May 26, 1953 J. R. WATT 2,639,594

FREEZING MACHINE

Filed Aug. 10, 1949 2 Sheets-Sheet 1

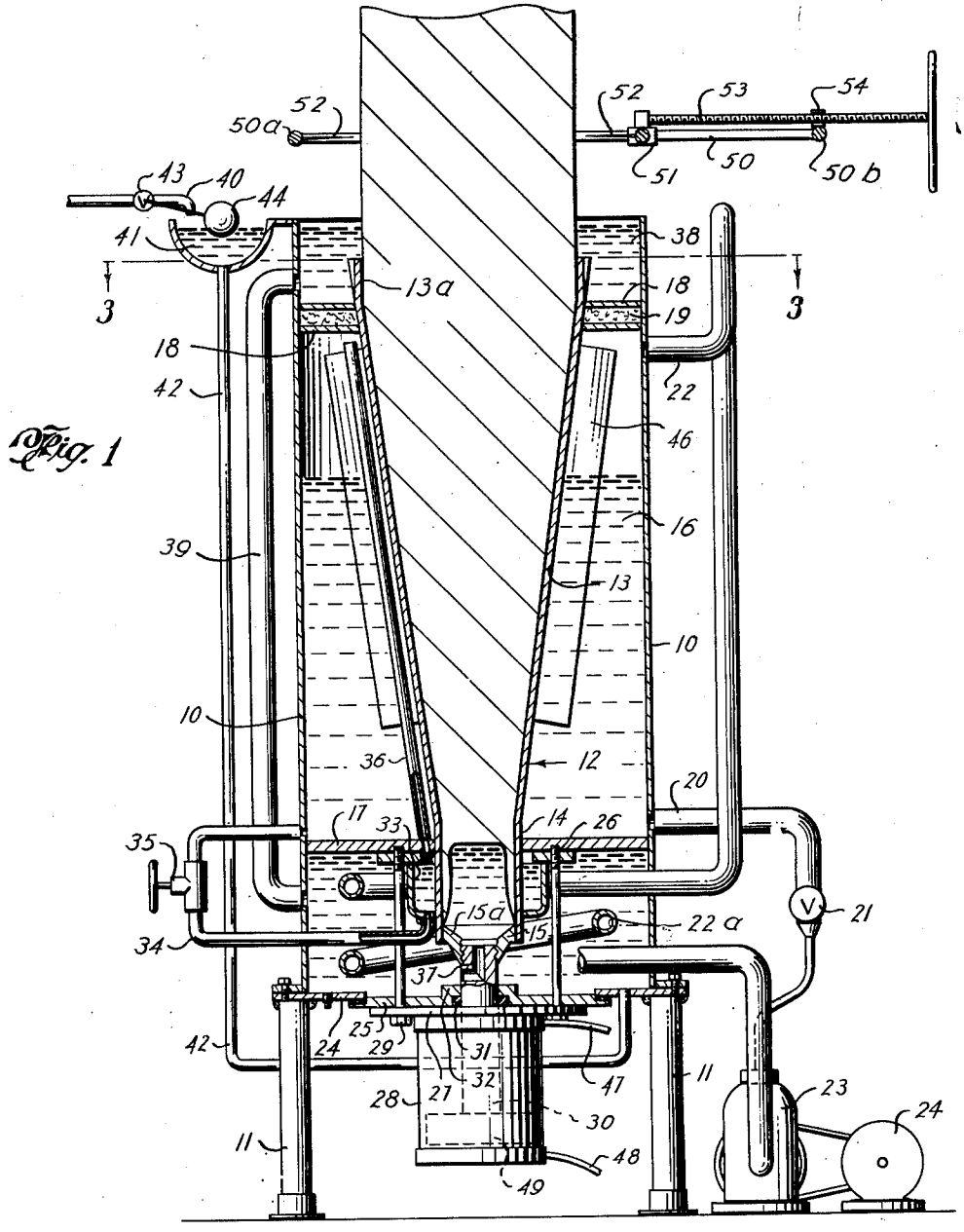


Fig. 1

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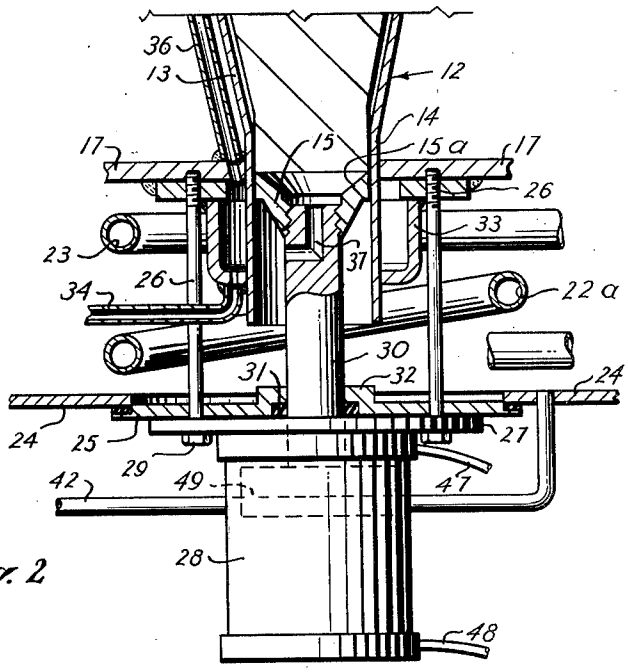


Fig. 2

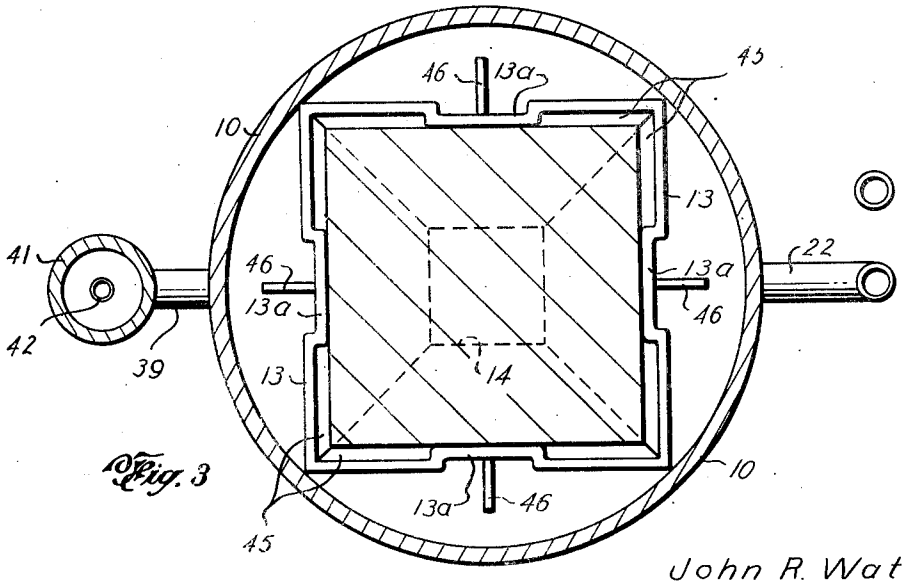


Fig. 3

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FREEZING MACHINE

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Application August 10, 1949, Serial No. 109,600

6 Claims. (Cl. 62—106)

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This invention relates to improvements in continuous freezing machines and refers more particularly to a continuous freezing machine of the type employing a freezing cell with a refrigerated surface on which the ice is formed with a reciprocating plunger, ram or the like which pushes the formed ice from the cell.

This application is a continuation in part of my co-pending application, Serial Number 656,265, filed March 22, 1946, entitled "Incremental Freezing," now Patent No. 2,571,506.

It has been attempted, prior to the filing of the above co-pending application, to continuously form ice in machines of this character employing a flared freezing cell, but the early efforts have not been commercially acceptable. One of the chief difficulties heretofore encountered in the type of machine having a flared cell has been due to the fact that the ice-core when moved by the plunger toward the large end of the cell has not remained centered in the cell but has tended to rest against one side of the cell so that liquid to be frozen, upon entering the cell, does not settle in a uniform layer between the frozen core and the refrigerated surface. A uniform liquid layer has been found to be very important for the freezing rate varies inversely with the square of the thickness of the layer or film so that even very small differences in the thickness of different portions of the film materially affects both the output rate of the machine and the solidity of the cake of ice formed in the machine.

Another problem heretofore encountered has been the great power required to activate the ram in order to shear the ice-core from the walls of the cell at each time that the ice-core is moved. Also, it has been difficult to start up the flared cell machines because of the tendency of the plunger guide portion to fill with ice. In addition, considerable difficulty has even been encountered in operation with the plunger freezing tight in its position of rest while the ice layer is forming between the ice-core and refrigerated surface. Then, too, the air forced from the water at it freezes in the cell has had a tendency to collect and form bubbles or voids in the ice block.

An object of this invention is to provide a machine for making ice rapidly and efficiently.

Another object is to provide a machine which will freeze a uniform product in a continuous operation.

Still another object is to provide in a machine of the character employing a flared freezing cell, a means for maintaining the ice-core centered within the freezing cell relative to the longitudinal axis of the cell.

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Still a further object is to provide in a freezing machine of the class described a plunger or ram construction which is very effective in shearing ice from the refrigerated surface.

Yet another object is to provide in a machine of the class described a plunger or ram construction especially adapted for packing frozen material scraped from the plunger guide walls to provide a packed ice block.

Even another object is to provide in a machine of the class described, for the elimination of air or gases from the freezing cell.

A further object is to provide a machine of the character described having means for selectively refrigerating a portion of the plunger guide to facilitate starting of the machine.

Even a further object is to provide a freezing machine of the class described which may be operated to freeze either a continuous block of ice or flake ice.

Other and further objects of the invention will appear from this description.

In the accompanying drawings, which form a part of the instant specification, are to be read in conjunction therewith and wherein like reference numerals are used to indicate like parts in the various views:

Fig. 1 is a vertical sectional view of a machine embodying this invention,

Fig. 2 is a fragmentary view upon an enlarged scale illustrating the lower mechanism of the machine shown in Fig. 1, and

Fig. 3 is a view, on the line 3—3 of Fig. 1, taken in the direction of the arrows.

Referring to the drawings, the machine, generally speaking, is comprised of a support receptacle 10 mounted upon base supports 11 with a freezing cell 12 mounted within the receptacle 10. The cell 12 has a flared portion 13 and a portion 14 having walls substantially parallel to the longitudinal axis of the cell, providing a guide for a ram 15 mounted for reciprocation therein under the influence of an actuating mechanism housed within cylinder 28 which preferably is energized hydraulically.

The cell 12 is mounted within receptacle 10 in such fashion as to provide a sealed chamber 16 between the cell and the receptacle. In the embodiment shown, the support receptacle also provides a refrigeration jacket about the freezing cell between the limits established by the lower plate 17 and the upper plates 18. Preferably, insulation material shown at 19 is provided between

plates 18 to rather sharply end the refrigerated zone of cell 13 at its upper end. Refrigerant of any type may be supplied to the jacket and is adapted to enter chamber 16 through conduit 20. Conduit 20 may be controlled by an expansion valve 21 where a liquid refrigerant to be evaporated is used, and the expanded refrigerant leaves the upper end of the cell through conduit 22. The refrigerant may be circulated by any suitable compressor and condenser shown schematically at 23, the compressor being operated by motor 24 through a pulley and belt drive.

In order to pre-cool the material to be frozen, in the interest of efficiency and rapid operation, a reservoir is included for water or other material to be frozen through which the refrigerant discharge conduit 22 passes in the form of a coil 22*a*. The reservoir preferably is provided about the plunger guide 14 and has a common wall such as 17 with the refrigerated chamber 16. With this arrangement, the wall 17 and the coil 22*a* both provide refrigeration for the pre-cooling chamber or reservoir.

The bottom plate 24 closes the lower end of receptacle 10 to provide the reservoir in the lower portion of the receptacle between the plates 17 and 24. Plate 24 has a central opening or handhole which may be closed by cover 25 and a suitable gasket held in place by a plurality of studs 26 secured at one end to the underside of plate 17. The studs extend through cover 25 and the flange of a base plate 27 secured to a cylinder 28, housing the actuating mechanism for ram 15. The heads 29 of the studs secure the cover 25 in place to seal off the handhole and also secure the cylinder 28 in operative position.

Cover 25 has a central aperture to receive the connecting rod 30. A seal is provided between the rod and handhole cover by packing 31 compressed between a washer 32 attached to the inside of cover 25, and the base plate 27. With this arrangement, the base plate 27 serves as a gland for tightening the packing 31 when the nuts 29 are tightened.

During normal operation, a portion of the plunger guide 14 should be refrigerated in order that ice may be scraped therefrom by the plunger and be packed in the center of the ice-core by the operation of the plunger against the lower end of the ice-core. However, in starting up operations, it is necessary to refrigerate the cell for a period of several hours prior to commencing the reciprocation of the plunger. During this period, the ice film which forms in the refrigerated portion of the guide 14 will become so thick as to make it very difficult and sometimes impossible to reciprocate the plunger. Even if the plunger is reciprocated, the ice-core will be lifted far too high in the cell for the plunger guide will be at least substantially filled with ice. This results in a very thick layer of liquid between the ice-core and cell which is very difficult to freeze. To avoid this difficulty, the machine preferably is constructed so as to have an intermediate portion of the plunger guide adapted to be selectively refrigerated and the end portion of the plunger guide, closest to the flared portion 13, is exposed to the interior of chamber 16 in order to refrigerate it at all times. The end of the plunger guide most remote from the flared portion 13 extends into the pre-cooling reservoir and is exposed to the liquid therein in order to provide a warm portion within the guide, which is maintained above the freezing point of the material to be frozen. The plunger resides in this heated portion of the guide when at rest. The lower end of the guide is open so that this liquid within the pre-cooling reservoir also contacts the plunger to maintain it above the freezing point of the material to be frozen.

The above conditions for proper refrigeration of the plunger guide may be insured by providing a refrigeration jacket 33 which surrounds the intermediate portion of the plunger guide. Refrigerant may be supplied to this jacket by conduit 34 controlled by valve 35. Preferably, the conduit 34 communicates with chamber 16 near its lower end whereby the liquid refrigerant collected in the bottom of chamber 16 may be supplied to the interior of jacket 33 by opening valve 35. The upper portion of the refrigeration chamber, provided by jacket 33, communicates through a conduit 36 with the upper portion of the chamber 16. Of course, the upper portion of chamber 16 is filled with refrigerant gas so that the hydrostatic column of liquid refrigerant within chamber 16 provides sufficient pressure differential to circulate the refrigerant through conduit 34 and jacket 33 and evaporated refrigerant from jacket 33 is returned through conduit 36 to chamber 16. With this arrangement, the refrigeration of the intermediate portion of the plunger guide may be cut off during the initial operation but is available for normal freezing operations.

Referring to the plunger 15, it has a novel construction which particularly adapts it for use in freezing machines of the class described. The outer peripheral contour of the plunger conforms to the inner surface of the guide and the plunger is fabricated with close tolerance so as to contact the ice-core closely adjacent the freezing surface. It has been found that where the abutment between the plunger and ice-core is closely adjacent the refrigerated surface that the force required to shear the ice-core from the cell is greatly less than where the contact between the core and plunger is even slightly spaced from the refrigerated surface. This arrangement, of course, permits only limited seepage of liquid past the plunger.

Inasmuch as the reciprocation of the plunger results in scraping of ice from the refrigerated surface and the packing thereof into the center of the ice cake formed, it has been found necessary to form the plunger with a concave engagement face in order to prevent the packed ice from packing between the ice cake and the plunger at some point spaced inwardly from the refrigerated wall. This is easily accomplished by making up the plunger in the form of an annular member 15*a* having a flared surface on its ice engaging face and attaching this portion to connecting rod 30 by threads or the like. The end of rod 30 preferably should provide a substantial recess at the center of the plunger and actually makes up a part of the plunger face.

In order that the plunger may be freely reciprocated, a passage 37 is formed therein communicating at one end with substantially the central portion of the ice engaging face of the plunger and having a lateral opening at its other end so that as the plunger is reciprocated in a direction toward the ice cake, the liquid that passes therethrough is discharged to one side within the pre-cooling reservoir. Thus, if any air or gas is forced from within the freezing cell through the passage 37, it will rise in the liquid within the reservoir and then will find its way to the reservoir 38 at the flared end of the ice cell.

The liquid to be frozen is charged to the freezing cell primarily through its flared end from reservoir 38. This reservoir is provided by the extended end of support cylinder 10, and the upper plate 18 and surrounds the end of cell 12. Liquid to be frozen is supplied to the reservoir 38 preferably from the pre-cooling reservoir by a conduit 39. The source of liquid may be any suitable faucet 40 or the like which preferably discharges into a float basin 41 connected by conduit 42 to the pre-cooling reservoir. Source 40 is controlled by float control valve 43 with float element 44 adapted to float in the liquid in basin 41. This controls the level of liquid within the reservoir 38.

For proper operation of the machine, it is requisite that the machine be formed so as to provide guide means for the ice emerging from the freezing cell to maintain the ice in centered position relative to the longitudinal axis of the cell for reasons hereinbefore stated. It is particularly important to maintain the centering of the ice at the flared end of the cell and at the same time, it is necessary to provide passages communicating between the interior of reservoir 38 and the space between the flared portion 13 of the cell and the block of ice as it is lifted in the cell by plunger 15.

The guides at the upper end of the cell are adjacent to the end of the refrigerated zone and may constitute inturned portions 13*a* illustrated best in Fig. 3. These guide means provide contact surfaces for engaging the ice block emerging from the cell. Their ice contact surfaces are located at a distance from the central longitudinal axis of the cell substantially equal to the distance from said axis of a point on a plane which includes the axis and the guide element surface, such point being defined by the inter-section of the plane with the termination of the refrigerated zone at the large end of the cell. Thus, it is seen that the inturned portions 13*a* of the cell provide ice engaging parts which are adjacent and spaced from the large end of the cell in order that the ice block will remain centered within the cell. By referring to Fig. 3, it will be seen that a plurality of ports 45 are provided for passing water from the interior of reservoir 38 into the space between the ice cake and the refrigerated surface. With this arrangement, the liquid to be frozen will settle in a uniform layer completely surrounding the ice-core.

It is to be understood that the lower end of the ice-core is held in centered position within the cell by the plunger guide. However, this portion of the ice-core is built up primarily of packed scraped ice and its strength is not sufficient to reliably center the entire ice block.

The refrigeration shell or cell 10 is subjected to considerable stress during the freezing operation and in order to strengthen it so that its thickness may be kept to a minimum to conserve both refrigeration and materials and keep down the weight of the machine, stiffeners 46 may be provided for the shell, preferably extending longitudinally thereof. These stiffeners actually increase the heat transfer characteristics of the shell but are provided primarily for reinforcement purposes.

In the form of the machine shown in the drawings, a hydraulic ram is employed to actuate the plunger 15. This includes the cylinder 28 having connections 47 and 48 for supplying and exhausting power fluid to the interior of the cylinder and includes a piston shown schematically in dotted lines at 49. It is to be understood that a mechanical means may be employed for reciprocating the plunger as, for instance, that shown in the copending application mentioned above.

It is contemplated that the freezing shell may be of a conical form rather than of the pyramid shape shown in the drawings but that, in any event, it will include a portion 14 with its walls substantially parallel to the longitudinal axis of the cell.

A novel means for severing the cake of ice emerging from the cell has been devised and includes a framework 50 of suitable rigid materials and of rectangular shape when used in conjunction with a machine having a pyramid type freezing cell. The framework 50 has a slide bar 51 extending between the side members of the framework and slidable thereon. This slide bar carries a plurality of pick elements 52 and an opposing row of pick elements 52 is secured to end member 50*a* of the frame. The slide bar 51 has a swivel connection with rod 53 which extends through a threaded sleeve 54 secured to end member 50*b* of the frame. The two rows of pick elements 52 may be brought together to cut the ice by rotating rod 53 in one direction and may be retracted by reverse rotation of the rod.

In operation, water or other liquid to be frozen is charged to the machine through basin 41 and a proper liquid level is maintained in reservoir 38 by float operated valve 43. The liquid is precooled in the liquid reservoir at the lower end of the machine and then passes into the freezing cell through the openings or passages 45 at the upper end of the cell. The ice is formed in a plurality of incremental ice layers rapidly frozen to the ice-core and conforming to the contour of the flared portion of the cell. The plunger intermittently advances the ice-core from the cell whereby more liquid to be frozen enters the cell between the refrigerated surface and the ice-core through openings 45.

The stroke of the plunger will depend to some extent upon the size of the machine. However, in commercial size installations, the plunger stroke will usually vary from about three to six inches, but all of this stroke will be within the plunger guide and most of it will serve only to scrape ice formed on the refrigerated portion of the plunger guide into the center of the ice-core. Usually approximately the last ¼ inch of the stroke will effect a movement of the entire block of ice approximately the same distance, that is, ¼ inch toward the flared end of the cell. This ¼ inch is not critical and may be more or less to meet the conditions of operation, size of the machine and the like, but probably will seldom exceed ½ inch. Any suitable refrigerant may be employed such as ammonia, sulphur dioxide, or dichlorodifluoromethane sold under the trademark "Freon 12."

It is contemplated that this pack ice principle may be incorporated in a machine without the flared portion where all the liquid to be frozen enters through the plunger. Such a machine would be especially desirable for producing cube ice or the like.

The spent refrigerant from chamber 16 circulates through the pre-cooling reservoir at the lower portion of the machine, and the wall 17, being common to both the reservoir and chamber 16, also provides a part of the refrigeration for the pre-cooling of the material to be frozen.

During initial starting up operations for the freezing of block ice, the valve 35 is closed and the piston 15 is not reciprocated for a prolonged

period of time, usually over-night, in order that an ice shell of substantial thickness may form within the cell. Then the reciprocation of the plunger is commenced so the ice shell formed in the cell may be sheared from the refrigerated surface and lifted somewhat therein. Valve 35 is then opened to refrigerate an intermediate portion of the plunger guide so that ice will form therein which is scraped off by the plunger. Due to the concave surface of the plunger, the scraped ice may collect in the center and the edge of the plunger contacts the lower end of the ice cake whereby the lifting force is transmitted from the plunger to the cake at locations closely adjacent the bond between the ice cake and the freezing cell. This has been found to greatly reduce the force required to effect shearing of the ice. The center core of the ice cake is made up chiefly of the ice scraped from the plunger guide and packed in the center of the ice cake by the action of the plunger. During reciprocation of the plunger a liquid or gas may by-pass the plunger through passage 37 and air released by the freezing water within the cell is permitted to escape from the cell and rise within the pre-cooling reservoir.

The reciprocal movement of the plunger is of an intermittent character and during the periods of rest it is maintained above the freezing point of the material to be frozen to prevent the freezing of the plunger within the guide or ice sticking to the plunger when it is moved into the refrigerated zone so as to interfere with its movement or stop up the passage through it. The liquid within the pre-cooling reservoir, in contact with the guide and the plunger and surging through passage 37, serves as a heating medium for this purpose while being precooled itself.

The over all plunger stroke may be as much as four inches or even more but the ice cake is actually usually lifted less than ½ inch during each stroke. The water filling the space between the cell and ice-core prevents settling back of the ice-core within the cell. After the ice cake is lifted, the plunger is quickly returned to rest in the warm zone of the guide.

The cutting tool shown is manually operated at selected intervals to sever predetermined lengths of ice blocks from the main cake, but it is contemplated that mechanical severing means may be employed.

The invention has been explained as it applies to the freezing of block ice, but it is to be understood that many of the principles and sub-combinations of the invention have utility in the freezing of flake ice and cube or pack ice. For example, the plunger, guide and reservoir arrangement lends itself for use as a cube or pack ice machine wherein the guide, at the discharge end, is somewhat extended and provides the complete freezing cell for continuously making pack ice forms. In such case a means, as a spring cap, is employed to resist extrusion of the ice from the cell until it is packed in tightly enough to itself provide sufficient resistance to the plunger to insure packing of the ice scraped from the wall of the cell. The arrangement of the guide, plunger and reservoir, so as to provide a warm retracted position for the plunger or ram is of special advantage in machines for freezing block ice, flake ice and pack ice, although in freezing flake ice it is preferred to employ a plunger which can either pass over ice formed on the guide, on its retraction stroke, or scrape it therefrom so that a simple harmonic plunger reciprocation may be used. One such type plunger is shown in my above identified co-pending application and designated therein as a resilient plunger or ram. The construction of the plunger, so as to provide for the escape of air or other gas released by the liquid in the freezing cell, is also adapted for use in freezing the other forms of ice.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. In a freezing machine a freezing cell having a flared wall section merging at its small end with a wall section formed parallel to the central longitudinal axis of the cell adapted to receive and guide a reciprocally mounted plunger, means for refrigerating the flared wall section and the closely adjacent portion of the plunger guide section, means for selectively refrigerating an intermediate portion of the plunger guide section and means for heating the portion of the guide section in which the plunger resides when in its position most remote from the flared portion.

2. A machine as in claim 1 wherein the means for selectively refrigerating the intermediate portion of the plunger guide section includes a refrigeration jacket exteriorly surrounding same, and a larger container encircles the jacket and end of the guide section to be heated with connections for circulating fluid to be frozen through the larger container to provide the heating means for the end of the guide section and for prechilling of the material to be frozen.

3. In a freezing machine of the type having a freezing cell made up of a refrigerated wall with a flared portion and merging at its smaller end with a plunger guide section whose wall is parallel to the central longitudinal axis of the cell, a plunger mounted for reciprocation within the guide portion, said plunger having a peripheral scraping edge having close tolerance with the guide section, a concave surface within and terminating in the scraping edge and a passage for by-passing fluid to and from the interior of the cell and past the plunger.

4. In a freezing machine of the type having a freezing cell made up of a refrigerated wall with a flared portion and merging at its smaller end with a plunger guide section whose wall is parallel to the central longitudinal axis of the cell, a plunger mounted for reciprocation within the guide portion, said plunger having a peripheral scraping edge having close tolerance with the guide section, a concave surface within and terminating in the scraping edge and a passage for by-passing fluid to and from the interior of the cell and past the plunger, said passage communicating between the concave portion of the

plunger and a lateral opening in the plunger at a position outside the end of the guide section remote from the flared portion of the cell providing a trap for gas passing through said passage from the interior of the freezing cell.

5. In a freezing machine of the type having a freezing cell made up of a continuous flared wall portion and a plunger guide section merging with the smaller end thereof, said guide section having a continuous wall parallel to the central longitudinal axis of the cell, means for refrigerating the cell wall to provide a refrigerated zone including most of the cell wall, means including a plunger mounted for intermittent reciprocation solely within the guide section for moving ice formed within the cell from the flared end thereof, substantially rigid guide elements spaced from the large end of the refrigerated zone, each element positioned a distance from the central longitudinal axis of the cell substantially equal to the distance from said axis of a point on a plane which includes the axis and the element, said point defined by the intersection of the plane with the termination of the refrigerated zone at the large end of the cell, said guide elements adapted to center the frozen material emerging from the cell relative to the longitudinal axis thereof, means for providing a liquid reservoir at the flared end of the cell, and passages between the reservoir and the interior of the cell adapted to bypass liquid into the cell past the guide elements.

6. In a freezing machine, a freezing cell having a flaring portion adapted to be refrigerated, a portion at the smaller end of the cell with walls parallel to the longitudinal axis of the cell providing a plunger guide, a plunger fitting closely within the guide and mounted for reciprocation therein with its limit of movement toward the flaring portion falling somewhat short thereof, substantially rigid centering parts adjacent the large end of the cell with their engaging surfaces spaced from the longitudinal axis of the cell a distance to just engage the periphery of a frozen form emerging therefrom in operation, said centering parts positioned about the cell so as to center the frozen form within the cell, a reservoir for liquid positioned to open into the large end of the cell and wherein passages are provided between the reservoir and the interior of the cell to fill the space between the cell wall and a frozen form advanced by the plunger toward the large end of the cell.

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