

July 1, 1941.

G. A. BRACE

2,247,903

REFRIGERATION

Filed Feb. 3, 1938

3 Sheets-Sheet 1

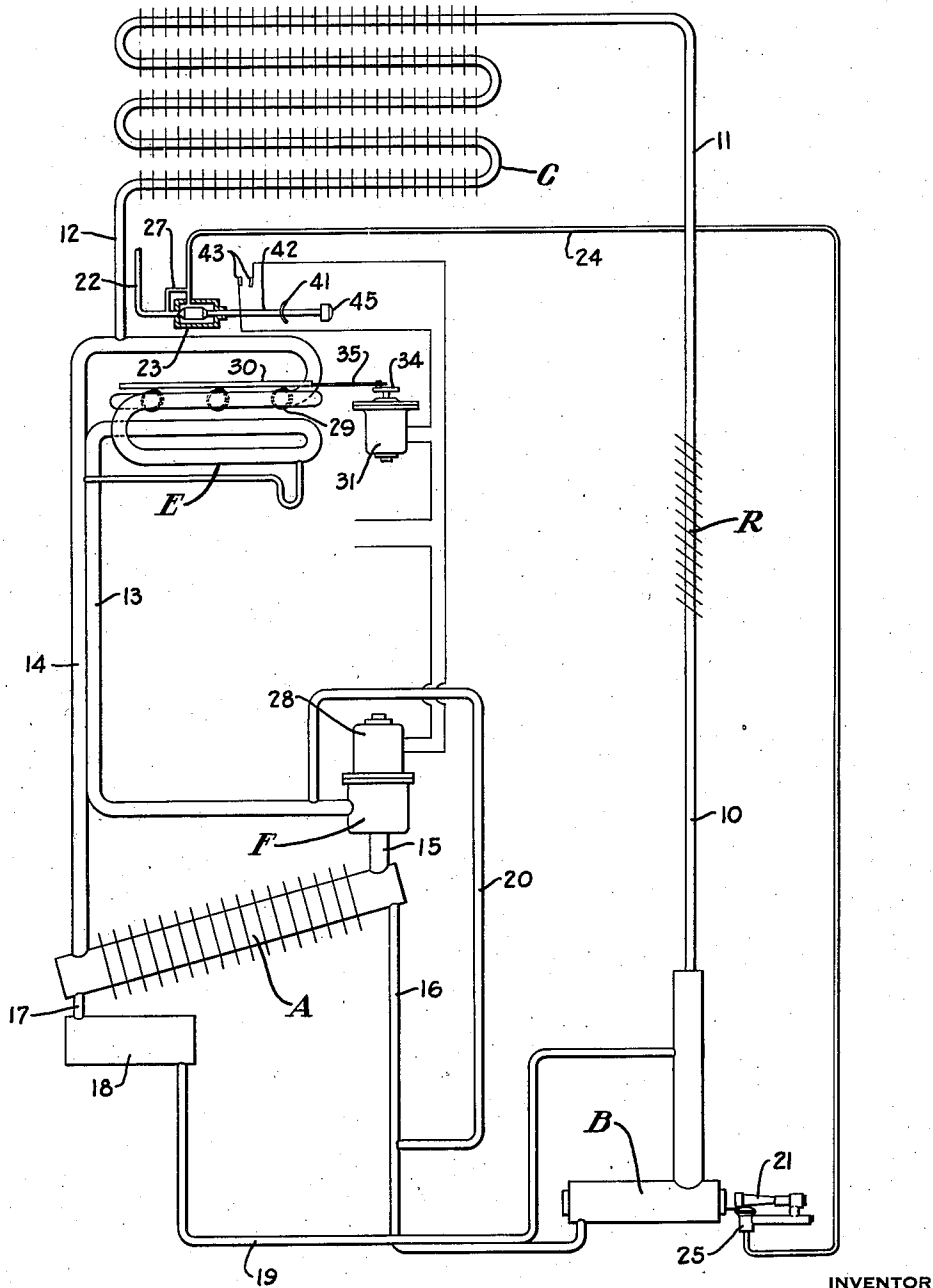


Fig. 1

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3 Sheets-Sheet 2

Fig. 2

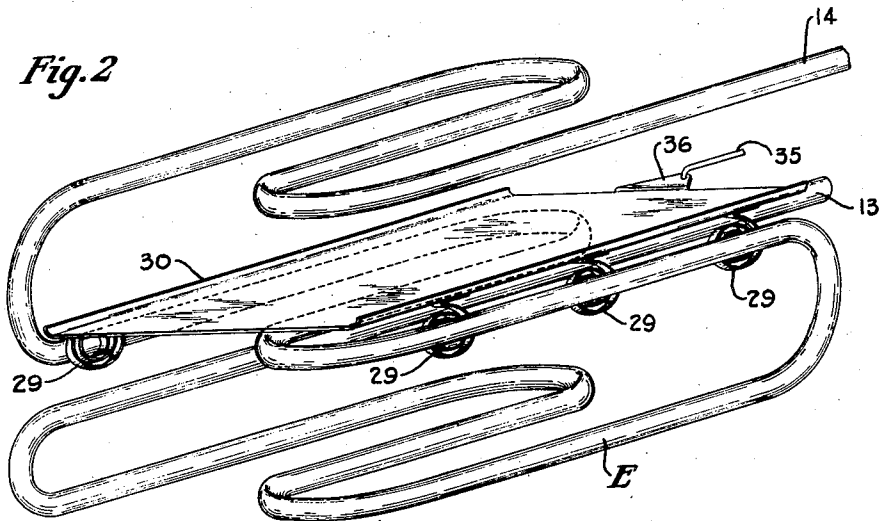
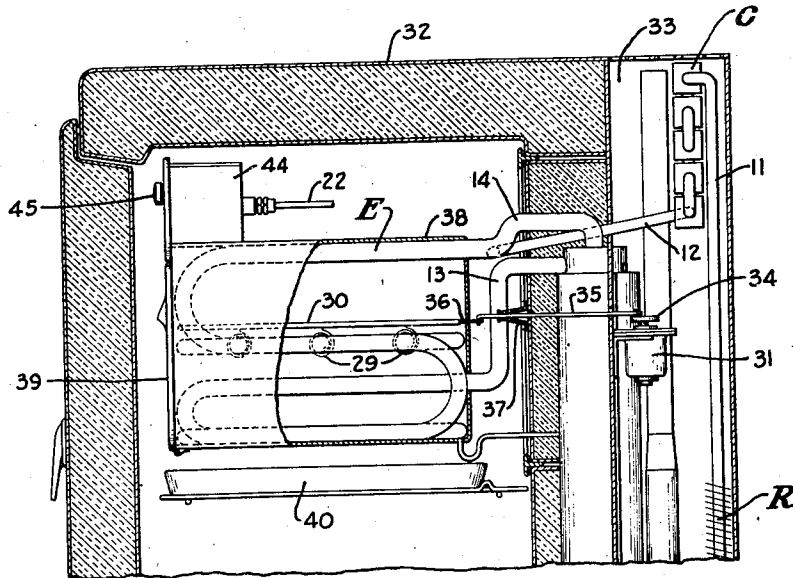


Fig. 3

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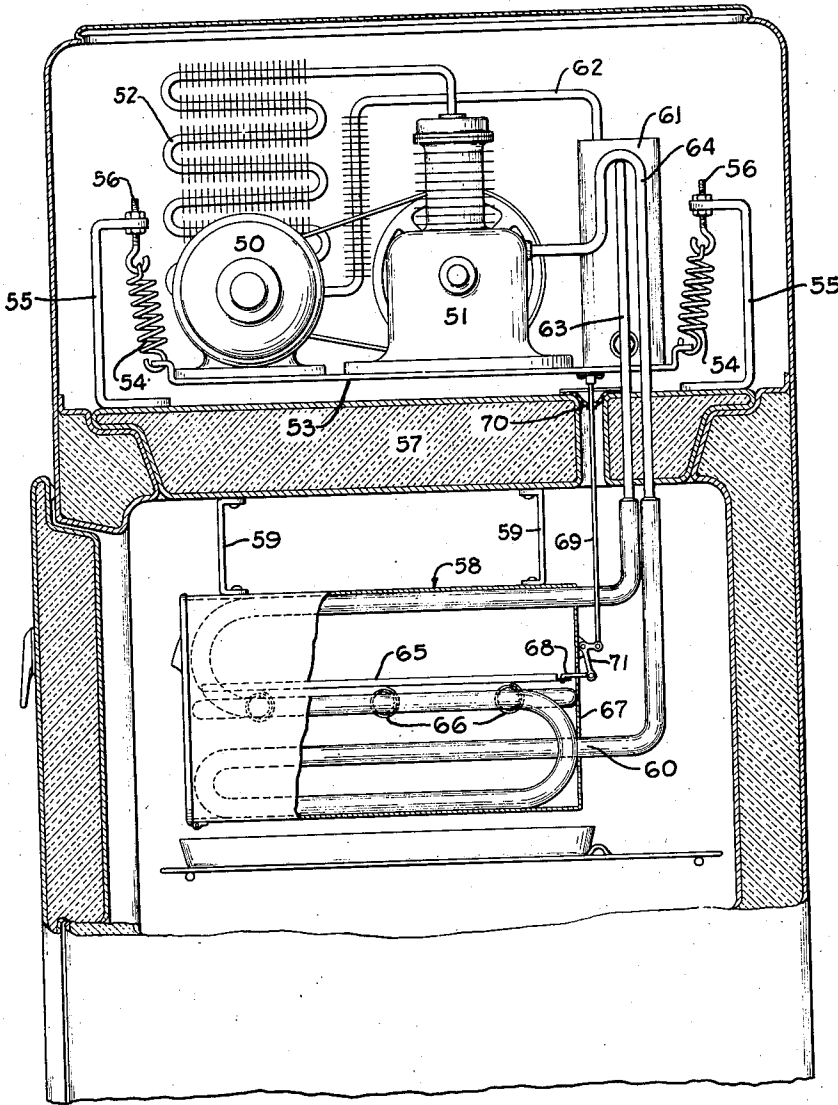


Fig. 4

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2,247,903

REFRIGERATION

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16 Claims. (Cl. 62—105)

This invention relates to mechanical refrigerators, and more particularly to novel apparatus and a new method of making ice and other congealables.

It has been customary, especially in refrigerators of the domestic and smaller commercial type, to produce a certain quantity of ice simultaneously with and as an aid to the cooling of a cold storage space. In addition, it is often desirable to congeal certain food stuffs requiring a lower temperature than that normally prevailing in the cold storage space proper. At such times it is advantageous to agitate the water or edible while it is congealing to improve the final product.

Conventional domestic refrigerating machines are provided with an evaporator which includes shelves upon which ice trays are mounted. These trays are provided with internal grids which divide the ice into separable cubes. However ice produced in this manner is cloudy and foggy in appearance. Not only is the ice cloudy and unsanitary in appearance, but it is also of poor quality because it melts more rapidly than clear ice. All of these undesirable characteristics are largely due to the separation of minute air bubbles from the water as it congeals. These fine bubbles adhere to the side walls of the forming ice and are eventually surrounded by solidifying water. Since most commercial ice now available is clear, housewives find it difficult to believe that the cloudy ice obtained from their refrigerators is suitable for home use. Their experience that cloudy ice melts more quickly than clear ice is amply substantiated by laboratory data. This is undoubtedly due to the additional surface area of the melting ice afforded by the air bubbles. Consequently there are both real and psychological reasons for making clear ice.

It is accordingly an object of my invention to provide a simple apparatus and method of making clear ice and congealing food stuffs in a refrigerator of the domestic type.

A further object of the invention is the production of clear ice in the conventional evaporator or sharp freezing apparatus with a minimum modification of this apparatus, and by means requiring a minimum of actuating energy. Moreover, according to one form of the invention, I propose to utilize waste energy entirely in the making of clear ice and superior frozen food products.

Another object of the invention is the provision of means for agitating water, or other liquids so long as heat is being abstracted there-

from, and for discontinuing such agitation after the liquid has congealed, or only so long as the refrigeration apparatus itself is in operation.

Still other objects and advantages of the invention will become apparent from the specification and drawings, wherein the numerals have been employed to designate like parts, and in which:

Figure 1 is a diagrammatic view of an absorption refrigeration apparatus in which one form of the invention is incorporated;

Figure 2 is a perspective view of an evaporator shelf resiliently supported on the coils forming the evaporator;

Figure 3 is a sectional view of a refrigerator cabinet showing the arrangement therein of parts of an absorption refrigeration system, and the mechanism for agitating an ice tray supporting shelf; and

Figure 4 is a view of another embodiment of the invention incorporated in a compression type mechanical refrigerator.

For purposes of illustrating and describing one embodiment of my invention, I have shown a continuous absorption refrigeration system in Figure 1. This apparatus comprises a boiler B, a rectifier R, a condenser C, an evaporator E, and inert gas circulating fan F and an absorber A. These elements are connected by various conduits to form a complete refrigeration system.

This system may be charged with a refrigerant medium such as ammonia, an absorbent as water, and an inert pressure equalizing medium as hydrogen or nitrogen. When heat is applied to the boiler containing a solution of the refrigerant and absorbent mediums, refrigerant vapor is liberated and passes through conduit 10 to rectifier R wherein any water vapor contained in the refrigerant vapor is condensed and returned by gravity to the boiler. Substantially pure refrigerant vapor now passes through conduit 11 into the top of condenser C where it is liquefied, and the resulting refrigerant liquid flows by gravity into the evaporator coil E to be described in detail presently.

Evaporator E and absorber A are connected in a gas circuit provided by conduits 13, 14 and 15. The gas circulating fan is located between conduits 13 and 15, and in such manner that gas is circulated from the top of the absorber through conduit 15 and into conduit 13 from which it flows into the bottom of the evaporator. In the embodiment shown in Figure 1, the liquid refrigerant flows into the top of the evaporator through conduit 12, but it will be understood

that the refrigerant may be conveyed into any part of the evaporator if desired. When the liquid refrigerant comes into the presence of the inert gas, evaporation of the liquid takes place by the absorption of heat from the surrounding medium to produce refrigeration in the evaporator. The resultant rich mixture of refrigerant vapor and inert gas passes to the absorber through conduit 14 and is brought into the presence of lean absorbent medium derived from the boiler B.

The lean absorbent medium is elevated into the top of absorber A by means of gas lift pump 16 which is also connected to the boiler. The absorbent liquid is elevated through this conduit in well known manner by a small amount of inert gas under pressure derived from conduit 13 and led into the gas lift pump through conduit 20. Absorbent liquid then flows by gravity through the absorber and absorbs the ammonia vapor. The resultant enriched absorbent medium flows through conduit 17 into receiving vessel 18 and from there back to the boiler assembly through conduit 19. The relatively pure inert gas is returned to the evaporator by fan F. Gas conduits 13 and 14 are preferably in heat exchange relation as shown, as are absorption liquid conduits 16 and 19.

Any preferred manner of heating the boiler B may be utilized. As shown in Figure 1, a gas burner 21 is mounted on the apparatus in position to heat the boiler. Fuel is supplied from a suitable source through a conduit 22, a valve 23, a conduit 24 and a safety thermostatic or other heat responsive shut-off valve 25. The usual bypass 27 is provided around valve 23 to provide a pilot flame when valve 23 is closed. The pilot flame is of sufficient size to maintain thermostatic safety cut-off device 25 in open position, and if desired, may be of sufficient size to maintain the contents of boiler B at some temperature below that necessary to produce refrigerant vapor. In this event, as soon as valve 23 is opened, refrigerant vapor is produced almost immediately, and refrigeration is produced very soon thereafter.

Gas circulating fan F is driven by an electric motor 28 which is preferably hermetically sealed within the refrigeration apparatus, and may be of the induction type requiring no internal connections to the armature. The control for the motor and remainder of the apparatus will be described presently.

The evaporator E is conveniently formed from a continuous length of steel tubing bent in the manner illustrated in Figure 2 to provide a sharp freezing compartment having two or more sections of the tubing disposed in horizontal planes to provide ice tray supports. Ice tray shelves may be resiliently supported from the horizontal sections of the conduit as by resilient heat conducting strips 29. These strips may be formed into a spiral coil with one end attached to the evaporator coil, and the other end attached to the tray supporting shelf 30. It is desirable to so mount the resilient members 29 that the planes of the spirals are all parallel to one another. It will be appreciated that if the tray is moved in a plane at right angle to the plane of the spirals so as to coil and uncoil the spirals, very little effort will be required.

Resilient members 29 may be attached to the evaporator coil and to the tray in any desired manner as by welding, brazing, soldering, and are so positioned that shelf 30 does not rest upon the

evaporator conduit when filled trays are resting upon the shelf. However, it may be advantageous to permit the shelf to rest lightly upon the conduit when filled trays are placed on the shelf to facilitate the transfer of heat from the ice trays to the evaporator coil, although the heat conducting capacity of members 29 has been found quite adequate for this purpose. While the drawings only show one resiliently supported shelf 30, it will be understood that there may be as many shelves as there are freezing compartments in the evaporator assembly.

Shelf 30 may be agitated by means of an electric motor 31 preferably positioned outside of the refrigerator cabinet 32. An especially convenient location for the motor is in the combined air flue and apparatus compartment 33 directly behind the rear wall of the cabinet. As shown, the motor is positioned vertically and is provided with a crank 34 to which is pivoted a connecting rod 35. The other end of the connecting rod passes through the rear wall of the cabinet directly behind the evaporator and is detachably connected to extension 36 on shelf 30. A suitable gasket 37 serves to seal the enlarged opening through the rear wall through which connecting rod 35 passes. If more than one movable shelf 30 is employed, a second connecting rod may be connected to crank 34, or to a similar crank on the opposite end of the motor shaft to agitate this shelf simultaneously with shelf 30.

It will be obvious that there are several advantages in locating the motor in air flue 33. A stream of cooling air is always flowing upwardly through the air flue when the apparatus is in operation, and this maintains motor 31 cool. The motor is located outside of the cabinet and is easily reached for servicing if this should ever become necessary. Moreover, the heat therefrom does not effect the temperature condition of the food compartment in any way. Neither does the motor take up any useful space in the food compartment.

Evaporator coils E may be enclosed by a sheet metal housing 38 of conventional form. If desired, the evaporator may be provided with a hinged door 39 at its front, and with the usual drip tray 40 and associated supporting means below the evaporator.

Referring now to Figure 1, it will be seen that the very simple control mechanism for the refrigeration system as well as for the ice tray agitating motor 31 may be employed. In order to control the operation of the refrigeration apparatus in accordance with the demand for refrigeration, any desirable form of thermostatic means, as the snap-acting thermostatic member 41, positioned to be responsive to either the evaporator temperature or the food compartment temperature is suitably connected through a rod 42 to the electrical circuit breaker 43 and fuel valve 23. Accordingly, the fuel valve and the electrical circuit are simultaneously operated and controlled by the thermally responsive means. The fuel valve and the electrical switch are simultaneously opened or closed. Connected in circuit with switch 43 is the fan motor 28 and the agitating motor 31. When a predetermined desired temperature has been reached in the refrigerator, snap-acting device 41 operates to cut off the main supply of fuel to burner 21, and to deenergize both the inert gas fan 28 and the agitating motor 31. If desired, a manually operated switch may be inserted in the electrical control circuit to place the agitating motor 31 under the con-

trol of the operator independently of the condition of switch 43.

Electrical switch 43 and valve 23 may be positioned in any convenient and accessible location as on top of and at the front end of evaporator E within the food compartment. A suitable compartment 44 has been shown for these elements in Figure 3, and a manual control knob 45 is operable in known manner to control the operating range of the thermostatic control mechanism:

Referring now to Figure 4 of the drawings, it will be seen that I have shown by way of example one manner in which the invention may be practiced in connection with a compression type refrigeration apparatus. As shown in this figure, the refrigeration mechanism, and more particularly the heat dissipating portion thereof is shown as located above the food compartment, but it will be understood that this assembly may be located behind or beneath the food compartment if desired. A unitary and rigidly interconnected assembly comprising a motor 50, a compressor 51, a condenser 52, and a platform 53 is resiliently suspended by coil springs 54 from brackets 55 by means of adjustable leveling eyebolts 56. Brackets 55 are preferably secured to a removable section 57 of the refrigerator cabinet wall. As shown, this section forms a part of the top wall of the food compartment, but it will be understood that this section might be in one of the side walls, or the bottom wall of the cabinet.

The evaporator assembly may be secured to closure member 57 as by brackets 59. For convenience of illustration, the evaporator proper is shown as formed from a continuous piece of tubing 60 bent in the same general manner as was in the case in the form illustrated in Figure 1. Suitable refrigerant liquid flow control mechanism 61 is supported upon platform 53. This mechanism receives liquid refrigerant from the condenser through conduit 62 and delivers refrigerant to the evaporator through conduit 63. A return refrigerant vapor conduit 64 is connected to the opposite end of the evaporator conduit and to the intake side of the compressor 51. One or more ice tray shelves 65 are resiliently supported upon the evaporator conduit 60 by a plurality of resilient spiral heat conducting members 66 similar to corresponding members 29 in Figure 1.

Instead of employing a separate motor or other means for agitating shelf 65, I prefer to utilize waste energy from the motor compressor unit itself for this purpose. A convenient method of accomplishing this is by providing a connection between the vibrating motor compressor assembly and shelf 65. Such a connection may consist of a bell crank 71 pivoted on the rear of the evaporator casing 67, one arm of which is connected by a link 68 to the shelf 65, and the other arm of which is connected by a rod 69 to the bottom of platform 53. As is well known, when the motor compressor unit is in operation, the unbalanced forces will cause rapid, limited movement of the platform 53 due to its suspension from coil springs 54.

In addition to the control of the agitation of the unit afforded by the design and adjustment of coil springs 54, the agitation of the shelf can be readily increased or decreased by properly proportioning the two arms of bell crank 71. For this purpose, the bell crank may be provided with the connections at various distances from the pivot on each of the arms. Of course, agitation

of the shelf results in the agitation of the contents of the ice trays, whether these contents be water or some other fluid or foodstuffs. In the case of water, the agitation of the water will free any bubbles of air tending to cling to the sides of the congealing water, and these bubbles will then flow to the surface and escape into the air.

Connection 69 may be held in place against platform 53 in any suitable manner which permits of some lateral play between this connection and the platform. As shown in Figure 4, removable wall section 57 is provided with an enlarged opening through which the connection passes, and this opening is sealed by a flexible gasket 70.

Any suitable form of automatic control mechanism for the refrigeration unit may be employed. However, it is unnecessary to provide for any control of the ice tray shelf agitating means, since this shelf will be automatically set into motion whenever the apparatus is operating to produce refrigeration, and will become stationary as soon as the refrigeration unit ceases to operate.

From the foregoing detailed description of two embodiments of the invention it will be apparent that I have provided a very simple change in the design and construction of an evaporator for use in refrigerators of the household type in which one or more resiliently supported shelves may be agitated to produce clear ice or superior frozen foodstuffs. These shelves may be actuated either by waste energy from the operation of the refrigeration apparatus, or from a very small separate source of energy. Thus, the invention is equally applicable to either motor compression systems or to absorption systems. Due to the use and manner of locating the resilient supports for the evaporator shelves, I am enabled to utilize the inherent resiliency of these members to supplement the small amount of energy required to maintain the shelf in motion. In a preferred construction, the tray does not rest upon the pipes at all but all heat is conducted from the tray through the resilient supporting members, and therefore there are no sliding contacts between the shelf and any other parts of the evaporator.

Various modifications of both constructions are within the scope of the invention, and it is to be understood that the two forms shown are to be taken as illustrative only and not in a limiting sense.

I claim:

1. In a refrigerating system, a refrigerating unit, a resiliently mounted platform supporting said unit, said platform being vibrated as a result of the vibration set up by the operation of said unit, an evaporator, a shelf movably supported in said evaporator, and means connecting said platform and shelf to transmit said platform vibrations to said shelf to agitate the latter.

2. Refrigeration apparatus comprising a unitary motor-compressor unit resiliently supported in heat insulated relationship from a compartment to be refrigerated, an evaporator within said compartment, means supporting a container therein, and means for agitating said container supporting means operated by unbalanced forces in said motor-compressor unit when said apparatus is in operation.

3. Refrigeration apparatus comprising an insulated cabinet, an apparatus compartment and a flue outside said cabinet, refrigeration appa-

ratus in said compartment, an evaporator within the cabinet having means for supporting trays, and means in said flue connected to said tray support and operable to agitate said tray, said last named means being cooled by cooling air flowing through said flue.

4. An evaporator adapted for use in a domestic refrigerator, resilient, heat conducting members secured to said evaporator, a plate on said members for supporting a container for liquids and to conduct heat therefrom to said evaporator in response to a lowering of the temperature of the latter, said resilient heat conducting members being constructed from light springy material whereby a small amount of energy suffices to set said members into vibration and thereby agitate said container and its contents.

5. Apparatus for removing cloud-forming material from ice in process of congelation in a domestic refrigerator comprising an evaporator of a domestic refrigerating apparatus, a resiliently mounted tray supporting element in said evaporator, an ice tray resting on said element, and means for imparting a rapid vibration to said tray-supporting element.

6. The combination with a refrigerator having an evaporator, of a shelf for supporting an ice tray in said evaporator, means supporting said shelf on said evaporator and permitting limited movement with respect thereto, and means for moving said shelf repeatedly within the range of movement permitted by said supporting means to aid the escape of free gas present in the water.

7. The combination with a refrigerator having a stationary evaporator, of an ice tray supporting shelf mounted on said evaporator, an ice tray thereon, and means for vibrating said shelf and the ice tray to cause occluded gases in the water to escape to permit the freezing of substantially clear ice.

8. In combination with a refrigerator, a control circuit for controlling the operation of said refrigerator, a shelf mounted in said refrigerator having a large flat surface for direct contact with the bottom of a flat container and constructed and arranged to support the container and to abstract heat therefrom, and motor driven means for vibrating said shelf and a container thereon, said motor driven means being independent of said container and controlled by said control circuit.

9. The combination with a refrigerator having an evaporator, of a control circuit for controlling operation of said evaporator, a shelf for supporting an ice tray mounted in said evaporator for movement in a generally horizontal direction, and motor driven means for imparting gentle but substantially continuous movement to said shelf, said motor driven means being connected to and controlled by said control circuit.

10. In combination, a domestic refrigerator having a resiliently mounted refrigerating unit, said unit being subject to vibration as a result of the operation thereof, a liquid container support within said refrigerator and supported independ-

ently of said refrigerating unit, and means operatively connecting said unit and said support so that said support is agitated by the unbalanced forces of said unit while said unit is operating.

11. Apparatus for removing cloud forming material from ice in process of congelation in a domestic refrigerator comprising a stationary evaporator of a domestic refrigerating apparatus, a movably mounted ice tray support in said evaporator, and means for agitating said ice tray support to cause free gas present in the contents of said tray to escape.

12. Apparatus for producing clear ice comprising a refrigerating apparatus including a stationary evaporator and a movably mounted refrigerant supply mechanism connected thereto, a movable tray support associated with said evaporator, and means for transmitting movements of said refrigerant supply mechanism to said tray support to remove occluded gases by agitation from the contents of a tray supported thereon.

13. In combination, refrigerating means having a heat abstracting element, a support for a container for a fluid to be congealed by the abstraction of heat, a plurality of heat conducting members interposed between said support and said heat abstracting element, said members providing good heat transfer between the support and heat abstracting element while permitting limited relative movement therebetween, and means for imparting movement to said container support.

14. An evaporator of the type adapted to make ice, said evaporator being adapted to contain a refrigerant, a fluid container supporting shelf, a plurality of heat conducting members interposed between said shelf and evaporator and so constructed and arranged as to conduct heat readily between the evaporator and shelf while permitting free but restricted relative movement therebetween.

15. An evaporator of the type adapted to enclose a fluid container, said evaporator having a fluid container support mounted for limited movement in a generally horizontal direction, and means located outside said evaporator and operably associated with said support to move the same to and fro in a generally horizontal direction to agitate the contents of a fluid container on said support while the same is being congealed to aid the escape of gas from said contents before the same congeal.

16. Refrigeration apparatus comprising a cooling element operable at temperatures suitable for congealing fluids, power driven refrigerant supply means supported independently of said cooling element but connected to supply and withdraw refrigerant medium to and from said cooling element, and means actuated by unbalanced forces of said power driven means for agitating a fluid container while the contents of the same are being congealed by said cooling element whereby occluded gases in the fluid may escape before the fluid congeals.

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