

APPARATUS FOR AUTOMATICALLY MAKING ICE AND WATER TANK FOR THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to an automatic ice making apparatus that supplies water to an ice making tray to make ice and to a water tank for the same.

Description of the Related Art

Hitherto, an automatic ice making apparatus of the foregoing type, arranged as shown in Fig. 42, has been disclosed in Japanese Patent Laid-Open No. 3-
10 137473.

Referring to Fig. 42, a water reservoir 300 comprises a measuring container 301, a slit 302 and a receiver 303. The receiver 303 has a water supply tank 308 which comprises a valve 304 and a cap 305. The measuring container 301 comprises a motor 307 having impeller blades 306 and a water supply pump
15 having a water supply pipe 309.

As a result of the structure above, water in the water supply tank 308 is allowed to flow through the valve 304 to be reserved in the water reservoir 300, water being then allowed to flow through the cap 305 to be introduced into the measuring container 301. At the time of supplying water, water in the measuring
20 container 301 is pumped up to be supplied. Since water to be supplied to the measuring container 301 is allowed to flow through the cap 305 at this time, a low flow rate per unit time is realized. Therefore, water in the measuring container 301 is, in a predetermined quantity, supplied to the ice making tray.

Although water can be, in the foregoing automatic ice making apparatus, supplied to the ice making tray regardless of the vertical positional relation between the ice making tray and the water supply apparatus, there arise a problem in that the overall cost cannot be reduced because of the structure of the water supply pump and so forth and another problem in that excessively high level noise is generated.

That is, there arises a problem in that noisy rotation sound of the motor 307 of the water supply pump is generated at the time of supplying water. What is worse, irregular rotations of the motor 307, the inclination of the refrigerator which takes place at the time of installing the same and an error occurring at the time of assembling elements incline the measuring container 301. The inclination changes the water level, causing a problem to rise in that the quantity of water to be supplied to the ice making tray is made irregular.

A conventional automatic ice making apparatus arranged as shown in Fig. 43 to overcome the foregoing problems has been disclosed in Japanese Patent Laid-Open No. 3-221769.

The automatic ice making apparatus has an arrangement that an ice making tray 312 is disposed in an ice making chamber 310 and a water supply unit 313 is disposed in a refrigerating chamber 311 so that water in a water supply tank 314 is supplied from the water supply unit 313 to the ice making tray 312.

Specifically, the ice making tray 312 in the ice making chamber 310 is located at a position lower than the position of the water supply unit 313 in the refrigerating chamber 311, the ice making tray 312 being connected to the water supply unit 313 by way of a water supply pipe 322.

The water supply unit 313 comprises a water reservoir container 315 and a water receiver 323. Further, the water supply tank 314 is disposed above the water receiver 323.

5 The water reservoir container 315 has an inlet port 317 formed in the upper portion thereof, the inlet port 317 being formed to establish the connection between the water receiver 323 and the water reservoir portion 316. Further, the water reservoir container 315 has an outlet port 318 formed in the lower portion thereof, the outlet port 318 being formed to establish the connection between the water reservoir portion 316 and the water supply pipe 322. The inlet port 317 and the
10 outlet port 318 can be opened/closed by an inlet valve 320 and an outlet valve 321 which are under control of an electromagnetic solenoid 319.

That is, the electromagnetic solenoid 319 controls the inlet valve 320 and the outlet valve 321 in such a manner that the outlet port 318 is closed when the inlet port 317 is opened and that the outlet port 318 is opened when the inlet port
15 317 is closed.

As a result of the foregoing structure, water discharged from the water supply tank 314 is temporarily reserved in the water receiver 323, and then water is introduced into the water reservoir portion 316 through the inlet port 317. Since the inlet valve 310 is opened and the outlet valve 321 is closed at this time, water
20 introduced into the water reservoir portion 316 is reserved in the water reservoir portion 316, causing the water reservoir portion 316 to be filled with water. When water is supplied to the ice making tray 312, the electromagnetic solenoid 319 is actuated to open the outlet valve 321 and close the inlet valve 320. It leads to a fact that only water in the water reservoir portion 316 is introduced into the ice

making tray 312 by way of the water supply pipe 322 so that water in a predetermined quantity is supplied to the ice making tray 312.

An automatic ice making apparatus of the foregoing type usually comprises a water supply detection unit for detecting water supply to the water tank and
5 completion of ice making and a tank setting detection unit for detecting setting of the water supply tank.

Fig. 44 is a cross sectional view which illustrates a refrigerator comprising an automatic ice making apparatus having a water supply detection unit and disclosed in Japanese Utility Model Laid-Open No. 2-128069 and a tank setting
10 detection unit disclosed in Japanese Utility Model Laid-Open No. 1-136869.

Referring to Fig. 44, reference numeral 330 represents a refrigerating chamber. A water supply tank 331 is disposed in the refrigerating chamber 330. The water supply tank 331 is connected to a centrifugal water supply pump 333 by way of a water receiving tray 332. A water supply pipe 334 connected to an ice
15 making tray 336 disposed in a freezing chamber 335 is attached to the water supply pump 333.

As a result of the thus-constituted structure, water in the water supply tank 331 is temporarily reserved in the water receiving tray 332, and then water is, by the water supply pump 333, supplied to the ice making tray 336 through the water
20 supply pipe 334.

Fig. 45 is a perspective view which illustrates the water supply detection unit disposed in the foregoing automatic ice making apparatus. The water supply detection unit 340 comprises a temperature sensor 341 attached to a position adjacent to the ice making tray 336 in the freezing chamber 335 and an indication

lamp 342 disposed in the refrigerator or on the outside of the same.

The temperature sensor 341 detects temperature rise in the freezing chamber 335 occurring at the time of supplying water to the ice making tray 336 so that water supply to the ice making tray 336 is confirmed.

5 Specifically, if no temperature rise can be detected though the operation of supplying water to the ice making tray 336 is performed, a discrimination is made that no water is present in the water supply tank 331, causing the indication lamp 342 to be lit on to urge a user to supply water to the water supply tank 331. After the user has reset the water supply tank 331, the indication lamp 342 is lit off.

10 Fig. 46 is a schematic view which illustrates the tank setting detection unit.

Referring to Fig. 46, reference numeral 350 represents the tank setting detection unit. The tank setting detection unit 350 comprises a switch 352 having an exposed button 351 and a lever 355 rotatively pivoted by a shaft 353 and pulled by a spring 354 in a direction toward the button 351.

15 As a result of the foregoing structure, the lever 355 is rotated by the spring 354 in a direction designated by an arrow if the water supply tank 331 has not been set. As a result, the button 351 is depressed by the right end of the lever 355, and therefore the switch 352 is switched on. Thus, a state where the water supply tank 331 is not set can be detected. If the water supply tank 331 has been set to the
20 contrary, the lever 355 is rotated against the spring 345 in a direction opposing the direction designated by the arrow. As a result, the right end of the lever 355 is separated from the button 351, causing the switch 352 to be switched off.

Therefore, a state where the water supply tank has been set can be detected.

However, the automatic ice making apparatus disclosed in Japanese Patent

Laid-Open No. 3-221769 and constituted as described above causes water reserved in the water receiver 323 to be exposed to air. In the foregoing case, there is a risk that bacteria suspended in the air invade water in the water receiver 323 and therefore water can be made slimy or rotten.

5 Further, the supply port of the water supply tank 314 is too small to clean up the water supply tank 314. Therefore, if water reserved in the water supply tank 314 is not used for a long time and then the electromagnetic solenoid 319 is actuated, insanitary water in the water supply tank 314 is undesirably supplied to the ice making tray 312.

10 What is worse, water in the water receiver begins to smell of foods in the refrigerating chamber 311, causing a problem to rise in that made ice gives an offensive smell.

The automatic ice making apparatus having the water supply detection unit and disclosed in Japanese Utility Model Laid-Open No. 2-128069 and the tank
15 setting detection unit disclosed in Japanese Utility Model Laid-Open No. 1-136869 is arranged in such a manner that the indication lamp 342 of the water supply detection unit 340 is lit off only when the water supply tank 331 is reset regardless of a fact whether or not water supply to the water supply tank 331 has been performed. Therefore, if the water supply tank 331 has been erroneously reset
20 without the supply of water, the indication lamp 342 is undesirably lit off. It leads to a fact that a user cannot, from the outside of the freezer, confirm whether or not water has been supplied, causing the user to keep the misconception that the water supply to the water supply tank 331 has been completed.

Since the tank setting detection unit 350 is constituted mechanically and

complicatedly, the cost of the automatic ice making apparatus cannot be reduced. Another problem arises in that the operation cannot be performed due to freezing.

The foregoing automatic ice making apparatus using the centrifugal water supply pump 333 involves a fact that water left in the water supply pipe 334 returns
5 to the water receiving tray 332 to be reserved when the operation of the water supply pump 333 is stopped. Therefore, waterweeds and mold grow in water in the water receiving tray 332, and therefore there arises a necessity of periodically cleaning the water receiving tray 332. As a result, a problem arises in that maintenance cannot easily be completed.

10 SUMMARY OF THE INVENTION

The present invention is directed to overcome the foregoing problems and therefore an object of the same is to provide an automatic ice making apparatus and a water supply tank for the automatic ice making apparatus which can be protected from bacteria suspended in the air and smell and in which generation of
15 noise can be prevented, water can be supplied in a uniform quantity and whether or not a water supply tank is present can easily be confirmed with a simple structure.

In order to achieve the foregoing object, according to one aspect of the invention, an automatic ice making apparatus comprises a water supply tank
20 including a quantitative chamber and a valve unit for closing an outlet valve when water flows in the quantitative chamber and opening an inlet valve when water flows out from the quantitative chamber, a drive unit which operates the valve unit to cause water to be supplied from the quantitative chamber to a receiving tray and



a water supply pump which sucks water in the receiving tray to supply water to an ice making tray.

As a result of the foregoing structure, the outlet valve of the valve unit is closed when water flows in the quantitative chamber and the inlet valve is closed when water flows out from the quantitative chamber. Water discharged from the quantitative chamber is supplied to the receiving tray, and water in the receiving tray is, by the water supply pump, supplied to the ice making tray. Therefore, water in the quantitative chamber can always be supplied to the ice making tray in a predetermined quantity. Since water is not exposed to outside air for a long time, water can be protected from bacteria suspended in the air so that air is not made slimy or rotten. Further, the water supply tank can easily be cleaned and maintained.

In one form of the invention, an automatic ice making apparatus has a control unit for controlling the opening/closing operation of a drain valve for opening/closing a drain passage. When the drain valve is opened by the control unit, water in a receiving tray is discharged into the drain passage. Therefore, even if water is left in the receiving tray, water can completely be drained, and therefore the receiving tray cannot be made slimy or rotten.

It is preferable that the drive unit and the water supply pump be formed integral with each other. When the motor is rotated forwards, the operation shaft acts on the valve unit, while the motor acts as a pump when the motor rotates in a reverse direction. As a result of the foregoing structure, the size of the automatic ice making apparatus can be reduced.

In another form of the invention, an automatic ice making apparatus has a



tank setting detection unit which stops the operation of a drive unit after a predetermined time has passed from setting of a water supply tank and lights on a display portion and which lights off the display portion if the tank is removed. After a predetermined time has passed from the moment at which the water supply tank
5 has been set, the operation of the drive unit is stopped and the display portion is lit on. When the set tank is removed, the display portion is lit off. Therefore, the user is able to settle down psychologically.

According to another aspect of the invention, an automatic ice making apparatus comprises a water supply tank equipped with a draft gauging pipe and a
10 valve unit capable of opening/closing an outlet port, a drive unit which operates the valve unit to cause water to flow out through the outlet port, a receiving tray having an internal volume equal to the full volume of an ice making tray when the surface of water reserved in the receiving tray reaches a leading portion of the draft gauging pipe, and a water supply pump.

15 When the valve unit is operated by a drive unit, water in the water supply tank is allowed to flow in the receiving tray through the outlet port. When water reaches the leading end of the draft gauging pipe, water is reserved in the receiving tray in a quantity corresponding to the full volume of the ice making tray. Then, water in the receiving tray is supplied to the ice making tray by the water
20 supply pump. Therefore, even if the time, in which the drive unit is operated, cannot be made uniform or the flow velocity of water discharged through the outlet port is nonuniform, their influences can be eliminated and water can be kept in the receiving tray in a quantity which is the same as the full volume of the ice making tray. Moreover, water in the receiving tray can immediately be sucked, and



therefore the problem of becoming slimy and rotten due to invasion of bacteria suspended in the air into water can be prevented.

In a further form of the invention, an automatic ice making apparatus comprises a cap attached to the operation shaft and capable of fluid-tightly sealing the drive unit. Since the drive unit is fluid-tightly sealed by the cap, undesirable
5 introduction of water in the receiving tray into the drive unit can be prevented.

It is preferable that an air venting member be attached to the drive unit. Since air in the cap can be removed by the air venting member, the drive unit can be operated with satisfactory response.

10 It is preferable that a filter be attached to the receiving tray. The suction operation performed by the water supply pump results in that foreign matters introduced into the receiving tray can be removed by the mesh filter. As a result, breakage of the engagement portion of the gear screws occurring due to invasion of the foreign matters can be prevented.

15 It is preferable that a suction hose and an extruding hose be connected to the water supply pump and that the water supply pump is disposed at a position higher than the receiving tray. Since the water supply pump is disposed higher than the receiving tray, splashing of the water discharged towards the receiving tray onto the water supply pump can be prevented.

20 It is preferable that the leading portion of the suction hose be disposed in and secured to a recess in the deepest portion of receiving tray. The suction hose, the leading portion of which is disposed in and secured to the recess, efficiently and completely sucks up water in the receiving tray.

It is preferable that the suction pump is a self-containing pump comprising



a motor and a pair of gear screws. The rotations of the engaged gear screws efficiently send water in the suction hose into the extruding hose.

It is preferable that the water supply pump is accommodated in a vibration preventive member. In this case, vibration noise of the water supply pump can be
5 absorbed by the vibration preventive member.

It is preferable that the extruding hose is composed of first and second extruding hoses connected to each other by a connection pipe. Water sucked into the suction hose is supplied to the ice making tray through the first and second extruding hoses.

10 It is preferable that a splash preventive member be disposed at the leading end of the extruding hose. In this case, splash of water discharged through the leading portion of the extruding hose can be prevented by the splash preventive member.

It is preferable that a flow-regulating portion be disposed in the extruding
15 hose. In this case, water in the extruding hose is decelerated and regulated by the flow-regulating portion so that water is supplied into the ice making tray in such a manner that splash is prevented.

In a further form of the invention, an automatic ice making apparatus comprises a control portion for operating a drive unit for a time longer than the time
20 taken for the water surface in the receiving tray to reach the leading end of a draft gauging pipe, stopping the drive unit and operating a water supply pump. After the drive unit has been operated for a time longer than the time taken for the water surface in the receiving tray to reach the leading end of a draft gauging pipe, the water supply pump is operated. Therefore, after water has been reserved



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in the receiving tray in a quantity which is the same as the full volume of the ice making tray, reserved water can be supplied to the ice making tray.

It is preferable that the water supply pump be operated for a predetermined time when the control portion has been reset or when the door of the refrigerator has been opened and the test switch has been depressed. Since the water supply pump is operated for a predetermined time when the control portion has been reset or when the test switch has been depressed, a problem that water is undesirably left in the water supply pump and so forth can be prevented.

According to a further aspect of the invention, an automatic ice making apparatus comprises a water supply detection unit and a door opening/closing discrimination unit which discriminates at predetermined intervals whether or not the door of the refrigerator has been opened/closed to transmit, to a water supply control portion, a water supply operation signal if it has discriminated that the door has been opened/closed or transmit a stop signal if it has discriminated that the door has not been opened/closed.

The water supply detection unit discriminates whether or not water has been supplied to the ice making tray, and the door opening/closing discrimination unit discriminates at predetermined intervals whether or not the door of the refrigerator has been opened/closed. If a discrimination has been made that the door has been opened/closed, the water supply operation signal is transmitted to the water supply control portion. If a discrimination has been made that the door has not been opened/closed, the stop signal is transmitted. As a result, a problem that no ice can be made due to setting of an empty water supply tank can be prevented. Since the mechanical and complicated tank setting detection

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unit can be omitted from the structure, the size of the automatic ice making apparatus can be reduced.

According to a further aspect of the invention, an automatic ice making apparatus comprises a water supply tank having a draft gauging pipe and a valve unit, a receiving tray to which a water supply pipe extending to the ice making tray is connected at the bottom portion thereof, an operation shaft for operating a valve unit and a valve operated inversely with respect to the valve unit to open/close the water supply pipe. When the drive unit is operated, the valve unit is opened and water is reserved in the receiving tray in a quantity which is the same as the full volume of the ice making tray. When the drive unit is stopped, the valve is opened so that water in the receiving tray is supplied to the ice making tray through the water supply pipe. The thus constructed automatic ice making apparatus can preferably be adapted to a refrigerator of a type in which the ice making tray must be disposed below the water supply tank.

According to a further aspect of the invention, an automatic ice making apparatus comprises a transparent case for accommodating water and a cover water-tightly joined to the case. A user is able to directly confirm whether or not water is present in the water supply tank through the transparent case which has been set. As a result, a problem that an empty water supply tank is undesirably set can be prevented.

According to a further aspect of the invention, an automatic ice making apparatus comprises a case which accommodates water and which has a transparent portion, and a cover water-tightly joined to the case. A user is able to directly confirm whether or not water is present in the water supply tank through the



transparent portion of the case.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view which illustrates the outline of a refrigerator to which an automatic ice making apparatus according to a first embodiment of the present invention is adapted;

Fig. 2 is a schematic cross sectional view which illustrates the automatic ice making apparatus according to this embodiment;

Fig. 3 is a cross sectional view which illustrates an essential portion of this embodiment;

Fig. 4 is a schematic view which illustrates a control board adapted to this embodiment;

Fig. 5 is a time chart of the operations of a drive mechanism and a water supply pump controlled by the control board;

Fig. 6 is a time chart of another example operation controlled by the control board;

Fig. 7 is schematic cross sectional view which illustrates a first modification of this embodiment;

Fig. 8 is schematic cross sectional view which illustrates a second modification of this embodiment;

Fig. 9 is a schematic cross sectional view which illustrates an automatic ice making apparatus according to a second embodiment of the present invention;

Fig. 10 is a schematic view which illustrates a control board adaptable to this embodiment;



Fig. 11 is a time chart of the operation of the control board;

Fig. 12 is a perspective view which illustrates a unit formed by integrating a drive mechanism and a water supply pump and adaptable to an automatic ice making apparatus according to a third embodiment of the present invention;

5 Fig. 13 is an internal structural view which illustrates the unit formed by integrating the drive mechanism and the water supply pump;

Fig. 14 is a view A of Fig. 13;

Fig. 15 is a view B of Fig. 13;

Fig. 16 is a schematic cross sectional view which illustrates a modification
10 of the unit formed by integrating a drive mechanism and a water supply pump and adaptable to an automatic ice making apparatus according to the third embodiment of the present invention;

Fig. 17 is a view A of Fig. 16;

Fig. 18 is a flow chart of the operation of the modification;

15 Fig. 19 is a partially enlarged view which illustrates the outline of a water supply tank corner adaptable to an automatic ice making apparatus according to a fourth embodiment of the present invention and having an LED attached thereto;

Fig. 20 is a time chart of a lapse LED;

Fig. 21 is a cross sectional view which illustrates an automatic ice making
20 apparatus according to a fifth embodiment of the present invention;

Fig. 22 is a cross sectional view which illustrates a spacer;

Fig. 23 is a rear view which illustrates the spacer;

Fig. 24 is a plan view which illustrates a filter;

Fig. 25 is a vertical cross sectional view which illustrates a water supply

pump;

Fig. 26 is a lateral cross sectional view which illustrates the water supply pump;

Fig. 27 is a cross sectional view which illustrates a state where the water supply pump is accommodated in a vibration preventive member;

Fig. 28 is a perspective view which illustrates a state where the water supply pump is accommodated in the vibration preventive member;

Fig. 29 is a cross sectional view which illustrates a state where extruding hoses are connected to each other;

Fig. 30 is a cross sectional view which illustrates a state where a splash preventive member and a flow-regulating portion are attached;

Fig. 31 is a cross sectional view which illustrates a refrigerator having an automatic ice making apparatus including a control portion according to this embodiment;

Fig. 32 is a flow chart of the operation controlled by the control portion;

Fig. 33 is a flow chart of the operation controlled by the control portion;

Fig. 34 is a cross sectional view which illustrates an essential portion of an automatic ice making apparatus according to a sixth embodiment of the present invention;

Fig. 35 is a partially broken perspective view which illustrates a water supply tank for an automatic ice making apparatus according to an embodiment of the present invention;

Fig. 36 is a perspective view which illustrates a water supply tank for an automatic ice making apparatus according to another embodiment of the present

invention;

Fig. 37 is a cross sectional view which illustrates a state where the water supply tank for an automatic ice making apparatus according to the embodiment is set;

5 Fig. 38 is a perspective view which illustrates an essential portion of an embodiment of an automatic ice making apparatus having a structure for irradiating the water supply tank for an automatic ice making apparatus and according to the present invention;

Fig. 39 is a partial cross sectional view which illustrates a refrigerator to which this embodiment is adapted;

Fig. 40 is a block diagram which illustrates a water supply detection unit adaptable to an automatic ice making apparatus according to an embodiment of the present invention;

Fig. 41 is a time chart which illustrates the embodiment;

15 Fig. 42 is a cross sectional view which illustrates a conventional automatic ice making apparatus;

Fig. 43 is a cross sectional view which illustrates another conventional automatic ice making apparatus;

Fig. 44 is a cross sectional view which illustrates a refrigerator having a conventional automatic ice making apparatus comprising a water supply detection unit and a tank setting detection unit;

Fig. 45 is a perspective view which illustrates a water supply detection unit; and

Fig. 46 is a schematic view which illustrates a tank setting detection unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Preferred embodiments of the present invention will now be described with reference to the drawings.

First Embodiment

5 Fig. 1 is a view which illustrates the outline of a refrigerator to which an automatic ice making apparatus according to a first embodiment of the present invention is adapted. Fig. 2 is a schematic cross sectional view which illustrates the automatic ice making apparatus according to this embodiment. Fig. 3 is a cross sectional view which illustrates an essential portion of this embodiment.

10 Referring to Fig. 1, a refrigerator 1 has a refrigerating chamber 2 and a freezing chamber 3 disposed on the refrigerating chamber 2. A water supply tank corner 4 is formed above the refrigerating chamber 2, while an ice making corner 5 is formed below the freezing chamber 3. The automatic ice making apparatus is disposed in each of the water supply tank corner 4 and the ice making corner 5.

15 As shown in Fig. 2, a water supply tank 10 is attached in the water supply tank corner 4, and a fastening port 11 having a large diameter which enables the hand to be introduced is formed in the lower portion of the water supply tank 10. Further, a quantitative chamber 20 is attached to the fastening port 11.

20 The quantitative chamber 20 is constituted by a cap 21, which is fastened to the fastening port 11 by means of threads and which has an outlet port 22 in the central portion thereof, an intermediate case 23 having an inlet port 24 in the upper portion thereof and an upper case 25 including activated carbon 26.

 An interlocking valve 27 for opening/closing the outlet port 22 and the inlet port 24 is attached to the outlet port 22 of the cap 21.

The interlocking valve 27 has an outlet-port valve 28 for closing the outlet port 22 and an inlet-port valve 29 for closing the inlet port 24, the interlocking valve 27 being urged downwards by a spring 30. That is, if no force acts on the interlocking valve 27, the interlocking valve 27 is moved downwards by the spring 30, causing the inlet port 24 to be opened. Further, the outlet port 22 is closed.

The intermediate case 23 is secured to the cap 21 by means of threads or by fitting, the intermediate case 23 having an air venting 23a in the upper portion thereof. The upper case 25 is attached to the upper surface of the intermediate case 23 by means of threads or by fitting so that water in the water supply tank 10 is introduced into the quantitative chamber 20 by way of the activated carbon 26. A receiving tray 32 is disposed below the fastening port 11 to which the intermediate case 23 is attached. The receiving tray 32, therein, has a water supply passage 31 which is inclined downwards and to which a drive mechanism 40 serving as the drive unit is attached.

The drive mechanism 40 includes an electromagnetic solenoid which vertically moves an operation shaft 41 by the electromagnetic effect thereof, the operation shaft 41 having an operation member 42 in the form of an umbrella or a truncated cone fastened to the leading end thereof. As a result, the interlocking valve 27 of the quantitative chamber 20 is pushed upwards by the truncated-cone-shaped operation member 42.

The operation member 42 is disposed to protect a fastening hole 31a of the water supply passage 31 from invasion of water through the outlet port 22, the operation member 42 being made of silicon material.

When the drive mechanism 40 is operated as described above to upwards

move the operation shaft 41, the interlocking valve 27 is pushed upwards so that the outlet port 22 is opened and the inlet port 24 is closed by the inlet-port valve 29.

5 The receiving tray 32, to which the drive mechanism 40 arranged as described above is fastened, has a water supply pump 45 as shown in Fig. 1. An extruding hose 46 is connected to the top end of the water supply pump 45.

The extruding hose 46 is extended to the ice making corner 5 in the freezing chamber 3, the leading end of the extruding hose 46 being allowed to reach a position above the ice making tray 47 in the ice making corner 5.

10 The water supply pump 45 is not a centrifugal pump but it is a self-containing type pump.

The operation of this embodiment will now be described.

If the drive mechanism 40 is not operated, only downward urging force of the spring 30 acts on the interlocking valve 27 of the quantitative chamber 20.

15 Therefore, the outlet port 22 is closed by the outlet-port valve 28 and the inlet port 24 is opened.

Therefore, in the foregoing state, water in the water supply tank is, through the activated carbon 26, introduced into the upper case 25, water being allowed to flow through the inlet port 24 and introduced into the intermediate case 23.

20 The introduction of water into the intermediate case 23 is performed smoothly by the operation of the air venting 23a. Since the outlet port 22 is closed by the outlet-port valve 28 at this time, the quantitative chamber 20 is filled with water.

When the drive mechanism 40 is operated, the operation shaft 41 is

moved upwards so that the operation member 42 upwards pushes the lower end of the interlocking valve 27 against the urging force of the spring 30. As a result, the outlet port 22 is opened and the inlet port 24 is closed by the inlet-port valve 29. Therefore, water in the intermediate case 23 is allowed to flow out through the outlet port 22 to the receiving tray 32. Water in the receiving tray 32 is, due to the operation of the water supply pump 45, supplied to the ice making tray 47 through the extruding hose 46.

Since the inlet port 24 is closed at this time, the quantity of water to be introduced to the receiving tray 32 is substantially the same as the volume of the intermediate case 23. Therefore, water in a predetermined quantity which is substantially the same as the intermediate case 23, is supplied to the ice making tray 47.

Since the outlet port 22 has no hole serving as an air venting, the time, in which water flows out, cannot be made constant, and also the displacement of the quantity of water in the receiving tray 32 cannot be made constant. However, since the self-containing type pump 45 immediately sucks water, no water will leave in the receiving tray 32. That is, even if the time, in which water flows out, is made irregular, no water is left in the receiving tray 32, and therefore water is supplied to the ice making tray 47 in a predetermined quantity.

Fig. 4 is a schematic view which illustrates a control board for controlling the operations of the drive mechanism 40 and the water supply pump 45. Fig. 5 is a time chart of the operation.

The control board 50 is disposed in the refrigerator 1 and connected to the drive mechanism 40 and the water supply pump 45. Reference numeral 51

represents a power source for the control board 50.

When a water supply start signal is, as shown in Fig. 5, transmitted from the control board 50, the drive mechanism 40 is turned on to be operated for a predetermined time. The timing is arranged in such a manner that the water supply pump 45 is, t_1 seconds after the drive mechanism 40 has been turned on, operated for a predetermined time.

The timing may be arranged in such a way that the water supply pump 45 is, t_2 seconds after the drive mechanism 40 has been turned on, operated for a predetermined time.

As a result of the operation of the drive mechanism 40, water reserved in the receiving tray 32 is sucked by the water supply pump 45, and therefore the receiving tray 32 is made empty.

A gear box (omitted from illustration) for rotating the ice making tray 47 to remove ice is disposed in the freezing chamber 3. The gear box detects the quantity of ice to be reserved in a water storage box so that the foregoing water supply start signal is transmitted from the control board 50 if a desirable quantity of ice has not been reserved. The detection of the quantity of ice is performed at the moment when a door of the freezer chamber 3 is opened or closed.

As described above, the automatic ice making apparatus according to this embodiment is able to prevent reservation of water in the receiving tray 32, but water can be supplied to the ice making tray 47 in a predetermined quantity. Moreover, the structure that the water supply tank 10 is sealed off prevents water from exposure to the outside air. As a result, bacteria suspended in the air cannot invade water so that generation of the bacteria is prevented.

If the extruding hose 46 has an internal diameter smaller than a predetermined value, the self-containing type pump 45 completely pumps up water in the extruding hose 46 as well as water reserved in the water supply pipe 31 and the receiving tray 32 to supply water to the ice making tray 47. Therefore,
5 generation of bacteria can further satisfactorily be prevented.

Further, the inside portion of the water supply tank 10 can easily be cleaned by removing the cap 21 and by inserting the hand through the large-diameter fastening port 11 of the water supply tank 10. Since the water supply tank 10 and the drive mechanism 40 are formed individually, the water supply tank
10 10 can arbitrarily be removed so that maintenance, such as cleaning and repair, is completed easily.

Since the operation member 42 of the drive mechanism 40 is made of silicon material, noise made due to the collision with the interlocking valve 27 can substantially be eliminated. Thus, generation of noise can substantially be
15 prevented.

A modification of the disposition of the water supply pump 45 will now be described.

Fig. 7 is a schematic cross sectional view which illustrates a first modification.

20 This modification is arranged in such a manner that the water supply pump 45 is disposed in the ice making corner 5 in the freezing chamber 3, and a water suction hose 48 is extended downwards from the same to the receiving tray 32. The lower end of the suction hose 48 is inserted into a recess 34 formed in the receiving tray 32.

It is preferable that the thus-disposed water supply pump 45 be a pump of a piston motion type or a type, such as a gear screw, that sends water by rotational motion, more preferably a low vacuum type pump because it is able to self-contain water to a satisfactorily high position.

5 Fig. 8 is a schematic cross sectional view which illustrates a second modification.

This modification is constituted in such a way that the water supply pump 45 is positioned lower than the positions of the water supply passage 31 and the receiving tray 32, and the extruding hose 46 is connected to the water supply pump
10 45.

Second Embodiment

Fig. 9 is a schematic cross sectional view which illustrates an automatic ice making apparatus according to a second embodiment of the present invention.

Fig. 10 is a schematic view which illustrates a control board adaptable to this
15 embodiment. Fig. 11 is a time chart of the control board.

This embodiment is different from the first embodiment in that a water drain structure is disposed to drain water left in the receiving tray 32.

The drain structure is, as shown in Fig. 9, constituted in such a manner that a drain passage 35 is so formed below the receiving tray 32 as to be
20 connected to the same. Further, a drain hose 36 is connected to the drain passage 35. In addition, a drain valve 37 is attached to an intermediate position of the drain passage 35. There sometimes arises a case that water in the receiving tray 32 cannot be sent to the ice making tray 47 depending upon the position and the type of the water supply pump 45. It leads to a fact that water is left in the

receiving tray 32 and there is a risk that bacteria grow.

This embodiment is directed to overcome the foregoing problem by constituting the structure such that the drain valve 37 is arbitrarily opened to discharge water left in the receiving tray 32 to the drain hose 36 through the drain passage 35 to evaporate water.

The operations of the drain valve 37, the drive mechanism 40 and water supply pump 45 are controlled by the control board 52 shown in Fig. 10.

That is, when a water supply start signal is transmitted from the control board 52 as shown in Fig. 11, the drive mechanism 40 is turned on to be operated for a predetermined time. Then, the water supply pump 45 is turned on to be operated for a predetermined time.

Since the residual structures, operations and effects are the same as those of the first embodiment, their descriptions are omitted here.

Third Embodiment

Fig. 12 is a perspective view which illustrates an integration unit of the drive mechanism and the water supply pump and adaptable to an automatic ice making apparatus according to a third embodiment of the present invention.

Fig. 13 is a view which illustrates the internal structure of the integration unit of the drive mechanism and the water supply pump. Fig. 14 is a view A of Fig. 13, and Fig. 15 is a view B of Fig. 13.

This embodiment is different from the first and second embodiments in that an integration unit of the drive mechanism and the water supply pump is used which is formed by integrating the drive mechanism 40 and the water supply pump 45.

Referring to Figs. 12 and 13, the integration unit 60 of the drive mechanism and the water supply pump has a structure formed by integrating the drive mechanism 40 and the water supply pump 45.

A case 61 of the integration unit 60 of the drive mechanism and the water supply pump includes a two-shaft motor 62. A one-way clutch 63 serving as a forward directional clutch mechanism is attached to either shaft of the two-shaft motor 62. Further, the water supply pump 45 is disposed to the foregoing shaft. A water suction pipe 64 communicated with the receiving tray 32 is connected to either end of the water supply pump 45, while the extruding hose 46 is connected to the residual end. A one-way clutch 65 serving as an inverse directional clutch mechanism capable of operating in the direction opposing the direction in which the one-way clutch 63 is operated is attached to the residual shaft of the two-shaft motor 62. Further, a reduction mechanism 66 is connected to the leading end of the foregoing shaft, the reduction mechanism 66 being connected to the operation shaft 41 through a gear 67.

The operation shaft 41, as shown in Figs. 14 and 15, has a lowest elongated hole 41a and a plurality of rectangular holes 41b, the operation shaft 41 being urged downwards by a spring 68 attached to the case 61.

As a result of the thus-arranged structure of the integration unit 60 of the drive mechanism and the water supply pump, when the two-shaft motor 62 is rotated in the inverse direction, the one-way clutch 63 runs idle. As a result, the one-way clutch 65 is connected so that the rotations of the two-shaft motor 62 are transmitted to the reduction mechanism 66.

Thus, the gear 67 is rotated to be engaged with the rectangular holes 41b

of the operation shaft 41, and therefore the operation shaft 41 is moved upwards against the urging force of the spring 68. When the gear 67 is further rotated to reach the elongated hole 41a, the gear 67 runs idle so that the upward movement of the operation shaft 41 is stopped. When the operation shaft 41 has been moved upwards, the operation member 42 pushes upwards the interlocking valve 27. Therefore, water in the quantitative chamber 20 is discharged into the receiving tray 32 to reach the water supply pump 45 through the suction pipe 64. If power supply to the two-shaft motor 62 is stopped in the foregoing state, the reduction mechanism 66 runs idle, causing the operation shaft 41 to be moved downwards by the spring 68. As a result, the outlet port 22 of the cap 21 is closed by the interlocking valve 27.

When the two-shaft motor 62 is rotated forwards, the one-way clutch 65 runs idle and the one-way clutch 63 is connected. As a result, the water supply pump 45 is operated, causing water to be sucked through the suction pipe 64 to be sent to the extruding hose 46.

A modification of this embodiment will now be described.

Fig. 16 is a schematic cross sectional view which illustrates this modification. Fig. 17 is a view A of Fig. 16.

This modification is arranged in such a way that a cam 70 having a spiral spring 71 is used in place of the gear 67.

As a result, when the cam 70 is rotated from point b toward point c shown in Fig. 13, the operation shaft 41 is moved upwards. If the two-shaft motor 62 has been stopped or in a case of power outage, the spiral spring 71 rotates the cam 70 from the point c toward the point b. As a result, the operation shaft 41 is moved

downwards. That is, when the two-shaft motor 62 is rotated inversely as shown in Fig. 18, the operation member 42 disposed at the leading end of the operation shaft 41 is pushed upwards to be displaced by a predetermined degree. When the two-shaft motor 62 is then rotated inversely, the water supply pump 45 is operated.

5 Since the residual structures, operations and effects are the same as those of the first and second embodiments, their descriptions are omitted here.

Fourth Embodiment

Fig. 19 is a partially enlarged view which illustrates the outline of a water supply tank corner 4 to which an LED is attached which is adapted to an automatic
10 ice making apparatus according to a fourth embodiment of the present invention.

Fig. 20 is a time chart of a lapse LED.

This embodiment is different from the first to third embodiments in that a water supply LED 80 and a lapse LED 81 are disposed in the water supply tank corner 4 of the refrigerator 1.

15 The water supply LED 80 is an LED that is widely employed in an automatic ice making apparatus for domestic use and realized by known technologies. That is, the water supply LED 80 is lit on if water in the water supply tank 10 is exhausted to urge the user to supply water. When water has been supplied to the water supply tank 10 and the water supply tank 10 has been set,
20 the water supply LED 80 is lit on.

The lapse LED 81 is lit on at a moment after a predetermined time (for example, one week) has passed from setting of the water supply tank 10 and arranged to stop the operation of the drive mechanism 40. The lapse LED 81 is lit off when the water supply tank 10 has been ejected.

That is, the lapse LED 81 is, as shown in Fig. 20, lit on t4 hours after the water supply tank 10 has been set and lit off after the water supply tank 10 has been ejected.

As a result of the thus-constituted structure, the water supply from the water supply tank 10 is stopped after a predetermined time has passed even if water in the water supply tank 10 can easily be rotten. Therefore, the user is able to settle down psychologically though ice cannot be made.

The positions at which the water supply LED 80 and the lapse LED 81 are respectively disposed are not limited to the positions shown in Fig. 19.

10 Fifth Embodiment

Fig. 21 is a cross sectional view which illustrates an automatic ice making apparatus according to a fifth embodiment.

The automatic ice making apparatus according to this embodiment comprises a water supply tank 90 to which a valve unit 93 is attached, a drive mechanism 100, a receiving tray 110 disposed below the water supply tank 90 and a water supply pump 120 for supplying water in the receiving tray 110 to an ice making tray 149 through extruding hoses 141 and 142.

The water supply tank 90 is attached in the water supply tank corner, and a fastening port 91 having a large diameter which enables the hand to be inserted is formed in the lower portion of the water supply tank 90.

The valve unit 93 is fastened to a cap 95 fixed to the fastening port 91 by means of threads and having an outlet port 94 at the central portion thereof. A valve 98 is secured to the top end of a shaft 97 inserted into a through hole 96 of the cap 95, the shaft 97 being urged downwards by a spring 99. That is, when the

shaft 97 has been moved upwards to cause the valve 98 to open the outlet port 94, water in the water supply tank 90 is allowed to flow toward the receiving tray 110. Further, a draft gauge pipe 95a is formed to project over the lower surface of the cap 95.

5 The drive mechanism 100 is secured to the receiving tray 110 by means of threads to vertically move the operation shaft 101 due to the electromagnetic operation of an electromagnetic solenoid disposed therein so as to upwards push the shaft 97 of the valve unit 93 by a cap 102 attached to the leading end of the operation shaft 101.

10 Specifically, the cap 102 is made of silicon rubber or the like and formed into a bag shape, the inside surface of the cap 102 being fastened to the leading portion of the operation shaft 101. The lower portion of the cap 102 is, while being fluid-tightly fitted within a hole 110a of the receiving tray 110, attached to a spacer 103 serving as an air venting member.

15 Thus, when the operation shaft 101 has been moved upwards, the top surface of the cap 102 is pushed onto the shaft 97. As a result of upward pushing of the top surface of the cap 102, the shaft 97 is moved upwards against the urging force of the spring 99, causing the valve 98 to open the outlet port 94. When the operation shaft 101 has been moved downwards, the top surface of the
20 cap 102 of the spring is moved downwards, and therefore the shaft 97 is moved downwards due to the urging force of the spring 99. As a result, the valve 98 closes the outlet port 94.

 The spacer 103, as shown in Figs. 22 and 23, is formed into a cylindrical shape having a hollow portion 104 through which the operation shaft 101 is

inserted, the spacer 103 having a flange portion 106 in which a plurality of grooves 105 communicated with the hollow portion 104 are formed.

As a result, air in the cap 102 is introduced/discharged to and from the hollow portion 104 through the grooves 105 when the operation shaft 101 is moved upwards and downwards. Therefore, the drive mechanism 100 is operated satisfactorily so that the top surface of the cap 102 can accurately be moved upwards or downwards.

The receiving tray 110, to which the drive mechanism 100 arranged as described above is attached, has a recess 111 at the bottom portion thereof, as shown in Fig. 21. The side walls and the bottom surface of the receiving tray 110 are inclined toward the recess 111. Further, a mesh filter 112 is detachably attached onto the inside of the receiving tray 110.

The outline of the filter 112 is, as shown in Fig. 24, formed into a shape which can be adaptable to the inner shape of the portion of the receiving tray 110 to which the filter 112 is attached. The filter 112 has a hole 112a in the central portion thereof, the hole 112a being formed to receive the cap 102.

By removing the cap 102 from the operation shaft 101 and by removing the filter 112 from the receiving tray 110, foreign matters allowed to adhere to the filter 112 can therefore easily be cleaned.

The volume of the receiving tray 110 is, as shown in Fig. 21, determined such that the ice making tray 149 is filled with water when draft line Z of water in the receiving tray 110 has reached the lower end of the draft gauge pipe 95a.

The suction hose 119 is secured in such a manner that its leading portion 119a is pressed against the bottom surface of the recess 111 of the receiving tray

110. The leading portion 119a is arranged in such a manner that the opening formed in the leading portion thereof cannot be closed by the bottom surface of the recess 111. The edge of the leading portion is disposed away from the bottom surface of the recess 111 by inclining the leading portion 119a with respect to the bottom surface of the recess 111, or by diagonally cutting the leading portion 119a or by forming a hole in the leading portion 119a.

As a result, water in the receiving tray 110 can efficiently be sucked from the bottom portion through the suction hose 119 to be sent to the water supply pump 120.

10 The water supply pump 120 is disposed to be higher than the top end of the receiving tray 110 to suck up water in the receiving tray 110.

The water supply pump 120, as shown in Fig. 25, comprises a motor 121 having a gear 122 attached to the rotation shaft thereof and gear screws 124 and 125 that are integrally rotated when a gear 123 engaged with the gear 122 is rotated. When the gear screws 124 and 125 are rotated, water sucked through the suction hose 119 is, as shown in Fig. 26, sent to the extruding hose 141.

The inner diameter D of the suction hose 119 connected to the water supply pump 120 is made to be a small value, for example, about 6 mm to raise the degree of vacuum in the suction hose 119. As a result, the function of the water supply pump 120 can satisfactorily be exhibited.

20 A mesh filter 113 may be attached into the suction hose 119 as shown in Fig. 26.

The water supply pump 120 may be secured to the receiving tray 110 while being received by a vibration preventive member 130 as shown in Figs. 27

and 28. That is, a port 126 for connecting the suction hose 119 is fitted to either of cut portions 131 of the vibration preventive member 130 and the connection is established between a port 132 for connecting the extruding hose 141 and a drain port (omitted from illustration) of the water supply pump 120. In the foregoing
5 state, the water supply pump 120 is accommodated in the vibration preventive member 130 so that vibrations, which can be propagated from the water supply pump 120 to the drive mechanism 100, are absorbed.

The extruding hose 141 connected to the drain port of the water supply pump 120 is, as shown in Fig. 21, extended to an intermediate partition wall 143
10 that partitions the water supply tank corner 4 of the refrigerator 2 from the ice making corner 5 in the freezing chamber 3. The extruding hose 141 is connected to the extruding hose 142 in the ice making corner 5.

Specifically, a connection pipe 150 is fastened to the intermediate partition wall 143 as shown in Fig. 29. Further, the leading portion of the extruding hose
15 141 is connected to a lower end connection portion 151 of the connection pipe 150. In addition, the upper extruding hose 142 is inserted into a large-diameter insertion portion 152 in the upper portion of the connection pipe 150 to be received by a sealing member 153 disposed in the insertion portion 152.

The sealing member 153 is made of silicon rubber or the like capable of
20 preventing invasion of air and water, the sealing member 153 having a plurality of rounded projections 154 on the outer surface thereof and a plurality of sharp projections 155 on the inner surface thereof.

As a result, the lower end of the extruding hose 142 is tightly held by the elasticity of the sealing member 153, resulting in that the risk of the separation of

the extruding hose 142 from the connection pipe 150 can be eliminated. If the water supply tank corner 4 or the ice making corner 5 has a trouble, it can be repaired by removing only the extruding hose 141 or 142 of either corner that has encountered the trouble.

5 The thus connected extruding hose 142 is, as shown in Fig. 21, extended to the ice making tray 149, the extruding hose 142 having, at the leading end thereof, a cap-shape splash preventive member 145 as shown in Fig. 30.

Therefore, flying of water discharged from the extruding hose 142 can be prevented and water can be supplied to the ice making tray 149. It should be
10 noted that reference numeral 146 shown in Fig. 30 represents a mesh-shape flow-regulating portion for regulating water in the extruding hose 142. Although Fig. 30 illustrates the foregoing flow-regulating portion 146, it can be eliminated if the splash preventive member 145 is attached. If the flow-regulating portion 146 is attached to the leading portion of the extruding hose 142, the splash preventive
15 member 145 can be omitted from the structure.

The operations of the drive mechanism 100 and the water supply pump 120 are controlled by a control portion 160 shown in Fig. 31.

The control portion 160 confirms the water supply timing (step S1 shown in Fig. 32) to bring the drive mechanism 100 and the water supply pump 120 to be
20 non-active state if it has discriminated that the water supply timing has not come (steps S2 and S3 if a discrimination "NO" is made in step S1 shown in Fig. 32).

When the water supply timing has come, the drive mechanism 100 is operated to upwards move the valve 98 of the valve unit 93 shown in Fig. 21, causing the outlet port 94 to be maintained at the opened state for 7 seconds (the

foregoing time is called "T1" hereinafter) (steps S4 and S5 if a discrimination "YES" is made in step S1).

Since the outlet port 94 shown in Fig. 21 is therefore continuously opened, water is allowed to flow from the water supply tank 90 to the receiving tray 110.

5 When the water draft line Z has been raised to reach the lower end of the draft gauging pipe 95a, air introduction into the draft gauging pipe 95a is interrupted, resulting in that the water flow from the water supply tank 90 to the receiving tray 110 is stopped. That is, the receiving tray 110 is filled with water five seconds (the foregoing time is called "T2" hereinafter) after the operation of the drive mechanism .
10 100 has been commenced. Further, the ice making tray 149 is filled with the quantity of water for the ice making tray 149 during a period from T1 second to T2 second.

The description "DRIVE MECHANISM ON" shown in Figs. 32 and 33 means a state where the valve 98 has been moved upwards and therefore the
15 outlet port 94 has been opened. Further, T1 seconds and T2 seconds are not limited to 7 seconds and 5 seconds. That is, the necessity lies in only that the period of T2 seconds is the time required for the draft line Z to reach the lower end of the draft gauging pipe 95a and that T1 seconds are longer than T2 seconds.

Then, the drive mechanism 100 is operated inversely after T1 seconds
20 have passed, and the water supply pump 120 is operated (steps S6 and S6 if a discrimination "YES" is made in step S5 shown in Fig. 32). The description "DRIVE MECHANISM OFF" shown in Figs. 32 and 33 means a fact that the valve 98 has been moved downwards and therefore the outlet port 94 has been closed.

After the water supply pump 120 has been operated for 14 seconds, the

operation of the water supply pump 120 is stopped (step S9 if a discrimination "YES" is made in step S8 shown in Fig. 32). As a result, water in the receiving tray 110 is completely sucked up in 12 seconds by the water supply pump 120 and sucked water is supplied to the ice making tray 149 in a period from 12 seconds to 14 seconds as shown in Fig. 33.

Although the time in which the water supply pump 120 is operated is made to be 14 seconds because water in the receiving tray 110 must be completely supplied into the ice making tray 149, the present invention is not limited to this. The time in which the water supply pump 120 is operated may be set to be adaptable to the length of the extruding hoses 141 and 142.

If the control portion 160 is undesirably reset or the door of the refrigerator 1 is opened and a test switch (omitted from illustration) is depressed, the characteristics of the water supply pump 120 cause water to be left in the suction hose 119 and the extruding hoses 141 and 142. Therefore, if the water supply pump 120 is again operated in the foregoing state, thus-left water and water in the receiving tray 110 are undesirably supplied into the ice making tray 149. In this case, water cannot be supplied to the ice making tray 149 in a predetermined quantity. Therefore, it is preferable that the water supply pump 120 is rotated for a predetermined time without exception when the control portion 160 is reset or the test switch is switched on to discharge water in the suction hose 119 and the extruding hoses 141 and 142.

The total operation of the automatic ice making apparatus according to this embodiment will now be described.

Since the operation shaft 101 has been moved downwards in a case

where the drive mechanism 100 is not operated, the shaft 97 is moved downwards by the urging force of the spring 99 and the outlet port 94 is therefore closed by the valve 98.

When the drive mechanism 100 is operated to move upwards the
5 operation shaft 101, the top surface of the cap 102 is pushed upwards onto the shaft 97, causing the valve 98 to be moved upwards to open the outlet port 94. As a result, water in the water supply tank 90 is allowed to flow in the receiving tray 110 through the outlet port 94 to be reserved in the receiving tray 110. Although a somewhat large quantity of water discharged from the water supply tank 90 is
10 sometimes splashed by the bottom surface or the side wall of the receiving tray 110, the arrangement that the water supply pump 120 is disposed higher than the receiving tray 110 protects the water supply pump 120 from splashed water.

When the draft line Z of water has been moved upwards to reach the lower end of the draft gauge pipe 95a, the introduction of air into the draft gauge pipe
15 95a is interrupted. Therefore, water discharge from the water supply tank 90 into the receiving tray 110 is interrupted. As a result, the receiving tray 110 is able to continuously reserve water of a quantity corresponding to the volume of the ice making tray 149 even if the drive mechanism 100 is operated. Therefore, even if the time in which the drive mechanism 100 encounters irregularity or the flow
20 velocity of water from the outlet port 94 cannot be made uniform, their influences can be eliminated and therefore the receiving tray 110 is able to continuously reserve water of the quantity corresponding to the volume of the ice making tray 149. If the receiving tray 110 is filled with water as described above, there arises a risk that water is undesirably introduced into the drive mechanism 100. However,

the arrangement that the drive mechanism 100 is completely sealed up by the cap 102 protects the drive mechanism 100 from the water introduction.

If the operation of the drive mechanism 100 is stopped in the foregoing state, the operation shaft 101 is moved downwards to contract the cap 102. At this
5 time, there arises a risk that buoyancy acts on the cap 102 due to air in the cap 102 and therefore the operation shaft 101 is pulled upwards resulting in that its downward movement is disturbed. However, the downward movement of the operation shaft 101 causes air in the cap 102 to be discharged through the grooves 105 of the spacer 103. As a result, the cap 102 can instantaneously be
10 contracted so that the drive mechanism 100 is able to be operated with excellent responsibility.

As a result, the shaft 97 of the valve unit 93 is moved downwards by the urging force of the spring 99, and accordingly the outlet port 94 is closed by the valve 98, causing water discharge from the water supply tank 90 to be stopped.

15 Substantially simultaneously with the stoppage of the operation of the drive mechanism 100, the water supply pump 120 is operated to suck up water reserved in the receiving tray 110 through the suction hose 119.

Since the leading portion 119a of the suction hose 119 is secured while being pressed against the bottom surface of the recess 110 and the edge of the
20 leading portion 119a is inclined with respect to the bottom surface of the recess 111 for example at this time, water in the receiving tray 110 is efficiently and completely sucked up through the bottom portion. Further, the arrangement that the inner diameter D of the suction hose 119 is made to be the small diameter of about 6 mm raises the degree of vacuum in the suction hose 119 so that the

function of the water supply pump 120 to be exhibited satisfactorily.

Therefore, water discharged from the supply tank 90 to the receiving tray 110 can instantaneously be sucked up, causing the time in which water in the receiving tray 110 is exposed to air in the refrigerator 1 to be shortened

5 significantly. As a result, a problem that made ice begins to smell due to smell given from foods in the refrigerator 1 can be prevented. Further, the undesirable introduction bacteria suspended in the air can substantially be prevented so that water is not made slimy or rotten.

Since water in the receiving tray 110 is sucked up by the suction hose 119
10 through the bottom portion, bits of food such as bread crumbs erroneously left by a user can be captured by the top surface of the filter 112. Therefore, the introduction of the bits of food into the water supply pump 120 to break the engagement portions of the gear screws 124 and 125 can be prevented. The bits can easily be removed by detaching the filter 112 from the receiving tray 110 and
15 by cleaning the filter 112.

Water sucked into the suction hose 119 is sent into the extruding hose 141 by the rotations of the gear screws 124 and 125 of the water supply pump 120.

If vibrations are generated due to the engagement of the gear screws 124 and 125 and the rotations of the motor 121, the propagation of the vibration noise
20 can be prevented by securing the water supply pup 120 to the receiving tray 110 while being accommodated in the vibration preventive member 130 as shown in Figs. 27 and 28.

Water in the extruding hose 141 is pushed up into the extruding hose 142 connected to the same through the connection pipe 150.

Since the extruding hose 142 is held by the sealing member 153 made of the silicon rubber or the like capable of preventing the invasion of air and water, the degree of vacuum between the extruding hoses 141 and 142 can satisfactorily be kept. As a result, undesirable introduction of air between the extruding hoses 141 and 142 and leakage of water from the connection pipe 150 resulting in deterioration of the water supply efficiency to the ice making tray 149 can be prevented.

If the ice making corner 5 has a trouble, it can easily be repaired by removing only the extruding hose 142. Since the plurality of the projections 154 formed to project over the outer surface of the sealing member 153 are rounded and the plurality of the sharp projections 155 formed on the inner surface of the same are allowed to cut into the extruding hose 142, the extruding hose 142 can smoothly be removed. Further, the sealing member 153 can be removed while being attached to the extruding hose 142 at the time of removing the extruding hose 142. Therefore, the extruding hose 142 can easily be connected to the extruding hose 141 by simply inserting the sealing member 153 into the insertion portion 152 at the time of again assembling the elements.

Water pushed up to the extruding hoses 141 and 142 is allowed to reach the leading portion of the extruding hose 142.

By determining the inner diameters of the extruding hoses 141 and 142 to be values smaller than a predetermined value and by raising the degree of vacuum in the extruding hoses 141 and 142, undesirable reserve of water in the water supply pump 120 and the extruding hoses 141 and 142 can be prevented but water can completely be sent to the ice making tray 149. As a result, the problem of the

growth of bacteria due to the reservation of water in water in the water supply pump 120 and the extruding hoses 141 and 142 can be prevented.

Water allowed to reach the extruding hose 142 is discharge to the ice making tray 149 through the opening formed in the leading portion of the extruding
5 hose 142.

Since the cap-shape splash preventive member 145 is attached to the leading portion of the extruding hose 142 as shown in Fig. 30, splashing of water discharged from the extruding hose 142 can be prevented and it is supplied to the ice making tray 149. If the flow-regulating portion 146 is attached in place of the
10 splash preventive member 145, water is decelerated by the flow-regulating portion 146 to be supplied to the ice making tray 149 while being prevented from splashing.

Sixth Embodiment

Fig. 34 is a cross sectional view which illustrates an automatic ice making
15 apparatus according to a sixth embodiment of the present invention.

This embodiment is different from the fifth embodiment in that the ice making tray can be disposed at a position lower than the water supply tank. Elements which are the same as those of the fifth embodiment are given the same reference numerals in the descriptions below.

20 The automatic ice making apparatus according to this embodiment is arranged in such a manner that a receiving tray 170 is disposed below a water supply tank 90 on which a cap having a valve unit 93 is installed, a drive mechanism 180 is attached to the receiving tray 170 and the water supply pump 120 according to the fifth embodiment is omitted from the structure.

The receiving tray 170 has an outlet port 171 in the bottom portion thereof.

A water supply pipe 172 communicated with the outlet port 171 is extended to a position above the ice making tray 149.

5 The drive mechanism 180 comprises a cap 182 having a substantially same arrangement as that of the cap 102 of the drive mechanism 100 but it comprises an operation shaft 181 arranged in a manner different from that of the operation shaft 101.

10 The operation shaft 181 is formed into an L-like shape and having an upper portion 181a which upwards project over the drive mechanism 180 to be in contact with the inner top surface of the cap 182. A lower portion 181b of the operation shaft 181 is bent into the an L-shape, the operation shaft 181 having a leading portion introduced into the water supply pipe 172 through an elongated hole 173.

15 A valve 183 capable of closing the outlet port 171 is, by using a link mechanism and so forth, attached to the upper portion of the leading portion of the lower portion 181b of the operation shaft 181.

20 As a result, when the operation shaft 181 is moved upwards, also the valve 183 is moved upwards to close the outlet port 171. When the operation shaft 181 is moved downwards, also the valve 183 is moved downwards to open the outlet port 171.

The operation of this embodiment will now be described.

When the drive mechanism 180 has been operated to move upwards the operation shaft 181, the upper portion 181a of the operation shaft 181 pushes up the top surface of the cap 182 to move upwards the valve 98 of the valve unit 93.

As a result, the outlet port 94 is opened so that water in the water supply tank 90 is allowed to flow in the receiving tray 170.

Since the upward movement of the operation shaft 181 upwards moves the lower portion 181b of the operation shaft 181 along the elongated hole 173, the valve 183 is carried upwards to close the outlet port 171. Therefore, water allowed to flow in the receiving tray 170 is reserved to the lower end of the draft gauging pipe 95a.

When the operation shaft 181 has been moved downwards from the foregoing state, the lower portion 181b of the operation shaft 181 is moved downwards. Also the valve 183 is moved downwards together with the lower portion 181b of the operation shaft 181 to open the outlet port 171. As a result, water in the receiving tray 170 is, due to the dead weight thereof, moved downwards so that water is introduced into the water supply pipe 172. Therefore, water is allowed to flow in the ice making tray 149 through the opening in the leading portion of the water supply pipe 172.

Since the residual structures and the operations are the same as those of the fifth embodiment, their descriptions are omitted here.

Seventh Embodiment

Fig. 35 is a partially broken perspective view which illustrates a water supply tank for an automatic ice making apparatus according to a seventh embodiment of the present invention.

The water supply tank for the automatic ice making apparatus according to this embodiment comprises a case 191 manufactured by blow molding and a plate-like cover 196.

The case 191 is formed into a transparent box-like shape through which its inside can be seen, the case 191 having the bottom portion in which a cap fitting portion 192 is formed. The cap fitting portion 192 has a thread 193 on the outer surface thereof. By causing the cap 21 according to the first embodiment or the cap 95 according to the fifth or sixth embodiment to be received by the thread 193, the cap 21 or 95 can be received by the cap fitting portion 192. Further, the central portion of the top end of a front surface 194 of the case has a handle 195 in the form of a recess.

The cover 196 is installed to the upper surface of the case 191. Specifically, the overall shape of the cover 196 is formed to be adaptable to the shape of the top end of the case 191. The cover 196 is bonded or welded to the upper surface of the case 191 in such a manner that a cut portion 197 formed in the front portion of the cover 196 aligns to the handle 195.

An example of use of the water supply tank 190 according to this embodiment will now be described.

First, water is injected into the water supply tank 190 through the cap fitting portion 192, and the cap 21 or 95 or the like is installed to the cap fitting portion 192.

In the foregoing state, the water supply tank 190 is, as shown in Fig. 37, set in the water supply tank corner 4 in the upper portion of the refrigerator 1. Since a surface 198 on which the case 191 and the cover 196 are joined together is positioned at the highest position in the case 191 as shown in Fig. 35, water surface Y in the state where the water tank 190 is set as described above is lower than the joining surface 198 without exception. Therefore, water leakage through

the joining surface 198 can be prevented even if the case 191 and the cover 196 have encountered a defect in bonding or welding.

When the water supply tank 190 has been set in the water supply tank corner 4 as described above, the front surface 194 of the water supply tank 190 is positioned adjacent to the eyes of the user, as shown in Fig. 37. Therefore, the user is able to visually confirm whether or not water is present in the water supply tank 190 through the front surface 194 of the transparent case 191. As a result, a problem that the water supply tank 190 in an empty state is undesirably set in the water supply tank corner 4 can be prevented.

Eighth Embodiment

Fig. 36 is a perspective view which illustrates a water supply tank for an automatic ice making apparatus according to another embodiment of the present invention.

The water supply tank 200 for an automatic ice making apparatus according to this embodiment is different from the seventh embodiment in that a portion of the case is made transparent.

That is, a transparent portion 204, through which the inside of the water supply tank 200 can be seen, is formed in a portion of a front surface 203 of the case 201 on which a cover 202 is bonded or welded, as shown in Fig. 36.

As a result, the user is able to directly and visually confirm whether or not water is present in the water supply tank 200 through the transparent portion 204 of the front surface 203 of the transparent case 201.

Since the residual structures, operations and effects are the same as those of the water supply tank 190 shown in Fig. 35, their descriptions are omitted

here.

Ninth Embodiment

Fig. 38 is a perspective view which illustrates an essential portion of an embodiment of the automatic ice making apparatus according to the present invention that has a structure having the foregoing water supply tank for an automatic ice making apparatus. Fig. 39 is a partial cross sectional view which a refrigerator to which this embodiment is adapted.

This embodiment is structured in such a manner that an irradiation lamp 210 is attached to the water supply tank corner 4 to which the water supply tank 190 is set.

Specifically, the lamp 210 is attached to a position from which the water supply tank 190 can be irradiated with light from a rear position. As a result, light of the lamp 210 is made incident into the water supply tank 190 through a transparent side surface 199 or the like. Therefore, the water surface Y is irradiated with light so as to be recognized through the transparent front surface 194. It leads to a fact that the quantity of water in the water supply tank 190 can easily be confirmed by the user.

It should be noted that the special lamp 210 according to this embodiment for use to irradiate the water supply tank may be replaced by a refrigerator lamp for irradiating the water supply tank corner 4 when the door (omitted from illustration) of the refrigerator 1 is opened.

Tenth Embodiment

Fig. 40 is a block diagram which illustrates a water supply detection unit adaptable to an automatic ice making apparatus according to a tenth embodiment

of the present invention.

The water supply detection unit according to this embodiment comprises a temperature sensor 211 serving as the water supply detection unit and a door opening/closing discrimination unit 220 connected to the temperature sensor 211
5 though a switch 213.

The temperature sensor 211 is disposed adjacent to the ice making tray 210, the temperature sensor 211 acting to discriminate whether or not water supply has been made to the ice making tray 210.

Specifically, if temperature has not been raised though the water has been
10 supplied to the ice making tray by the control board 50 and the control portion 160 and so forth adapted to the automatic ice making apparatus according to the first embodiment or the fifth embodiment, a discrimination is made that no water is present in a water supply tank (omitted from illustration), and accordingly operation signal E is transmitted from the temperature sensor 211 to an indication lamp 212
15 and a switch 213 to light on the indication lamp 212.

The temperature sensor 211 and the switch 213 can be constituted by, for example, thermostats.

The switch 213 has a function that, when the switch has received the operation signal E, it establishes the connection between a power source 214 to
20 the door opening/closing discrimination unit 220 to operate the door opening/closing discrimination unit 220.

The door opening/closing discrimination unit 220 is constituted by, for example, a microcomputer and including a clock 221 for transmitting clock signal K having a predetermined frequency, a counter 222 that counts the time in

accordance with the clock signal K to transmit count signal N denoting the counted time, and a processing portion 223 for performing a predetermined process in accordance with the count signal N.

5 The processing portion 223 reads out predetermined reference time T stored in a memory 224 to subject the reference time T and the count signal N to a comparison. If the time denoted by the count signal N is longer than the reference time T, the processing portion transmits stop signal V for stopping the water supply operation to the water supply control portion composed of the control board 50 and the control portion 160 and so forth adapted to the automatic ice making apparatus
10 according to the first embodiment or the fifth embodiment. Further, the processing portion transmits reset signal R to the counter 222. The processing portion 223 is connected to a door opening/closing sensor 230 attached adjacent to a door 7 of the refrigerator 1.

The door opening/closing sensor 230 detects opening/closing of the door
15 7 to transmit detection signal P denoting that the door 7 is opened or closed to the processing portion. When the processing portion 223 has received the detection signal P, it transmits water supply operation signal W for causing the water supply operation to be performed to the water supply control portion. Then, the processing portion 223 transmits stop signal S1 for turning off the door
20 opening/closing discrimination unit 220 and the power source 214, the processing portion 223 further transmitting a deactivating signal S2 for lighting off the indication lamp 212.

Then, the operation of the thus-constituted water supply detection unit will now be described.

If the user has unintentionally set the water supply tank in an empty state, the operation for supplying water to the ice making tray 210 will not raise the ambient temperature.

In the foregoing state, the temperature sensor 211 therefore transmits the operation signal E to the indication lamp 212 and the switch 213 to light on the indication lamp 212 and to switch on the switch 213 so that the door opening/closing discrimination unit 220 is operated.

As a result, the clock 221 of the door opening/closing discrimination unit 220 commences to transmit the clock signals K to the counter 222, and therefore the counter 222 transmits, to the processing portion 223, the count signal N calculated in accordance with the clock signals K and denoting the time.

As a result, the processing portion 223 reads the reference time T from the memory 224 to subject the reference time T and the time denoted by the count signal N to a comparison. If the time denoted by the count signal N is longer than the reference time T, that is, if the reference time T has passed after the activation of the door opening/closing discrimination unit 220, a discrimination is made that water has not been supplied to the water supply tank. Therefore, the processing portion 223 transmits the stop signal V to the water supply control portion to stop the water supply operation. Simultaneously with the foregoing process, the processing portion 223 transmits the reset signal to the counter 222 to cause the counter 222 to again count the time. The processing portion 223 repeats the foregoing process at intervals of the reference time T.

If the door 7 has been opened/closed within the reference time T as shown in Fig. 41, the door opening/closing sensor 230, that has detected opening/closing

of the door 7, supplies the detection signal P to the processing portion 223. As a result, the processing portion 223 transmits the water supply operation signal W to the water supply control portion to cause the portion to perform the water supply operation. Then, the processing portion 223 transmits the stop signal S1 and the
5 deactivating signal S2 to the switch 213 and the indication lamp 212 to turn off the door opening/closing discrimination unit 220 and the power source 214 and also light off the indication lamp 212.

As described above, the automatic ice making apparatus having the foregoing water supply detection unit permits the water supply operation only when
10 the water supply tank filled with water is set even if the empty water supply tank has been set. Therefore, a problem that no ice can be made due to setting of the empty water supply tank can be prevented. Further, the water supply detection unit can be constituted by using an electric and simple-structure microcomputer. As a result, the tank setting detection unit having a mechanical and complicated
15 structure arranged as shown in Fig. 46 can be omitted.

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What is claimed is:

1. An automatic ice making apparatus comprising:

a water supply tank including a quantitative chamber with an inlet port and an outlet port, and a valve unit having an inlet valve for opening/closing said inlet port and an outlet valve for opening/closing said outlet port, said valve unit being operable to drive said outlet valve and said inlet valve to close said outlet port and open said inlet port when water

is introduced from said water supply tank into said quantitative chamber, said valve unit being operable to drive said outlet valve and said inlet valve to open said outlet port and close said inlet port when water is discharged from said quantitative chamber;

a receiving tray;

a drive unit for operating said valve unit through an operation shaft to supply water in said quantitative chamber to said receiving tray through said outlet port in said quantitative chamber;

an ice making tray; and

a water supply pump for supplying water in said receiving tray to an ice making tray.

2. An automatic ice making apparatus according to claim 1 further comprising:

a drain passage formed in a bottom of said receiving tray;

a drain valve for opening/closing said drain passage; and

a control unit for controlling the opening/closing operation of said drain



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valve.

3. An automatic ice making apparatus according to claim 1 or 2, wherein said drive unit and said water supply pump are formed integral with each other.

4. An automatic ice making apparatus according to claim 3, wherein said
5 integral drive unit and said water supply pump comprises:

a motor with a rotation shaft;

a forward operation mechanism connected to the rotation shaft of said motor for causing said operation shaft to act on said valve unit when said motor rotates in a forward direction; and

10 a reverse operation mechanism connected to said rotation shaft of said motor for causing said motor to act as a pump when said motor rotates in a reverse direction.

5. An automatic ice making apparatus according to any one of claims 1 to 4, wherein said water supply tank is removable and can be set at a prescribed
15 position, said apparatus further comprising:

a display portion adapted to be lit on or off; and

a tank setting detection unit being operable to stop the operation of said drive unit to light said display portion on after a predetermined length of time has elapsed from the setting of said water supply tank, said tank setting detection unit
20 being further operable to light said display portion off when said tank has been removed.



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6. An automatic ice making apparatus comprising:

a water supply tank having an outlet port, a draft gauging pipe projecting therefrom so as to surround said outlet port, and a valve unit capable of opening/closing said outlet port;

5 a drive unit for operating said valve unit by way of an operation shaft to allow water in said water supply tank to flow out through said outlet port;

an ice making tray;

a receiving tray for receiving water which has flowed out of said water supply tank, said receiving tray having an internal volume equal to the full volume

10 of said ice making tray when the surface of water in said receiving tray has reached a leading end of said draft gauging pipe; and

a water supply pump for supplying water in said receiving tray to said ice making tray.

7. An automatic ice making apparatus according to claim 6 further comprising

15 a cap made of elastic material and attached to said operation shaft for fluid-tightly sealing said drive unit.

8. An automatic ice making apparatus according to claim 6 or 7, wherein said drive unit has an air venting member for venting air in said cap.

9. An automatic ice making apparatus according to any one of claims 6 to 8

20 further comprising a mesh filter disposed adjacent to a bottom portion of said receiving tray.



10. An automatic ice making apparatus according to any one of claims 6 to 9,
further comprising:

a suction hose having a basal end thereof attached to a suction side of
said water supply pump and a leading end disposed in said receiving tray; and

5 an extruding hose having a basal end attached to a drain side of said
water supply pump and a leading end extending to said ice making tray;

wherein said water supply pump being disposed higher than said receiving
tray.

11. An automatic ice making apparatus according to claim 10, wherein a
10 recess is formed in the deepest portion of said receiving tray with the leading end
of said suction hose disposed in and secured to said recess.

12. An automatic ice making apparatus according to claim 10 or 11, wherein
said water supply pump is a self-containing type pump having a motor with a
rotation shaft and a pair of gear screws connected to the rotation shaft of said
15 motor in such a manner that said pair of gear screws are engaged with each other
to force water in said suction hose into said extruding hose.

13. An automatic ice making apparatus according to claim 12, wherein said
water supply pump is accommodated in a vibration preventive member.

14. An automatic ice making apparatus according to any one of claims 10 to
20 13, wherein said extruding hose comprises:



a first extruding hose having one end thereof connected to the drain side of said water supply pump, and the other end thereof connected to a connection pipe attached to an intermediate partition wall which partitions said ice making tray from said water supply tank, said drive mechanism, said receiving tray and said
5 water supply pump; and

a second extruding hose having one end thereof disposed in said ice making tray and the other end thereof fitted into said connection pipe through a hermetic sealing member.

15. An automatic ice making apparatus according to any one of claims 10,
10 wherein said extruding hose has, at the leading end thereof, a splash preventive member for preventing splash of discharged water to the outside of said ice making tray.

16. An automatic ice making apparatus according to any one of claims 10,
wherein said extruding hose includes a flow-regulating portion that regulates the
15 flow of water to prevent water splash.

17. An automatic ice making apparatus according to any one of claims 6 to 16 further comprising a control portion for controlling said drive unit in such a manner that said drive unit is operated for a period of time longer than the time taken for said water surface in said receiving tray to reach the leading end of said draft
20 gauging pipe, said control portion being thereafter operable to stop said drive unit to thereby terminate the discharge of water from said water supply tank and



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actuate said water supply pump.

18. An automatic ice making apparatus according to any one of claims 6 to 17,
wherein said water supply pump is operated for a predetermined time when said
control portion is reset or when a door of the refrigerator is opened to depress a
5 test switch.

19. An automatic ice making apparatus comprising:
a water supply detection unit for detecting whether or not water supply is
made to an ice making tray;
a water supply control portion for controlling the water supply to said ice
10 making tray; and
a door opening/closing discrimination unit adapted to be operated, when
said water supply detection unit detects that no water has been supplied to said ice
making tray, to determine at predetermined intervals whether or not a door of a
refrigerator has been opened/closed, said water supply detection unit being further
15 operable to transmit to said water supply control portion a water supply operation
signal for causing water to be supplied to said ice making tray if it is determined
that said door has been opened/closed, and a stop signal for stopping said water
supply operation if it is determined that said door has not been opened/closed.

20. An automatic ice making apparatus comprising:
20 a water supply tank having an outlet port, a draft gauging pipe arranged to
surround said outlet port, and a valve unit capable of opening/closing said outlet



port;

an ice making tray;

a receiving tray having an internal volume equal to the full volume of said ice making tray when the surface of water reserved in said receiving tray has
5 reached a leading portion of said draft gauging pipe, said receiving tray having a bottom portion to which is connected a water supply pipe extending to said ice making tray; and

a drive unit having an operation shaft for operating said valve unit to cause water in said water supply tank to flow into said receiving tray through said outlet
10 port, and a valve which is operated in reverse relation to the operation of said valve unit to open/close said water supply pipe.

21. A water supply tank for use with an automatic ice making apparatus, said water supply tank comprising:

a transparent case for reserving water; and
15 a cover fluid-tightly joined to said case.

22. A water supply tank for use with an automatic ice making apparatus, said water supply tank comprising:

a case with a transparent portion for reserving water; and
a cover fluid-tightly joined to said case.



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23. Automatic ice making apparatus substantially as herein described with reference to figures 1 to 6, figure 7, figure 8, figures 9 to 11, figures 12 to 15, figures 16 to 18, figures 19 and 20, figures 21 to 33, figure 34, figure 35, figure 36 and 37, figures 38 and 39, or figures 40 and 41 of the accompanying drawings.



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