March 5, 1968 F. M. RAVER ET AL 3,371,505

AUGER ICEMAKER

Filed March 2, 1964 2 Sheets-Sheet 1

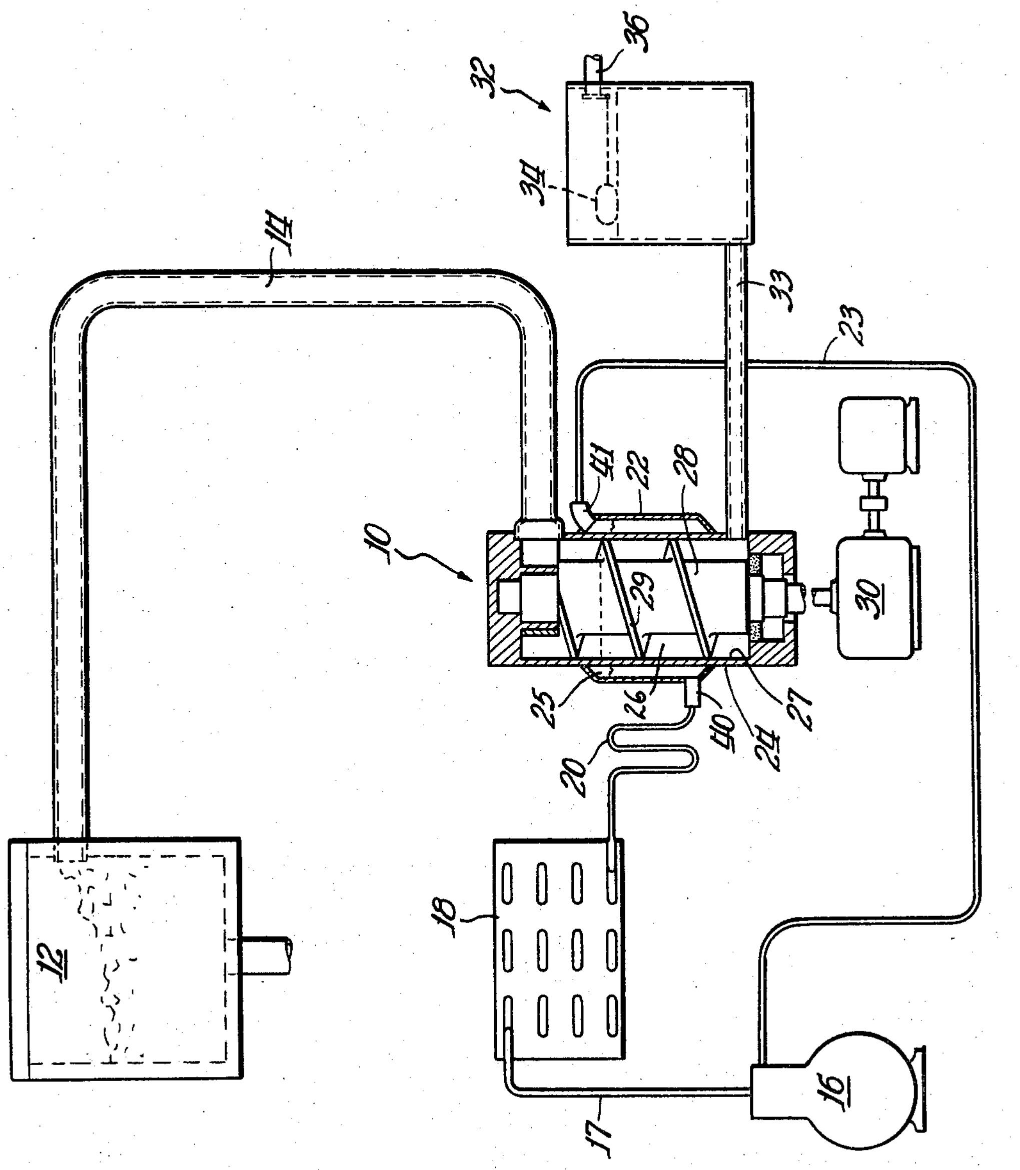


Fig. 1

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Fig. 3

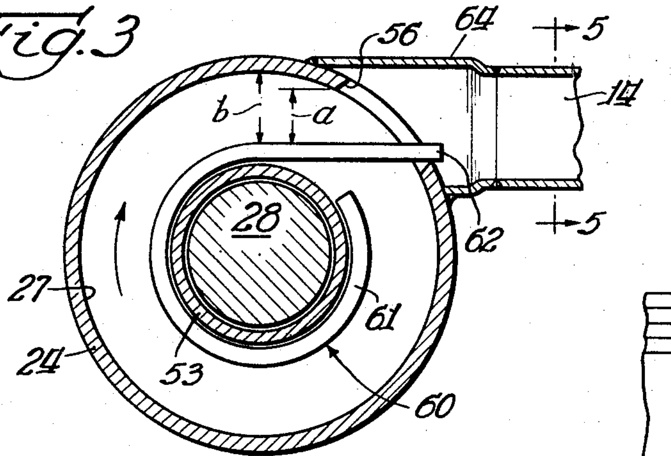



Fig. 4

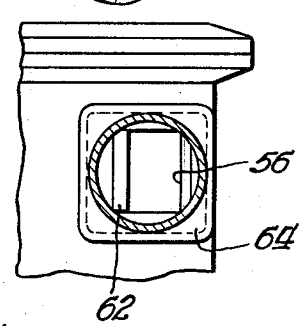



Fig. 2

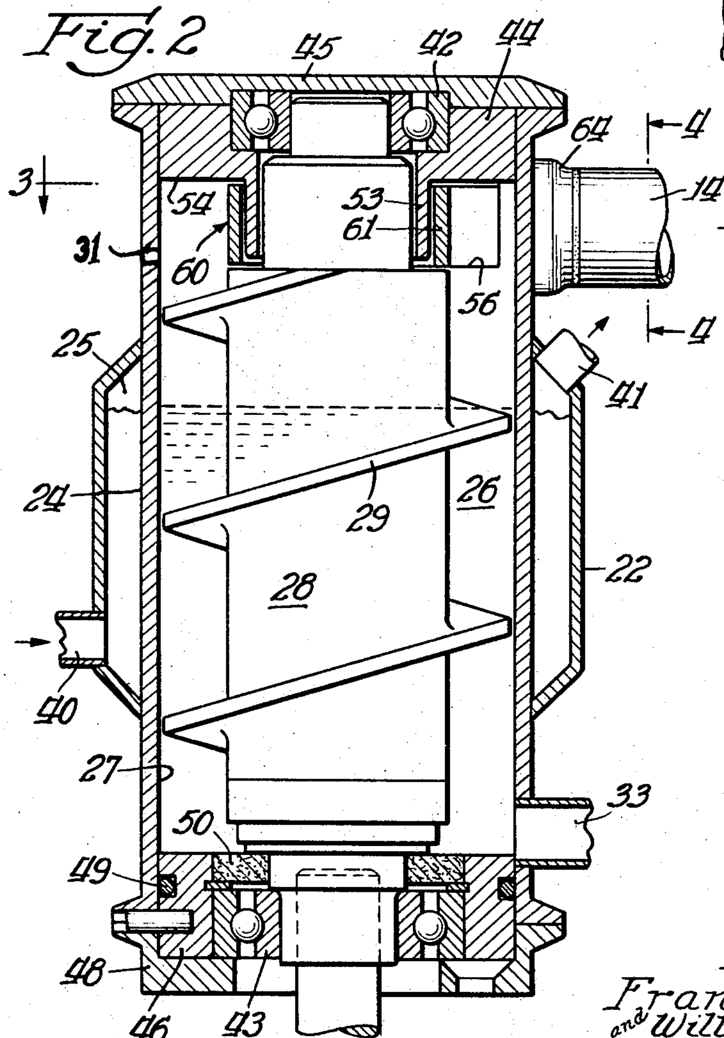
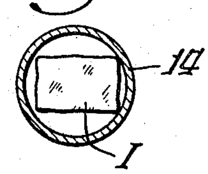



Fig. 5

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United States Patent Office 3,371,505 Patented Mar. 5, 1968



3,371,505

AUGER ICEMAKER

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Filed Mar. 2, 1964, Ser. No. 348,512
6 Claims. (Cl. 62—320)

This invention relates to icemaking apparatus and more particularly to an improved icemaking unit which is suitable for use in an ice dispensing unit where ice delivery is required at a location remote from the icemaking unit or in a soft drink vending machine of the type which charges a controlled amount of flaked or chipped ice directly into the drinking cup.

For one reason or another, known prior art units of the aforementioned type are frequently designed so that the ice produced in the freezing unit is transferred by gravity into a receiving and storage receptacle which is located below the level of the icemaking unit. In this arrangement, the compressor and condenser of the refrigeration circuit are commonly located near the base of the cabinet or enclosure and the evaporator-freezer is disposed a considerable distance above the level of the compressor and condenser. The ice from the freezer is transferred to the upper portion of an open chute and slides by gravity into the storage bin. An example of this type of unit is described in U.S. Patent No. 2,753,694.

The conventional prior art arrangement, as referred to above, has a number of disadvantages. First of all, the evaporator-freezing unit is large and relatively heavy so it requires a space-consuming supporting structure to hold the freezing unit in the upper portion of the enclosure or housing. Maintenance is made more difficult with the compressor and condenser in one section and the evaporator in another, often hidden behind a maze of other components. Moreover, it is difficult to isolate the freezing unit for the purpose of maintaining hygienic control and suppressing the noise associated with operation of the evaporator and ice extruding mechanism. With respect to hygienic control, it is desirable that the freezing unit be sealed off from any mechanism which could splatter lubricants or other contaminants into the freezing chamber.

In accordance with a preferred embodiment of the invention, the improved icemaking apparatus described herein comprises an arrangement whereby the ice is formed in a first zone and transferred through a conduit to an ice delivery means adapted to discharge ice into a receiver in a second zone located either above said first zone or in a position where the ice will not readily flow to the second zone by gravity alone. The conduit connecting the ice forming means to the receiving zone is sized in relation to the dimensions of the ice so that the ice is advanced through the conduit solely by the force of additional ice being delivered from said ice forming means. Another aspect of the invention relates to providing a relatively simple, low-cost freezing and extruding unit which is capable of producing a commercially acceptable grade of ice by shearing off a uniform section of the ice formed in the freezer and advancing it through a restriction, whereby the compressive force exerted thereon removes excess water and compacts the ice.

It is, therefore, a principal object of this invention to provide improved icemaking apparatus for producing ice in one zone and advancing it to a second zone where the spatial relationship between the first and second zones is such that the ice will not readily flow by gravity alone from the former to the latter.

Another object of the invention is to provide an improved ice freezing and extruding unit of the internal auger type having a simple, low-cost form of construction.



Additional objects and advantages will be apparent from a reading of the following detailed description taken in conjunction with the appended drawings wherein:

FIGURE 1 is a schematic diagram of an icemaking apparatus embodying the principles of the present invention;

FIGURE 2 is a cross-sectional view of the ice freezing and extruding unit;

FIGURE 3 is a cross-sectional view taken along the plane line 3—3 of FIGURE 2;

FIGURE 4 is a cross-sectional view taken along the plane of line 4—4 of FIGURE 2; and

FIGURE 5 is a cross-sectional view taken along the plane of line 5—5 of FIGURE 3.

Referring now to FIGURE 1, which is a schematic or diagrammatic illustration of a preferred embodiment of the invention, it will be seen that the system comprises an ice freezing and extruding unit **10** and conduit means **14** arranged to conduct ice formed in said freezing and extruding unit to an ice delivery means, which in the example is formed by the distal end of the conduit, discharging said ice into a storage bin or receptacle **12**. Refrigeration means are provided for cooling the freezing and extruding unit, said refrigeration means including a compressor **16**, a hot gas line **17**, a condenser **18**, a capillary (or expansion valve) **20**, an evaporator **22** surrounding the freezing and extruding unit **10**, and a suction line **23** interconnecting the evaporator with the suction side of the compressor.

Freezing and extruding unit **10** comprises a casing **24** provided with a freezing chamber **26** having a cylindrical side wall **27** and a vertically extending auger **28** journalled within said freezing chamber and driven by a combination motor and speed reduction unit **30**. Water is continuously supplied to the freezing chamber **26** from a reservoir **32** through a conduit **33**. A constant level is maintained in the reservoir **32** (and in the freezing chamber) by means of a float valve arrangement **34** controlling the supply of water to the reservoir through inlet **36**.

Any conventional refrigerant, such as, for example, refrigerant **12**, is discharged under pressure from the compressor **16**, through the hot gas line **17** to the condenser **18** where it liquifies. From there it flows through a restriction, such as capillary element **20** or an expansion valve, to the evaporator, which in the present apparatus is formed by the jacket **22** around the freezing chamber **26**. The liquid refrigerant, under low pressure in the evaporator, boils and extracts heat through the heat conductive walls of the casing **24** to cause a portion of the water in the freezing chamber **26** to freeze on the cylindrical side walls **27**. As the auger is rotated, the auger blades scrape the ice formed on the walls of the freezing chamber and convey it upwardly toward the upper end of the freezing chamber. The ice at this stage is quite watery or slushy owing to the fact that it is in contact with liquid water in the freezing chamber. Consequently, means are provided for extruding the ice through a restriction to compress the excess water out of the ice thereby producing a clearer and more coherent form thereof. This latter arrangement will be more fully described in connection with the construction of the freezing and extruding unit.

Attention is now directed to FIGURE 2 which shows the construction and arrangement of the freezing and extruding unit **10** in greater detail. It will be noted that the casing **24** includes a jacket **22** which completely encircles the median portion of said casing to provide an annular space **25** between the jacket and the casing, said space being maintained at suction pressure and constituting the evaporator of the refrigerant circuit. Liquid refrigerant is admitted to the evaporator through inlet port **40** and the refrigerant vapor is exhausted through port **41** to the suction side of the compressor. A vent opening **31** is provided in the upper portion of the casing **24** to facilitate the flow of water into the freezing chamber.

The auger **28** is vertically arranged within the casing and journalled in upper and lower anti-friction bearing assemblies **42** and **43** respectively. The upper bearing **42** is retained in position between an upper bearing housing **44** and a cover cap or plate **45** closing the upper end of the casing. The lower bearing **43** is supported within a lower bearing housing **46** which is held in place by a retaining ring **48**. Water is prevented from leaking out of the bottom of the freezing chamber by means of an O-ring seal **49** between the bearing housing **46** and the casing wall and a packing member **50** between the auger shaft and the bearing housing.

As mentioned in the preliminary remarks, an important aspect of the present invention is the provision of means for shearing off a uniform "ribbon" of ice and compressing it to remove excess water therefrom. The soft, slushy ice scraped from the inside wall of the freezing chamber is advanced along a restricted path to effect a transformation of the ice into a more compacted and clearer condition. While means for extruding formed ice through a restricted opening are known per se, it is believed that the present design offers significant advantages from the standpoint of fabrication costs, operating efficiency, and uniformity of product.

As best shown in FIGURES 2 and 3, the upper bearing housing **44** includes a downwardly depending sleeve portion **53** and a flat annular surface **54** extending in plane generally normal to the axis of the auger shaft. Radially outwardly from the sleeve portion of bearing housing **44**, a rectangular aperture **56** is provided in the wall of casing **24**, said aperture constituting a passage through which ice is extruded into the conduit **14**. As the ice is advanced toward the upper portion of the freezing chamber, it packs against the annular surface **54** of said freezing chamber and is molded into a generally cylindrical configuration; the rotation of the auger will cause rotation of this cylinder of ice. Means for shearing off a uniform cross-section of the ice as it is rotated and for guiding and restricting the path of the ice as it is extruded is provided in the upper portion of the freezing chamber. A preferred embodiment of this element, designated by reference numeral **60**, includes a loop portion **61** encircling the upper bearing housing sleeve **53** and an elongated shear blade portion **62** which extends tangentially toward the aperture **56** and is engageable with one edge of said aperture. It should be understood that the shear element need not be in this particular form; for example, this element could be made integral with the bearing housing or may comprise a part of the casing **24**.

Element **60** is retained in its operative position between annular surface **54** on the bearing housing and an annular surface near the upper end of the auger shaft. While the loop portion is loosely arranged around the sleeve portion **53** of the bearing housing, it is prevented from revolving because the tangentially extending portion **62** projects at least partially through the aperture and engages the peripheral edge thereof. As perhaps best shown in FIGURE 3, a fitting or connector element **64**, having one end shaped in the form of a rectangle, is welded or otherwise secured to the outside of casing **24** over the aperture **56**. The other end of the fitting has a generally circular cross-section to permit connection to the tubular conduit **14** leading to the ice receiving and storage bin. This arrangement ensures that the ice, which is extruded through the aperture and has a generally rectangular cross-section, is passed into the conduit **14** without jamming and clogging the passage. It should be understood that the shape of the discharge aperture is not critical.

The unique manner in which the ice is removed from the sides of the freezing chamber and extruded out of the aperture will now be discussed in greater detail. The auger **28** is provided with at least one complete flight of helical blades **29** which terminate, at their upper ends, adjacent to the shear and guide elment **60**. The peripheral or radially outer edges of the auger blades are arranged with a slight clearance (about 0.005 to .010 inch) away from the cylindrical side walls of the casing. As the auger is rotated in the direction of the arrow (FIGURE 3), the ice is scraped from the side walls of the freezing chamber and advanced upwardly against the annular surface **54** on the bearing housing. The slushy ice is compacted against this surface in the annular space defined between the radially outer surface of element **60** and the side wall of the casing **27** to form an annular-shaped body of ice. As the auger continues to rotate, this body of ice is caused to move in a circular path through this annular space. The blade portion **62** of element **60** shears off a "ribbon" of ice from the upper end of the rotating body and guides it tangentially out through the discharge aperture **56**.

As shown in FIGURE 3, owing to curvature of the cylindrical side wall, the distance $a$ between the elongated blade portion of element **60** is narrower than the distance $b$ just ahead of it to provide a restricted passage. As the ice is advanced through this restriction, the excess water is squeezed out of the rather wet, slushy ice to thereby effect a compaction and clarification of the same. The excess water flows down into the freezing chamber so that there is no build-up of slush in the discharge throat.

It is an important feature of the present invention that the ice is sheared off in substantially uniform pieces with respect to the cross-sectional area thereof. The ice which passes beyond the restriction is in the form of a series of discrete particles having substantially uniform, transverse cross-sectional dimensions. The uniform, predetermined cross-section of this ice makes it possible to "pipe" the ice through the tubular conduit without jamming. The ice, as will be remembered from the previous description, has a rectangular configuration due to the shape of the passage through which it is extruded. In order to facilitate the transport of the ice through the conduit solely by means of additional ice being extruded out of the aperture, the shape and cross-sectional area of the conduit must be selected so that the ice does not jam or wedge in the passage and block further advancement thereof. Accordingly, as best illustrated in FIGURE 5, the diameter of the conduit **14** is only slightly larger than the diagonal distance across the rectangular cross-sectional area of the ice which is designated by the reference character I. In this way, the tendency of a portion of ice to pile up and wedge against ice immediately ahead of it is avoided. The conduit **14** may be made of flexible tubing such as rubber of plastic, and it should be understood that the cross-sectional configuration of the conduit is not critical as long as its dimensions conform closely to those of the ice being transported therethrough. The distal end of conduit **14** provides an ice delivery means which obviously may take several forms, i.e. a nozzle, chute, or some other mechanism for guiding the ice into the storage receptacle.

Concerning the auger arrangement for removing the ice from the side walls of the freezing chamber, it will be obvious that other mechanisms can perform the same function. For example, a reciprocating scraper could be provided in combination with means for rotating the scraper at the end of the srtoke to shear off a uniform quantity of ice and advance the ice through a discharge throat.

With regard to the general principle of transferring ice from the freezing zone to the storage zone, an important advantage of this principle is that the ice is in the same form at both the entrance end and the exit end of the transfer or conveying conduit. In other words, since the ice is compacted and "preshaped" into discrete particles having uniform, transverse cross-sectional dimensions before it is introduced into the conduit, it will not disintegrate from the compressive force applied during its passage from the icemaking unit to the storage receptacle. This is particularly important where the amount of external force to move the ice is appreciable.

It should be emphasized that the special characteristics of the ice freezing and extruding unit have special utility in a system where gravity alone is insufficient to overcome the friction impeding the movement of ice through the tube, i.e., where some external force on the ice is required to facilitate movement. This condition may occur even when the receiving zone is situated below the level of the icemaking zone, for example, where the storage receptacle is at a considerable distance from the icemaking unit or where the transfer or conveying tube has a number of bends or convolutions.

From the foregoing description it will be seen that the present invention provides an improved icemaking apparatus having many advantages not found in prior art mechanisms of a similar character. While the invention has been described with reference to a specific preferred embodiment thereof, it is obvious that various modifications will be apparent to those skilled in the art. The invention is defined solely in terms of the appended claims which should be given a construction as broad as is warranted by the prior art.

What is claimed is:

1. Icemaking apparatus comprising:

a casing having a freezing chamber including a generally cylindrical freezing wall and means defining a compacting surface extending in a plane substantially normal to the axis of said freezing chamber;

means defining an aperture in the upper portion of said casing to provide a discharge passage;

means for supplying water to said freezing chamber;

refrigeration means for cooling said freezing chamber to freeze a portion of the water supplied thereto on said freezing wall;

a rotatable auger disposed within said freezing chamber for scraping ice frozen on said freezing wall and conveying it toward and through said aperture; and

a shearing and guiding element in the upper portion of said chamber, said element including a loop portion arranged generally coaxially with respect to the axis of said chamber, and a straight, elongated blade portion extending at least partially through said aperture, said loop portion and the upper portion of said freezing wall defining an annular space therebetween, said straight, elongated blade portion cooperating with a portion of said freezing wall to define a restricted path for the ice as it is guided through said aperture.

2. Icemaking apparatus comprising:

a casing having a freezing chamber including a generally cylindrical freezing wall;

means defining an aperture in the upper portion of said casing to provide a discharge passage;

means for supplying water to said freezing chamber;

refrigeration means for cooling said freezing chamber to freeze a portion of the water supplied thereto on said freezing wall;

a rotatable auger disposed within said freezing chamber for scraping ice frozen on said freezing wall and conveying it toward and through said aperture;

a shearing and guiding element in the upper portion of said chamber, said element including a loop portion arranged generally coaxially with respect to the axis of said chamber, and a straight, elongated blade portion extending at least partially through said aperture, said loop portion and said upper portion of said casing defining an annular space therebetween, said straight, elongated blade portion cooperating with the inner wall of said chamber to define a restricted path for the ice as it is guided through said aperture; and

conduit means adapted to receive the ice as it passes through said aperture, said conduit means being sized in relationship to the dimensions of said ice so that it is advanced through the conduit solely by the force of additional ice being introduced into said conduit means.



3. The combination comprising:

ice extruding means located in a first zone,

said extruding means including a discharge opening through which a plurality of discrete particles of ice are continuously ejected, said particles having substantially uniform, predetermined cross-sectional dimensions;

ice delivery means located in a second zone,

said second zone being remote from said first zone and spatially oriented with respect thereto such that said particles of ice cannot be transported from said first zone to said second zone under the influence of gravity alone; and

conduit means defining a passage having predetermined internal clearance dimensions,

said conduit means being arranged to receive ice at one end thereof and conduct it to said delivery means, said predetermined internal clearance dimensions being sized in relation to the cross-sectional dimensions of said ice particles so as to substantially eliminate jamming of said particles within said conduit means, whereby the ejection of ice particles through said discharge opening into said conduit is effective to maintain flow of said particles through said conduit means without significant compaction thereof.

4. The combination comprising:

ice extruding means located in a first zone, said extruding means including

means for shearing a substantially uniform section from a column of rotating, compacted ice particles, a restriction through which said sheared particles are forced to further compress said ice and mold it into particles having a uniform, transverse cross-sectional area, and a passage terminating in a discharge opening through which said ice particles are ejected;

ice delivery means located in a second zone,

said second zone being remote from said first zone and spatially oriented with respect thereto such that said particles of ice cannot be transported from said first zone to said second zone under the influence of gravity alone; and

conduit means defining a passage having predetermined internal clearance dimensions,

said conduit means being arranged to receive ice at one end thereof and conduct it to said delivery means, said predetermined internal clearance dimensions being sized in relation to the cross-sectional dimensions of said ice particles so as to substantially eliminate jamming of said particles within said conduit means, whereby the ejection of ice particles through said discharge opening into said conduit is effective to maintain flow of said particles through said conduit means without significant compaction thereof.

5. Icemaking apparatus comprising:

a casing having a freezing chamber including a generally cylindrical freezing wall and means defining a compacting surface extending in a plane substantially normal to the axis of said freezing chamber;

means defining an aperture in the upper portion of said casing to provide a discharge passage;

means for supplying water to said freezing chamber;

refrigeration means for cooling said freezing chamber to freeze a portion of the water supplied thereto on said freezing wall;

a rotatable auger disposed within said freezing chamber for scraping ice frozen on said freezing wall and forming a generally annularly shaped body of ice in the upper portion of said freezing chamber, said rotatable auger being effective to rotate said body of ice; and

shearing and guiding means in the upper portion of said chamber, said means including a straight, elongated blade element extending entirely across the path of the rotating body of ice, said blade element co-operating with a portion of said freezing wall to define a restricted path for the ice as it is guided through said aperture, said blade element being so spatially related to the freezing wall so as to form a compacted body of ice from which a uniform section is sheared by said blade element.

6. The combination comprising:

ice extruding means including a discharge opening through which a plurality of discrete particles of ice are continuously ejected, said particles having substantially uniform cross-sectional dimensions;

ice delivery means spaced from said ice extruding means;

conduit means connecting said ice extruding means to said ice delivery means and defining a passage having predetermined internal clearance dimensions,

said ice extruding means, said ice delivery means, and said conduit means being so spatially oriented with respect to each other that said particles of ice cannot be transported from said ice extruding means to said ice delivery means through said conduit means under the influence of gravity alone,



said conduit means being arranged to receive ice at one end thereof and conduct it to said delivery means,

said predetermined internal clearance dimensions of said conduit being sized in relation to the cross-sectional dimensions of said ice particles so as to substantially eliminate jamming of said particles within said conduit means,

whereby the ejection of ice particles through said discharge opening into said conduit is effective to maintain flow of said particles through said conduit means without significant compaction thereof.


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