

Oct. 27, 1953

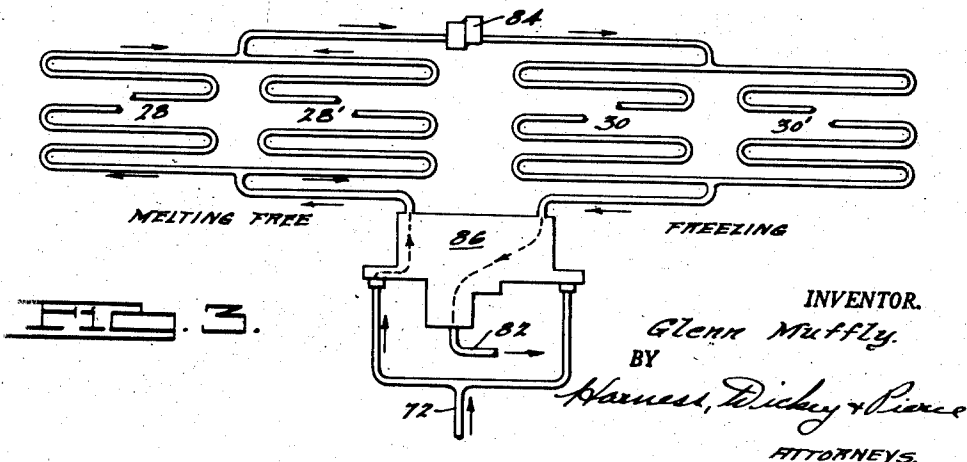
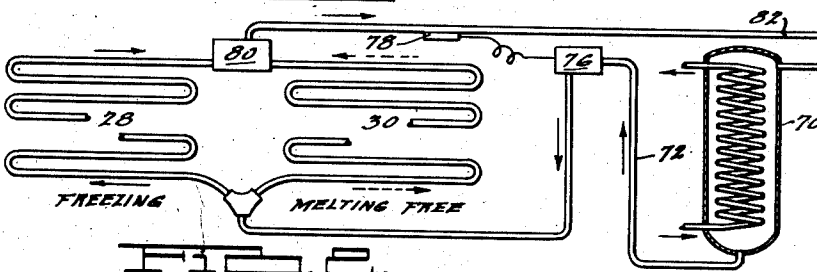
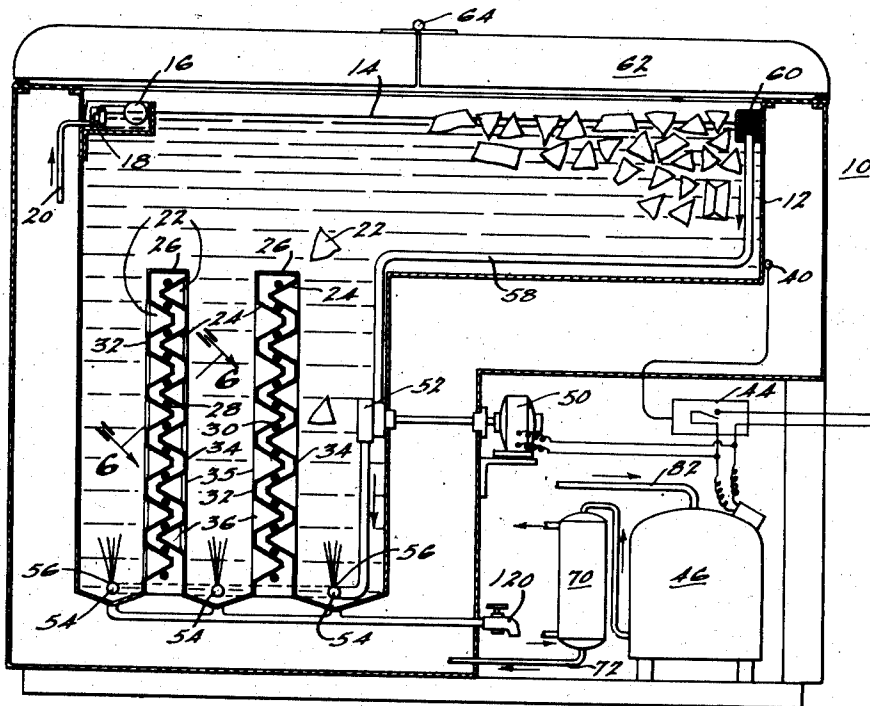
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2,656,689

METHOD OF AND APPARATUS FOR AUTOMATIC ICE-MAKING

Filed June 15, 1948

2 Sheets-Sheet 1



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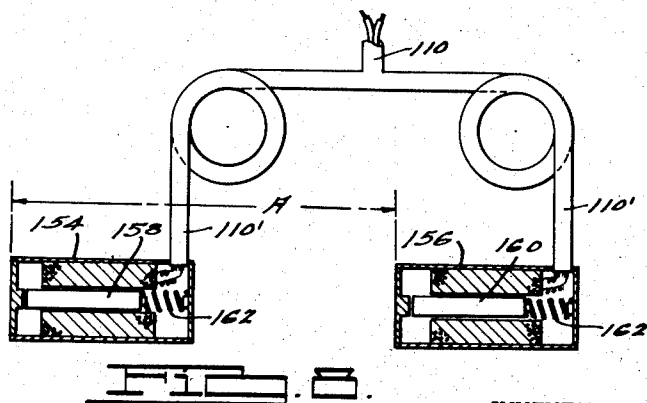
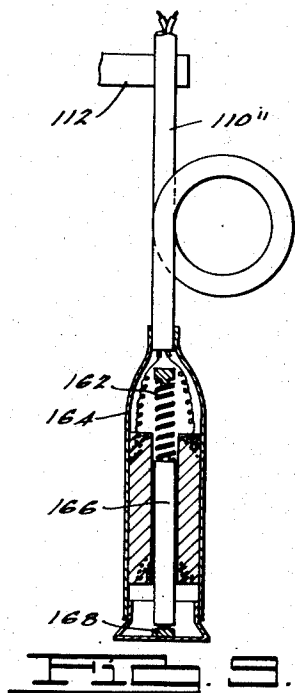
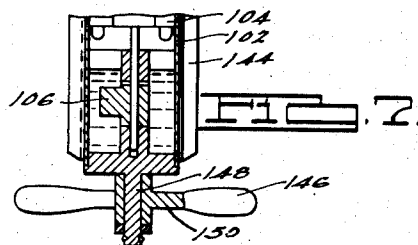
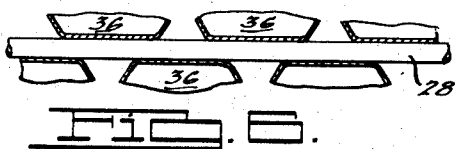
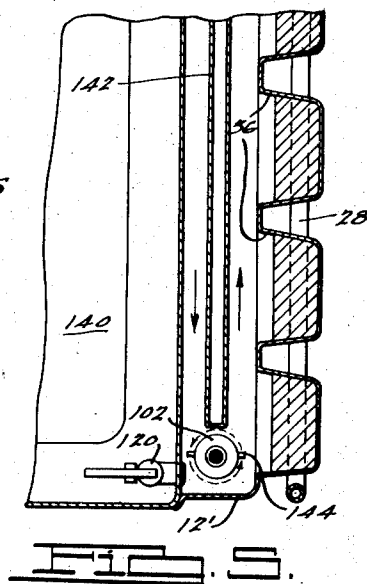
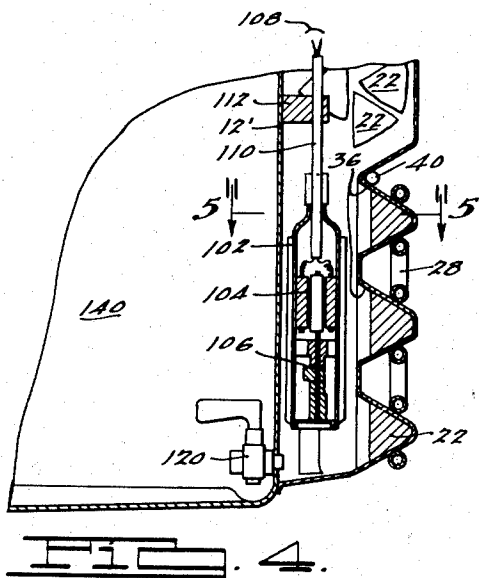
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2,656,689

METHOD OF AND APPARATUS FOR AUTOMATIC ICE-MAKING

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,656,689

METHOD OF AND APPARATUS FOR
AUTOMATIC ICE-MAKING

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Application June 15, 1948, Serial No. 33,179

14 Claims. (Cl. 62—106)

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This invention relates to automatic ice making equipment and methods of the general type disclosed in my previously issued U. S. Patents Nos. 2,145,773, 2,145,774, 2,145,775, 2,145,777 and 2,359,780 and in my pending U. S. applications Nos. 621,241, now Patent No. 2,497,903, dated February 21, 1950, 533,778, now Patent No. 2,496,304, dated February 7, 1950, 569,132, now Patent No. 2,572,508, dated October 23, 1951, and 771,181, to some of which specific references are made herein.

An object of this invention is to provide a type of automatic ice maker in which clear ice is made and a considerable quantity of ice stored.

Another object is to provide improved agitating means for causing the water in the ice maker tank to flow over the surfaces of newly formed ice, thus washing air bubbles from these surfaces and producing clearer ice.

A further object is to produce a greater volume of ice on a given area of wall surface or in a given amount of space.

A still further object is to cool a greater area of ice making surface with a given length of evaporator conduit.

Figure 1 is a vertical sectional view of a commercial type of ice maker arranged to store a considerable quantity of ice in flotation.

Figure 2 is a diagrammatic representation of a refrigerating system adapted for use in Figure 1.

Figure 3 is a modification of Figure 2 showing an alternative method of connecting the two evaporators of Figure 1 with the same condensing unit.

Figure 4 is a fractional view of a modification showing a different agitating device.

Figure 5 is a plan view partly in section taken on the line 5—5 of Figure 4.

Figure 6 is an enlarged sectional view taken on the line 6—6 of Figure 1.

Figure 7 is an enlarged detail showing a modification of the agitating device of Figure 4.

Figure 8 is a further modification showing a pair of solenoid type motors for producing compressional waves in the water.

Figure 9 is another modification of the solenoid type of agitating motor.

Figure 1 shows a cabinet 10 having insulated walls enclosing an L-shaped tank 12 which is filled with water to the level 14 under control of the float 16 which is arranged to open the valve 18 when the water level drops, thus admitting water from the tube 20 which is connected with a source of water supply. The upper portion of this tank, including the horizontally extend-

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ing L, is of proportions to store a considerable quantity of water and floating pieces of ice 22. The ice as illustrated is in the form of short triangular bars which are frozen in the V-shaped recesses or molds 24 of which a considerable number are located on each side of each of the upwardly extending evaporator units 26 of which two are shown in the downwardly extending L of the tank 12.

There are two evaporator coils 28 and 30 each one being secured between a pair of embossed or corrugated sheets of metal 32 and 34. In the event that these sheets are corrugated as might be done on a brake, it is planned to place a number of tapered dividing walls 35 in each of the exposed troughs so that the troughs formed by the corrugations are divided longitudinally into several shorter ice-making recesses or molds 36. Each pair of stamped or corrugated sheets is welded or soldered together with an evaporator coil between to form one of the ice making units 26. This ice making unit is welded or soldered to the sides and bottom of the tank 12 so that no water can reach the space in which the evaporator coil is located. This coil is, therefore, outside of the tank though extending upwardly into the sealed ice making unit.

It will be noted that a given section of the evaporator tube contacts two of the ice making pockets or molds 36, thus utilizing the evaporator tubing to the best possible advantage. A small machine may have only one of the ice making units 26 and be equipped with a condensing unit which remains idle while ice melts free to float in the tank 12, but a larger machine will have two or more of these ice making units, preferably an even number so arranged that half of them are refrigerated at a time while ice is melting free from the other half. This allows the condensing unit to operate continuously until a sufficient bank of ice has been built up, whereupon the accumulation of ice in the tank will extend downwardly to a level opposite the control bulb 40. This control bulb is associated with the thermostatic switch 44 which is arranged to stop and start the motor-compressor 46 of the condensing unit assembly. While ice is being formed the water in the lower portion of tank 12 adjacent the faces of the ice making units 26 is agitated for the purpose of washing air bubbles from the surfaces of the ice in process of forming. One method of accomplishing this is illustrated in Figure 1 where the motor 50 drives the pump 52 to deliver water to the several tubes 54 which are horizontally located near each of the faces

of the ice making units and provided with several holes 56 arranged to direct jets of water upwardly, thus promoting circulation of water over the ice surfaces. The pump 52 draws water through the tube 58 and the screen 60 thus producing a gradual circulation of water within the tank 12. The direction of this circulation is such that ice having floated upwardly after release will float toward the right-hand end of the horizontal leg of the tank. Thus the last part of the upper portion of the tank to be filled with floating ice will be that portion directly above the ice making units, allowing clear space for more ice to be stored in flotation. When the upper portion of the tank is sufficiently filled with floating ice down to the level of the bulb 40 the condensing unit will cease operation and since the pump motor 50 is connected in parallel with the motor-compressor unit 46 the pump 52 will also be stopped.

The cabinet 10 is provided with a top door 62 hinged at 64 to provide access to that portion of the tank 12 in which the major part of the floating ice is stored. If desired each end of the cabinet top may be fitted with a door or the entire top of the cabinet made removable.

Figure 2 shows diagrammatically the refrigerant tubing connections of Figure 1 with the condenser 70 shown in section. It is immaterial whether an air cooled or water cooled condenser is used, but a water cooled condenser is here shown as water supply will usually be available where this equipment is used and sometimes the apparatus will be located in a confined space where air circulation is restricted. If water connection is not available an air cooled condenser may be used and the tank manually supplied with water after removal of a considerable quantity of ice. The two evaporators 28 and 30 are connected in parallel as shown in Figure 2. The liquid line 72 leads to an ordinary expansion valve 76, which may be of the thermostatic type as indicated by the bulb 78.

The outlets of the two evaporators are connected to a valve mechanism 80 which acts to open the outlet of one evaporator at a time to the suction tube 82. Valve mechanisms suitable for this use are described in detail in several of my issued patents, particularly Numbers 2,145,773, 2,145,774, 2,145,775, 2,145,777 and 2,359,780. For example the valve mechanism shown by Figures 9, 10 and 11 of the last mentioned patent is well adapted for use in this case. The action of this valve is to open one of the evaporators at a time to the suction line, allowing it to remain open for a period measured by the volume of refrigerant vapor flow. After a volume of vapor sufficient to match the refrigerating effect required to freeze a batch of ice on the surfaces associated with evaporator 28 or the lapse of a period of time sufficient to freeze such a batch of ice, the valve mechanism snaps to the position in which evaporator 30 is open to the suction line 82 and evaporator 28 is closed at its outlet. At this time refrigeration starts in evaporator 30 and substantially stops in evaporator 28. While the idle evaporator is still subject to the same pressure as the active evaporator, it has no outlet for vapor and such vapor as forms in it merely pushes liquid out at the bottom to enter the active evaporator. For a period after the switch from one evaporator to the other, the newly active evaporator will be fed to a large extent by liquid forced out of the evaporator which is becoming inactive. It will be understood that there may

be two or more evaporators 28 and two or more evaporators 30 if there are four or more ice making units connected with one condensing unit.

Such connection of evaporators in parallel is illustrated in Figure 3 where the evaporators 28 and 28' operate at one time while evaporators 30 and 30' operate at another time. Evaporators 28' and 30' could be connected in Figure 2 in the same manner, i. e. 28 and 28' in parallel and 30 and 30' in parallel, though the two banks of evaporators shown in Figure 3 are connected in series while the two banks of Figure 2 would still be connected in parallel.

The arrangement shown by Figure 3 makes use of valves which are shown in detail in my Patent No. 2,145,774 which issued January 31, 1939. The expansion valve assembly 84 of Figure 3 is seen in Figures 1 and 2 of the issued patent where it is identified by the numeral 36. The valve assembly 86 of Figure 3 may be as shown in Figure 6 or Figure 28 of this same patent or it may be as shown in the lower portion of Figure 1. Any one of these valves will act to reverse the flow of refrigerant with respect to the evaporators while the expansion valve 84 acts for either direction of flow.

As explained in the issued Patent 2,145,774, this causes the evaporator which has just completed making a batch of ice to be filled with warm, high pressure refrigerant liquid. This hastens the freeing of ice from the surfaces previously cooled by the evaporator which is now idle and provides cooled refrigerant liquid at the inlet to the expansion valve so that less flash gas is formed in the evaporator now active. Other of my issued patents show further modifications of valve devices suitable for use as number 80 in Figure 2 or 36 in Figure 3. The Fig. 3 hook-up is of a type generally referred to as a "reverse cycle" system and used for alternately heating and cooling the same space in air conditioning systems. Some of the valve devices disclosed by others in that connection could also be used in this ice making system.

Ordinarily it is not necessary to use hot refrigerant to release ice in an ice making system of this type since the warmer water is more dense than the 32° water in the upper portion of the tank and therefore settles to the bottom and aids in bringing the ice up to 32° so that it will free itself and float. There would be an actual disadvantage in too rapidly heating the surfaces upon which ice has been formed as this might cause the ice to release and float while its core is still subcooled. This might cause the separate pieces of ice to freeze together after they have floated free. I prefer to warm the ice up gradually to a uniform 32° before allowing it to float, as this insures against any future subcooling of ice surfaces which might cause the separate pieces of ice to freeze together.

There is, however, a particular reason for using the arrangement of Figure 3 in the cabinet and evaporator arrangement of Figure 1. This is twofold: First the evaporators of Figure 1 are so protected by insulation that they receive no heat directly from air; and secondly, the water circulating system of Figure 1 reduces the stratification normally caused by the reverse thermal expansion of water. I would, therefore, prefer to use the hook-up shown by Figure 3 in connection with Figure 1 but might prefer to use the hook-up of Figure 2 in Figure 1 if an air pump were substituted for the water pump 52 and the tube 58 lengthened so as to provide an air intake

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above the water level 14 in the tank 12. The pumping of air through the jets 56 will serve the same purpose of agitating the water to make clear ice, but causes less disturbance in the natural stratification which allows warmer water to remain in the bottom of the tank.

Another method of agitating the water without circulating it through the ice is shown in Figure 4. This illustrates a modified agitating device which is adaptable for use in Figure 1 in place of the water jets. Figure 4 is a vertical section through the lower portion of a water tank where an evaporator coil 28 cools the troughs or molds 24 as seen in Figure 1, with floating ice stored at a higher level in the same body of water. Water adjacent the ice making surfaces is agitated by vibration of the sealed casing 102 which encloses a small motor 104 having an out-of-balance weight 106 associated with its rotating element.

Electric wires 108 lead through the tube 110 to the motor 104. In the event that the motor 104 is fluid-operated a small fluid pressure tube may pass through the outer tube 110 in place of the electrical conductors, with exhaust fluid flowing through the annular space between the two tubes. The tube 110 extends downwardly within the casing 102 to form an oil trap which prevents lubricating oil from escaping through the tube 110 in the event that the complete assembly is turned up-side-down during handling or shipment. In normal position of the apparatus the lubricant is confined within the bottom portion of the casing 102. The bearing or bearings of motor 104 are preferably confined to the lower extension of its shaft so that they may be immersed in the oil while the rotor of the motor is above the oil level. The conduit 110 provides the sole support of casing 102 and is flexible enough to allow the casing to gyrate somewhat in response to rotation of the out-of-balance weight on the rotor. It is this gyration of the casing 102 which agitates the water, there being no shaft extension of the motor 104 through the casing 102. The bracket or support 112 located some distance above the casing 102 holds the tube 110 in place and limits the gyrations of the casing.

A drain cock 120 as seen in Figure 4 is provided for the purpose of occasionally flushing sediment from the bottom of the water tank. This is equivalent to the manifold connected with the valve 120 in Figure 1. Due to the fact that only a part of the water is frozen within the tank, there is an effect during each freezing portion of the cycle causing impurities to be frozen out of the ice and concentrated at the bottom of the tank. This is a desirable feature in producing ice of a higher degree of purity than that of the water supplied to the tank, but in order to obtain the full benefit of this effect it is necessary at times to drain the water from the lower portion of the tank where minerals or other impurities collect.

In Figure 4 I have shown only one evaporator coil and only one wall provided with ice-forming pockets 36. As explained in connection with Figure 1, these pockets may be formed by placing dividers in a channel or by pressing individual pockets in the sheet of metal. Figure 4 is intended to illustrate the latter construction and the section 5—5 thereof as seen in Figure 5 illustrates this more clearly. It will be understood that the separate pockets such as 36 of Figures 5 and 6 may be employed in Figure 1. In that case the two sheets 32 and 34 may be formed with the same die but so assembled that the

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pockets in one sheet are offset horizontally with relation to the pockets in the other sheet thus utilizing the heat exchange surface of the evaporator tube to better advantage, as indicated in Figure 6.

Figures 4 and 5 show the water tank 12' exposed on one side to the dry storage space 140 which is cooled by the tank wall. This arrangement may be used to provide a dry storage space in the cabinet shown in Figure 1 or this construction may be used where the main object is to cool an air-filled space and the ice making feature is incidental as in a household refrigerator.

In order that the gyrations of the casing 102 may circulate water throughout the lower portion of the tank 12' rather than merely agitating the water locally, a baffle 142 may be employed. This baffle is preferably formed by two sheets of metal with dry air sealed between them and so located that released ice pieces have ample clearance to float upward. If desired the casing 102 may be provided with external vanes 144 to augment its effect in circulating or agitating the water.

Figure 6 is an enlarged sectional view showing the relationship of pockets 36 to evaporator tube 28 in Figure 1. This same relationship exists in Figures 4 and 5, except that the tube 28 is soldered or welded to only one sheet with pockets 36 on one side of the tube only.

Figure 7 illustrates a form of propeller or water agitator 146 mounted for free rotation on a fixed stud 148. This propeller has no mechanical connection with the motor 104 but is rotated by the gyrations of the casing 102 because the propeller itself is eccentrically mounted or provided with an out-of-balance weight as indicated at 150. The casing 102 may be mounted either vertically or horizontally depending upon the shape of the tank and disposal of the ice making surfaces. It may be desired to circulate the water vertically as in Figure 1 or to circulate it horizontally as in Figures 4 and 5. It will be seen that the propeller arrangement of Figure 7 could be used with a vertical axis in each of the three downwardly extending water spaces of Figure 1. The direction of rotation and pitch of the propeller 146 can be arranged to cause water flow in either direction. Assuming that water is caused to flow upwardly at one side of one of the tank sections, it will flow downwardly at the other side (end) of the same section. If a propeller as driven in Figure 7 or otherwise is arranged to produce a general upward flow in the ice-making sections of the tank in Figure 1, water may be returned through a tubular connection such as 58 without the aid of the pump 52.

The arrangement of the pump 52 and motor 50 in Figure 1, with the pump exposed inside of the water tank and the motor exposed inside of the condensing unit compartment is designed to require the minimum number of openings to be gasketed or provided with running seals and yet keep the motor outside of the refrigerated space. By using the arrangement of Figure 4 or 7 in Figure 1 all gaskets and running seals are eliminated. It is true that waste heat from the motor 104 goes into the water from which ice is to be formed, but the input to such a motor can be very small and yet produce sufficient vibration to cause the ice to be quite clear.

Figure 8 shows two solenoid type vibrating motors 154 and 156 having armatures 158 and 160 respectively. These motors are supported by looped branch conduits 110' of the main conduit 110. If the motors are identical so that the

armatures strike their left hand stops simultaneously the distance A between corresponding heads is preferably a multiple of the wave length produced in the water so that the vibrations of the left-hand motor 154 synchronize with waves produced by the right-hand motor 155, thereby augmenting such waves and inducing flow of water in one direction. This direction may be horizontal, as suggested by the solenoid arrangement in Figure 8, or may be vertical if required by the arrangement of ice-making surfaces. If armatures strike their left stops alternately the distance A is one half wave length plus a multiple of the wave length.

Figure 9 illustrates a modification which may be applied to Figure 8 or employed with a single vibrating motor. It will be noted that the casing 164 of Figure 9 is formed with one rounded end and one larger end presenting a substantially flat surface to the water. This casing is supported by the conduit 110'' which is similar to 110 except for being looped to provide flexibility. When the armature 166 is attracted by the flow of current it compresses the spring 162 against the rounded end of the casing 164 which produces little or no effect upon the water, but when the armature 166 strikes the anvil 168 on the larger flat end of the casing 164 it produces a compressional wave which is propagated through the water in that direction. One or more of the assemblies shown in Figure 9 will be so located within the ice-making tank that the compressional waves produced in the water reach all of the ice making surfaces, producing sufficient agitation to result in the formation of clear ice.

The motors 104 of Figures 4 and 7 or of Figures 8 and 9 will be amply cooled by their immersion in the water which is at a temperature between 32° and 40°. The small amount of heat dissipated to the water or produced in it by agitation is negligible with respect to the amount of heat removed by the evaporator coil. Such slight heating of the water as does occur is confined to the water in the lower portion of the tank, below the floating ice, because water in the temperature range between 32° and 40° is more dense than the 32° water in the upper portion of the tank where the pieces of ice are floating.

I claim:

1. In an ice-maker, a water container, means arranged for freezing less than the whole of the water in said container, agitating means comprising a sealed water-tight casing, a flexible tube connected with said casing for transmission of energy thereto, and a motor within said casing including means for producing vibrations which cause movement of said casing to agitate said water for the purpose of causing ice to be frozen in clear form.

2. In an ice-maker of the flotation type, a tank arranged to contain a body of water, means forming a surface immersed by said water, means for intermittently refrigerating said surface to cause ice to be periodically formed thereon and released therefrom, and means for agitating said water to cause it to flow over the surface of said ice during ice formation, the last said means comprising a water-tight wall contacted by said water and a motor separated from said water by said wall for causing movement of the wall.

3. In an ice-making system, a container for water, means for freezing a portion of said water, and a stirrer adapted to cause movement within said water, said stirrer comprising a water tight

wall adapted to move said water and a motor sealed from said water by said wall.

4. In an ice-making system, means for retaining a body of water, an air-tight casing in said retaining means and positioned to be below the level of the water, a water agitating device mounted on said casing with freedom of movement relative thereto, and motor means enclosed by said casing, said motor means being arranged to cause gyrations of said casing and thereby to move said agitating device.

5. In an ice-making system, an L-shaped tank adapted to contain water, refrigerating means associated with a downwardly extending leg of said tank, means forming a plurality of surfaces on which ice is frozen by the action of said refrigerating means, and agitating means for causing said ice to be frozen in clear form, said agitating means also serving to aid in causing ice upon melting free from said surfaces to float upwardly into the upper portion of said tank and a horizontally extending leg thereof.

6. In an ice-making apparatus, a container for water, means comprising a refrigerated surface upon which a part only of said water is frozen to form ice, cyclically actuated means for releasing said ice from said surface, and a vibration-producing device including a sealed wall contacting said water and protecting the balance of the device from contact with the water, said sealed wall having an extension on its side exposed to the water for the purpose of augmenting the agitation of said water.

7. In a refrigerator, an ice-making system having ice-making surfaces, means for causing ice to be frozen on and released from said surfaces, a tank for storing water to be frozen by said system, a liner within said refrigerator enclosing an air-filled storage space, a wall portion of said tank forming part of the liner of said air-filled space, and water agitating means for washing air bubbles from the surfaces of said ice, said agitating means also being effective to agitate the water in contact with said wall portion and thereby facilitate heat transfer from said air-filled space to the water in said tank.

8. In an ice-making system, a tank containing water, means for causing a part only of said water to be frozen at one time, a water-tight container immersed by said water, motor means within said container adapted to cause gyrations of a wall of said container exposed to the water, and an out-of-balance revolvable element mounted on the water side of said wall, said element being rotatably responsive to said gyrations and acting to circulate water over the surface of newly formed ice to wash air bubbles therefrom.

9. In an ice-making apparatus, means forming a wall area exposed to contact with water, a refrigerating system arranged to cool said area to form ice from a portion of said water, and agitating means comprising a sealed casing immersed by said water, said agitating means including means for transmitting energy to the interior of said casing.

10. In an ice-making apparatus, means for freezing water to simultaneously form separate masses of ice, and means for agitating said water during the process of freezing, said means comprising a sealed casing contacted by said water and means for applying energy to the interior of said casing.

11. The method of agitating a body of water to wash air bubbles from the surfaces of a plurality of pieces of ice during their process of freezing

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by transmitting energy to a zone below the surface level of the water and maintained sealed separate from it to produce motion within the water.

12. In an ice making system, a refrigerating system in which a fluid refrigerant is circulated through a conduit, a tank arranged to contain water and having a pair of spaced walls, one of said walls having spaced areas thereof cooled by heat transfer to said conduit to cause the formation of separate small pieces of ice on said areas, and mechanical means acting upon said water to cause movement thereof to wash air bubbles from the surfaces of the separate pieces of ice as they are being frozen on said spaced areas, said walls being closely spaced from each other for the purpose of directing water flow over all surfaces of the individual pieces of ice except those surfaces by which the ice is attached to said areas of the tank wall.

13. In an ice making system, a refrigerating system arranged to circulate a fluid refrigerant, a tank arranged to contain water and having a pair of spaced walls, one of said walls having spaced areas thereof cooled by heat transfer to said refrigerant to cause the formation of separate small pieces of ice thereon, and agitation means comprising an elongated water-tight casing for causing movement of water to wash air bubbles from the surfaces of such ice as is being frozen on said areas, said walls being closely spaced from each other for the purpose of confining water flow over said ice to the immediate vicinity of the ice.

14. In an ice making system, a refrigerating system arranged to circulate a fluid refrigerant, a tank arranged to contain water and having a

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pair of spaced walls, one of said walls having spaced areas thereof cooled by heat transfer to said refrigerant to cause the formation of separate small pieces of ice thereon, and agitation means comprising an elongated water-tight casing with an outwardly extending projection for causing movement of water to wash air bubbles from the surface of such ice as is being frozen on said areas, said walls being closely spaced from each other for the purpose of confining water flow over said ice to the immediate vicinity of the ice.

GLENN MUFFLY.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
529,194	Richter	Nov. 13, 1894
529,344	Church	Nov. 13, 1894
1,947,941	Jackson	Feb. 20, 1934
2,133,521	Wussow	Oct. 18, 1938
2,145,775	Muffly	Jan. 31, 1939
2,198,637	Smith	Apr. 30, 1940
2,221,212	Wussow	Nov. 12, 1940
2,221,847	Rodgers	Nov. 19, 1940
2,226,271	Vose	Dec. 24, 1940
2,385,539	Pownall	Sept. 25, 1945
2,435,034	Chisholm	Jan. 27, 1948
2,440,397	Erickson	Apr. 27, 1948
2,506,614	Ribeiro	May 9, 1950
2,536,217	Pownall	Jan. 2, 1951

FOREIGN PATENTS

Number	Country	Date
19,661	Great Britain	1908
926,857	France	Oct. 14, 1947