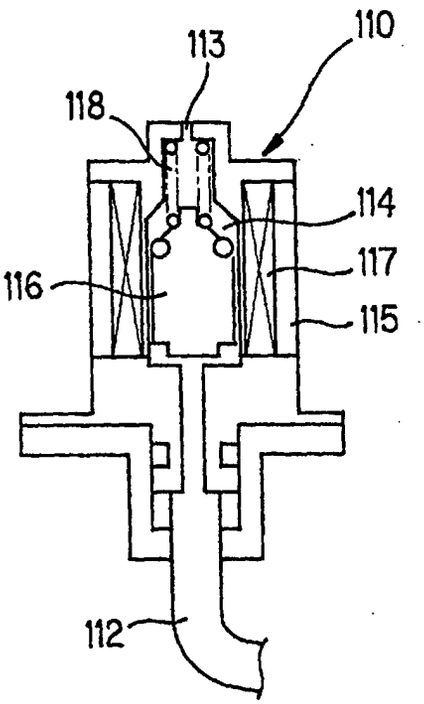


FIG. 12

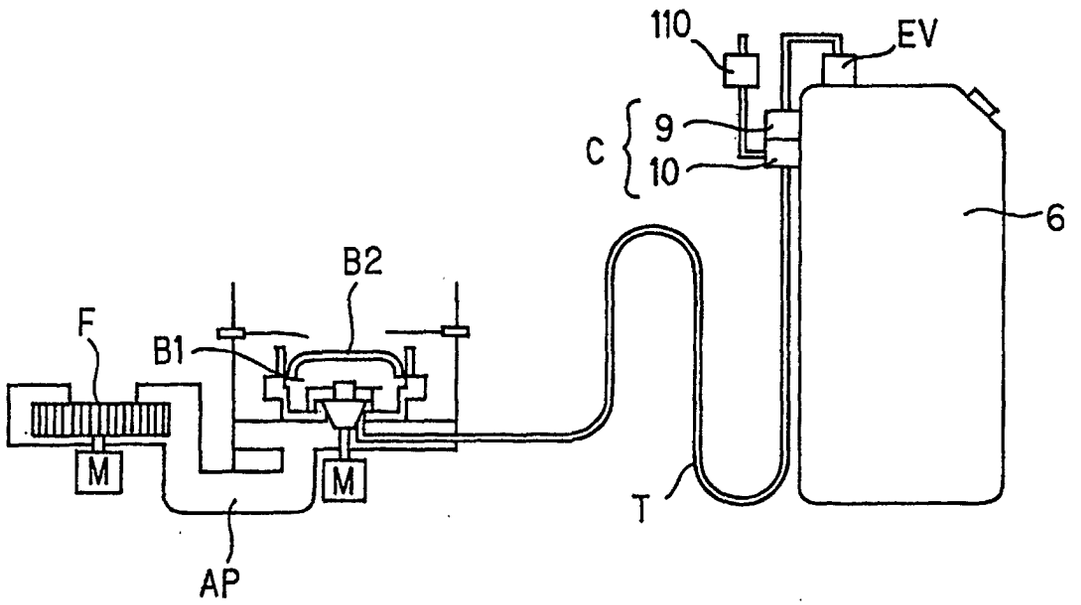


FIG. 13

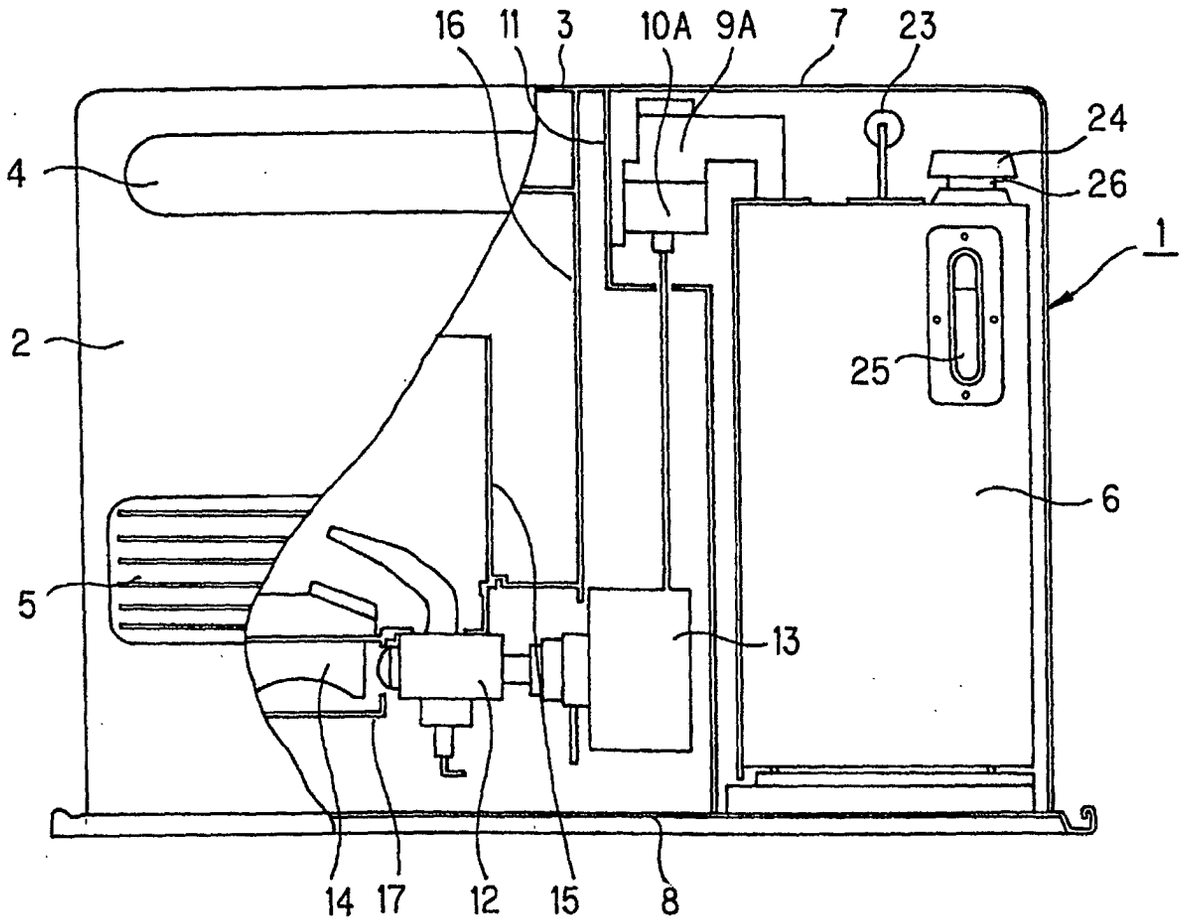


FIG. 14

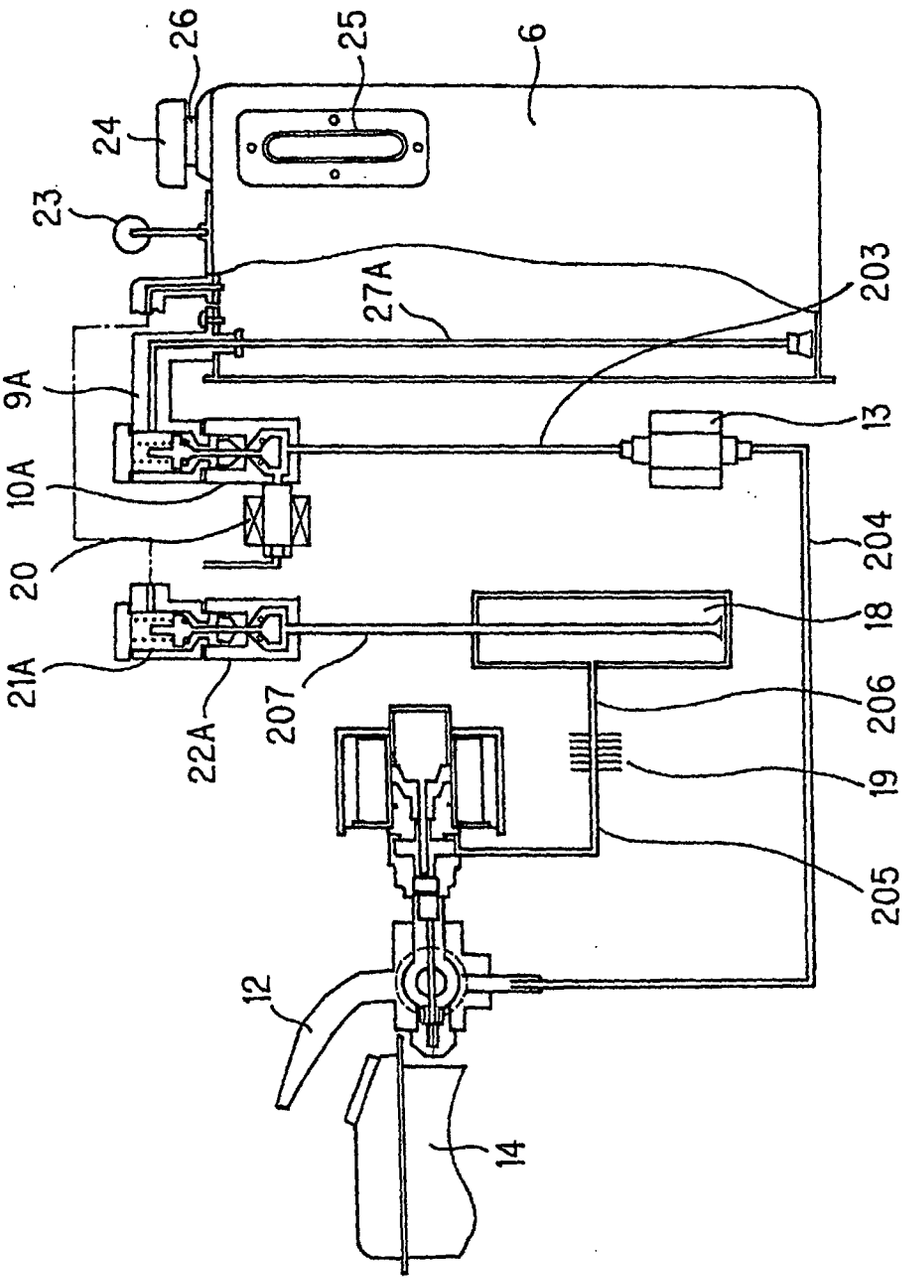

26
25
6
24
23
27A
203
9A
13
10A
204
20
18
21A
22A
207
206
19
205
12
14

FIG. 15

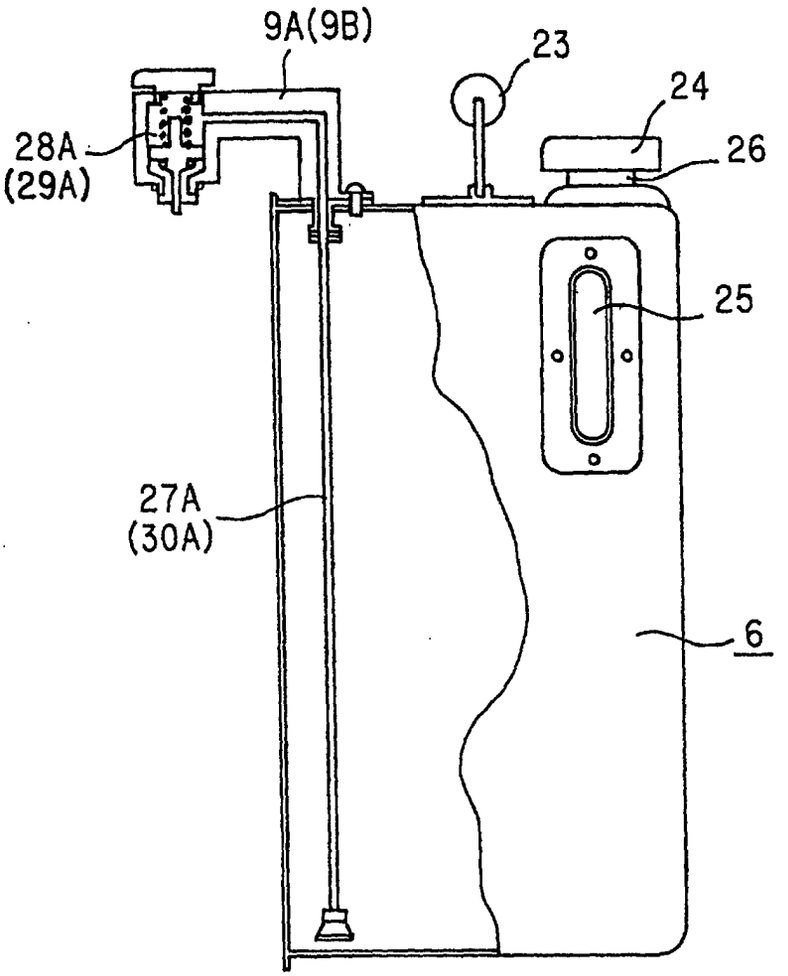


FIG. 16

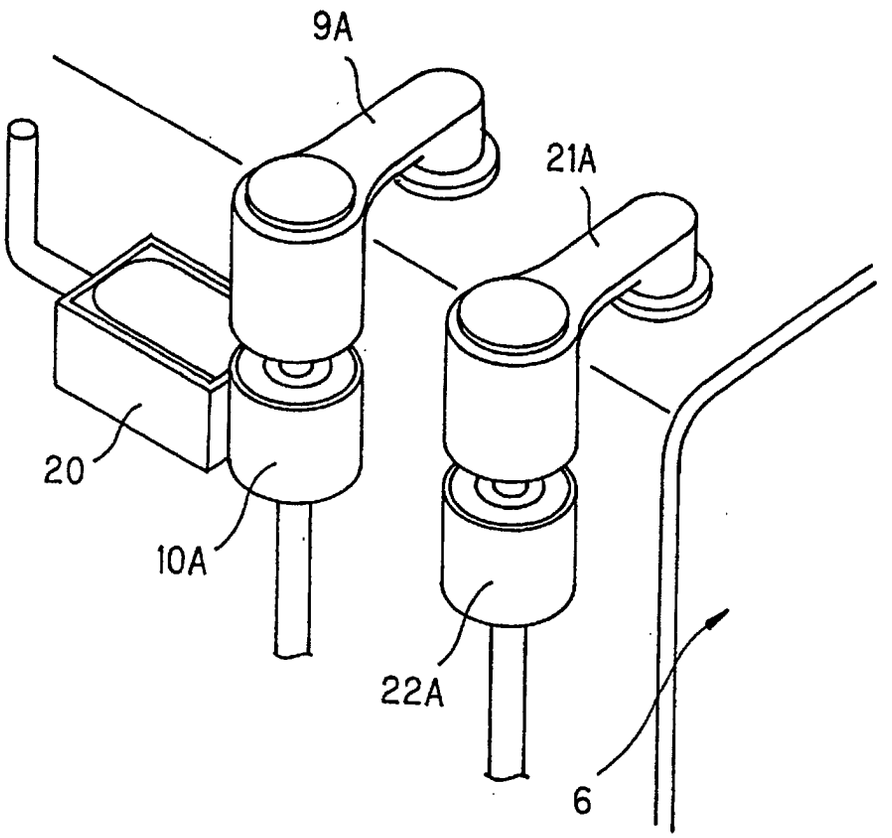


FIG. 17

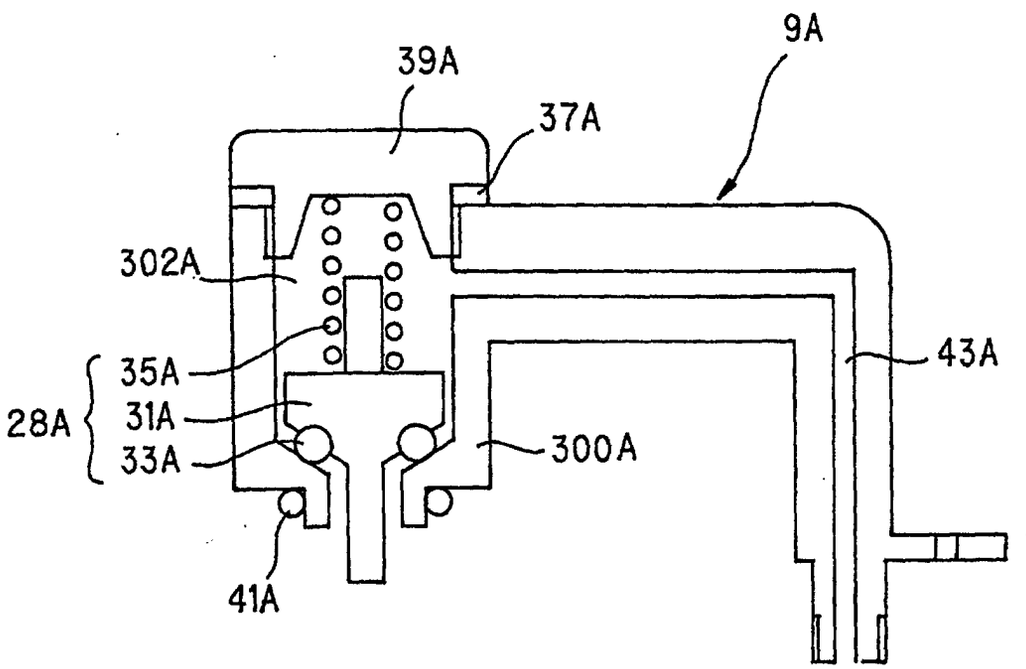


FIG. 18

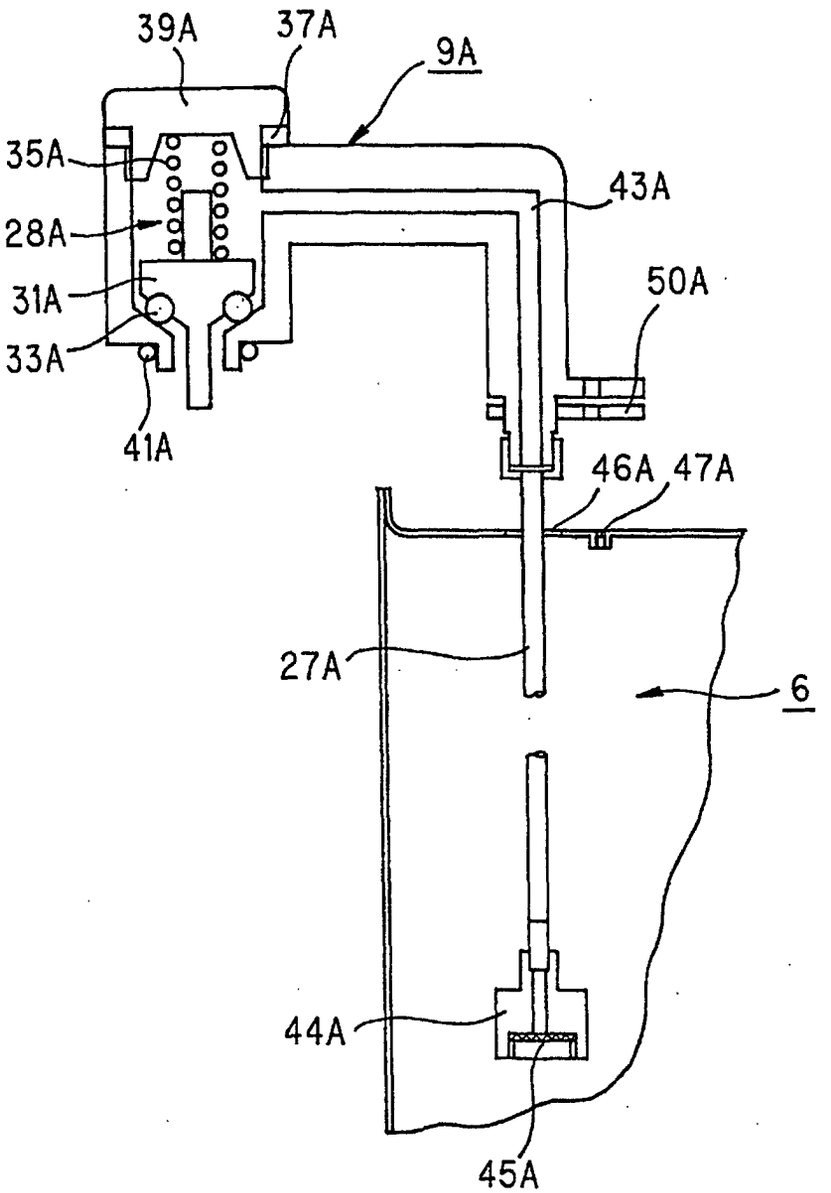


FIG. 19

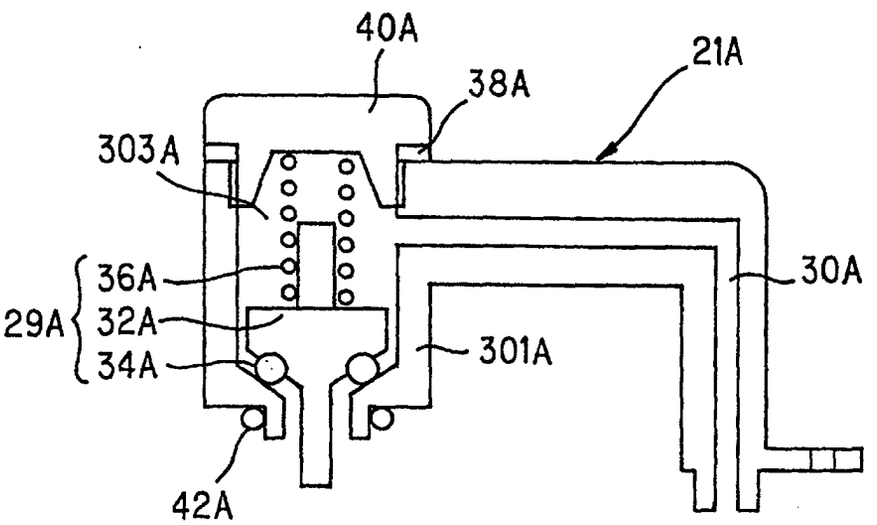


FIG. 20

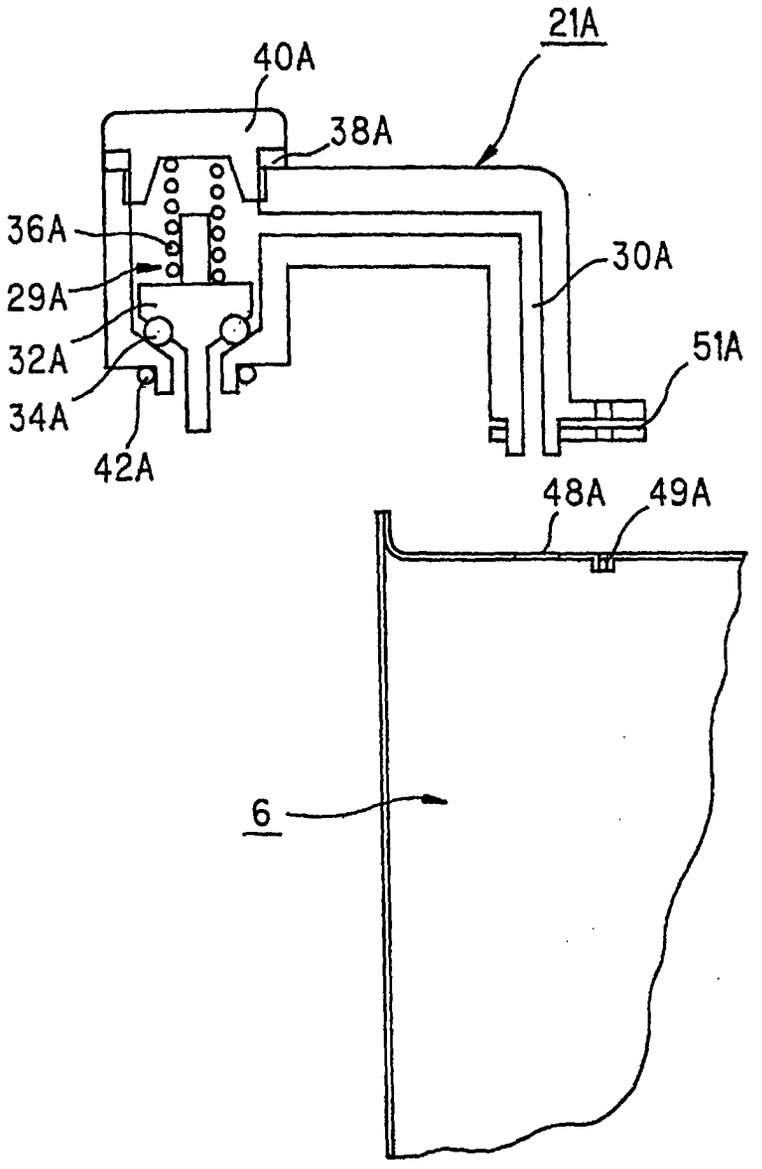


FIG. 21

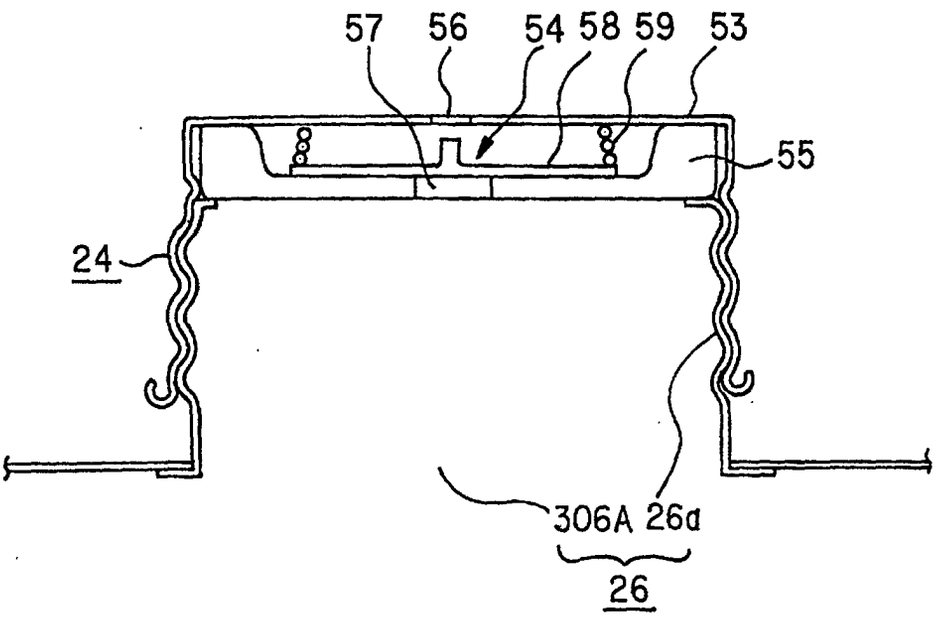


FIG. 22

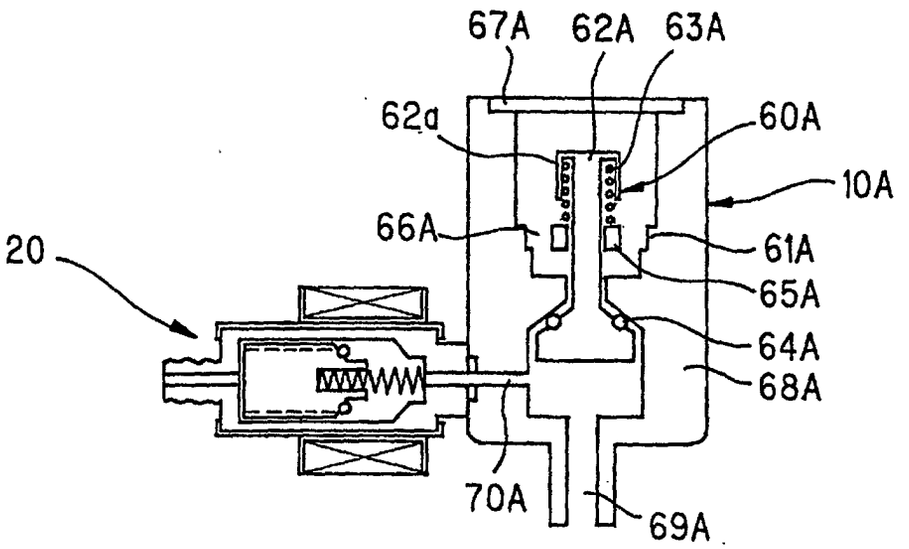


FIG. 23

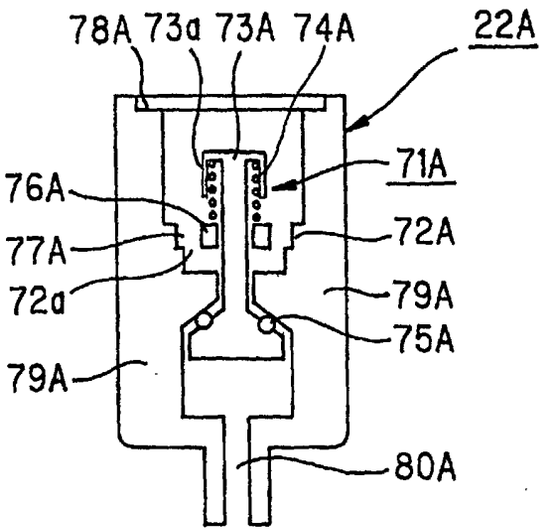


FIG. 24

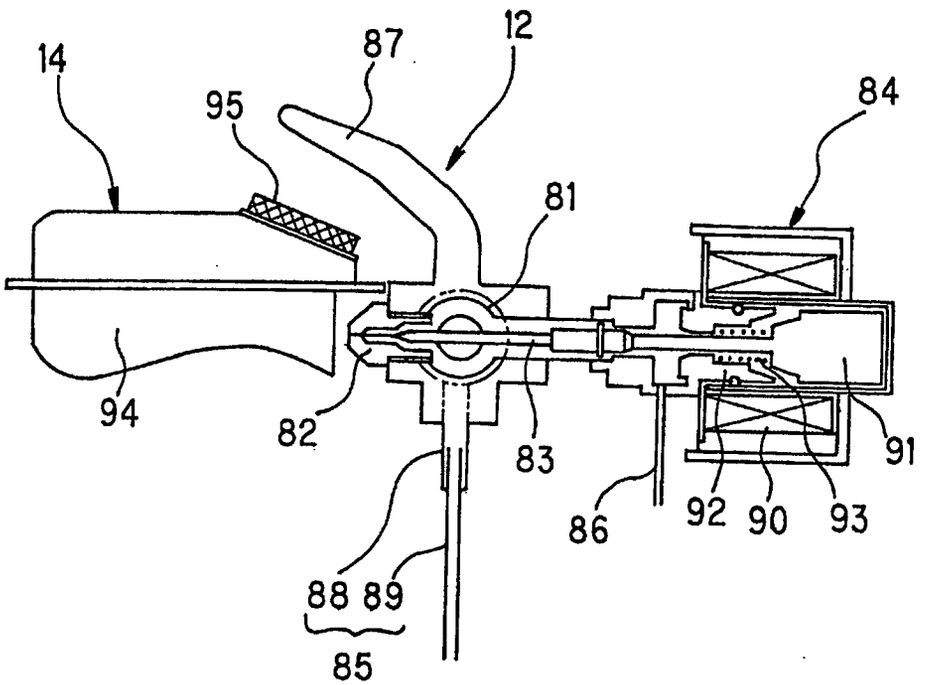


FIG. 25

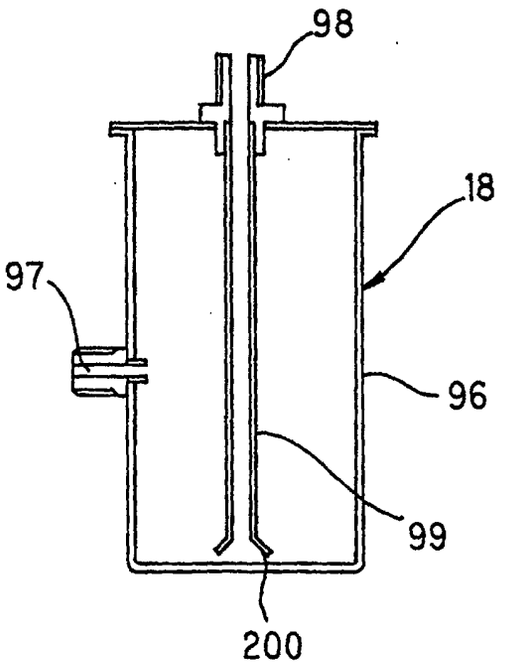


FIG. 26

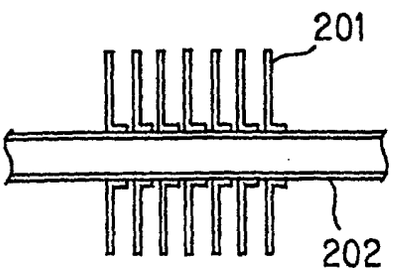


FIG. 27

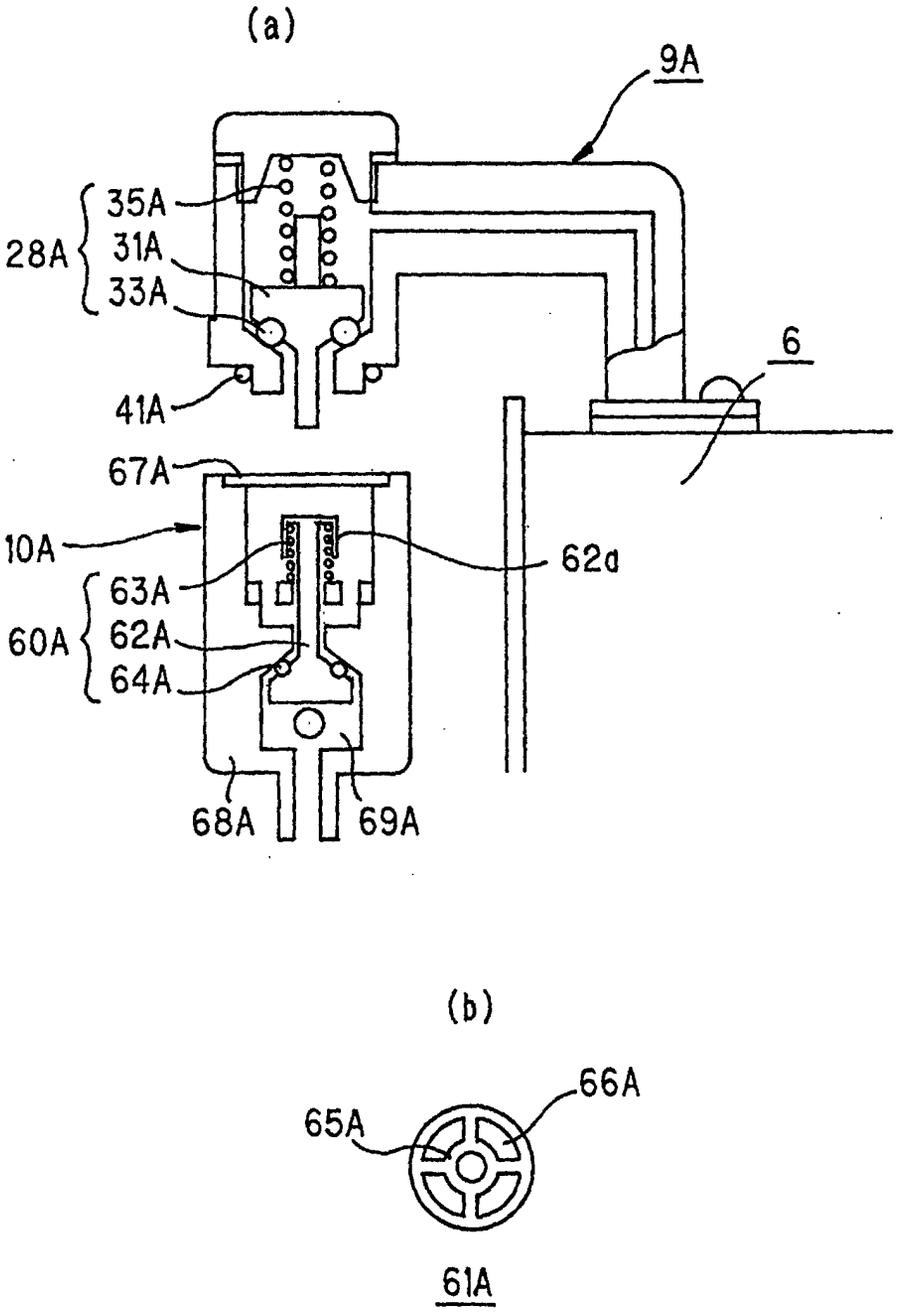

(a)
9A
35A
28A
31A
33A
6
41A
67A
10A
62a
63A
60A
62A
64A
68A
69A
(b)
66A
65A
61A

FIG. 28

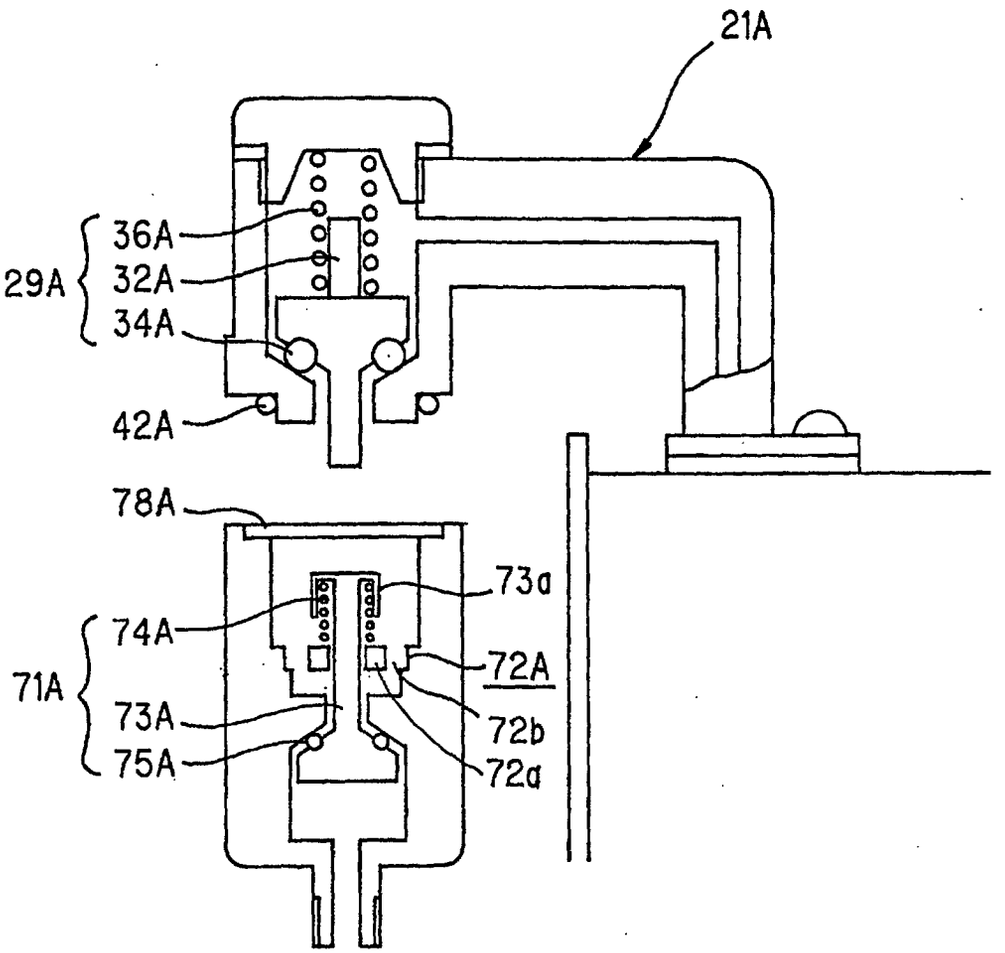


FIG. 29

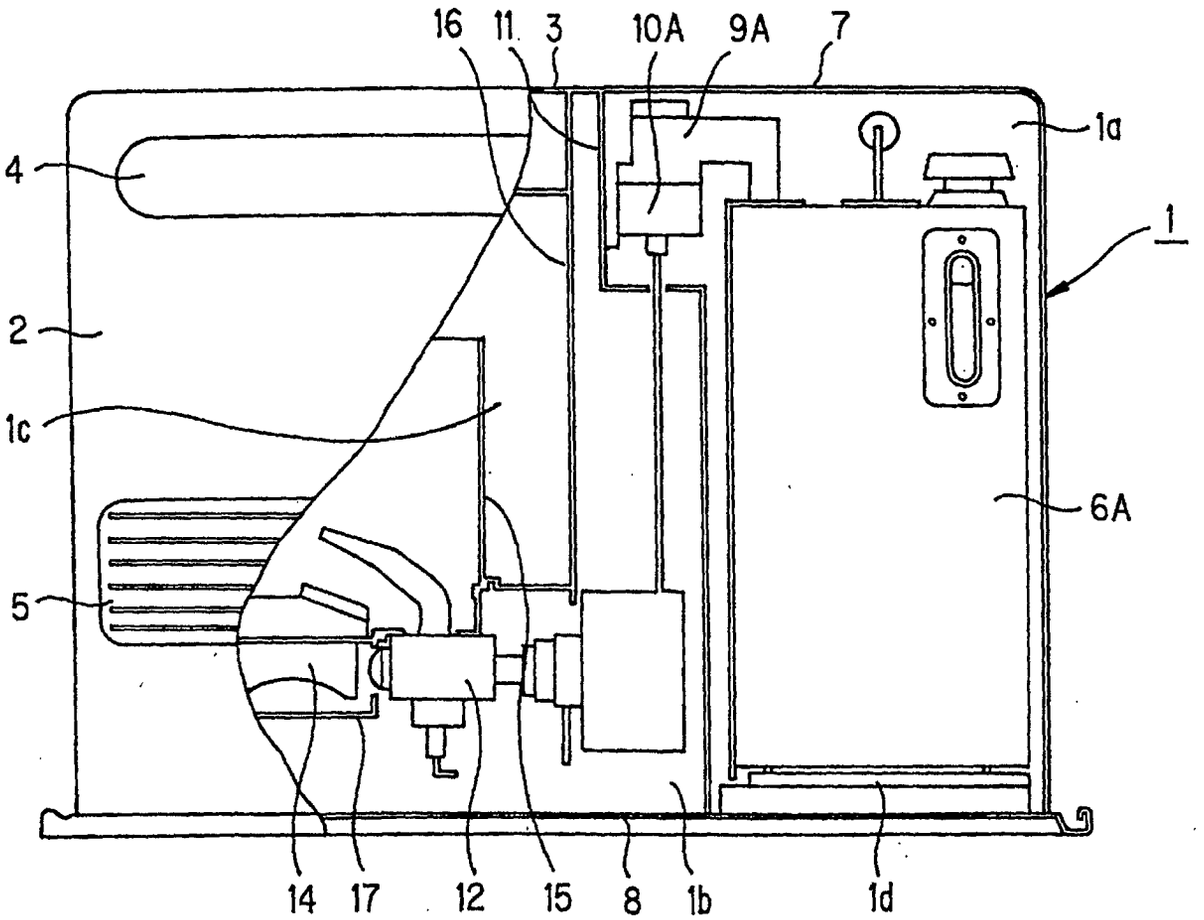


FIG. 30

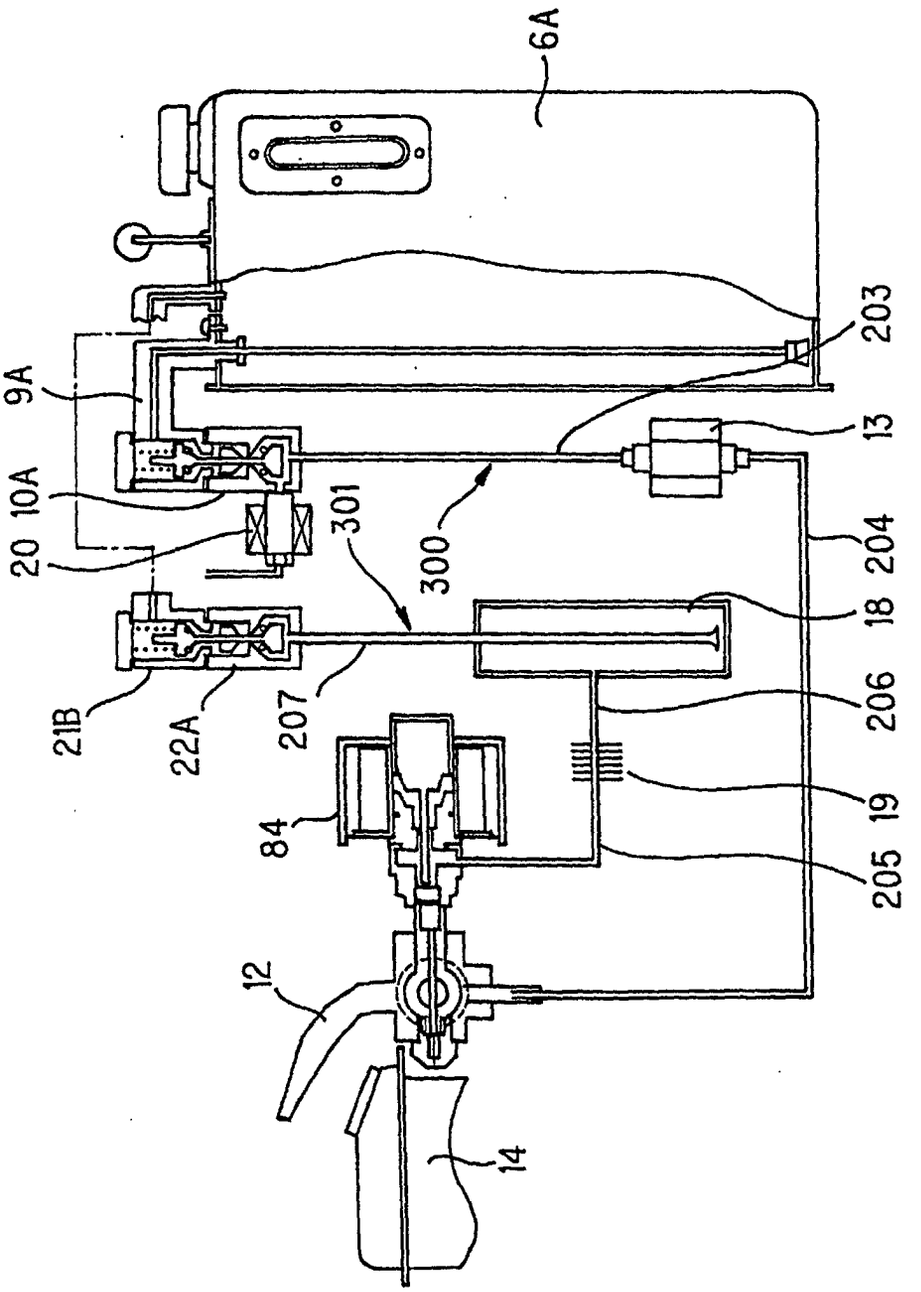


FIG. 31

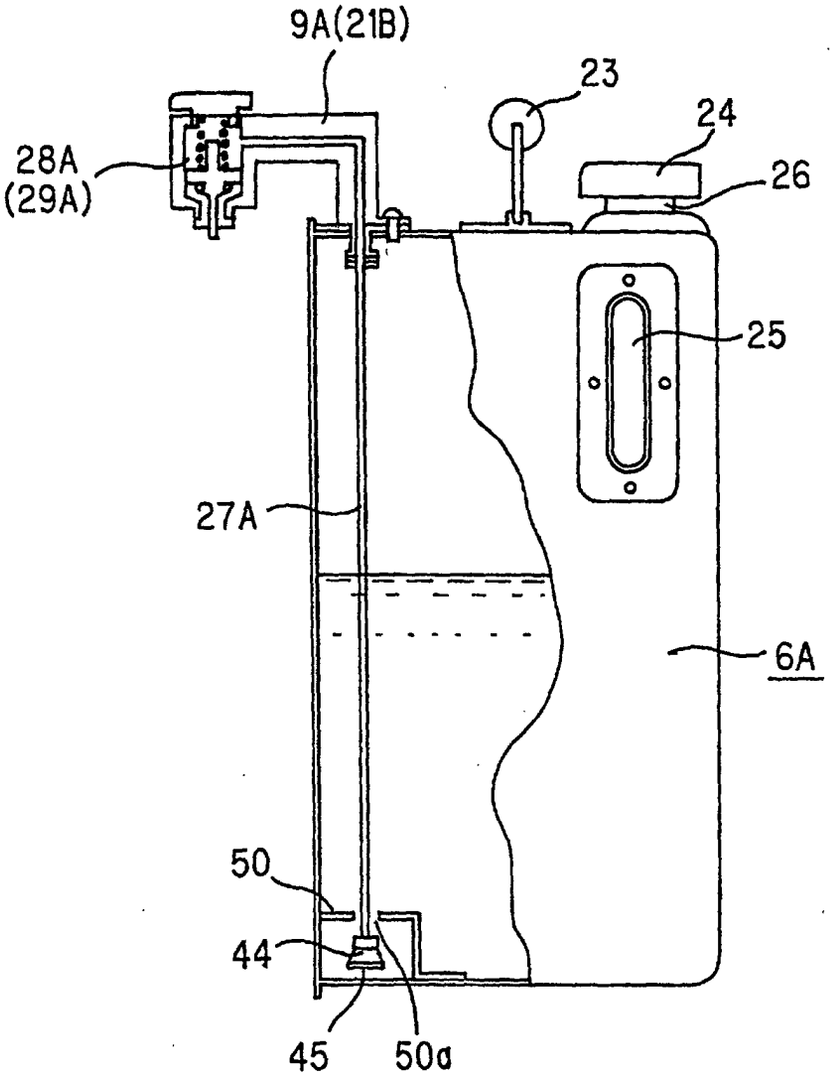


FIG. 32

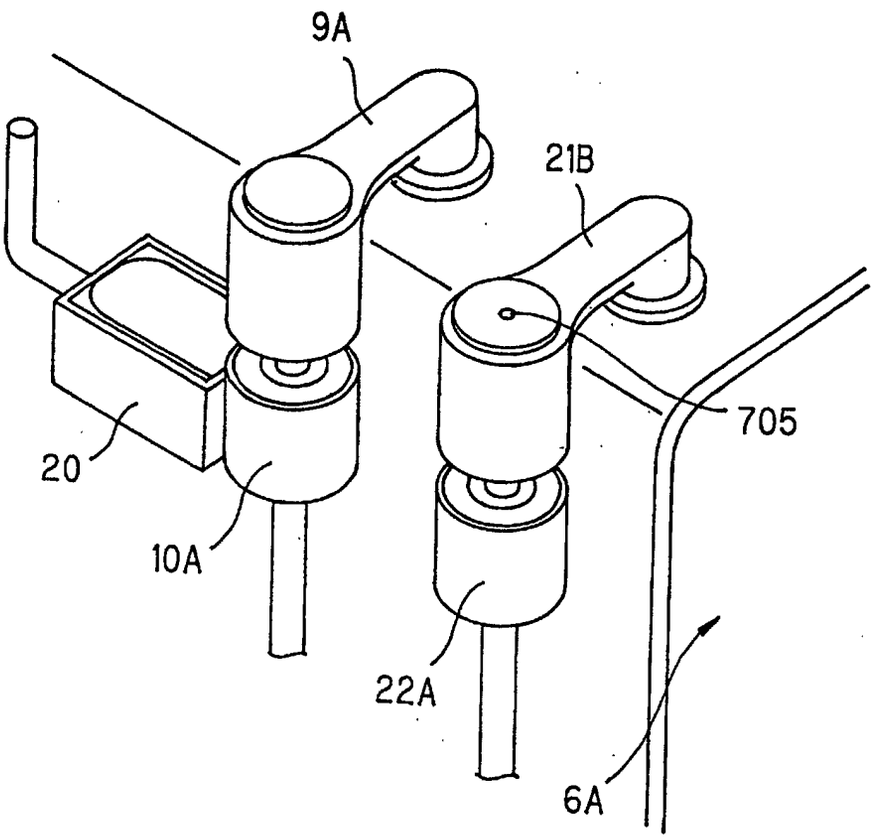


FIG. 33

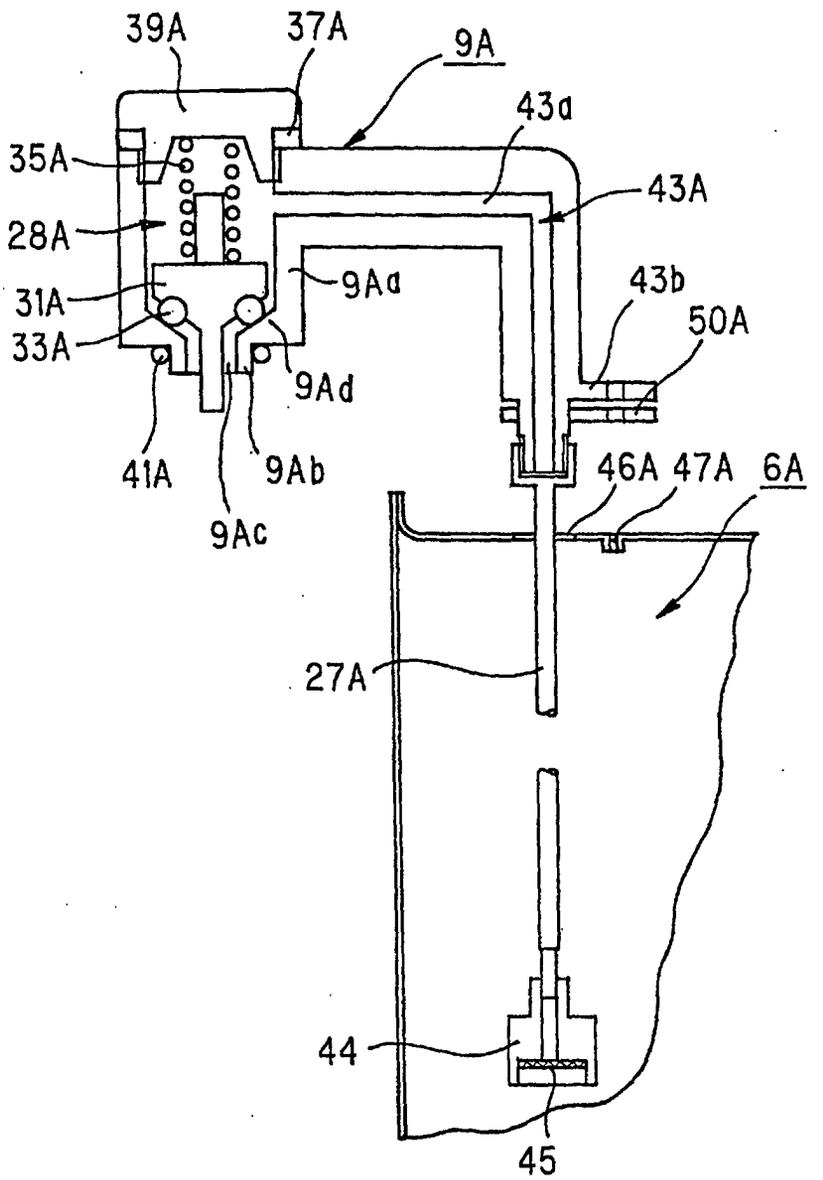

39A
37A
9A
43a
35A
43A
28A
9Aa
43b
31A
50A
33A
9Ad
41A
9Ab
46A
47A
6A
9Ac
27A
44
45

FIG. 34

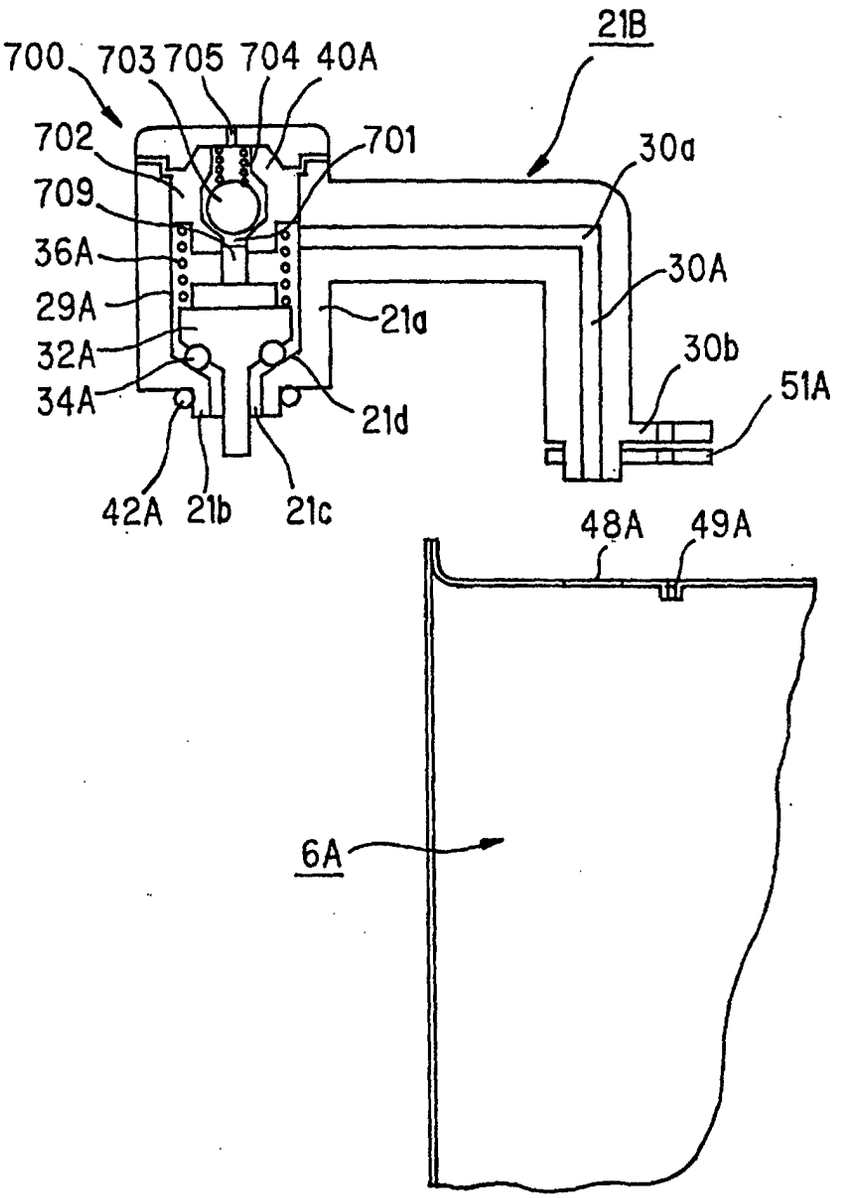
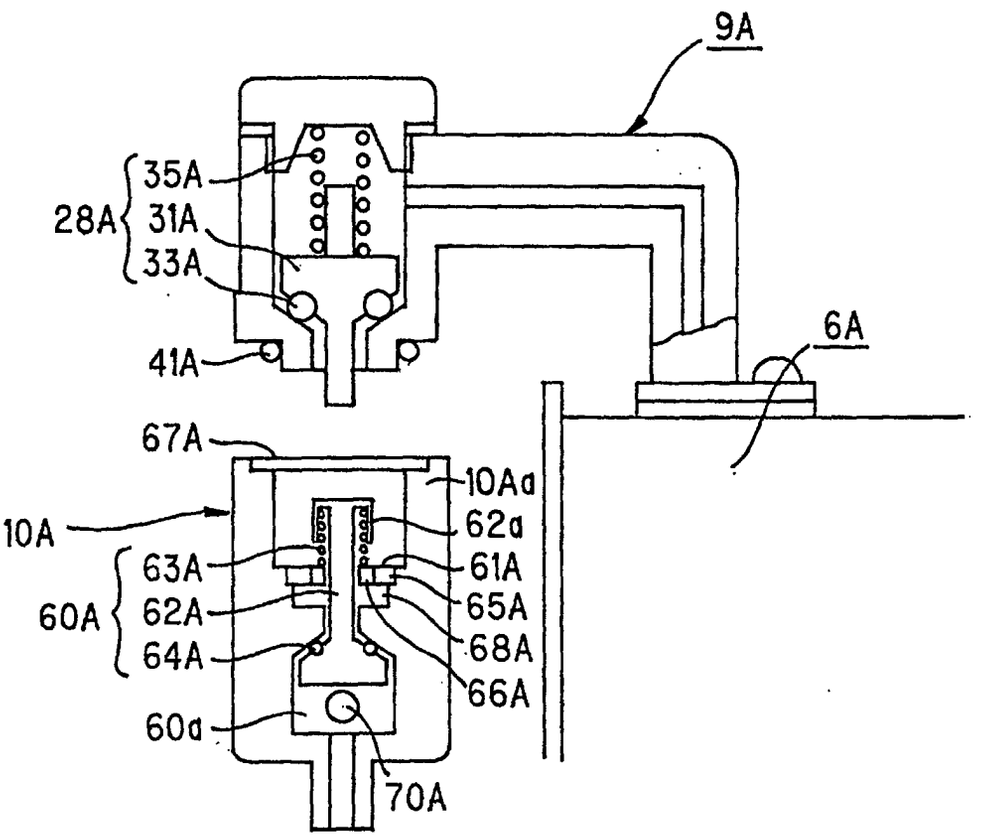

700
703
705
704
40A
21B
702
701
30a
709
36A
30A
29A
21a
32A
30b
34A
51A
21d
42A
21b
21c
48A
49A
6A

FIG. 35


9A
35A
28A
31A
33A
41A
6A
67A
10Aa
10A
62a
63A
61A
60A
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65A
64A
68A
66A
60a
70A

FIG. 36

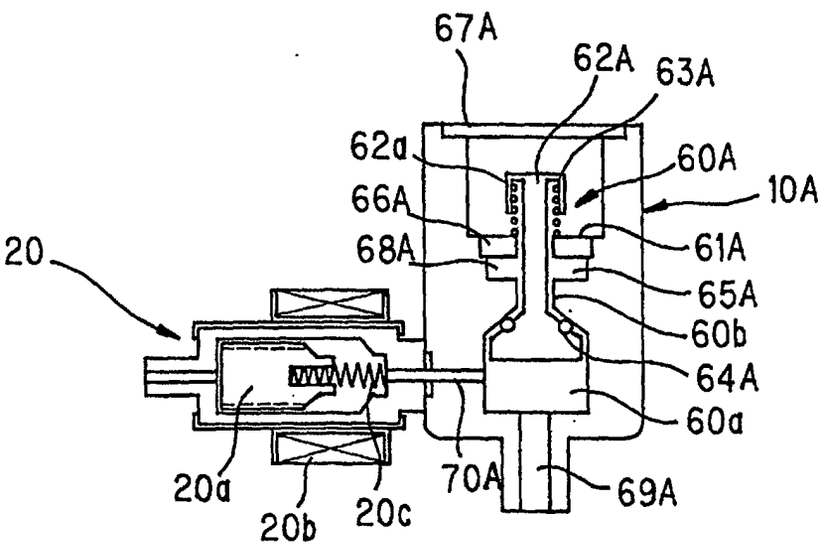

67A
62A
63A
62a
60A
10A
66A
68A
61A
65A
20
60b
64A
60a
20a
20b
20c
70A
69A

FIG. 37

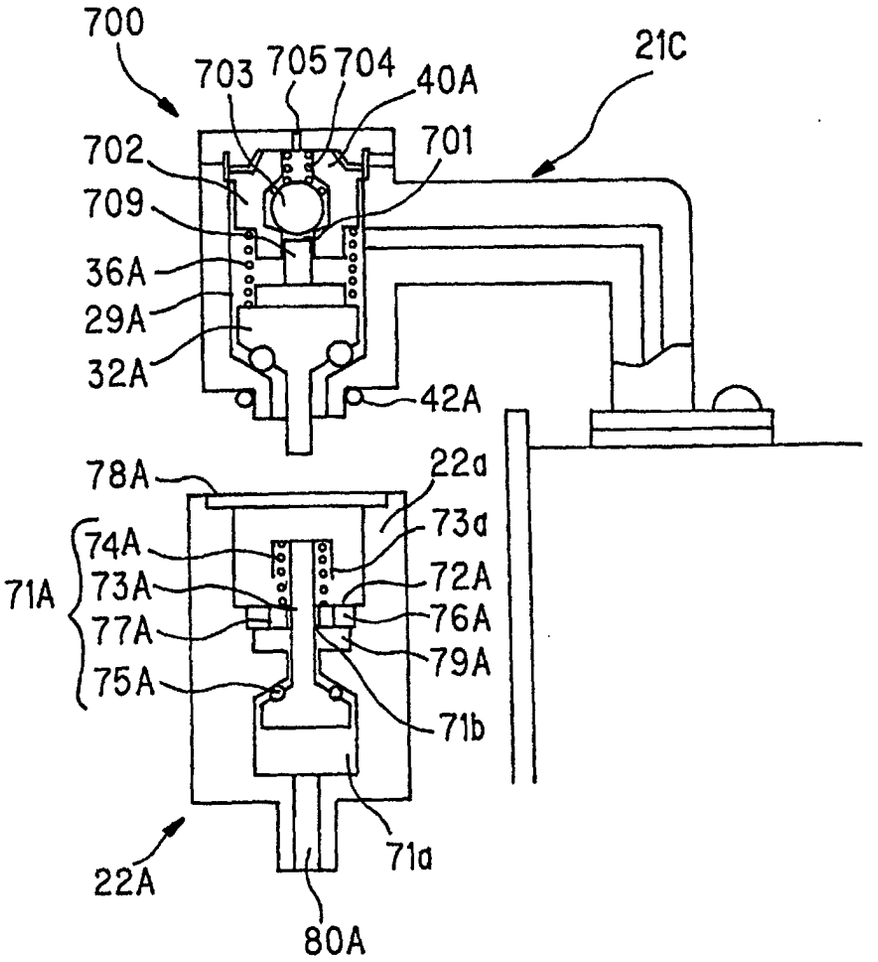

700
703
705
704
40A
21C
702
701
709
36A
29A
32A
42A
78A
22a
73a
74A
72A
71A
73A
76A
77A
79A
75A
71b
71a
22A
80A

FIG. 38

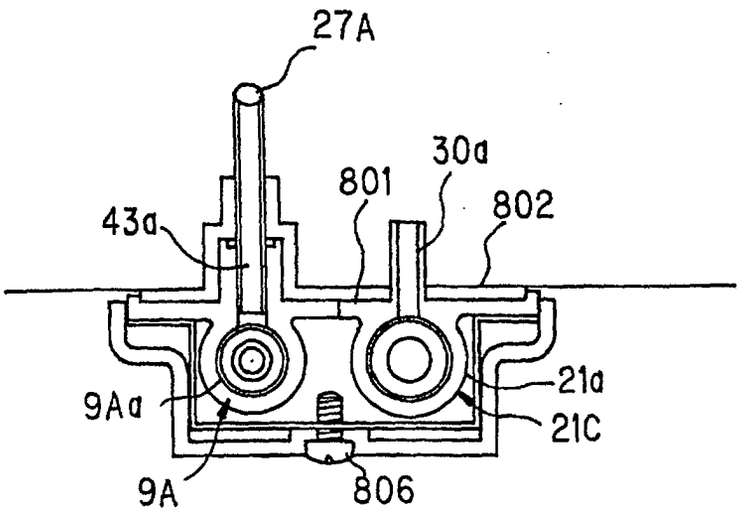

27A
30a
801
802
43a
21a
9Aa
21C
9A
806

FIG. 39

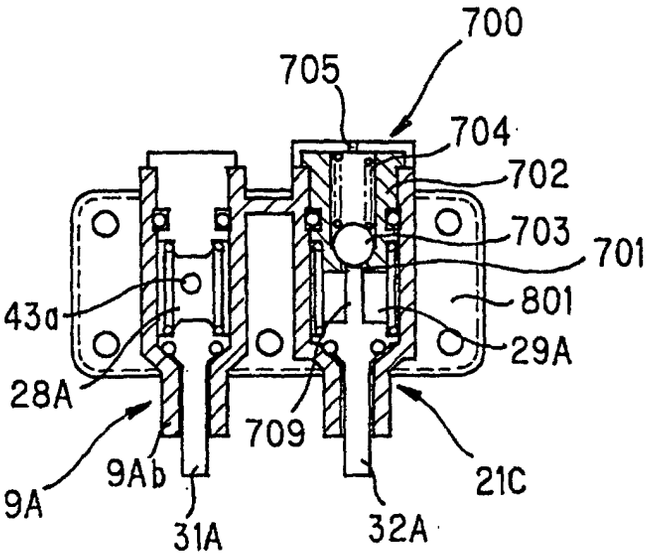

700
705
704
702
703
701
801
29A
43a
28A
709
9A
9Ab
31A
32A
21C

FIG. 40

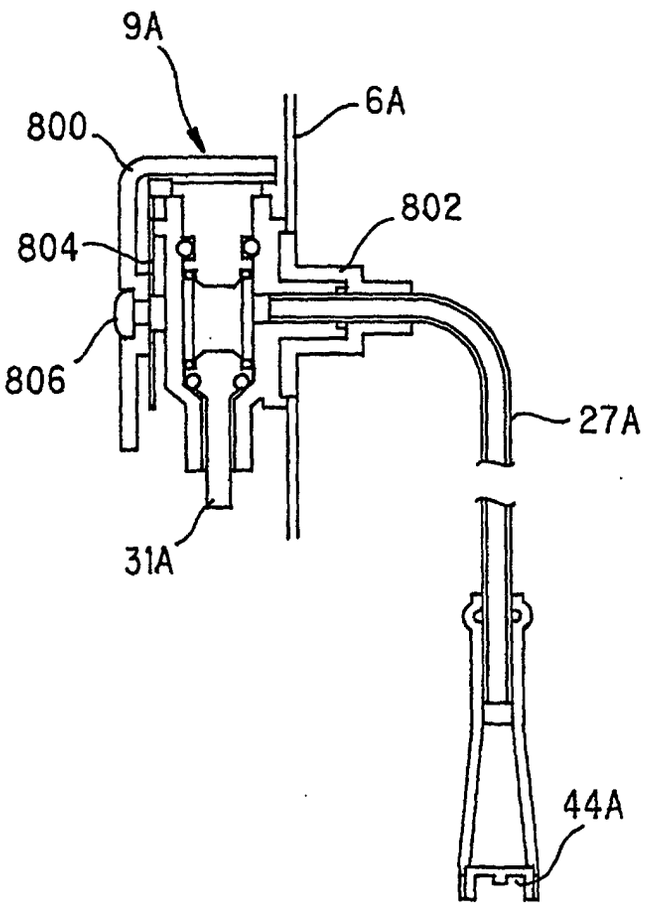

9A
6A
800
802
804
806
27A
31A
44A

FIG. 41

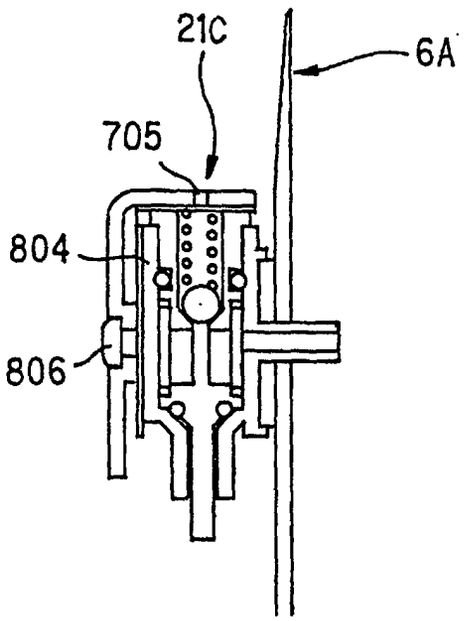


FIG. 42

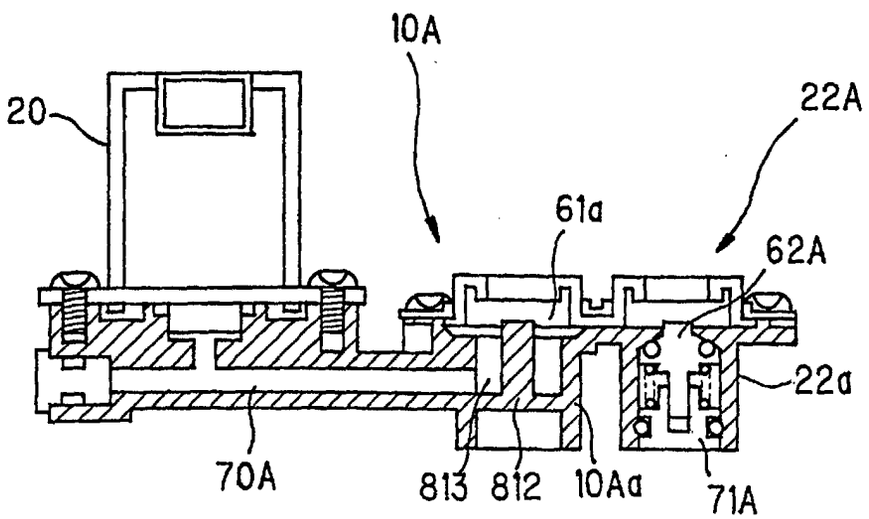


FIG. 43

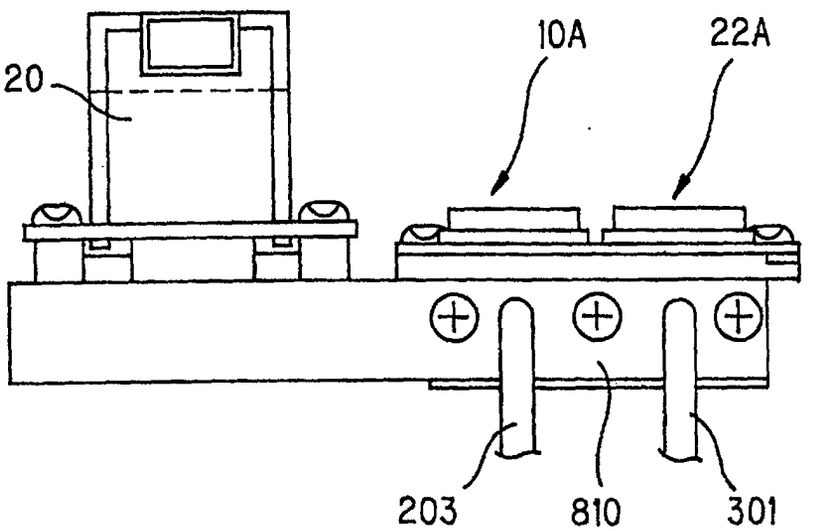


FIG. 44

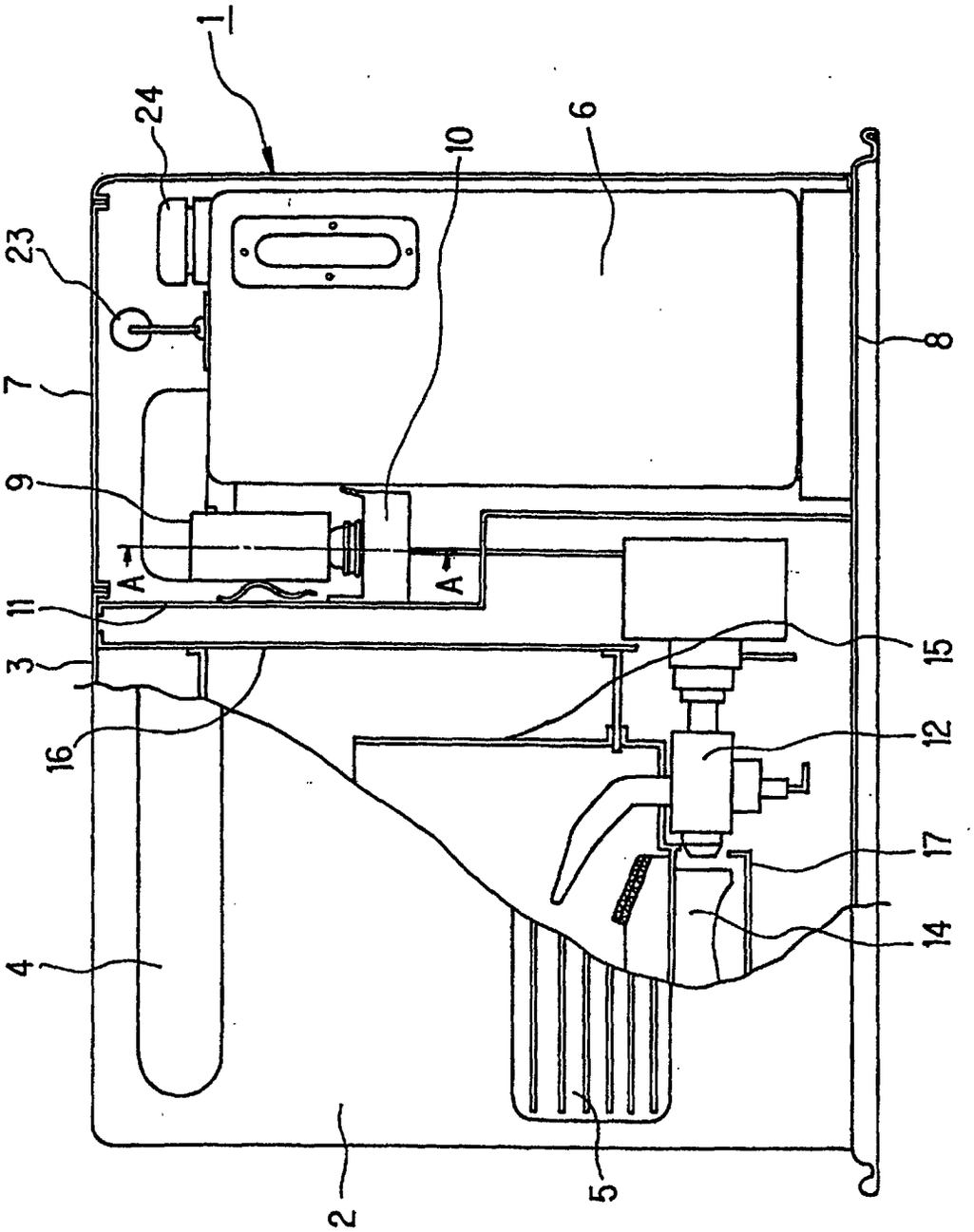


FIG. 45

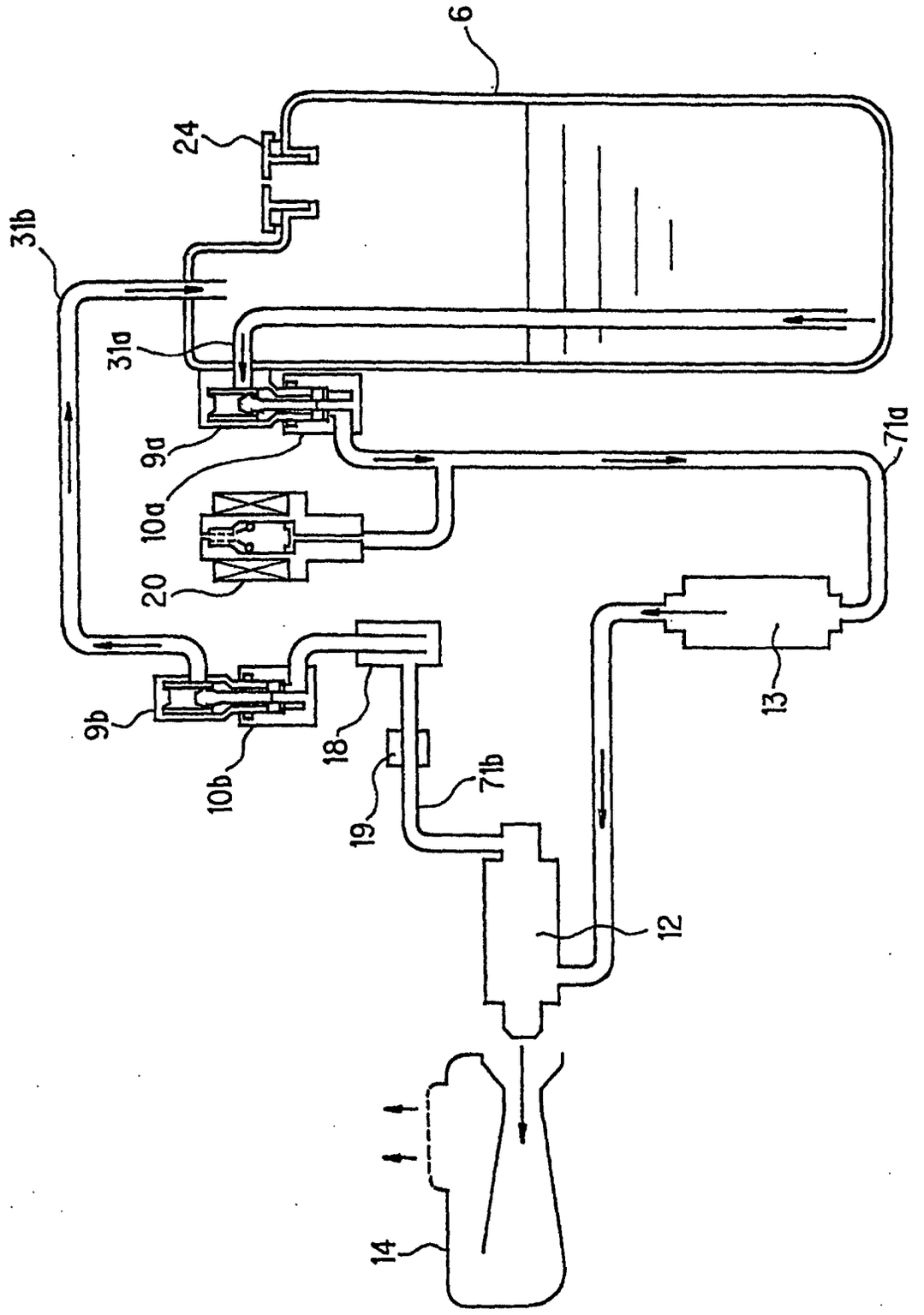


FIG. 46

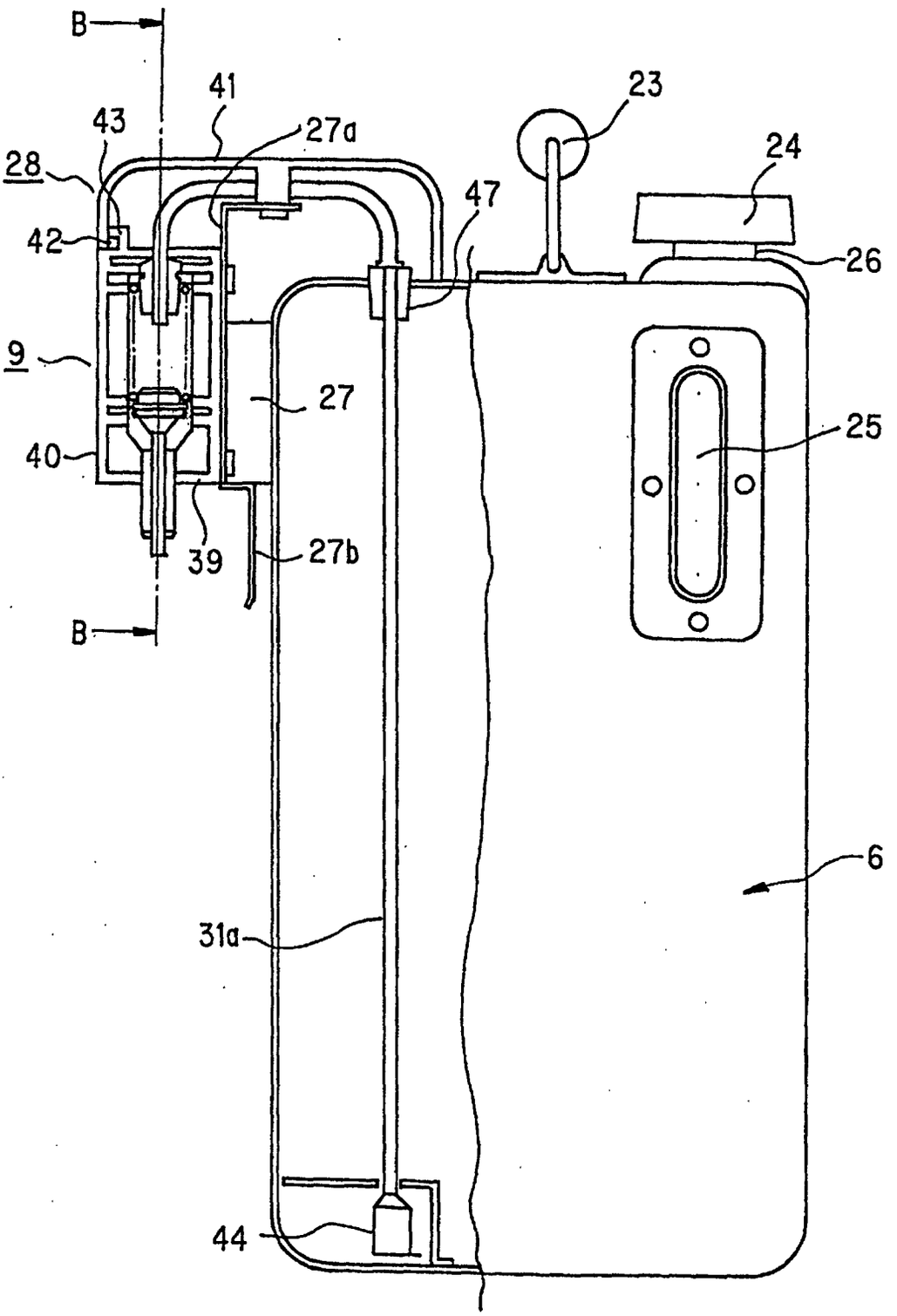
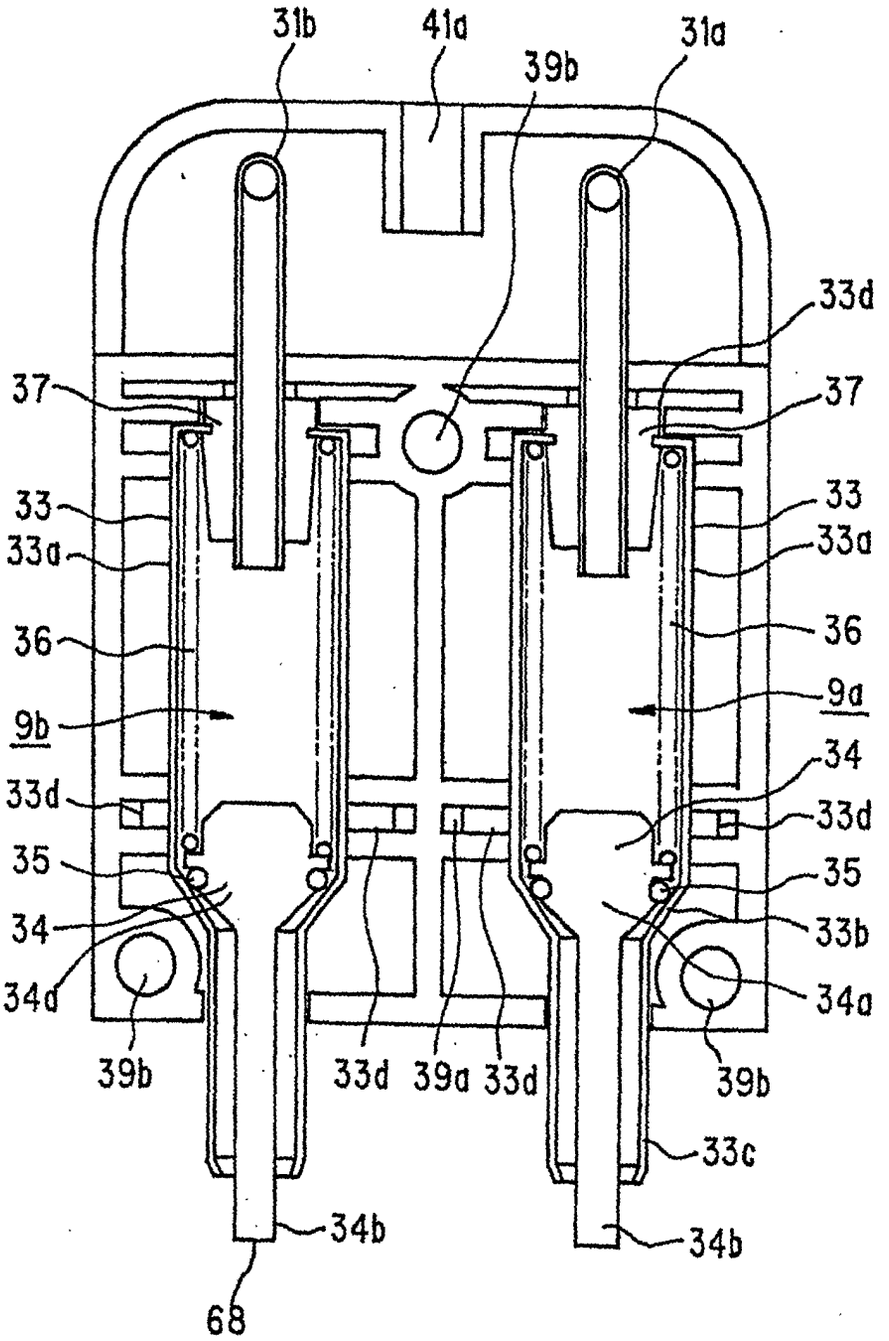


FIG. 47


31b
41a
39b
31a
33d
37
37
33
33a
33
33a
36
36
9b
9a
34
33d
33d
35
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34
33b
34a
34d
39b
33d
39a
33d
39b
33c
34b
34b
68

FIG. 48

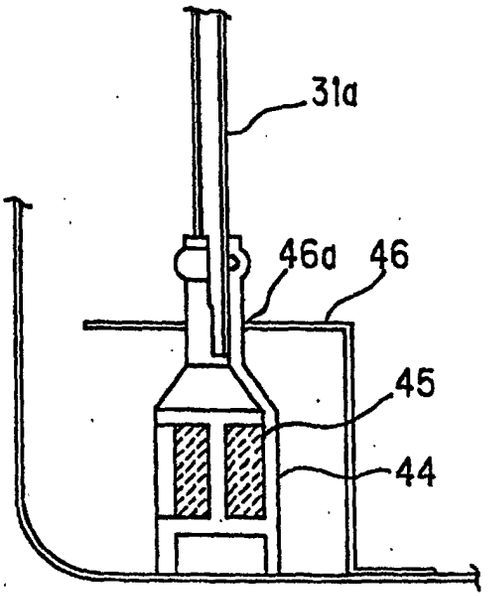


FIG. 49

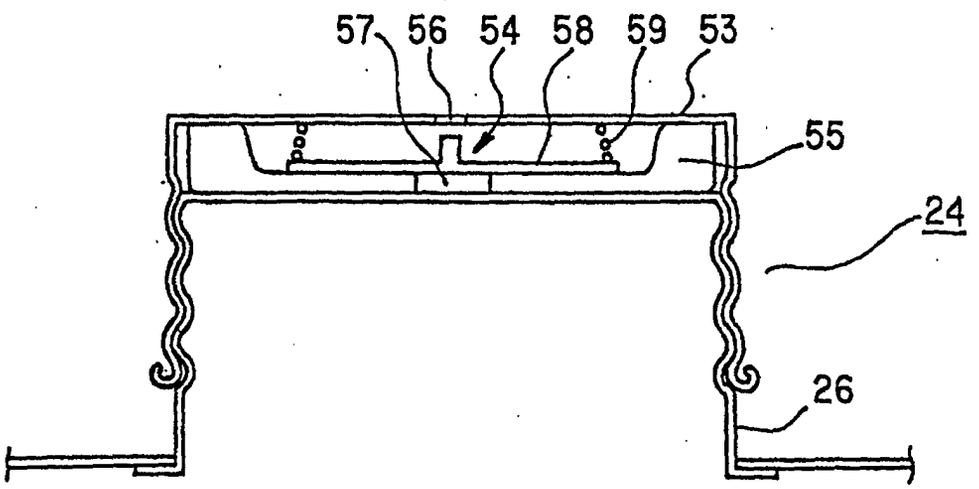


FIG. 50

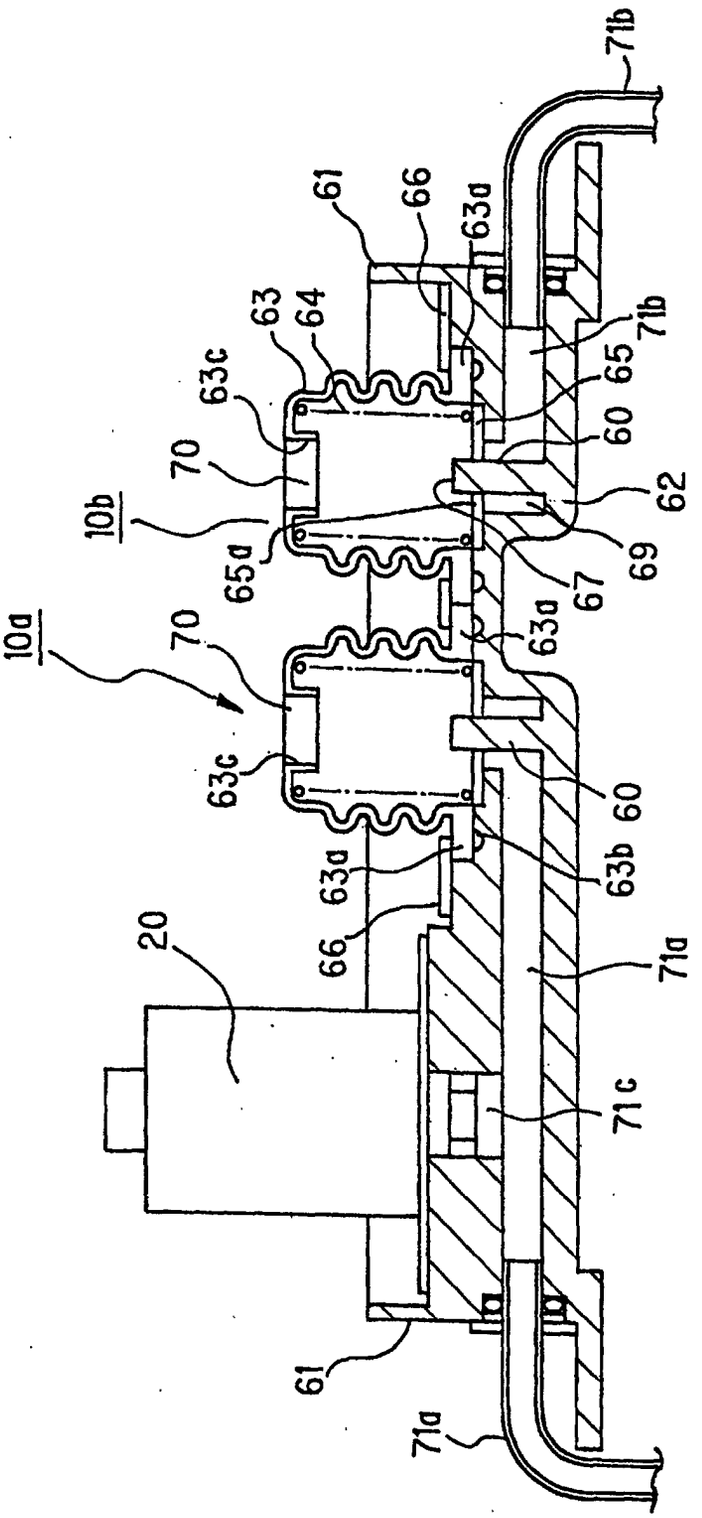

71b
61
66
63a
63
64
63c
71b
65
60
70
62
10b
65a
67
69
63a
10a
70
63c
60
63a
63b
66
20
71a
71c
61
71a

FIG. 51

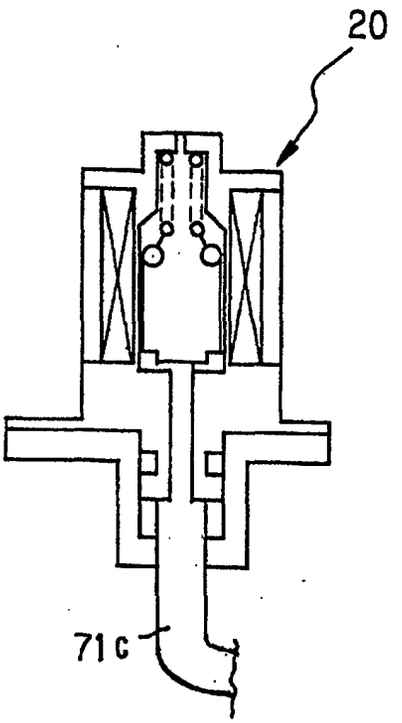


FIG. 52

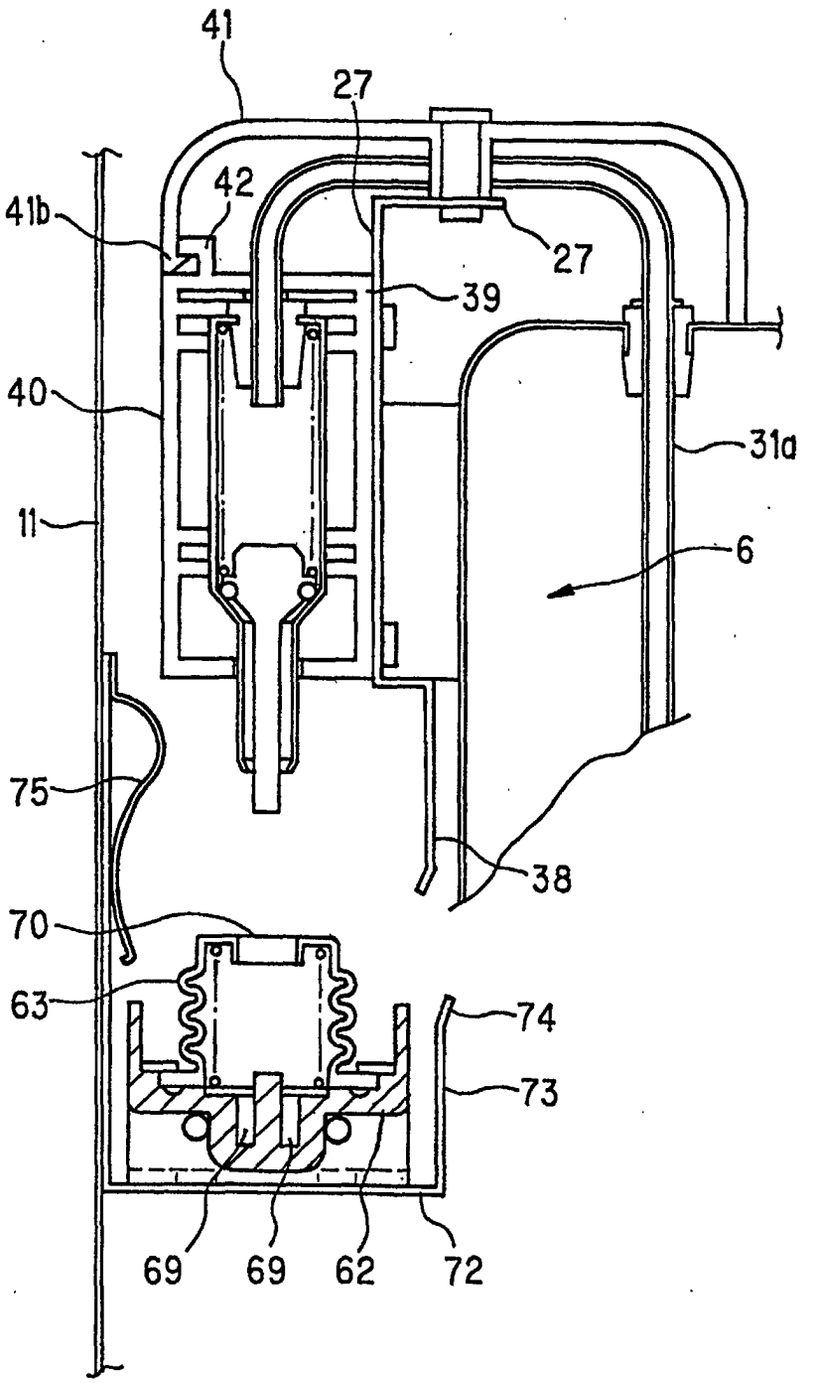


FIG. 53

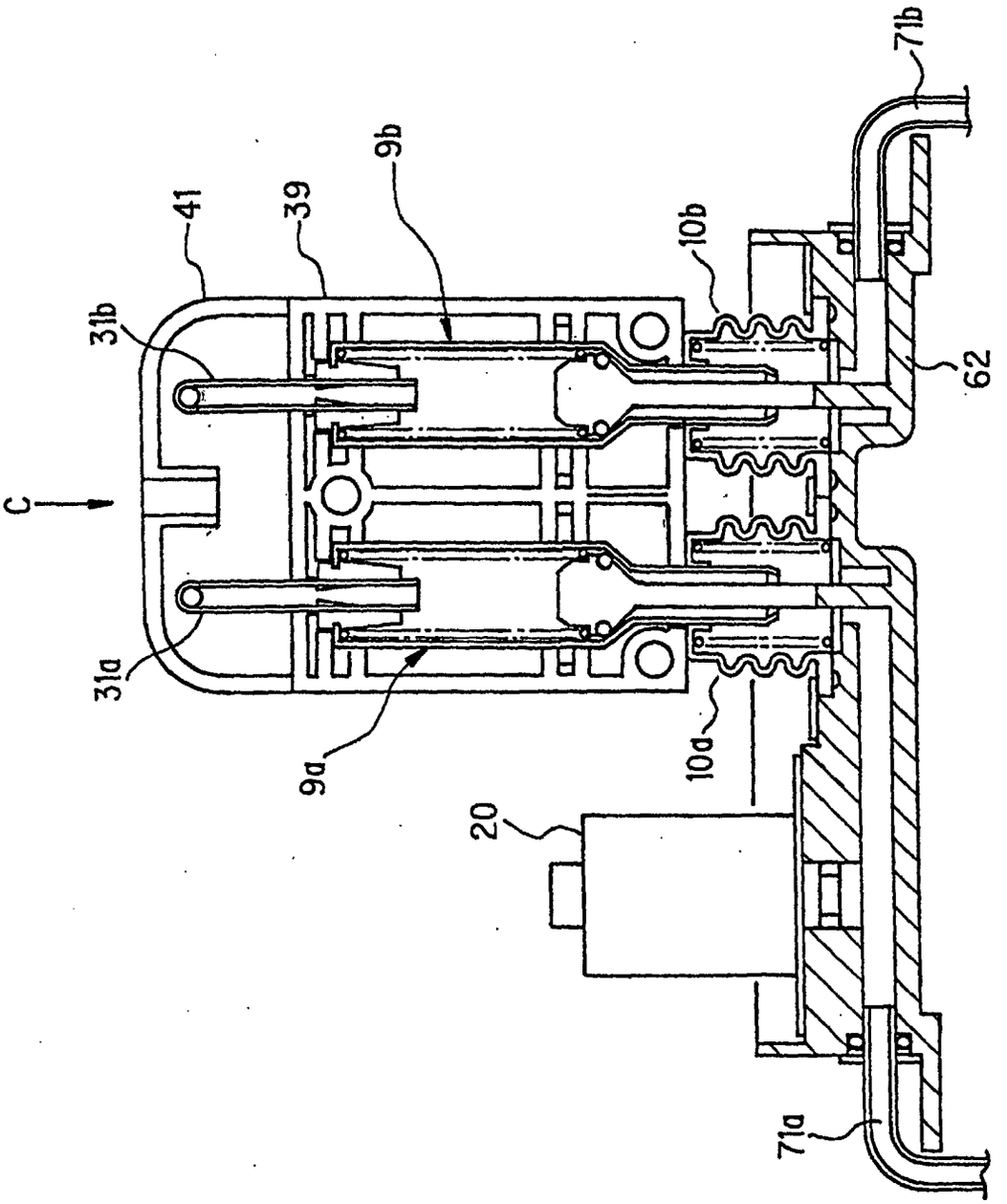


FIG. 54

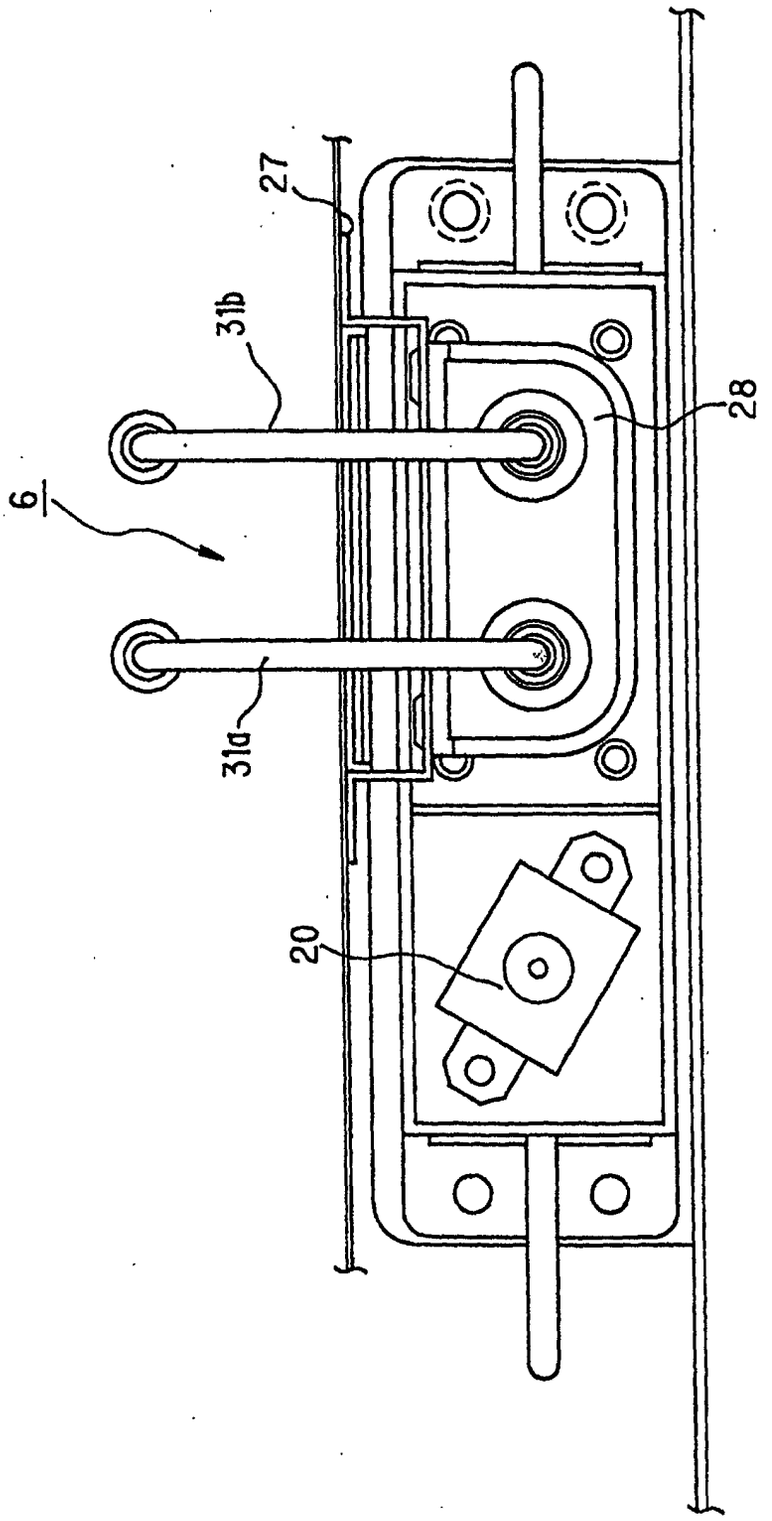


FIG. 55

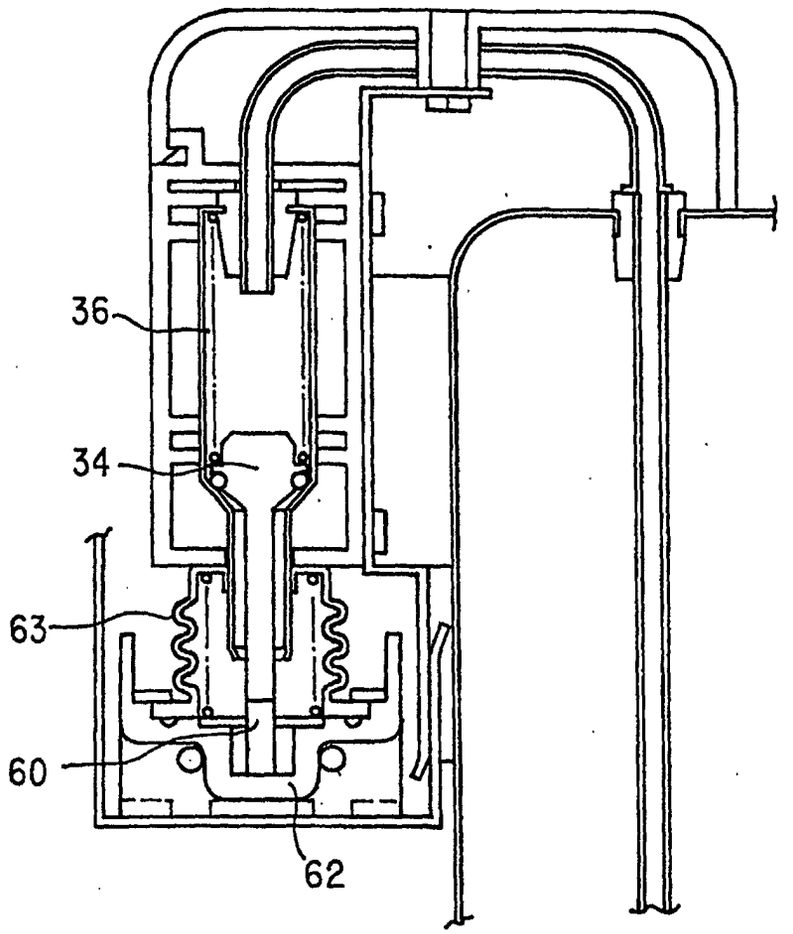


FIG. 56

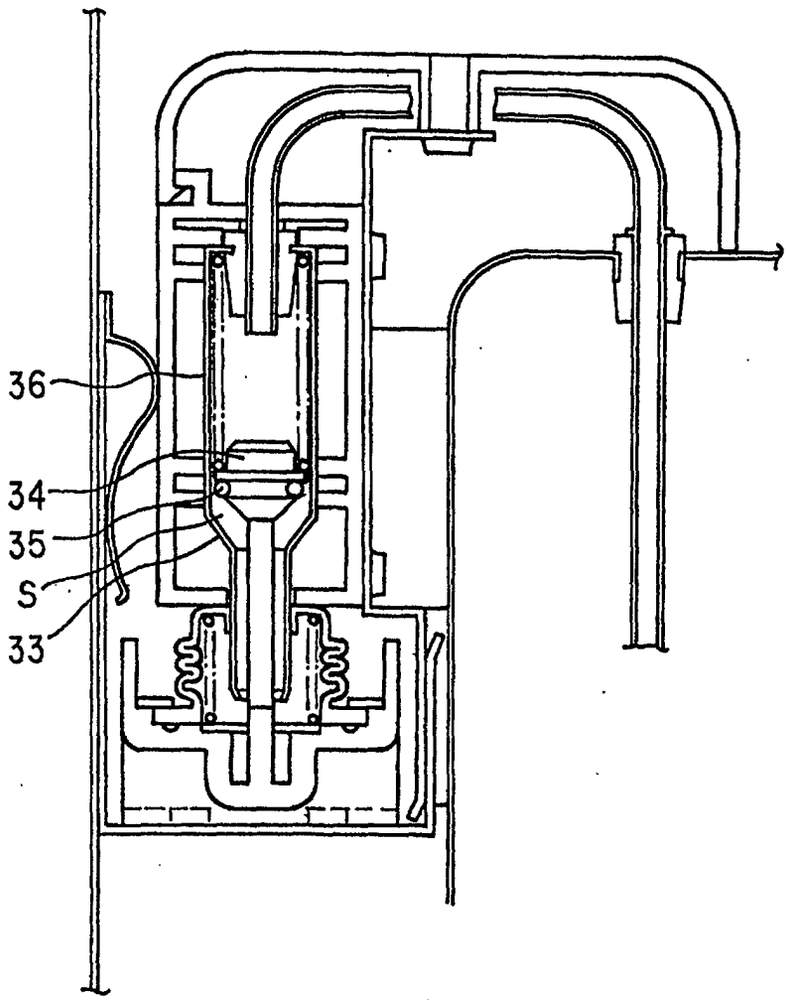


FIG. 57

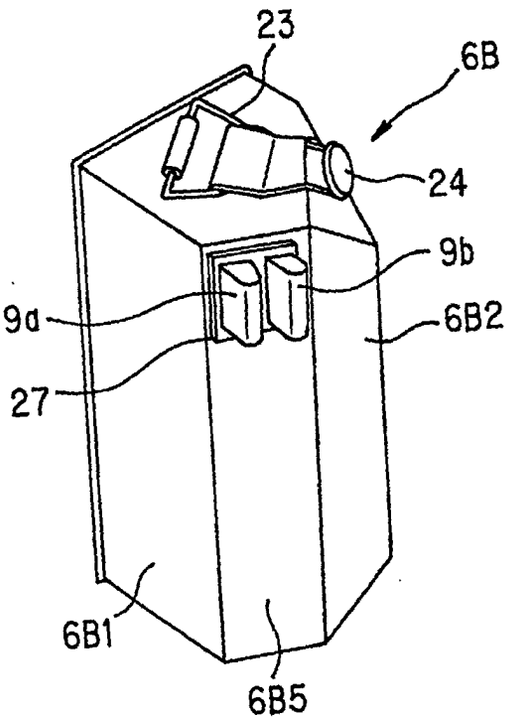


FIG. 58

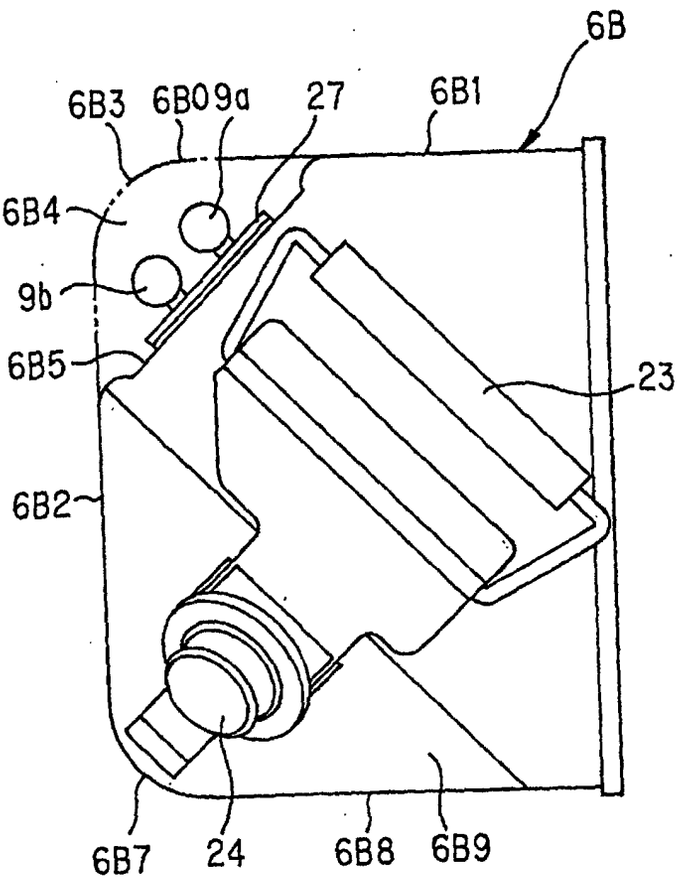


FIG. 59

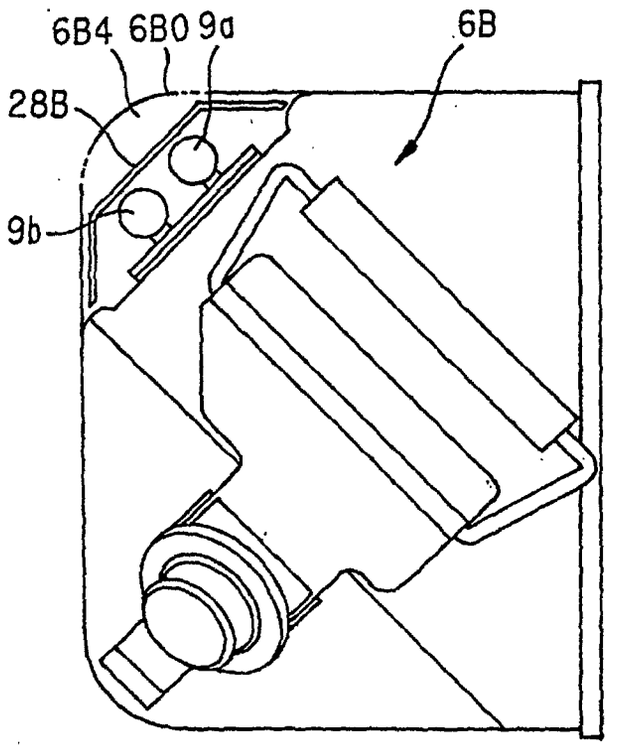


FIG. 60

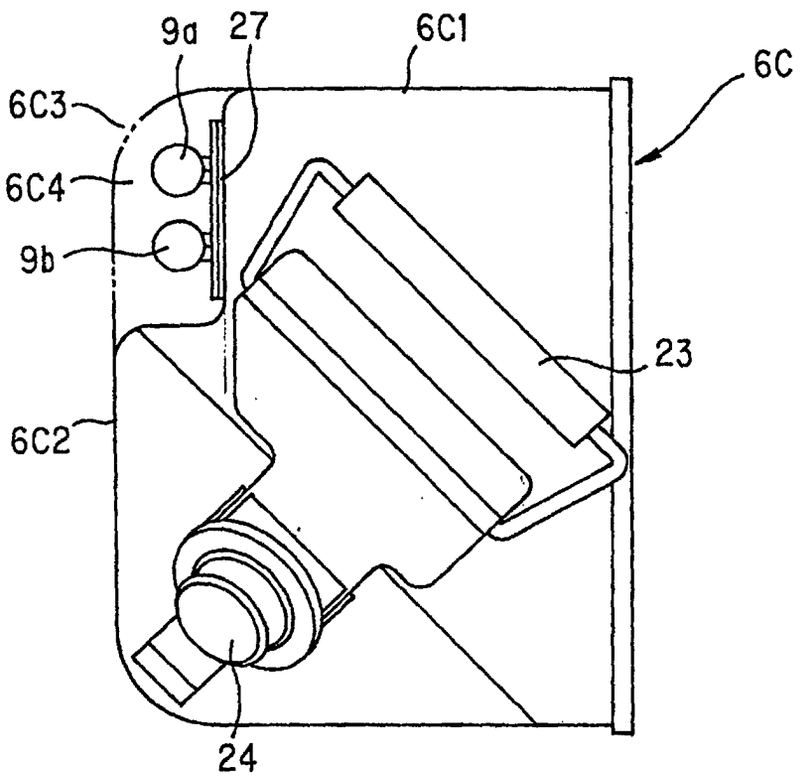


FIG. 61

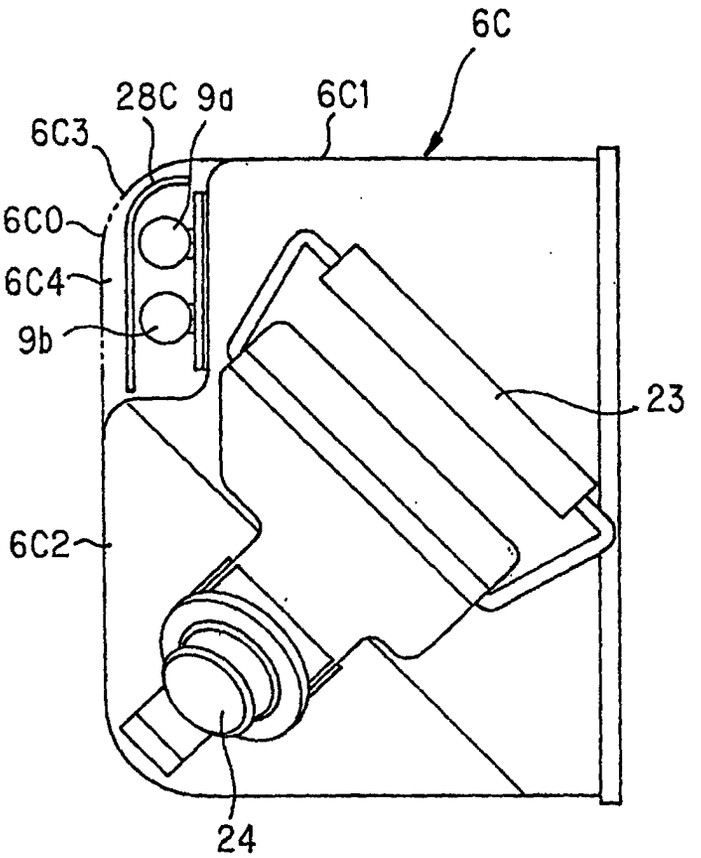


FIG. 62

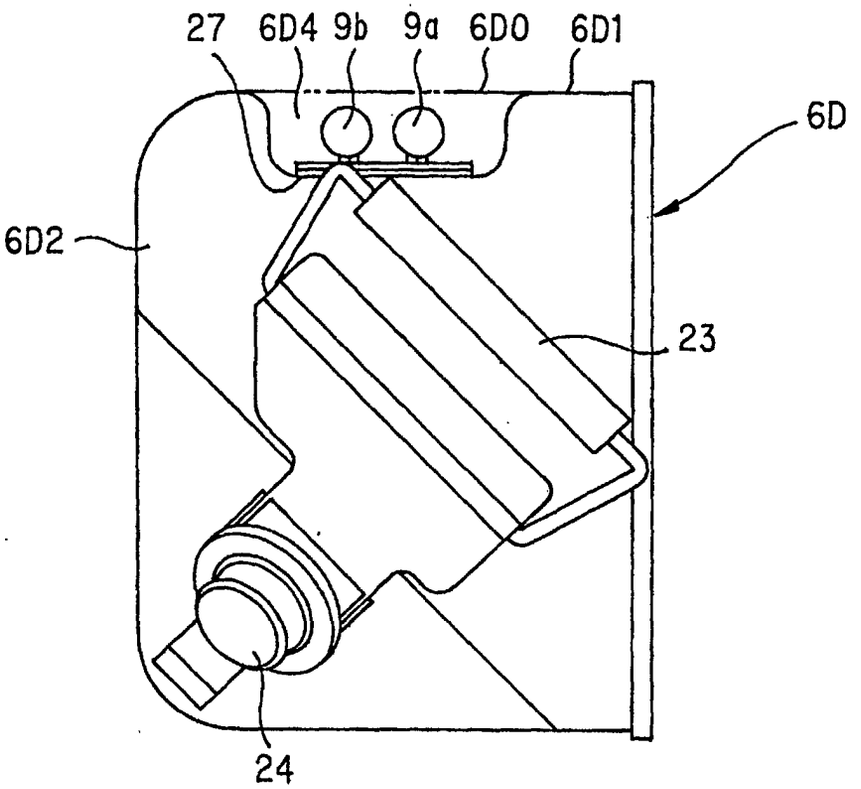


FIG. 63

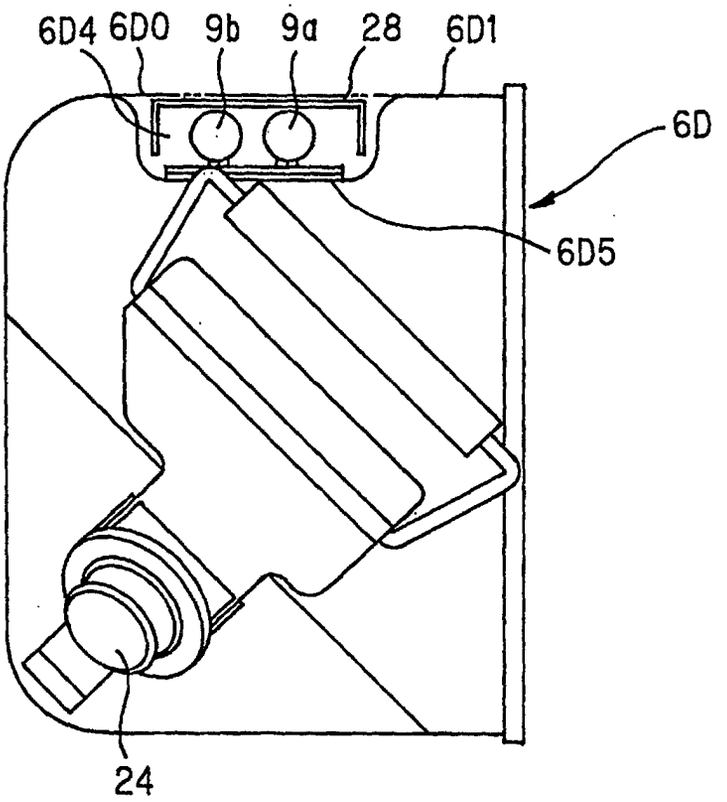


FIG. 64

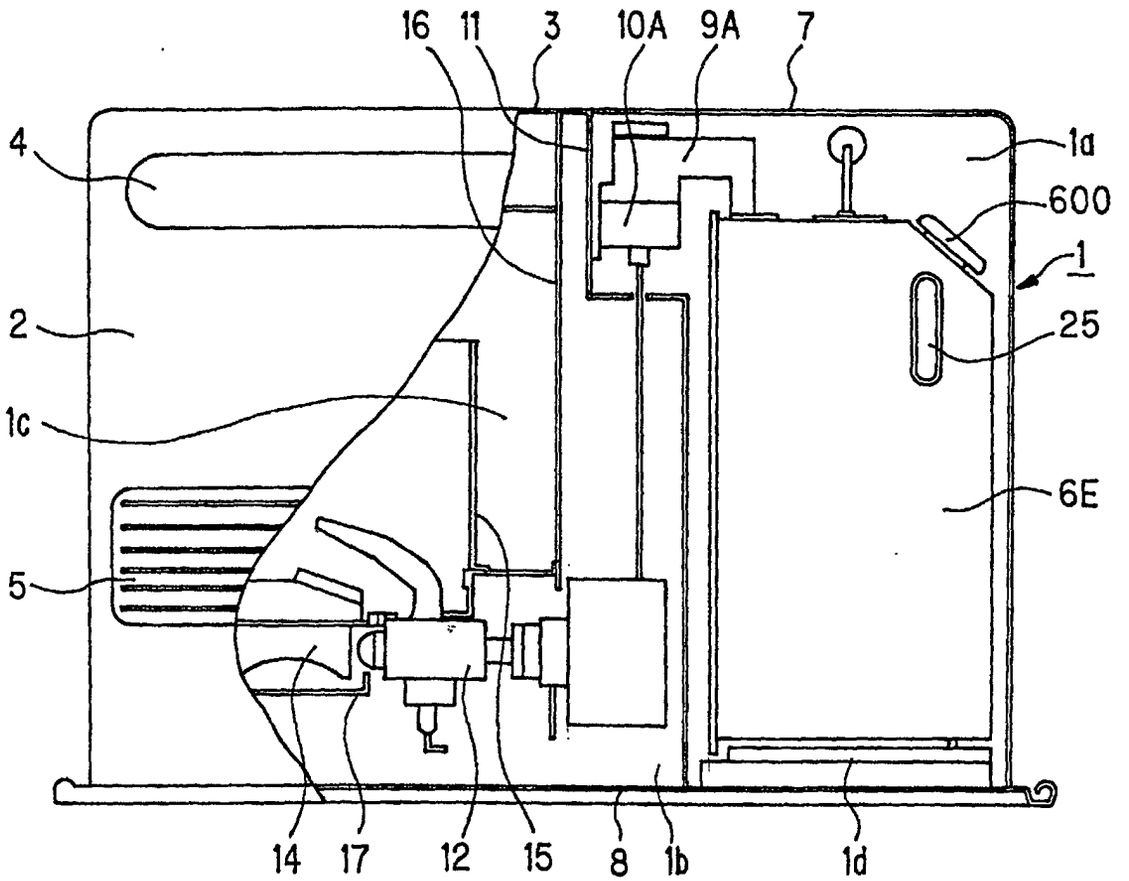


FIG. 65

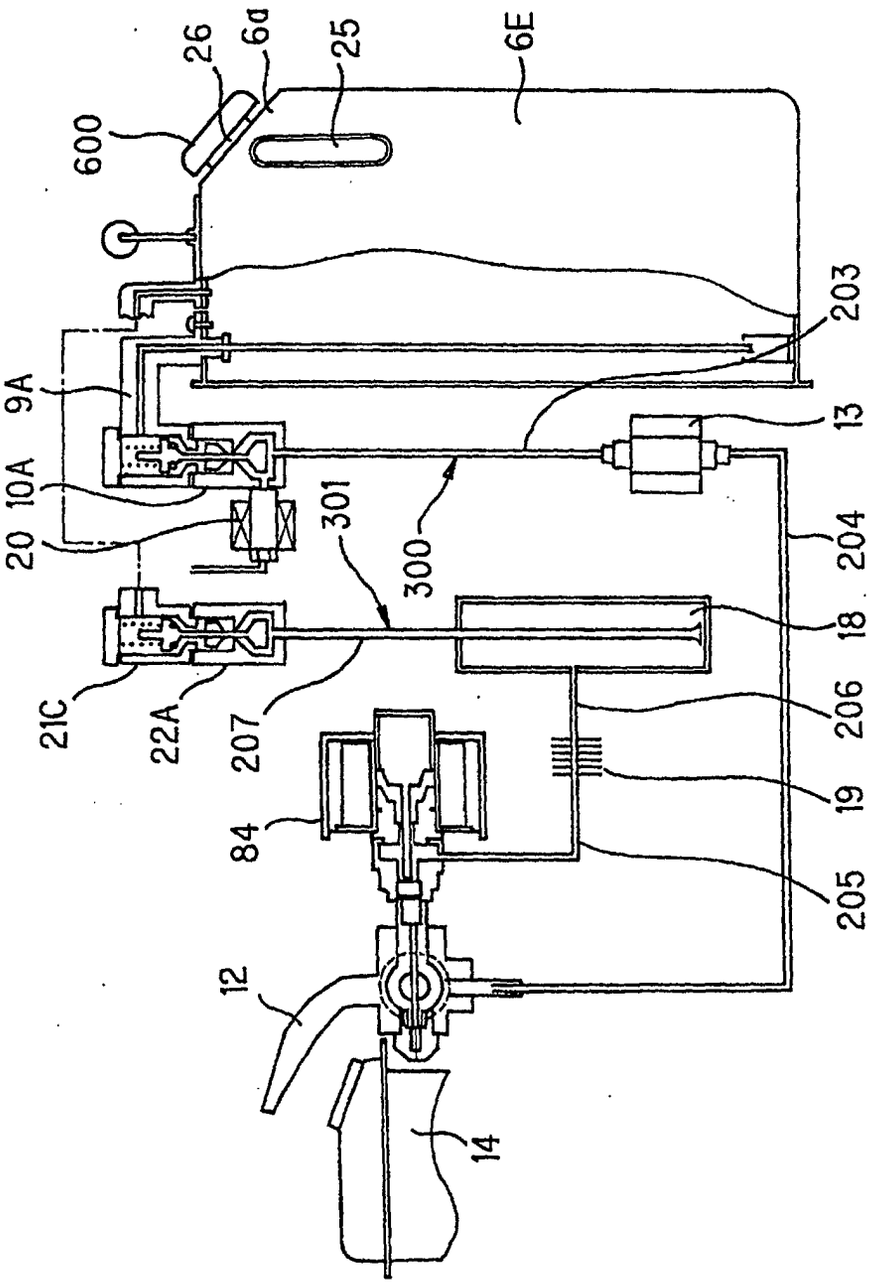

26
6a
25
6E
600
203
9A
13
10A
20
301
300
204
18
21C
22A
207
206
84
19
205
12
14

FIG. 66

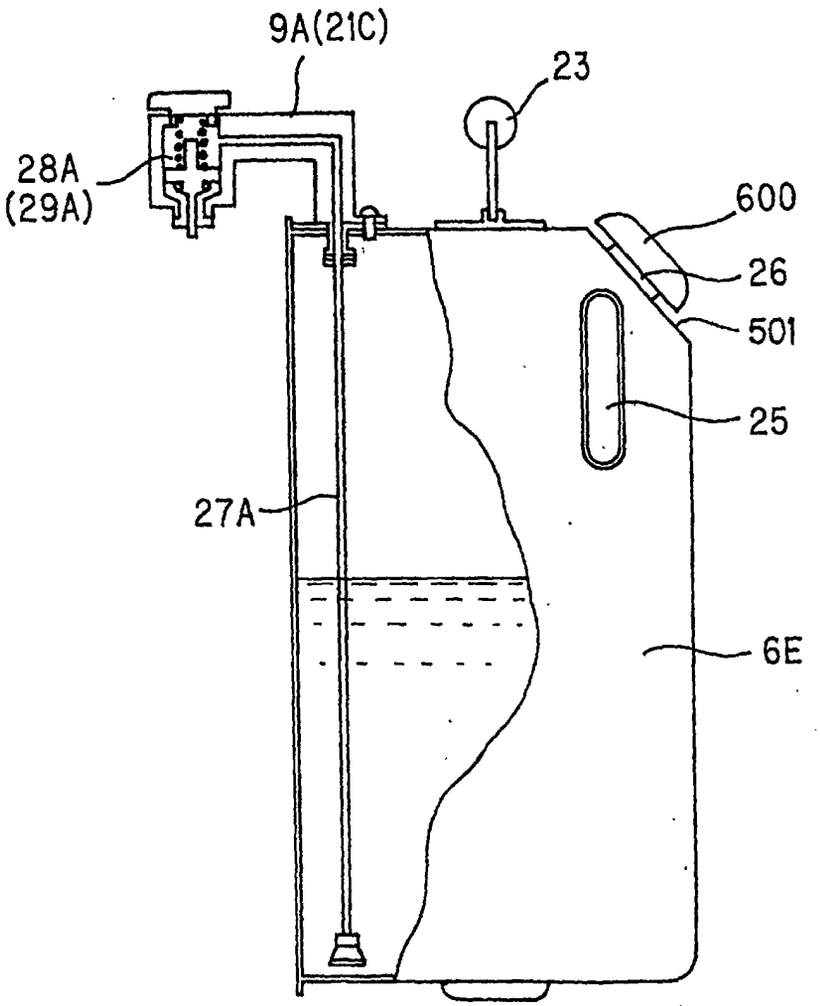


FIG. 67

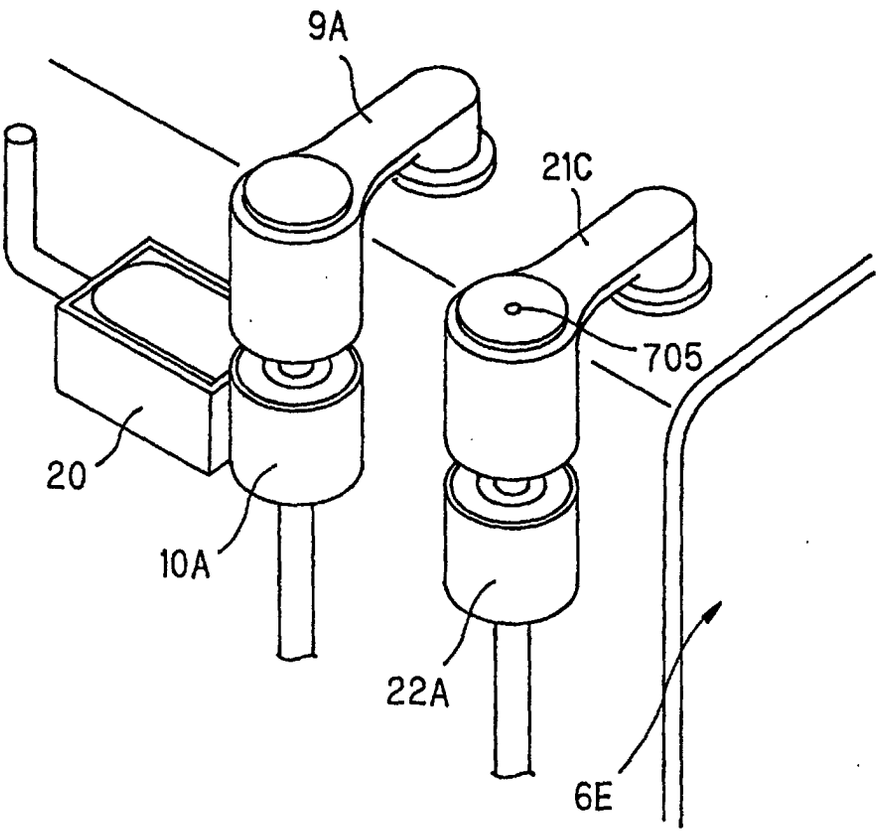


FIG. 68

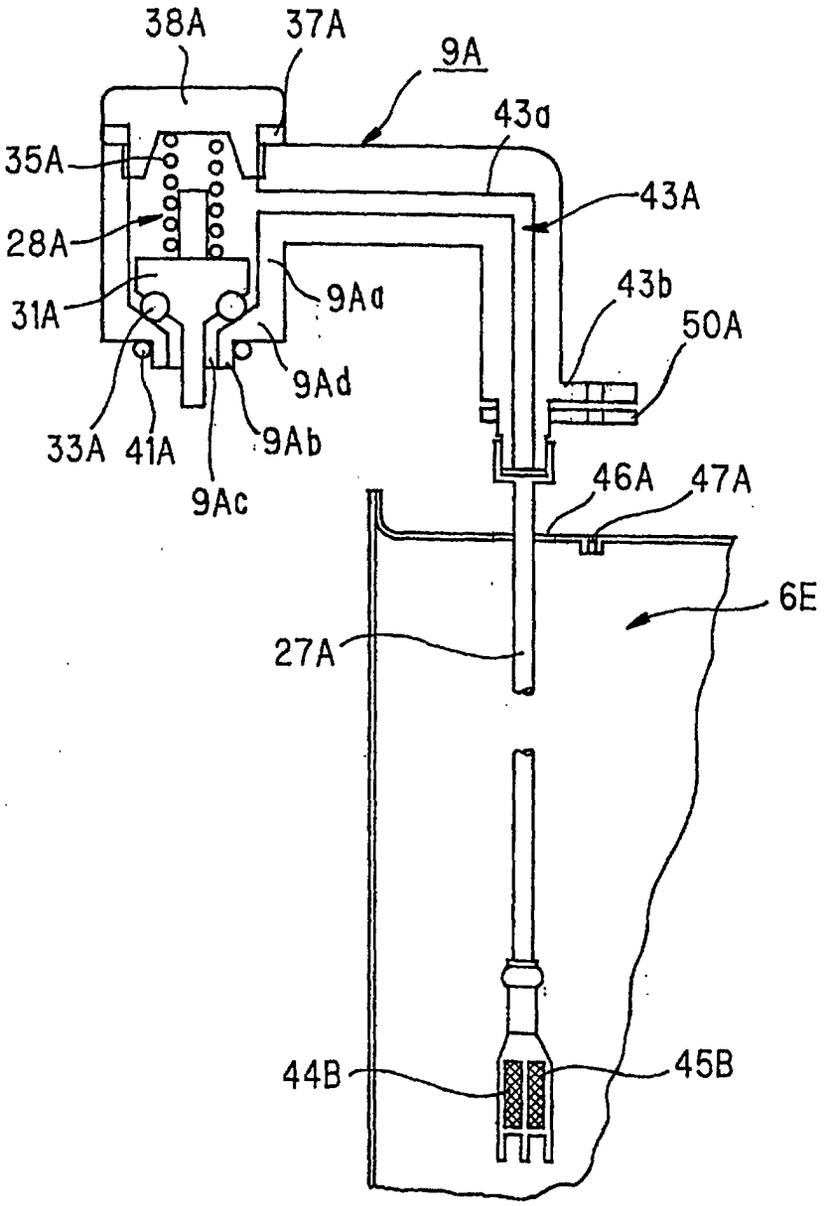

38A
37A
9A
43a
35A
43A
28A
31A
9Aa
43b
50A
9Ad
33A
41A
9Ab
9Ac
46A
47A
6E
27A
44B
45B

FIG. 69

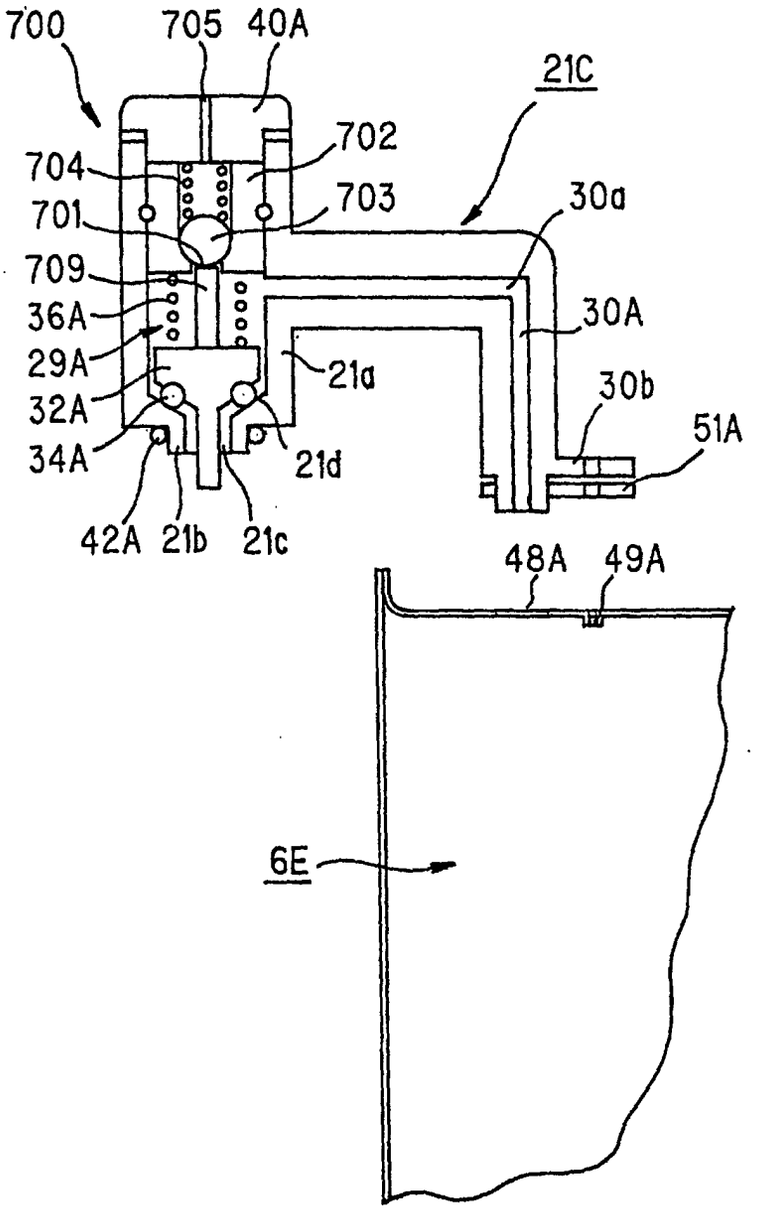

700
705
40A
21C
702
704
703
30a
701
709
30A
36A
29A
21a
30b
32A
51A
34A
21d
42A
21b
21c
48A
49A
6E

FIG. 70

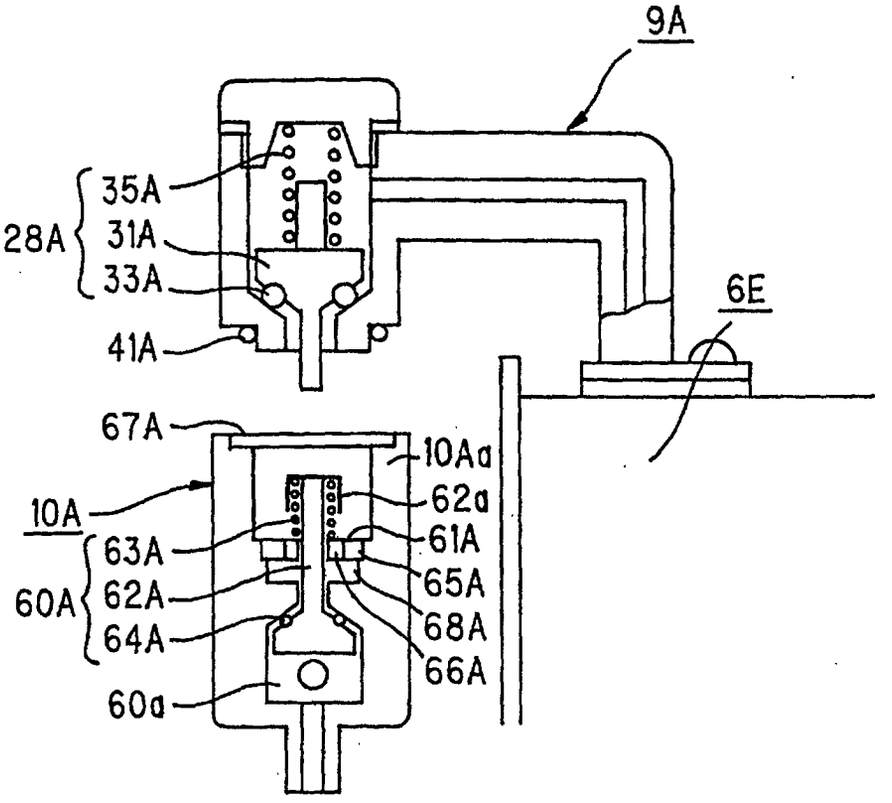

9A
35A
28A
31A
33A
41A
6E
67A
10Aa
10A
62a
63A
61A
60A
62A
65A
64A
68A
66A
60a

FIG. 71

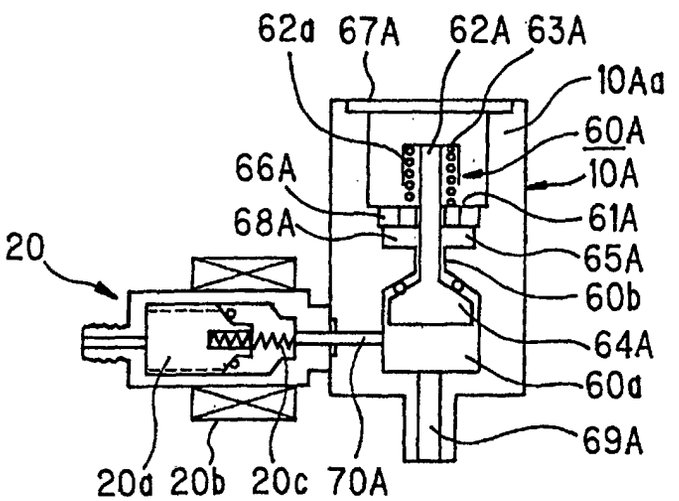

62a
67A
62A
63A
10Aa
60A
10A
66A
68A
61A
65A
60b
20
64A
60a
69A
20a
20b
20c
70A

FIG. 72

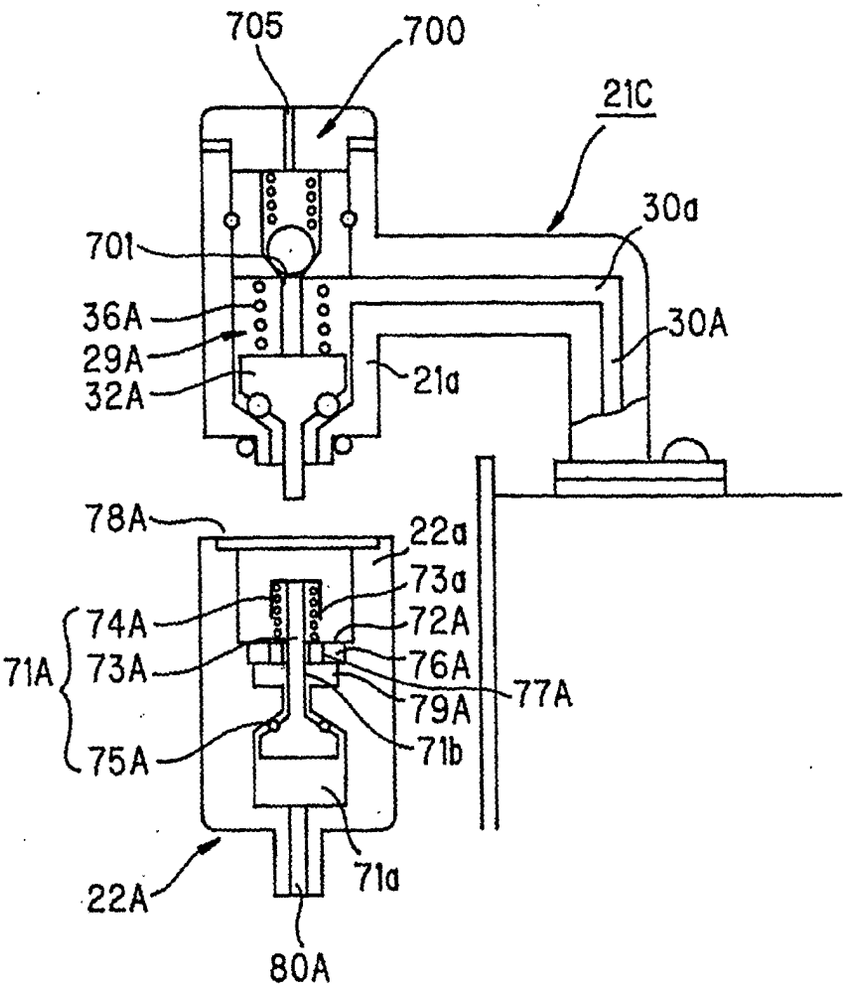

705
700
21C
30a
701
36A
29A
32A
21a
30A
78A
22a
73a
74A
72A
71A
73A
76A
77A
79A
71b
75A
71a
22A
80A

FIG. 73

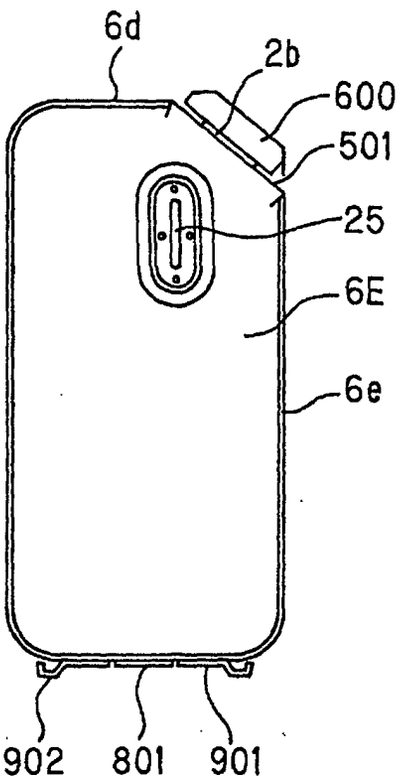


FIG. 74

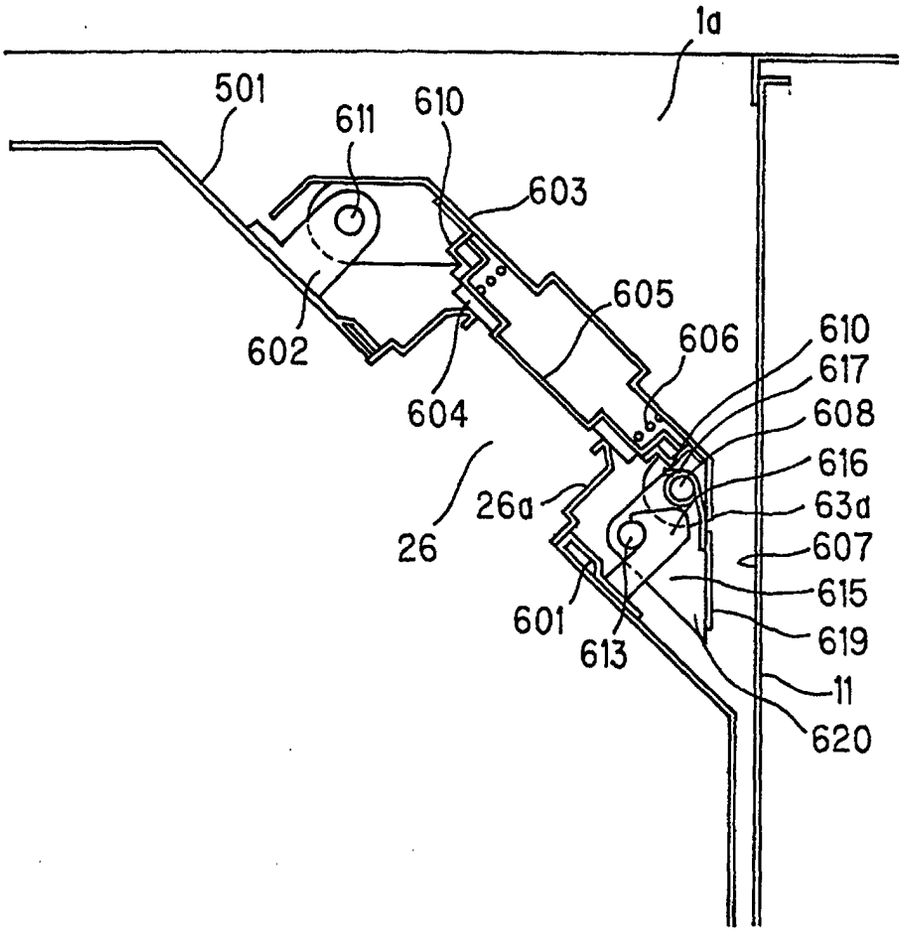

1a
501
611
610
603
605
606
602
604
610
617
608
616
63a
607
615
619
11
620
26a
26
601
613

FIG. 75

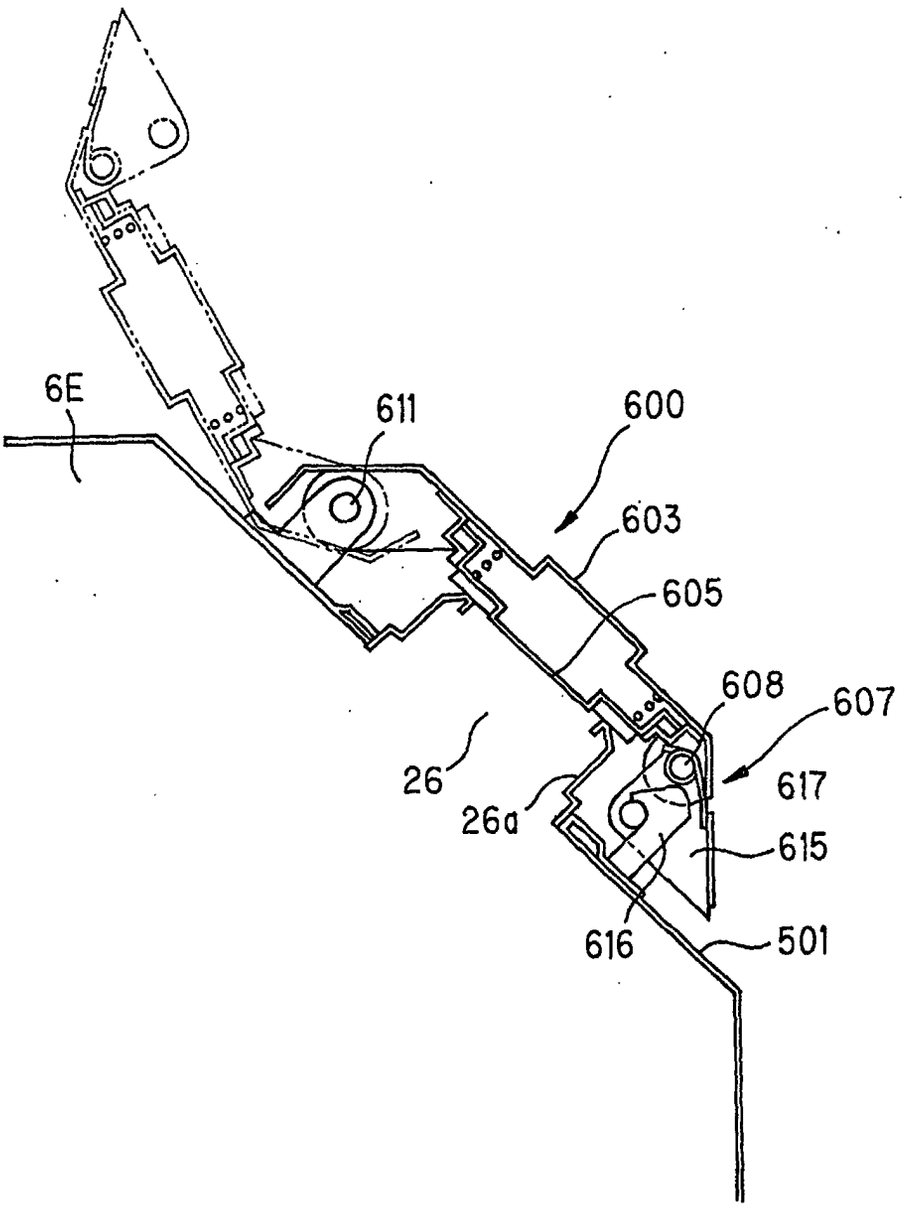


FIG. 76

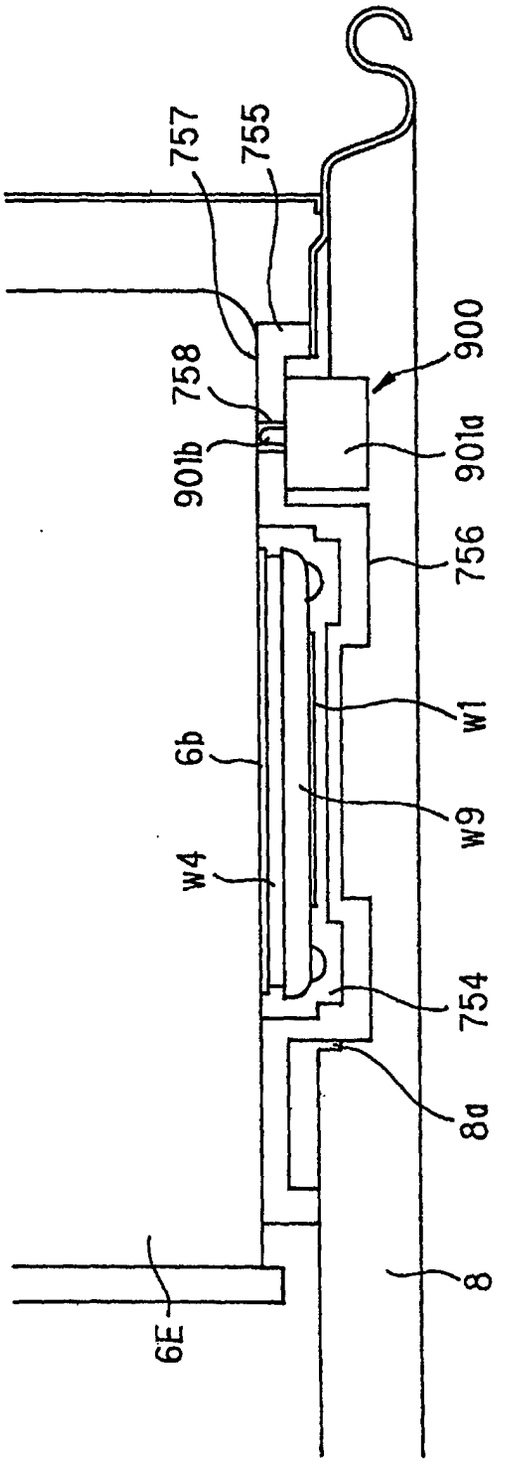


FIG. 77

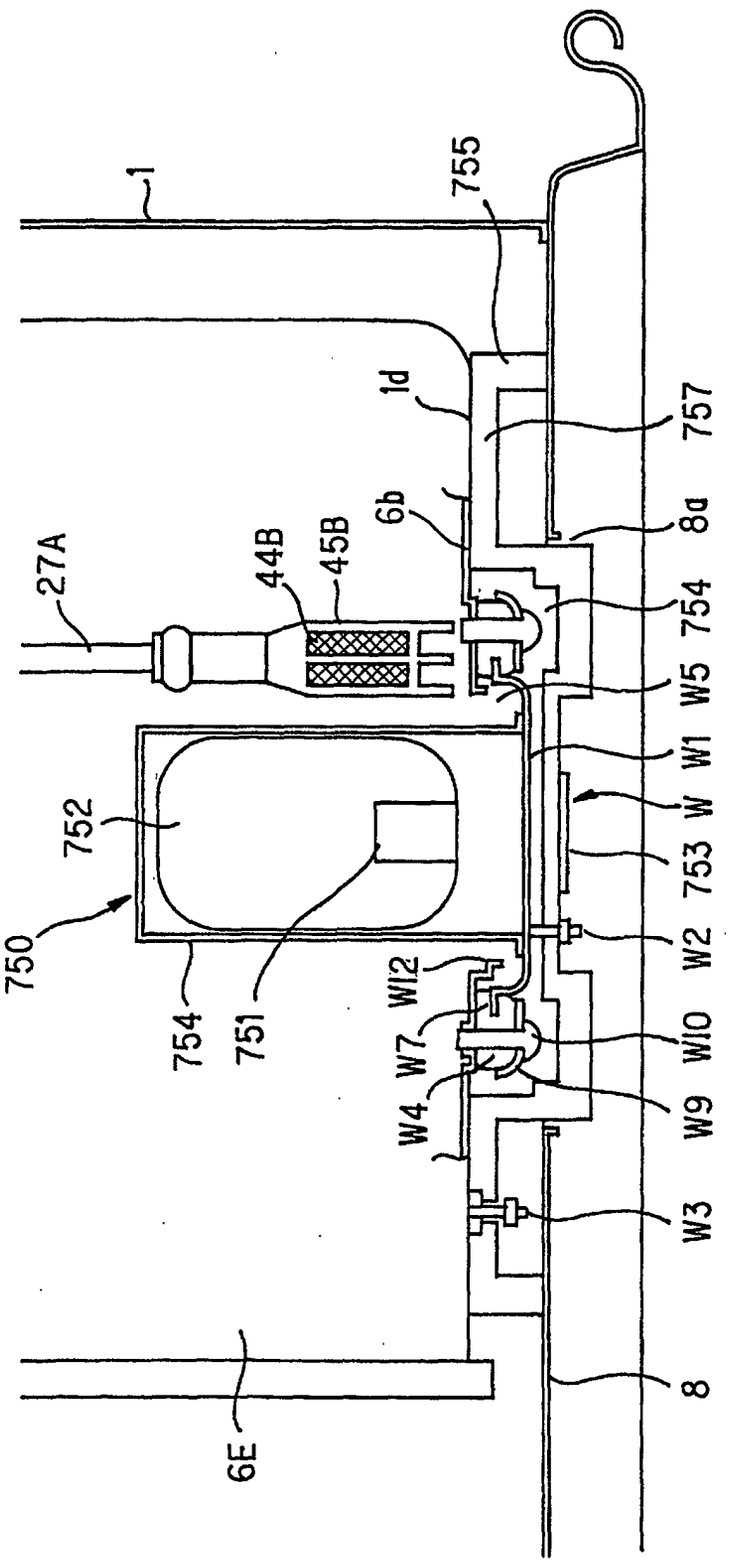

1
755
1d
757
6b
8a
27A
44B
45B
754
W5
W1
W
753
752
W2
750
W12
754
751
W7
W10
W4
W9
W3
8
6E

FIG. 78

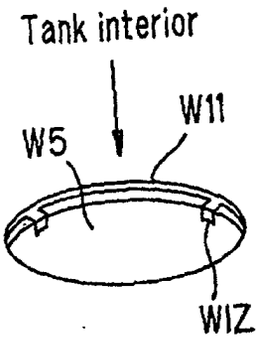

Tank interior
W5
W11
W12

FIG. 79

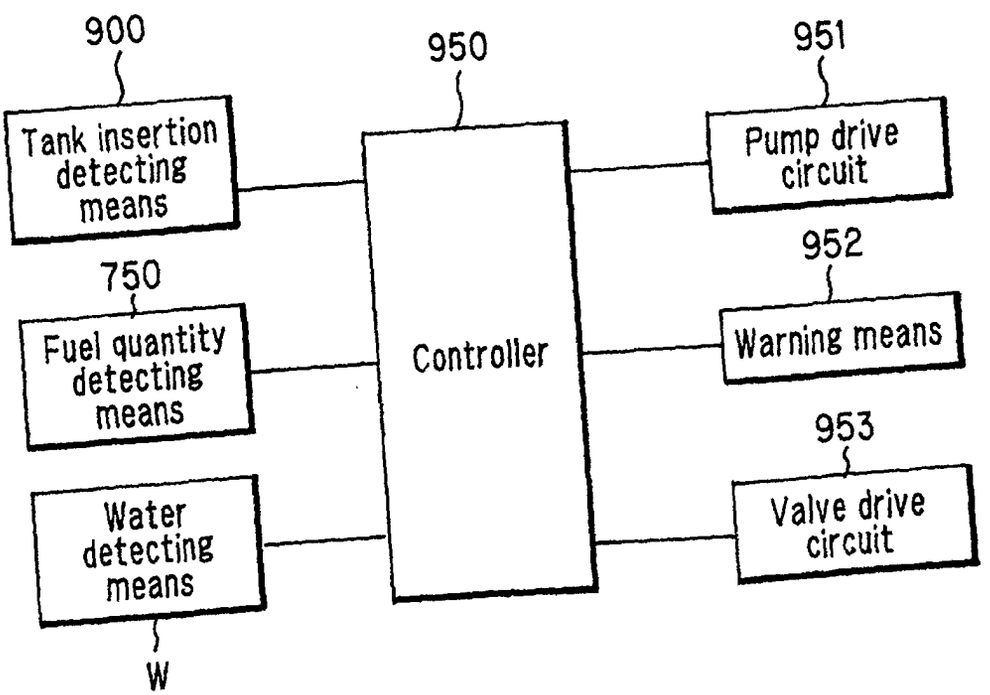

900
Tank insertion detecting means
750
Fuel quantity detecting means
Water detecting means
W
950
Controller
951
Pump drive circuit
952
Warning means
953
Valve drive circuit

FIG. 80

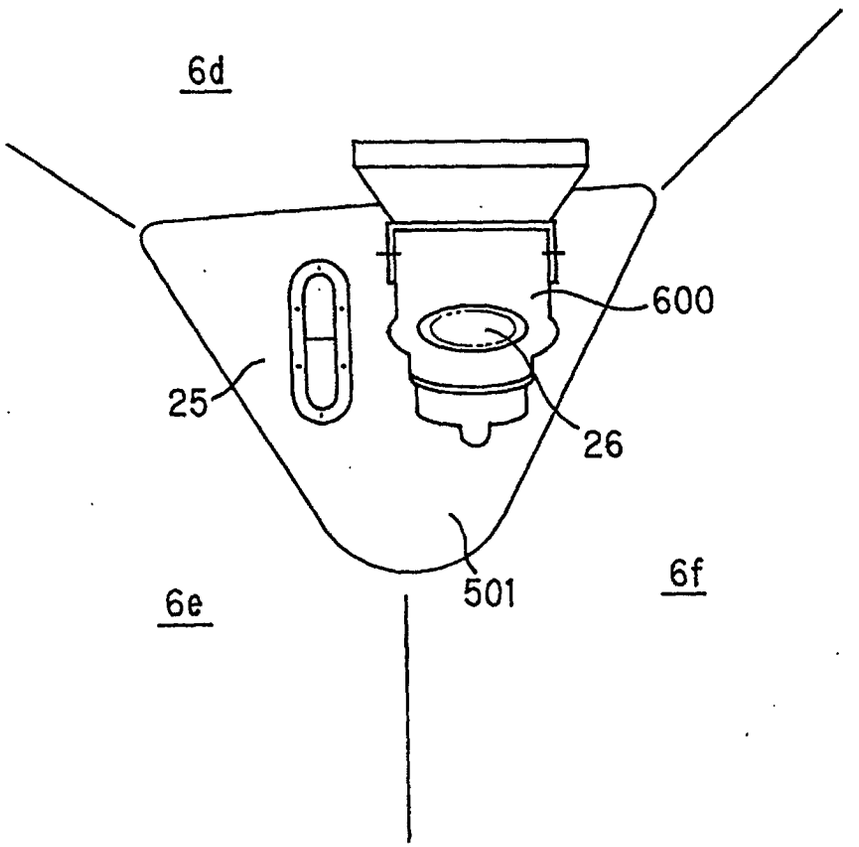


FIG. 81

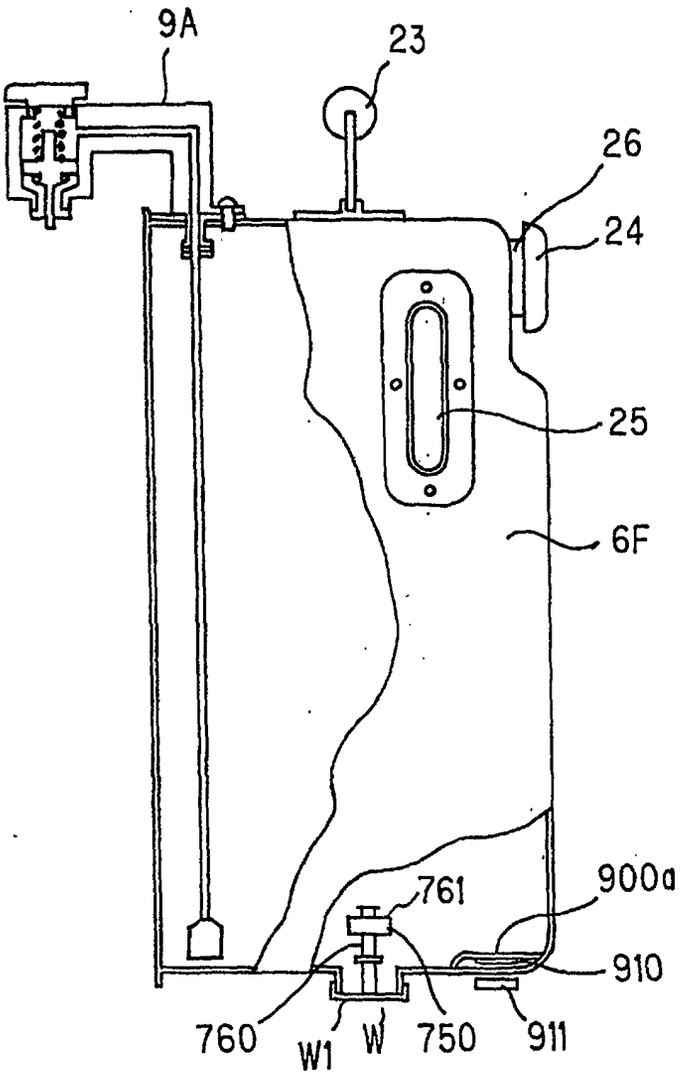


FIG. 82

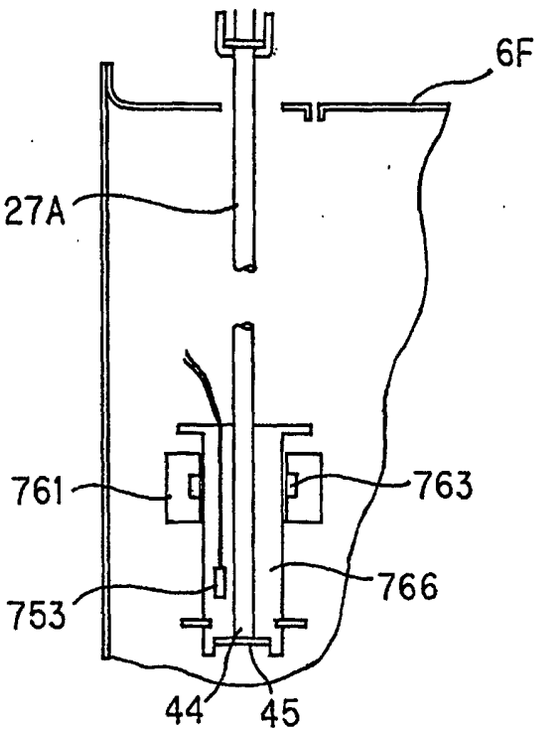


FIG. 83

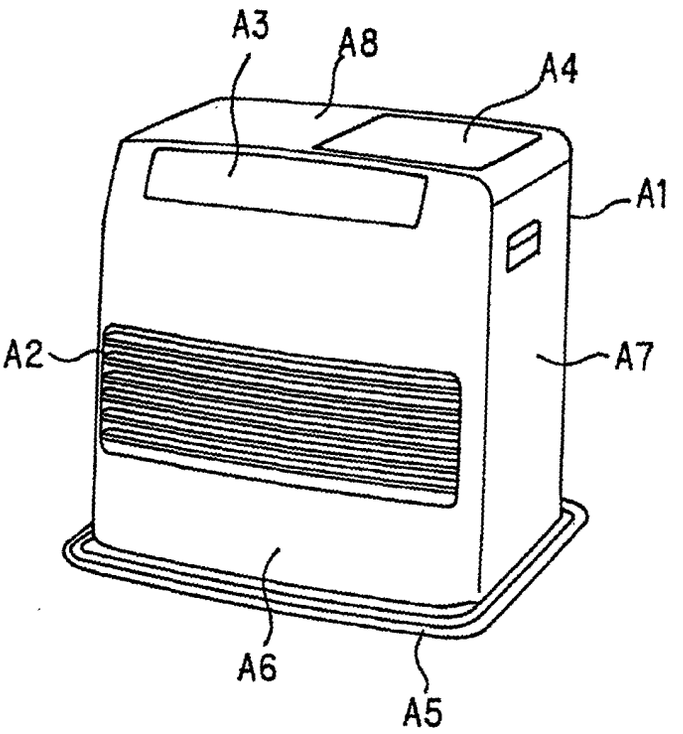


FIG. 84

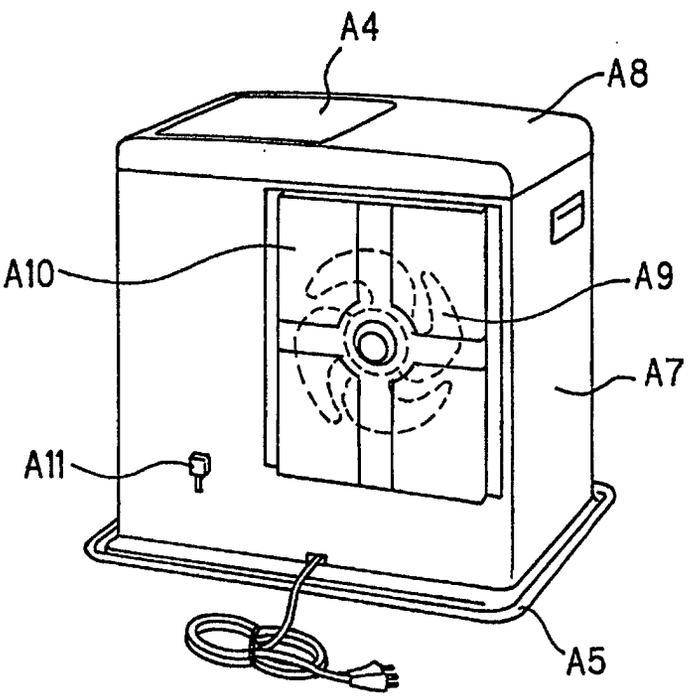


FIG. 85

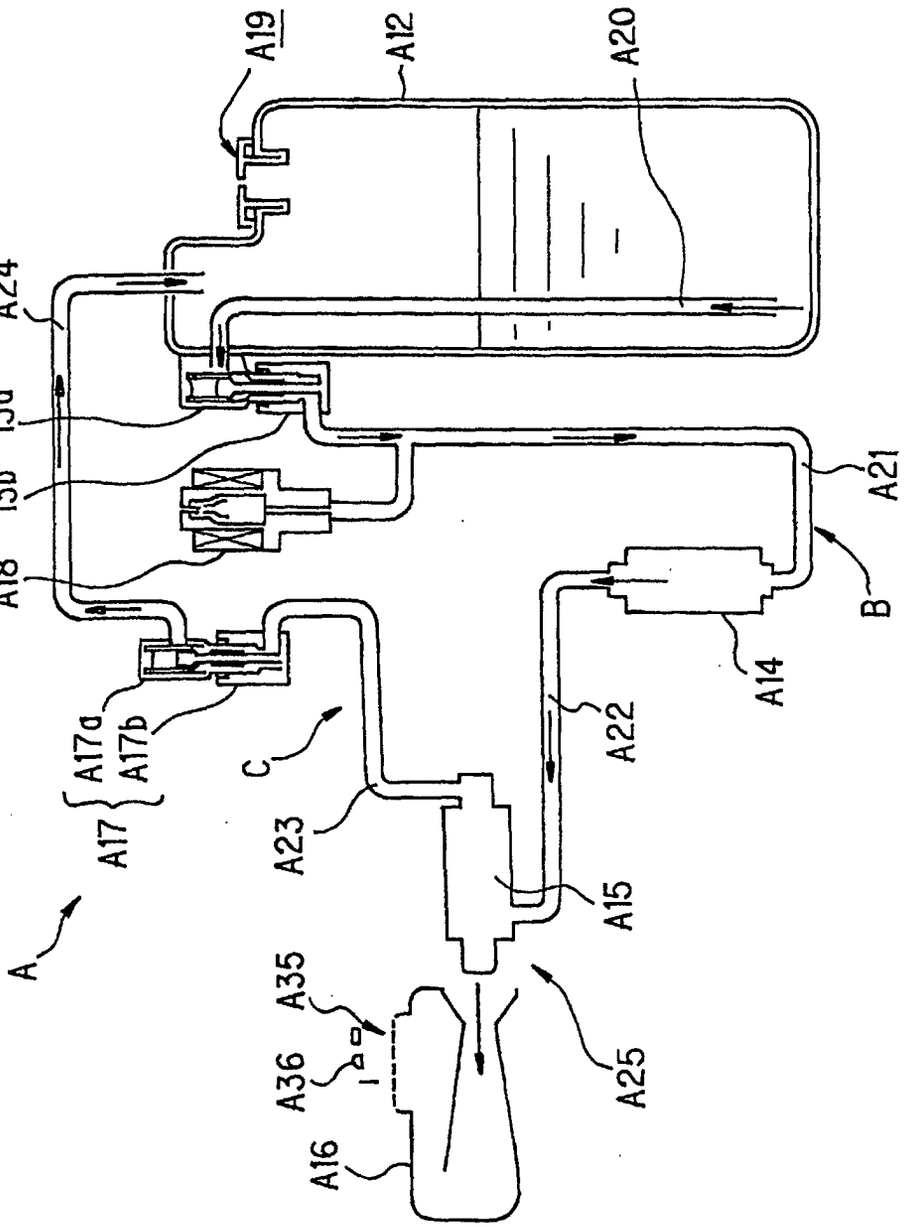

A19
A12
A20
A24
A13
13a
13b
A18
A21
B
A14
A22
A17a
A17b
A17
C
A23
A15
A
A35
A36
A16
A25

FIG. 86

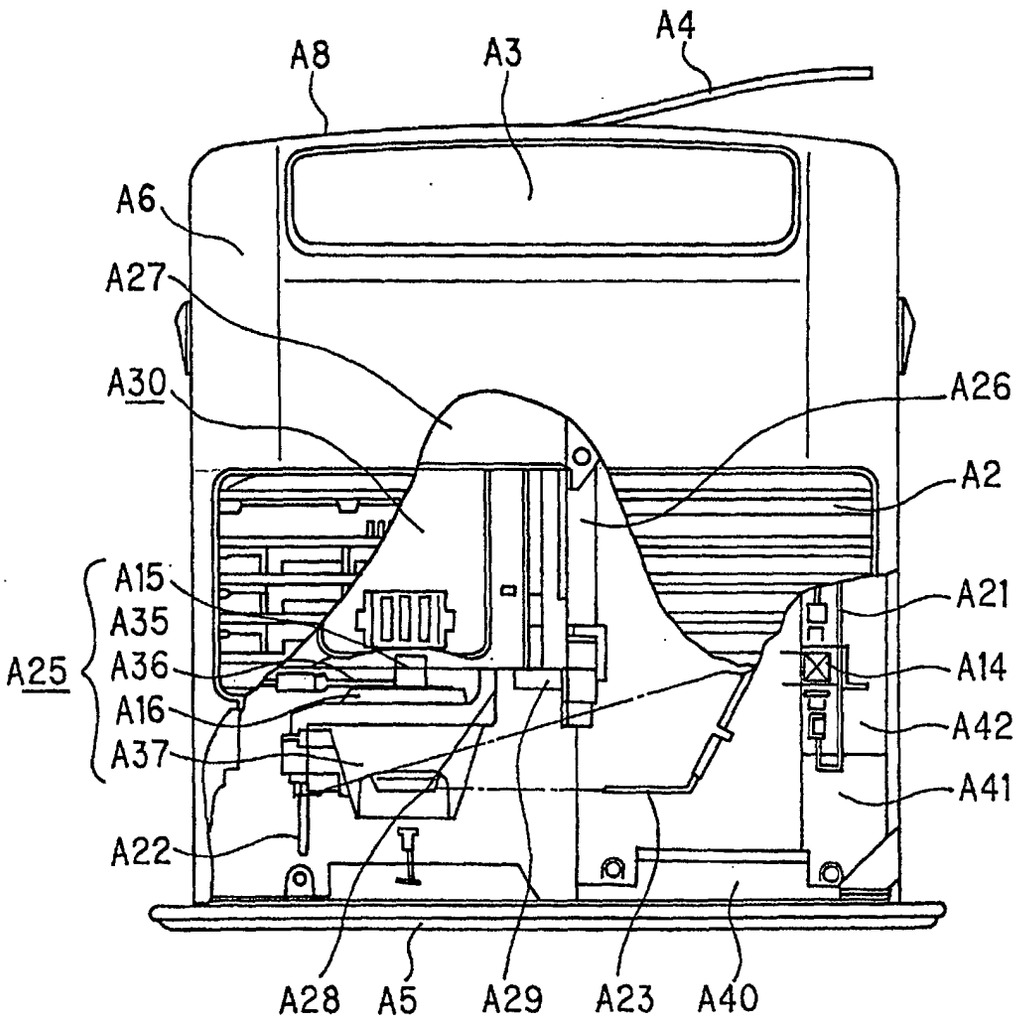

A4
A8
A3
A6
A27
A30
A26
A2
A15
A35
A25
A36
A16
A37
A21
A14
A42
A41
A22
A28
A5
A29
A23
A40

FIG. 87

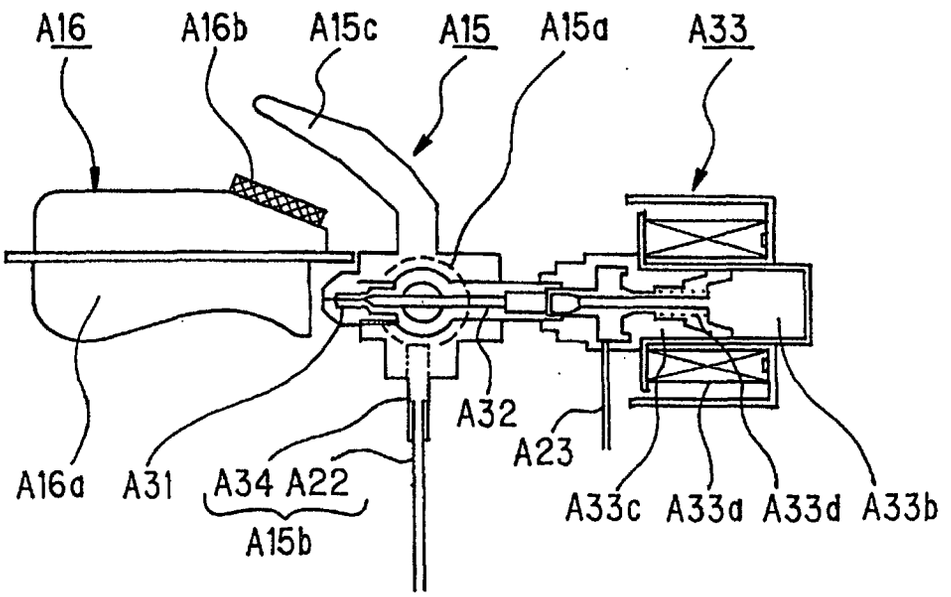

A16
A16b
A15c
A15
A15a
A33
A32
A23
A16a
A31
A34 A22
A15b
A33c
A33a
A33d
A33b

FIG. 88

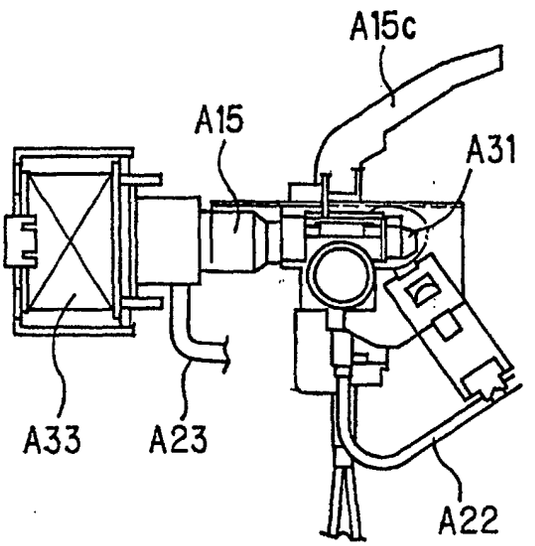


FIG. 89

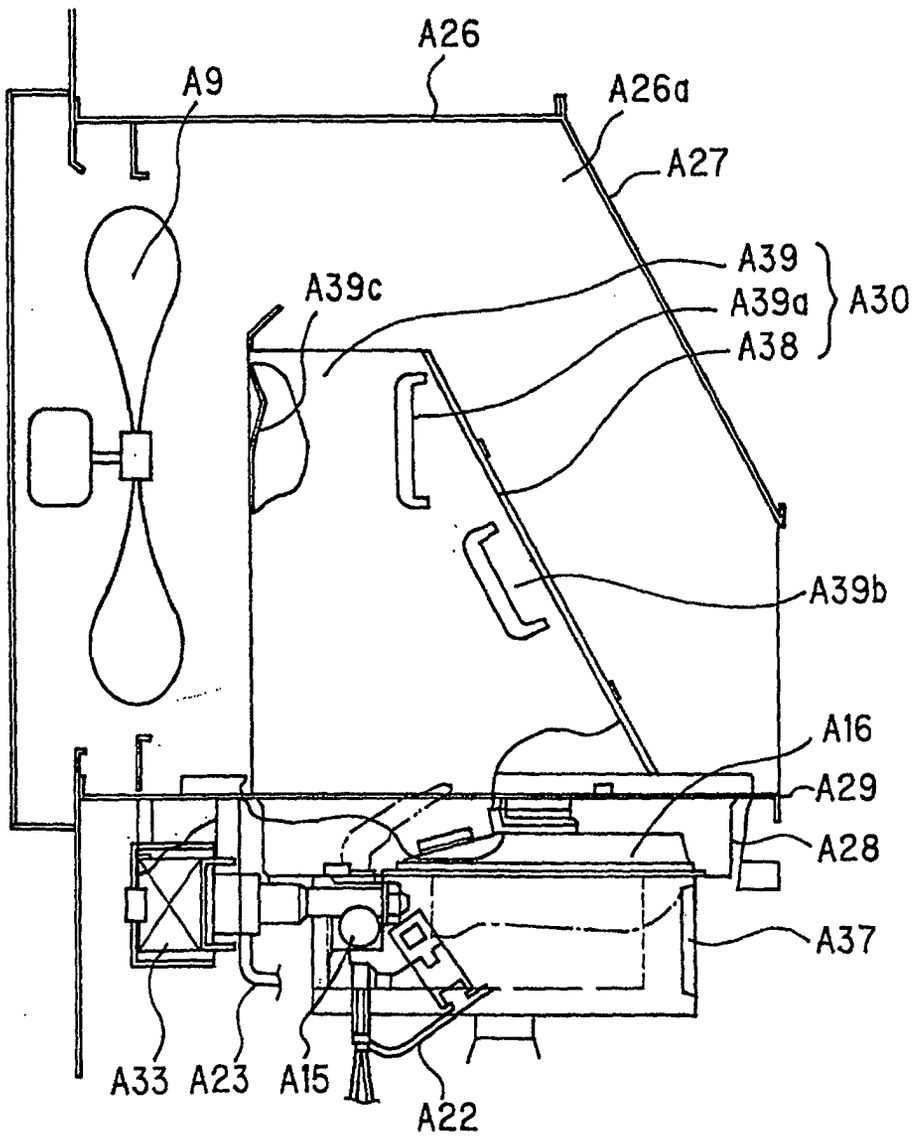

A26
A9
A26a
A27
A39
A39a
A30
A38
A39c
A39b
A16
A29
A28
A37
A33
A23
A15
A22

FIG. 90

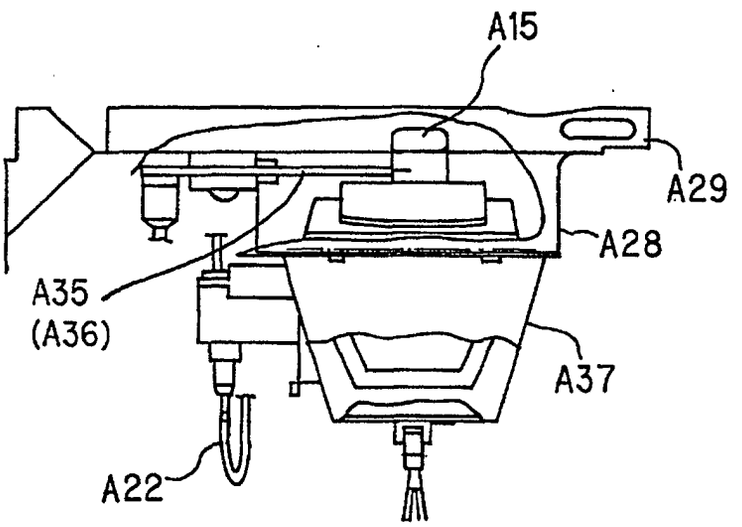


FIG. 91

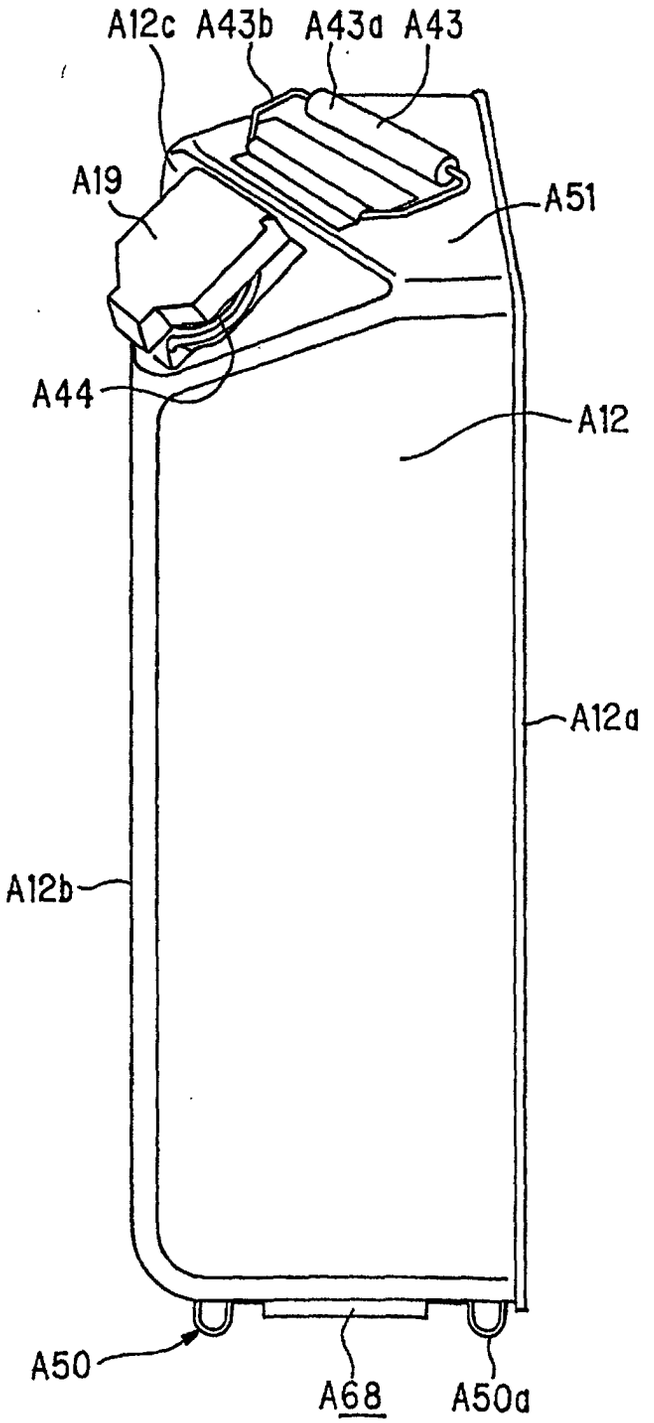


FIG. 92

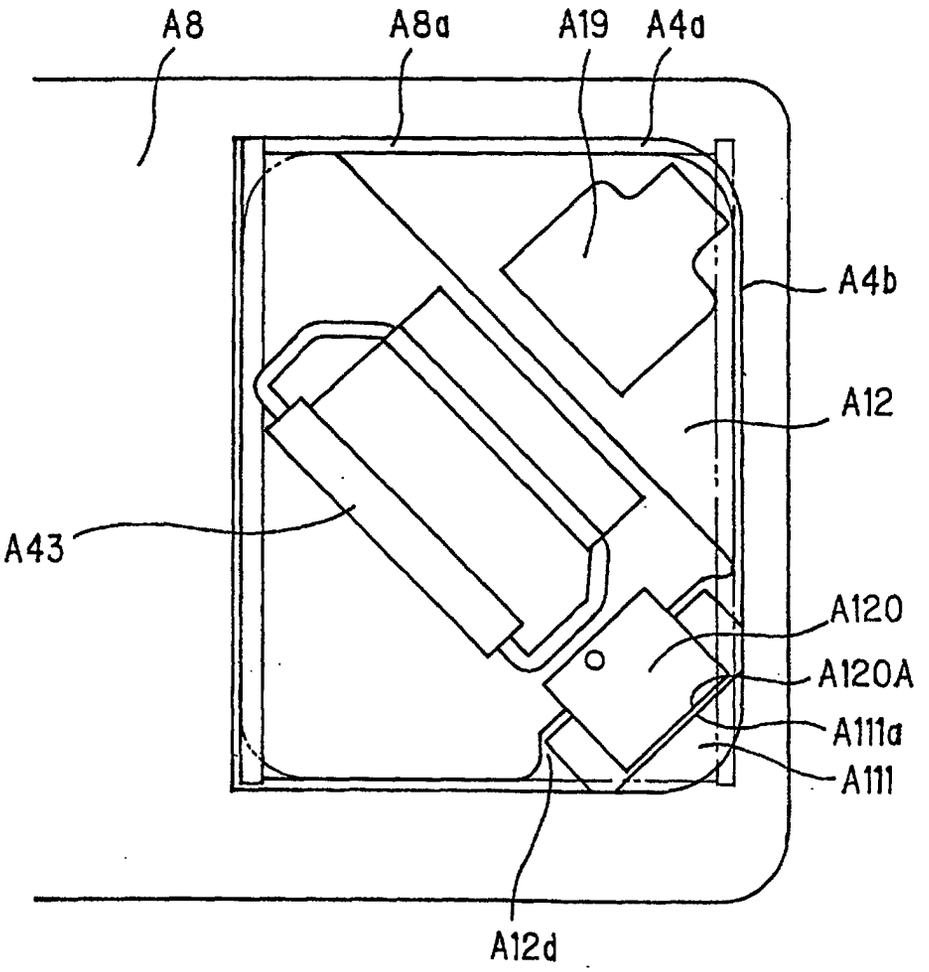


FIG. 93

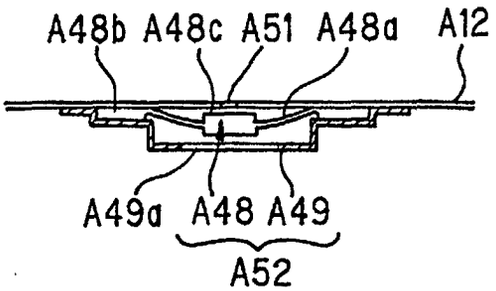

A48b
A48c
A51
A48a
A12
A49a
A48
A49
A52

FIG. 94

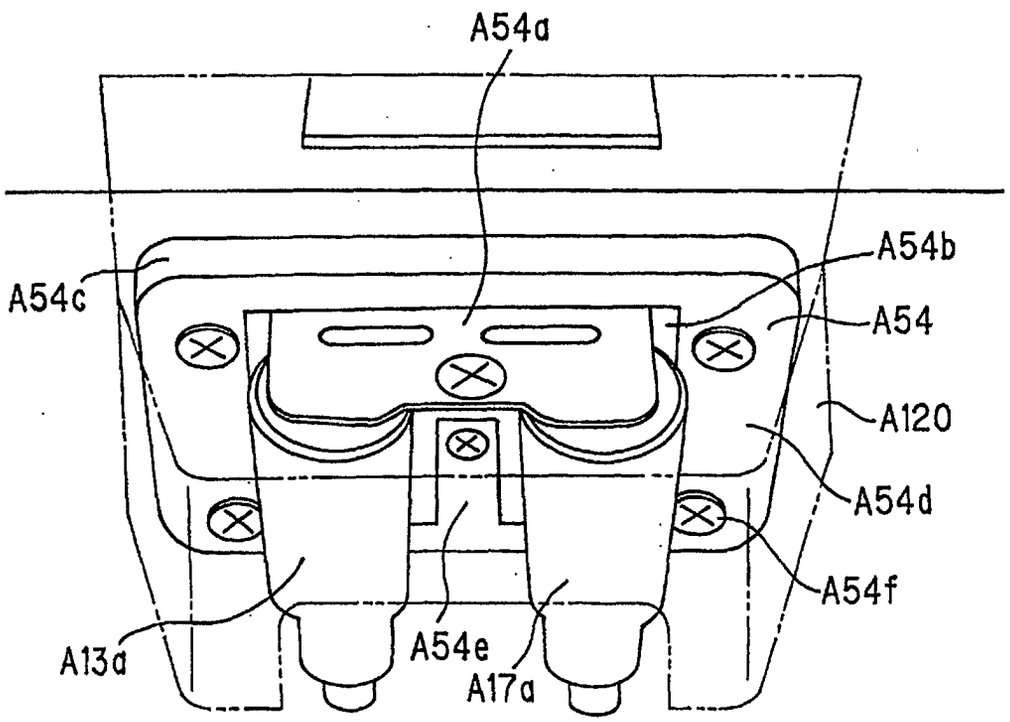

A54a
A54c
A54b
A54
A120
A54d
A54f
A13a
A54e
A17a

FIG. 95

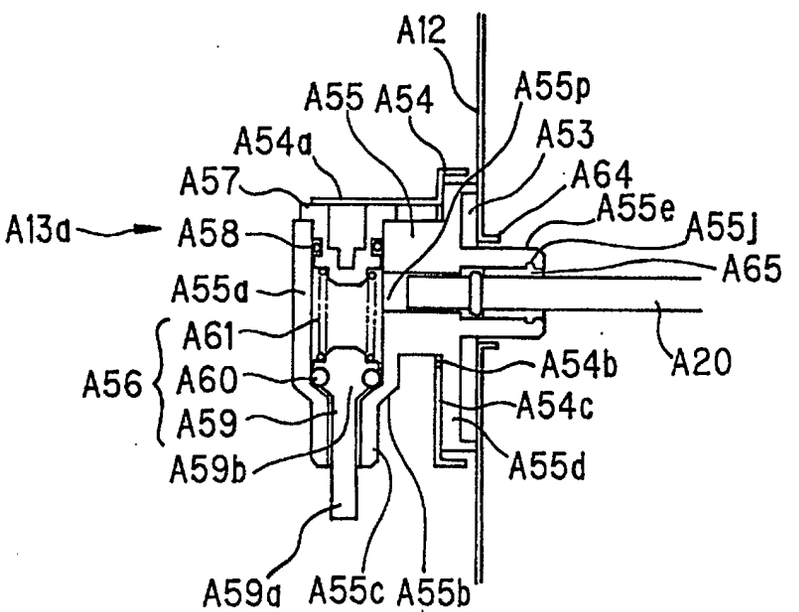
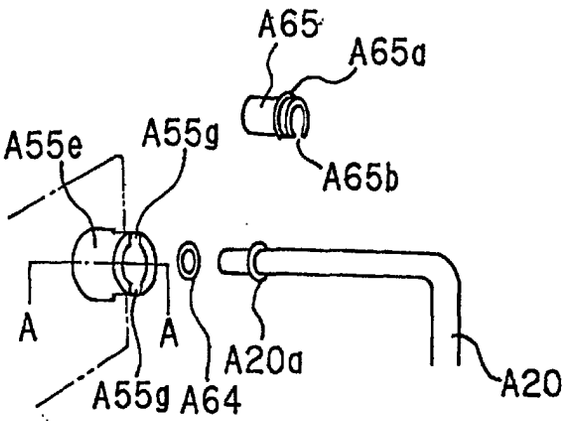

A12
A55p
A55
A54
A53
A54a
A64
A57
A55e
A55j
A13a
A58
A65
A55a
A61
A20
A54b
A56
A60
A54c
A59
A55d
A59b
A59a
A55c
A55b

FIG. 96

(a)



(b)

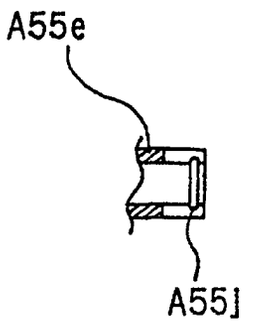


FIG. 97

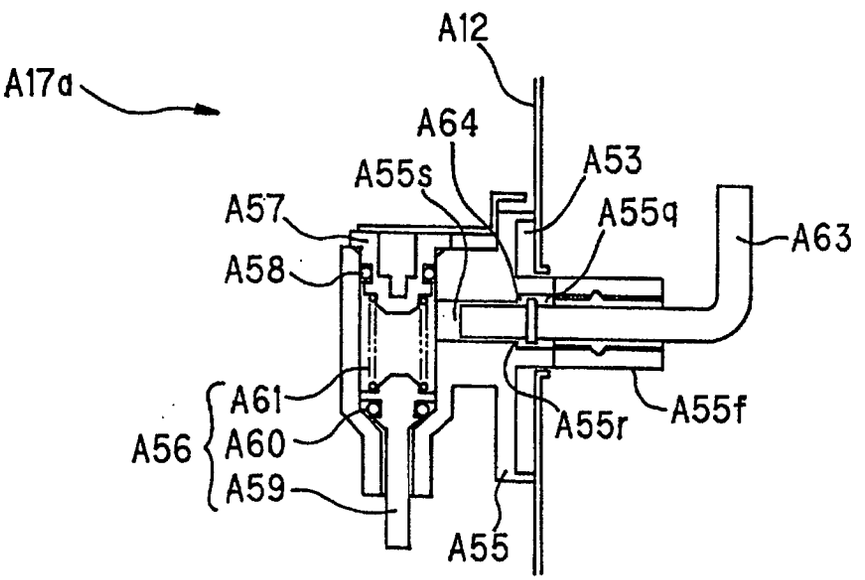
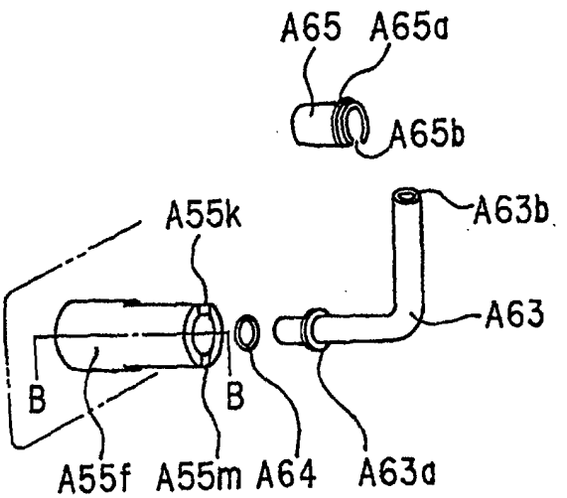

A12
A17a
A64
A53
A55s
A57
A55q
A63
A58
A61
A56
A60
A59
A55r
A55f
A55

FIG. 98

(a)



(b)

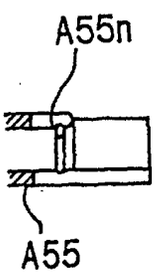


FIG. 99

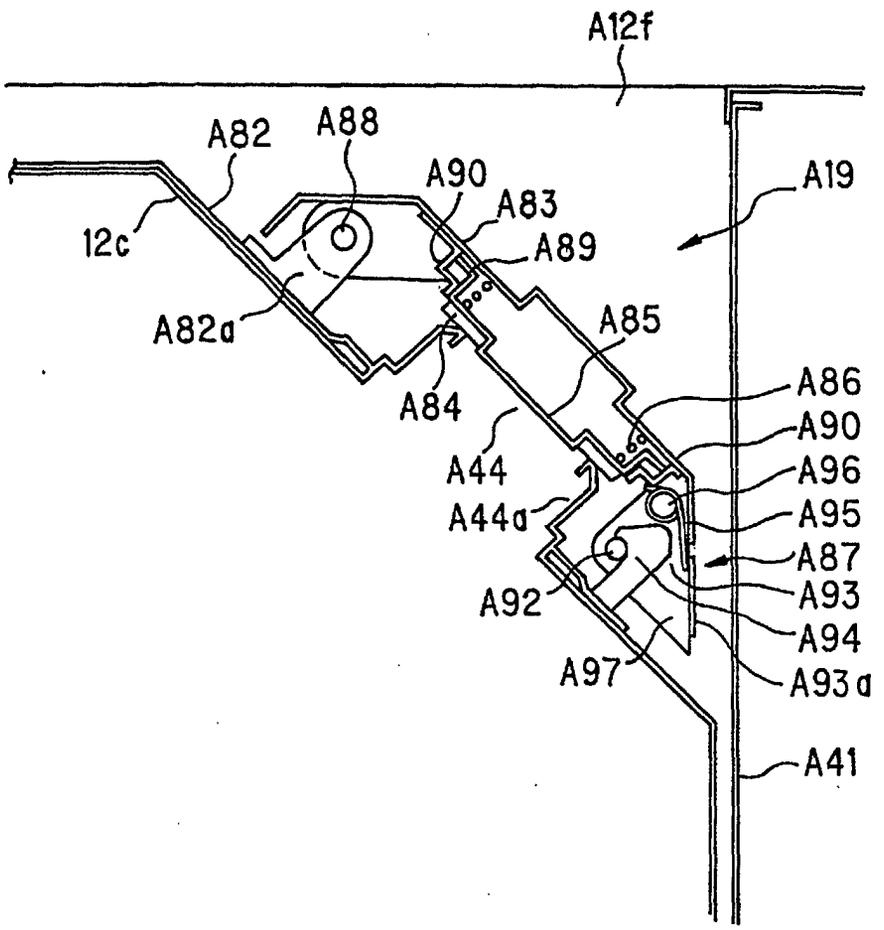

A12f
A82
A88
A90
A83
A89
A19
12c
A82a
A85
A84
A86
A90
A44
A96
A44a
A95
A87
A92
A93
A94
A97
A93a
A41

FIG. 100

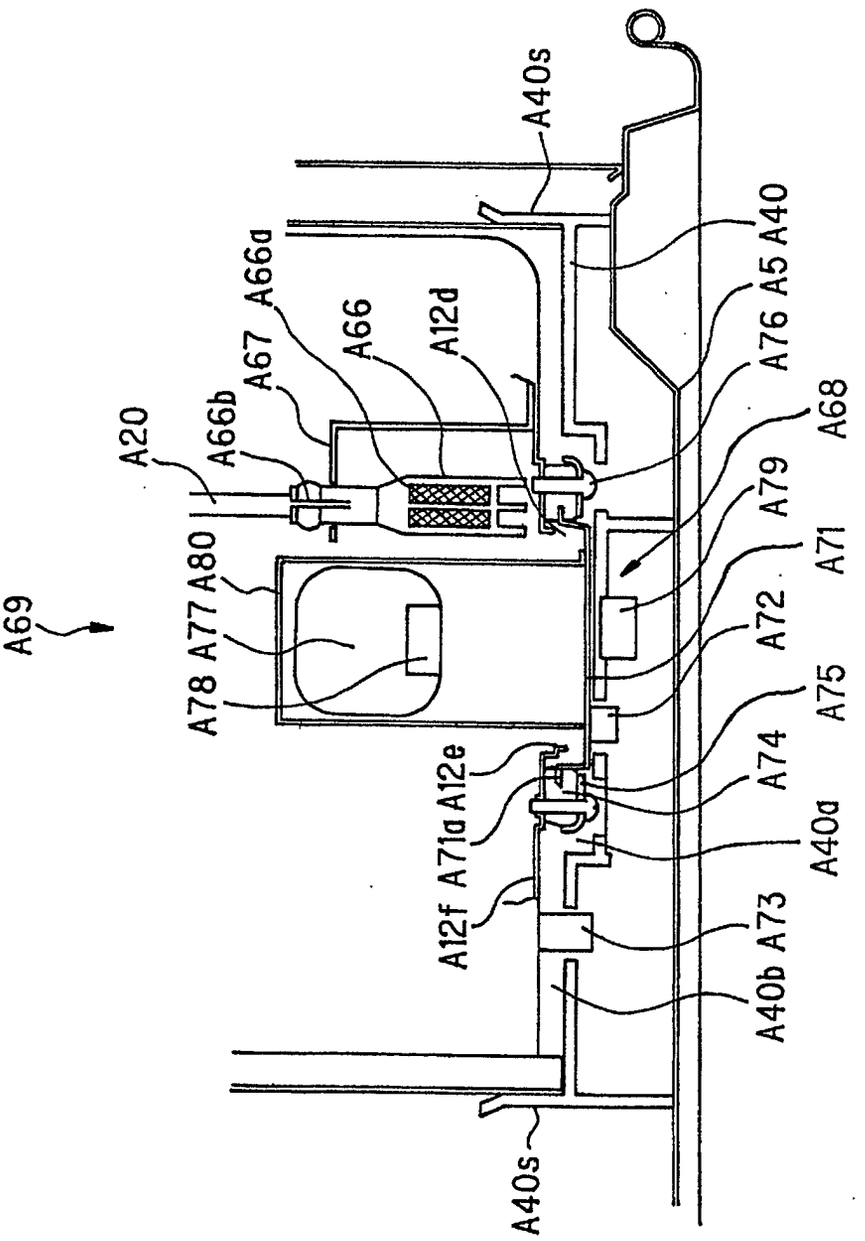

A69
A20
A66b
A67
A66d
A66
A12d
A40s
A40
A5
A76
A68
A79
A71
A72
A75
A74
A40a
A73
A40b
A80
A77
A78
A12e
A71a
A12f

FIG. 101

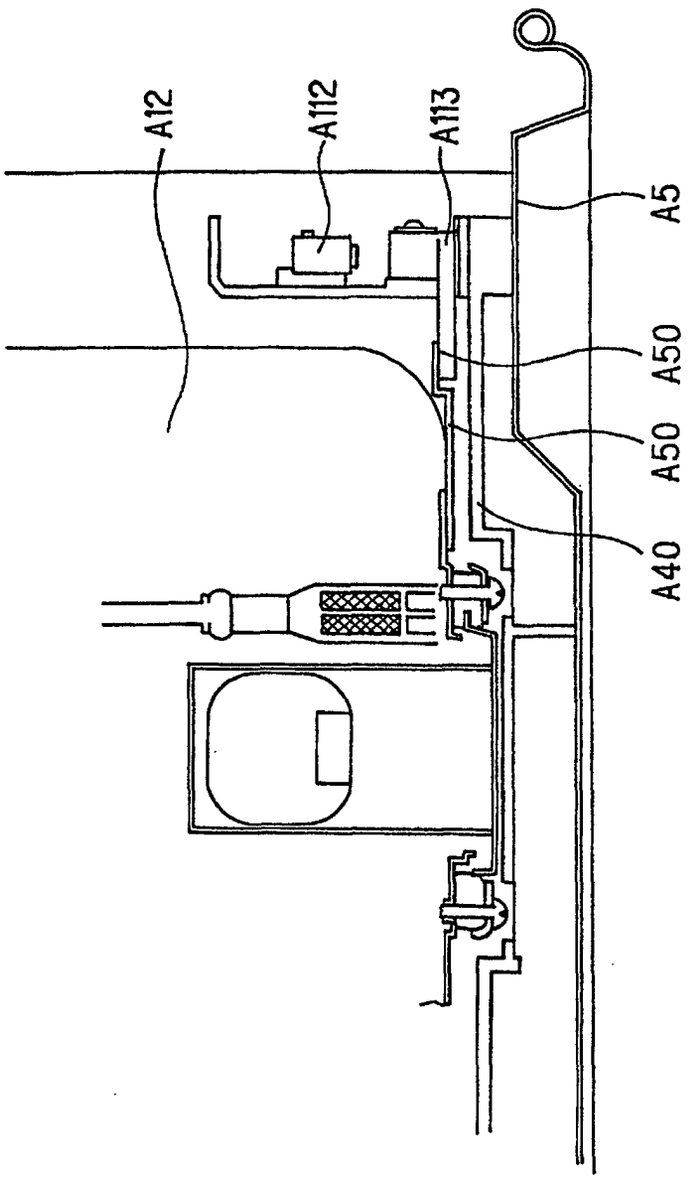


FIG. 102

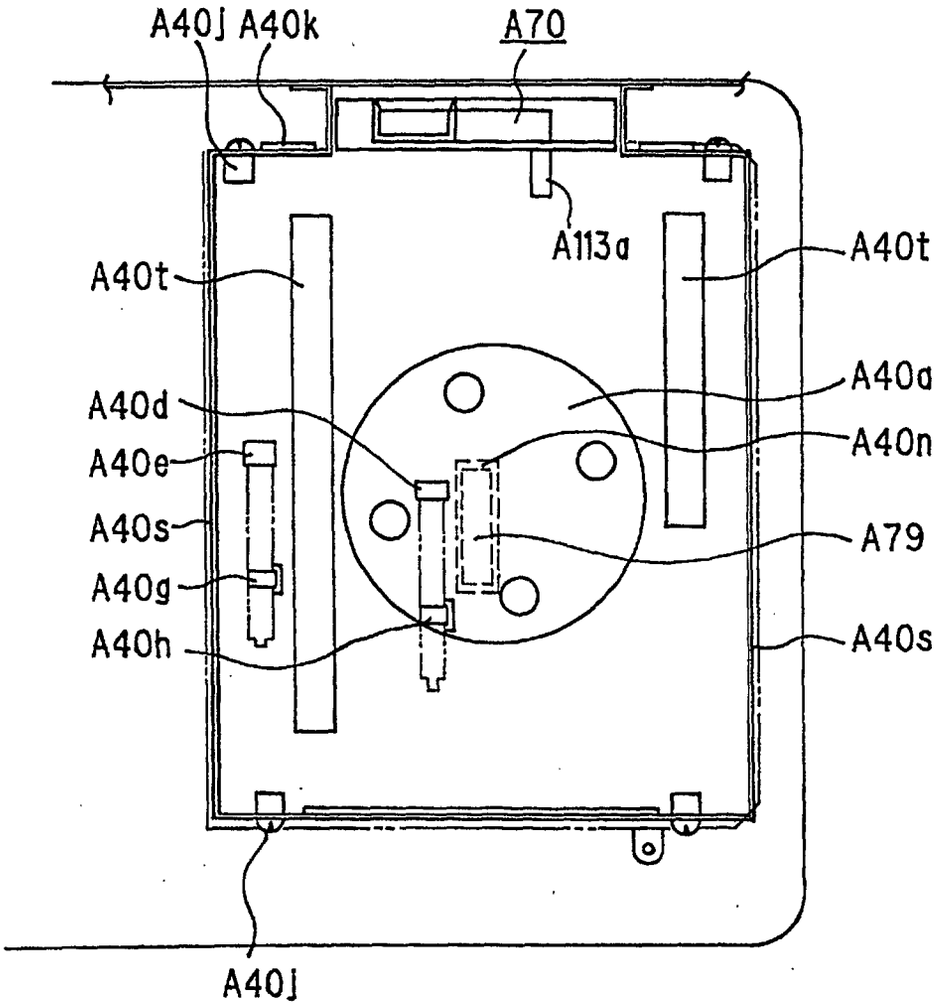
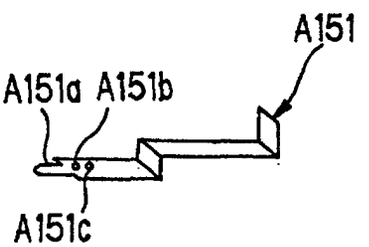

A40j A40k
A70
A113a
A40t
A40t
A40a
A40d
A40n
A40e
A40s
A79
A40g
A40h
A40s
A40j

FIG. 103

(a)


A151
A151a A151b
A151c

(b)

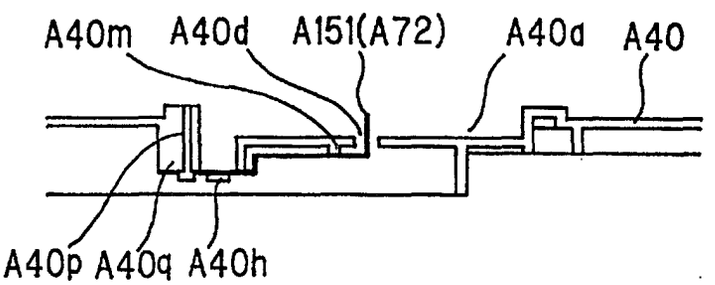

A40m A40d A151(A72) A40a A40
A40p A40q A40h

FIG. 104

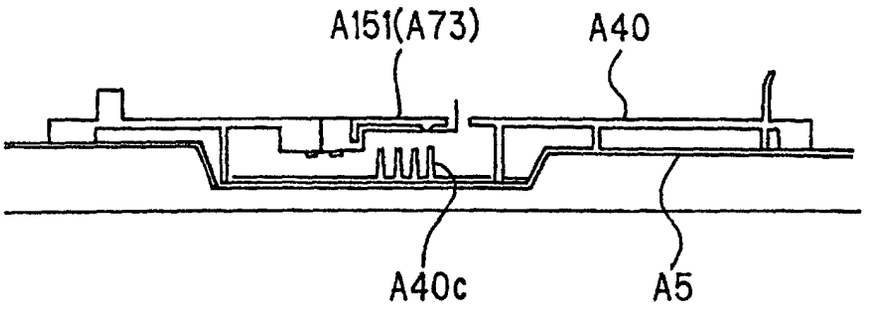


FIG. 105

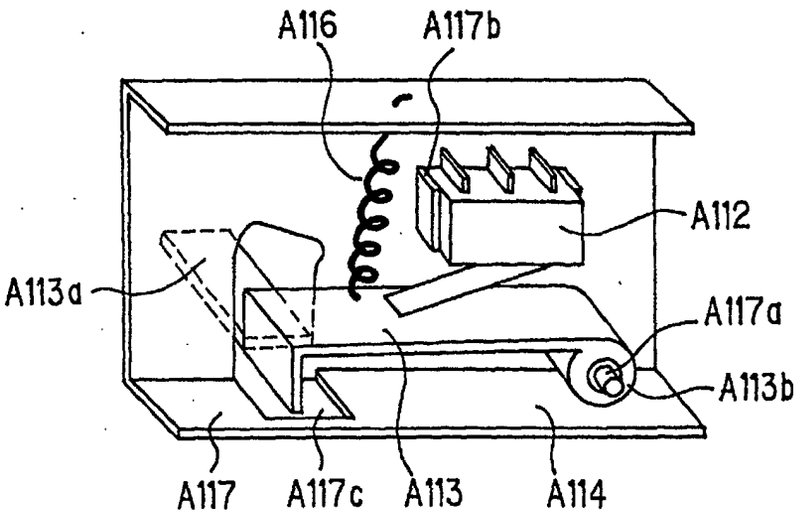


FIG. 106

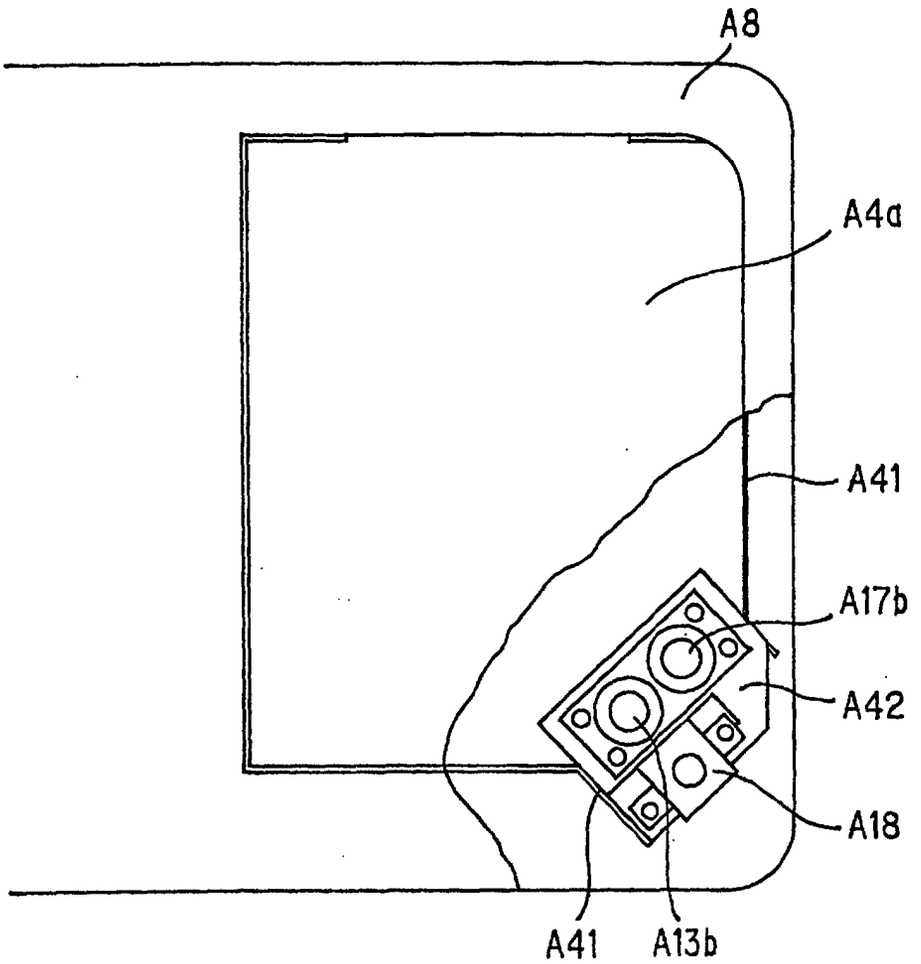


FIG. 107

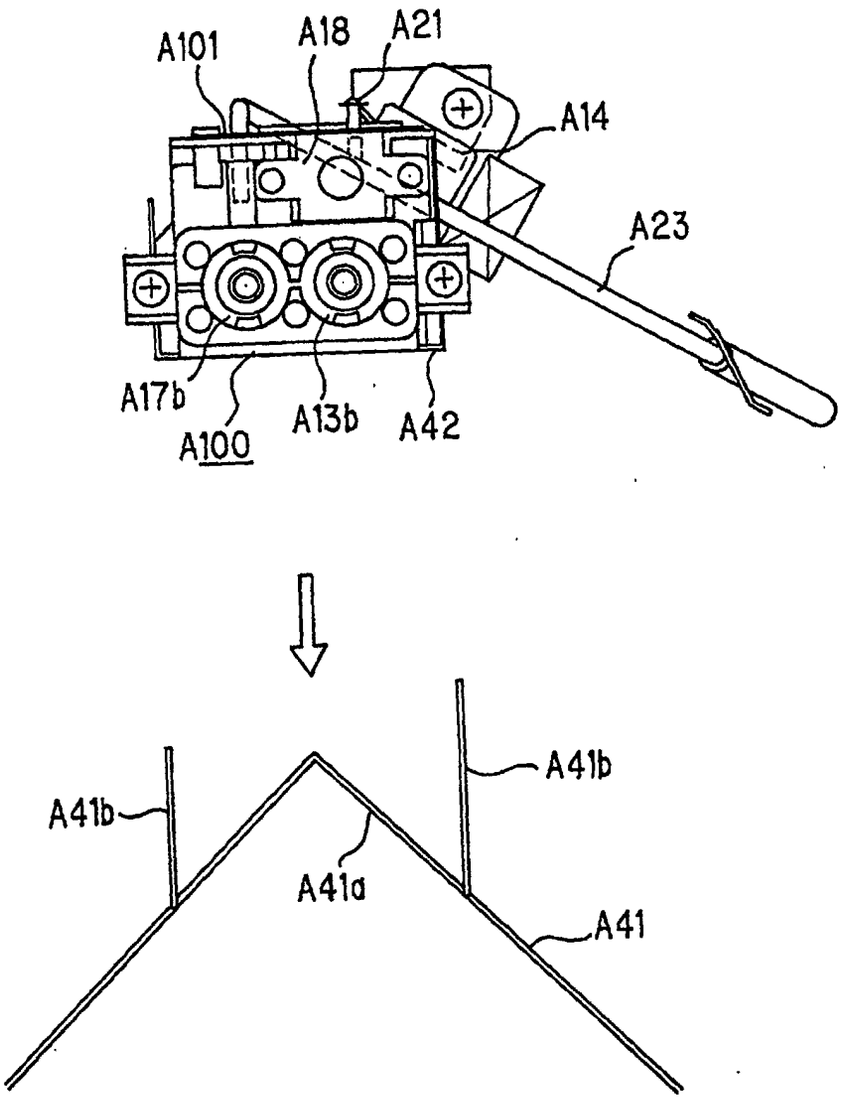


FIG. 108

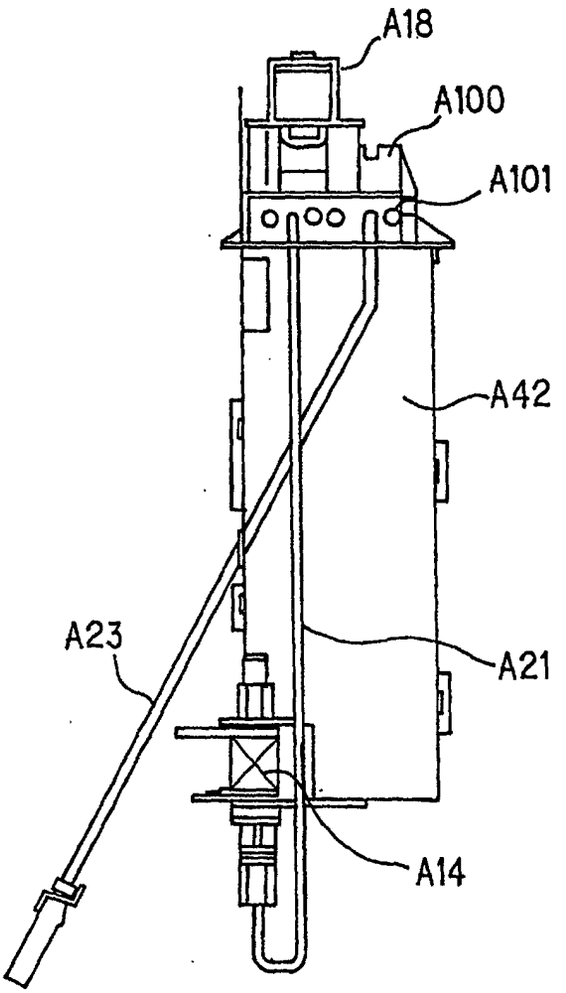


FIG. 109

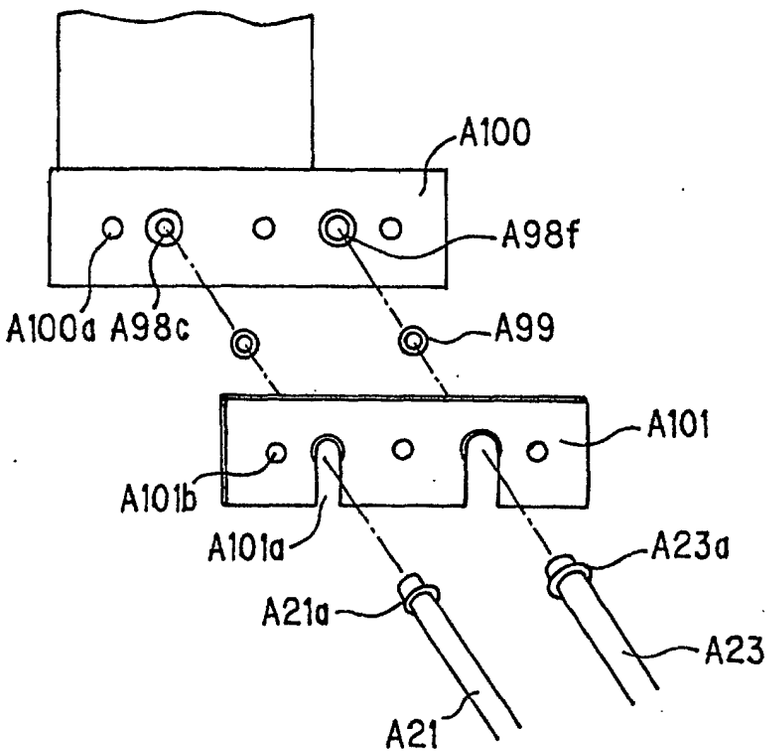
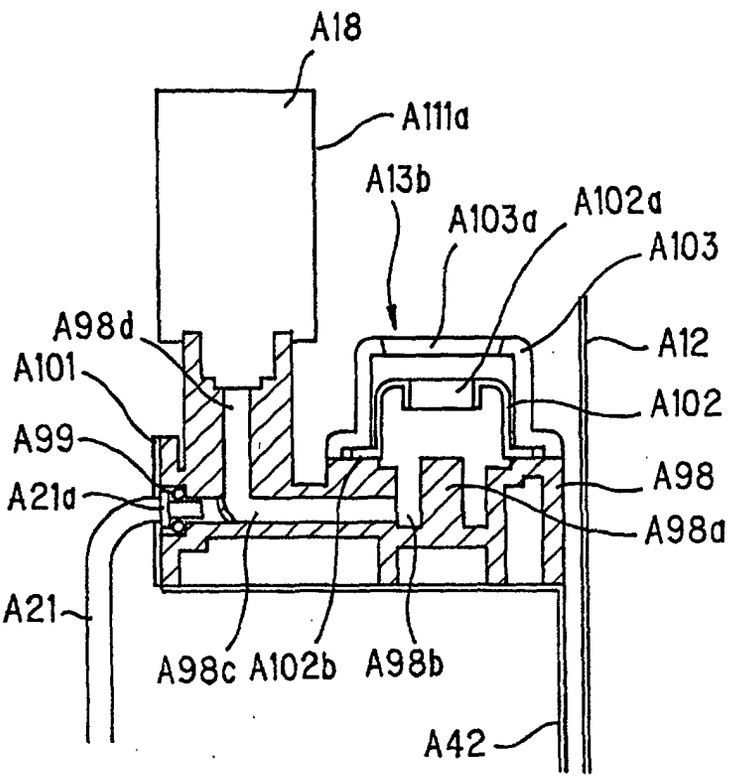


FIG. 110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A103
A98d
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A102
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A98
A21a
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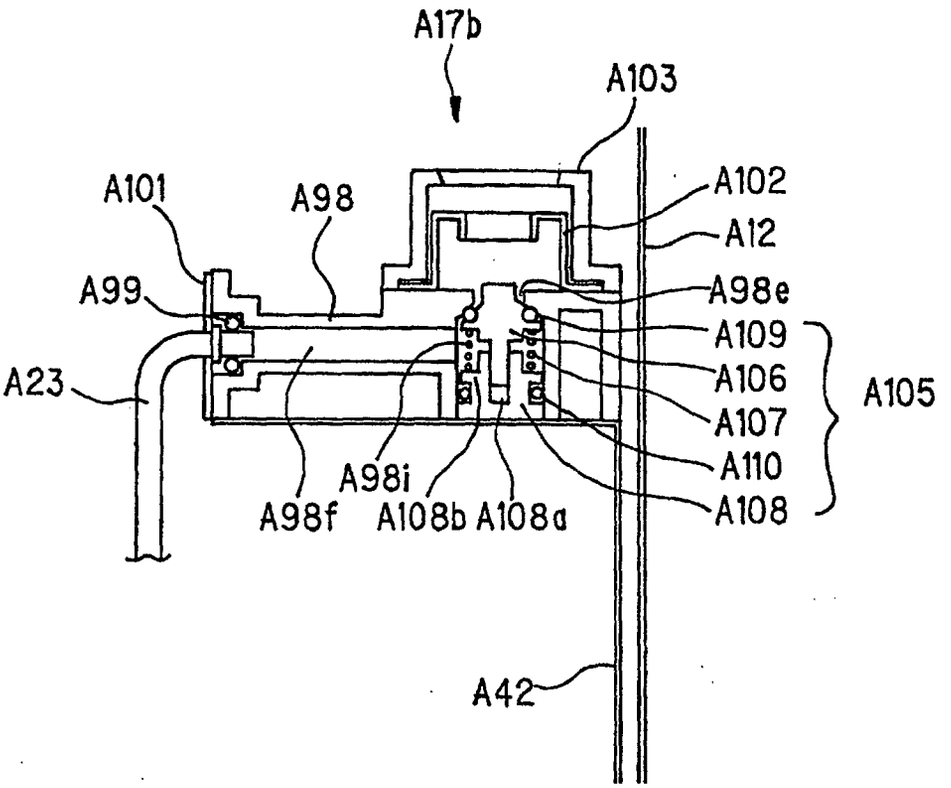
A21
A98c
A102b
A98b
A42

FIG. 111


A17b
A103
A101
A98
A102
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A99
A98e
A109
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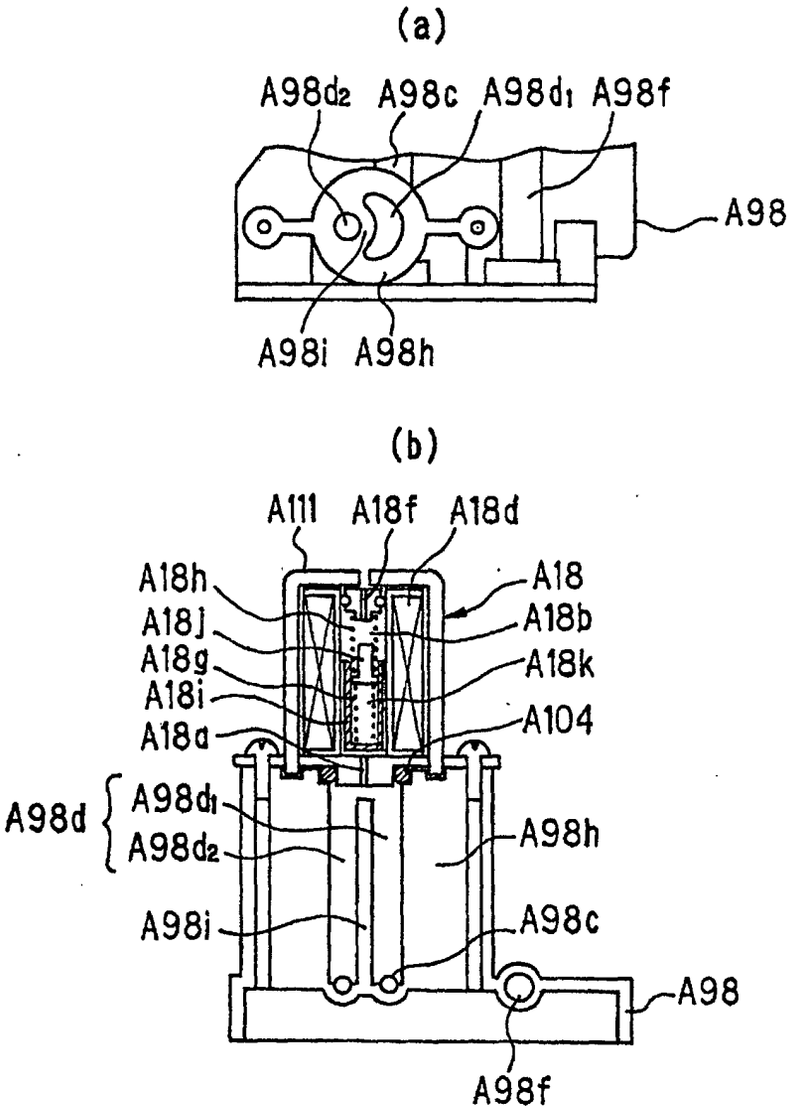
A105
A23
A107
A110
A98i
A98f
A108b
A108a
A108
A42

FIG. 112


(a)
A98d2
A98c
A98d1
A98f
A98
A98i
A98h
(b)
A111
A18f
A18d
A18h
A18
A18J
A18b
A18g
A18k
A18i
A104
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A98h
A98i
A98c
A98
A98f

FIG. 113

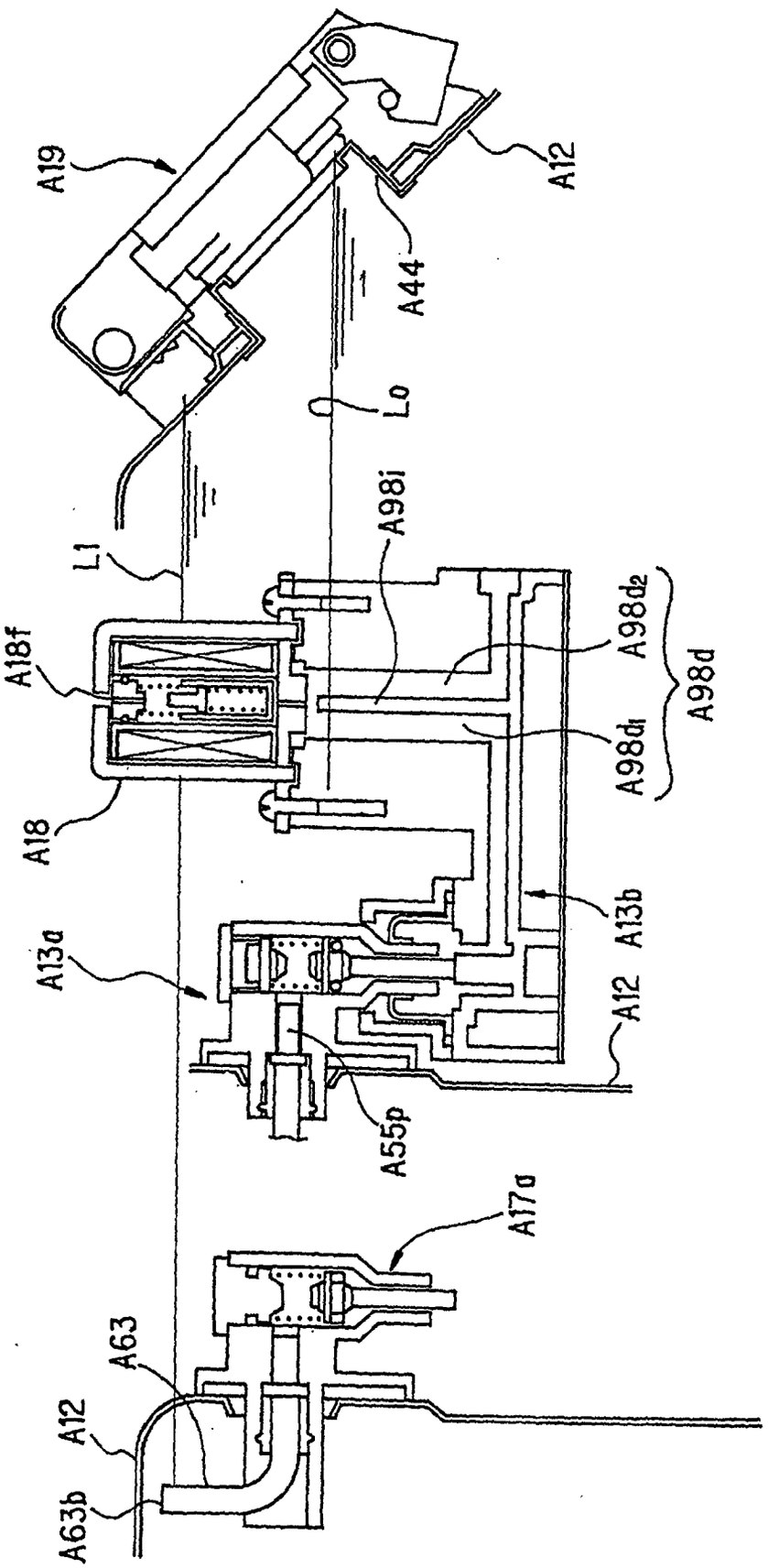

A19
A12
A44
Lo
L1
A98i
A18f
A98d2
A98d
A98d1
A18
A13b
A13a
A12
A55p
A17a
A63
A12
A63b

FIG. 114

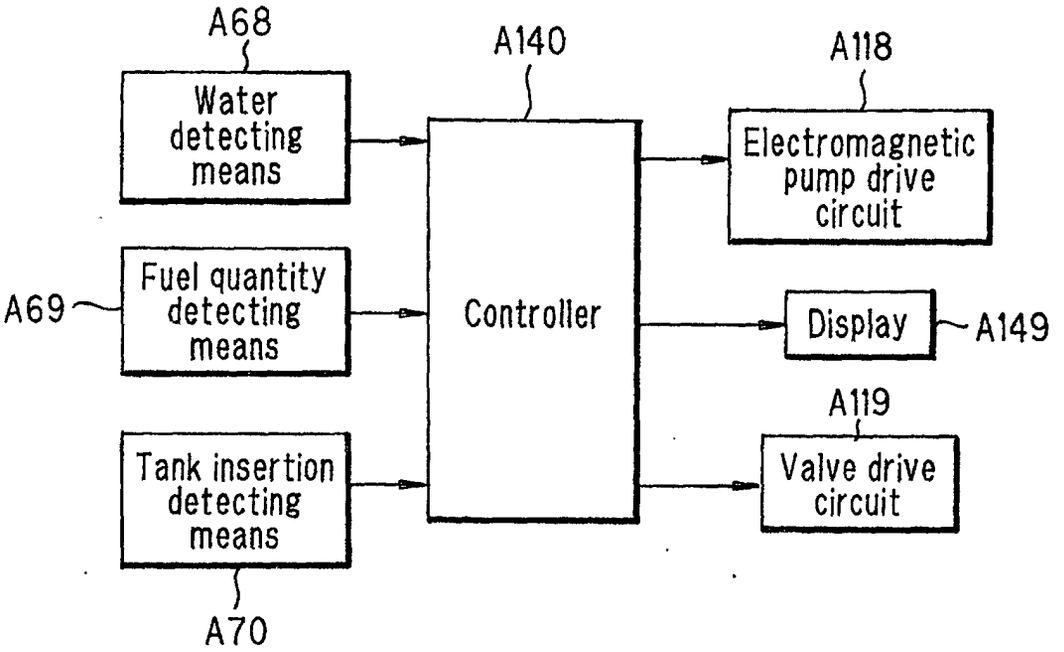


FIG. 115

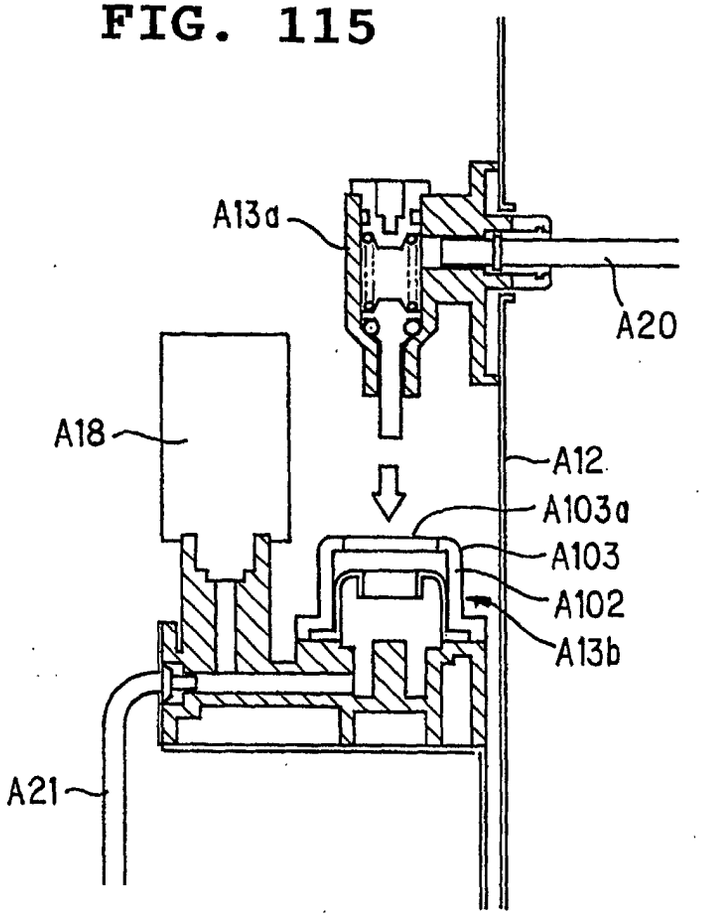


FIG. 116

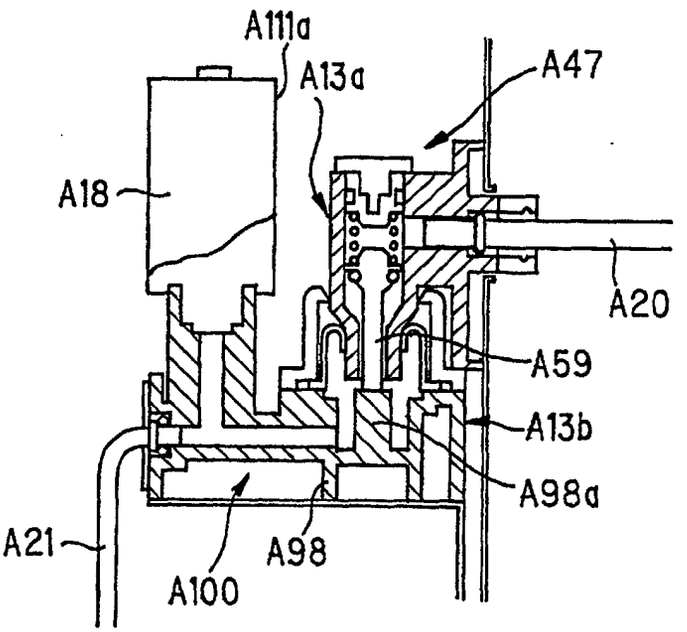


FIG. 117

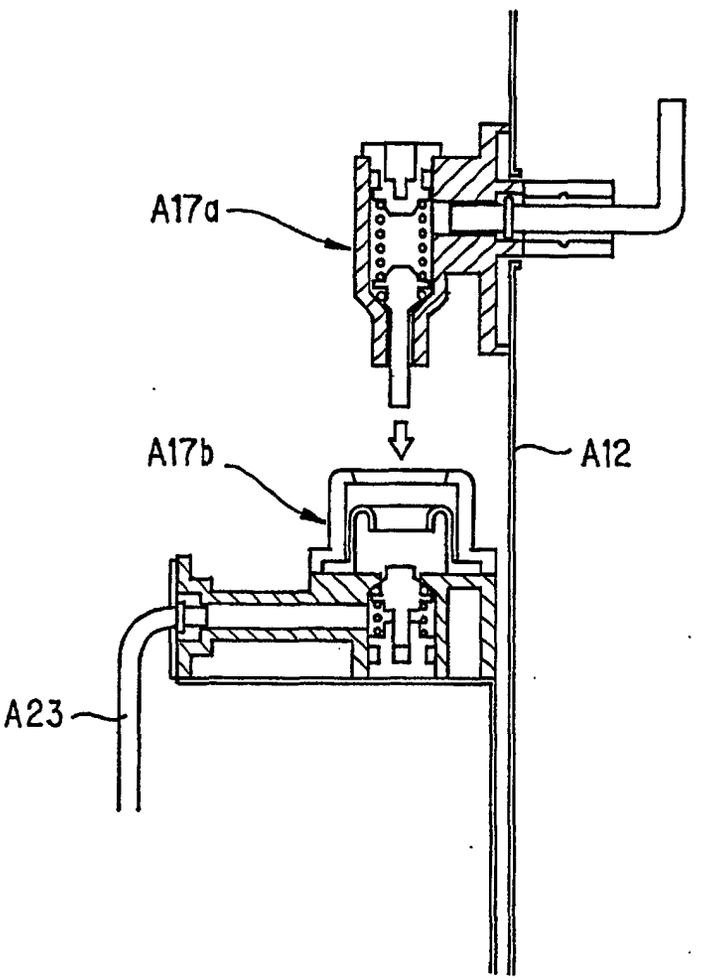


FIG. 118

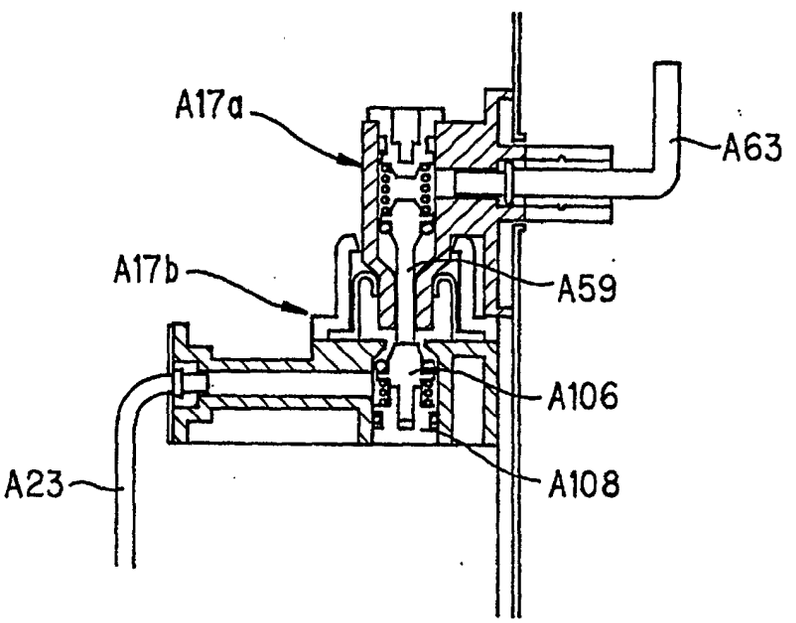


FIG. 119

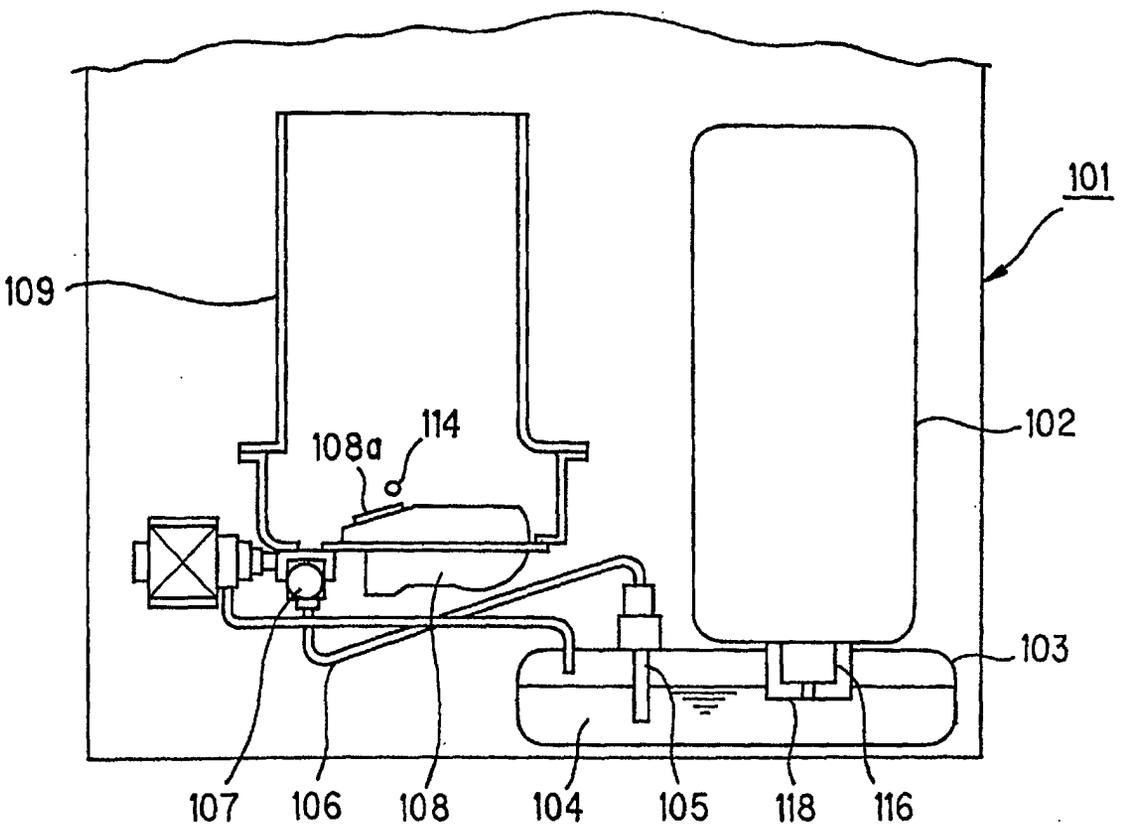


FIG. 120

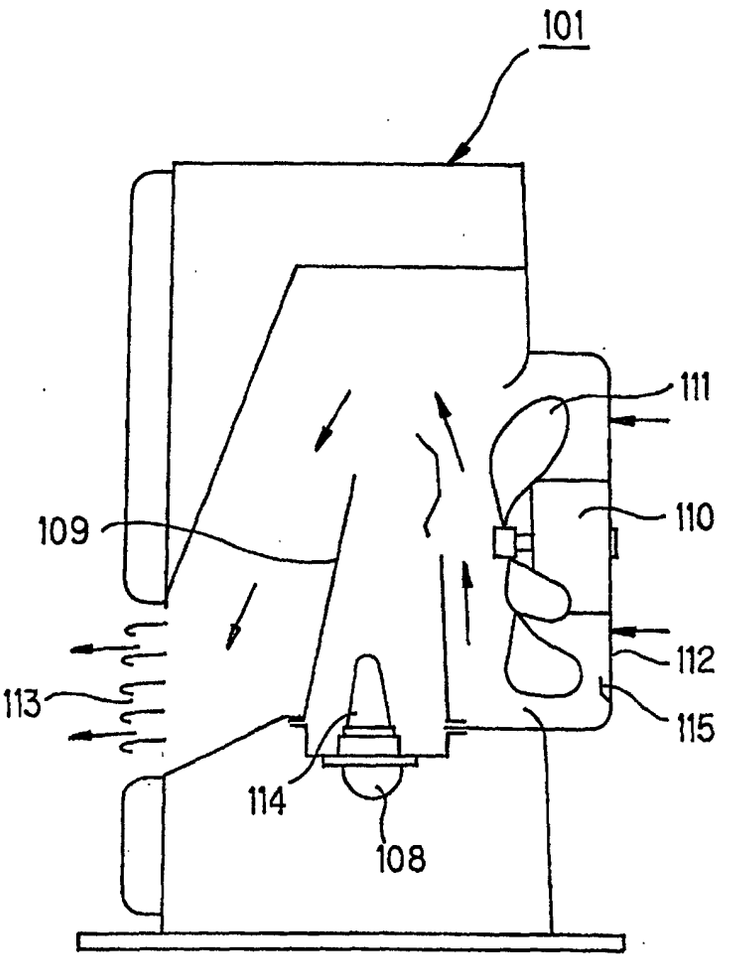
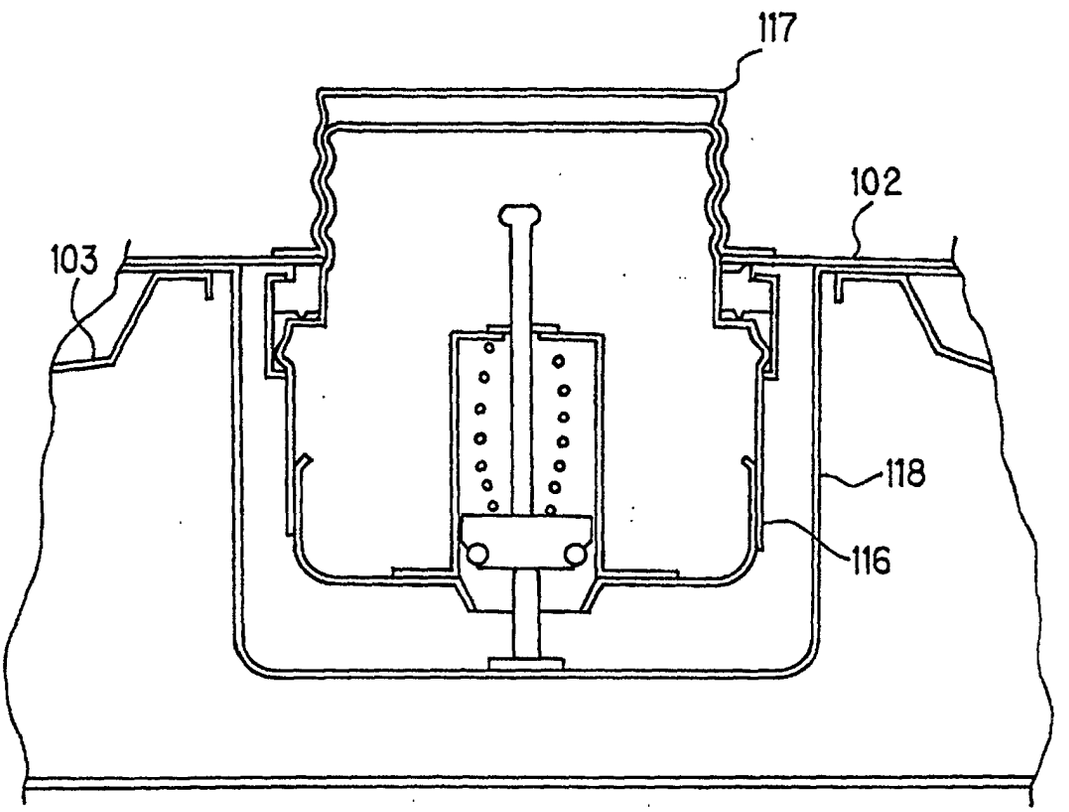


FIG. 121



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/00658

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.
	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),	
X	Full text; Fig.2	1,7,8,25,30-32
Y	Full text; Fig.2	3,15
A	Full text; Fig.2 (Family: none)	2,4-6,9-14,16-24,26-29,33
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 30458/1982 (Laid-open No. 137252/1983), (Toshiba Netsu Kigu K.K.), 14 September, 1983 (14.09.83), Full text; Figs.5,8 (Family: none)	3,15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"E" earlier document but published on or after the international filing date
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March, 2001 (13.03.01)	21 March, 2001 (21.03.01)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)