June 12, 1956 F. W. KNOWLES 2,749,722

APPARATUS FOR MAKING ICE IN SMALL PIECES

Filed Sept. 19, 1952 3 Sheets-Sheet 1

FIG. 1

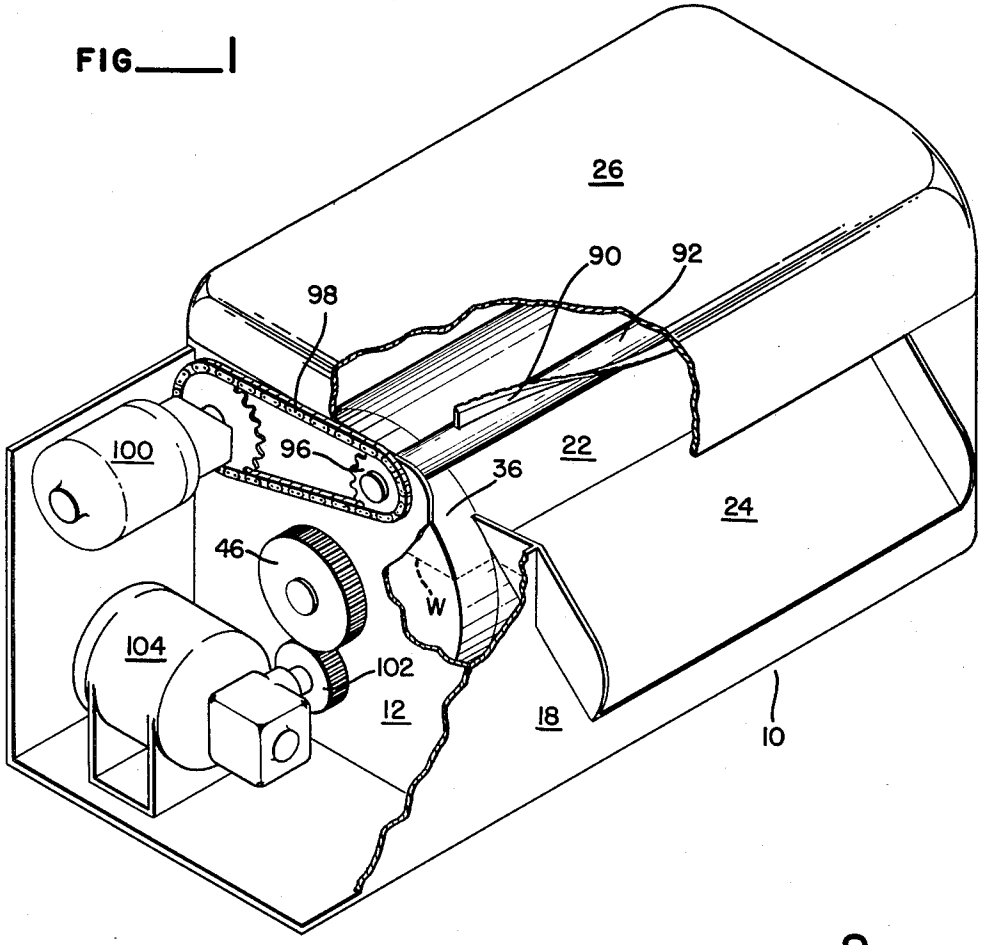
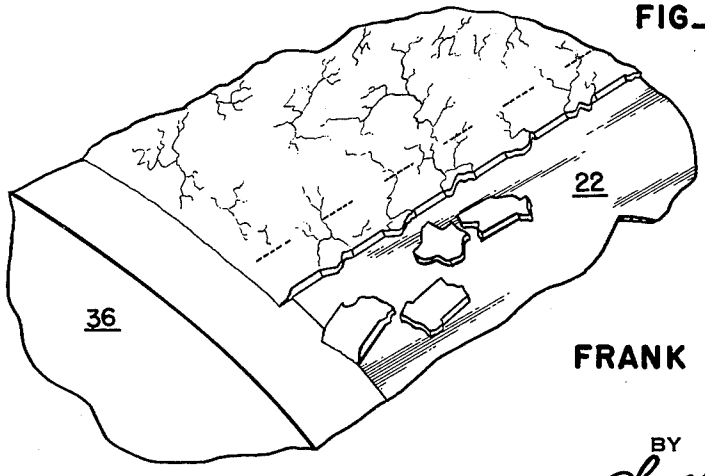


FIG. 2



FRANK W. KNOWLES
INVENTOR

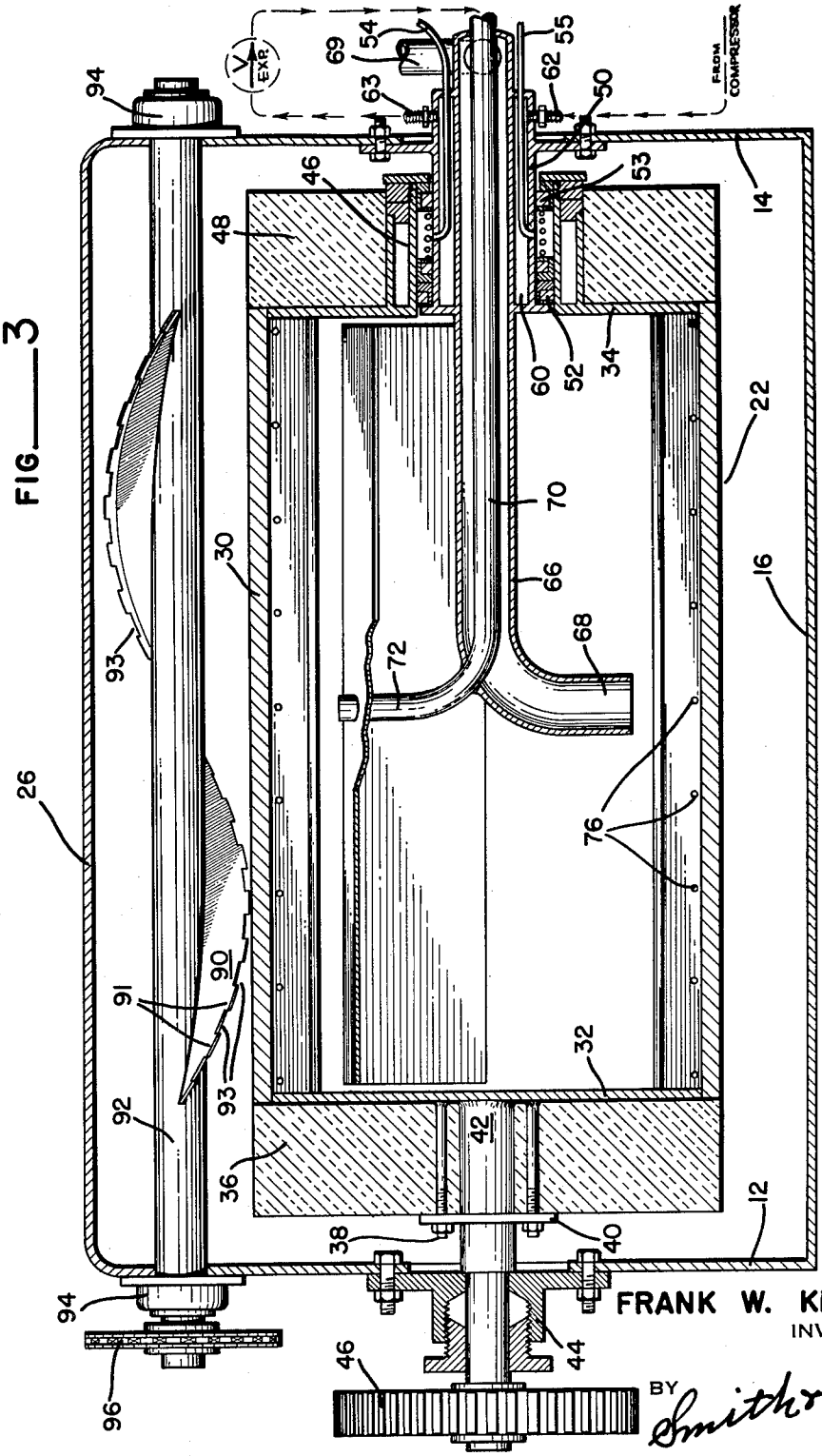
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APPARATUS FOR MAKING ICE IN SMALL PIECES

Filed Sept. 19, 1952 3 Sheets-Sheet 2

FIG. 3



FRANK W. KNOWLES
INVENTOR

BY Smith & Tuck

June 12, 1956 F. W. KNOWLES 2,749,722

APPARATUS FOR MAKING ICE IN SMALL PIECES

Filed Sept. 19, 1952 3 Sheets-Sheet 3

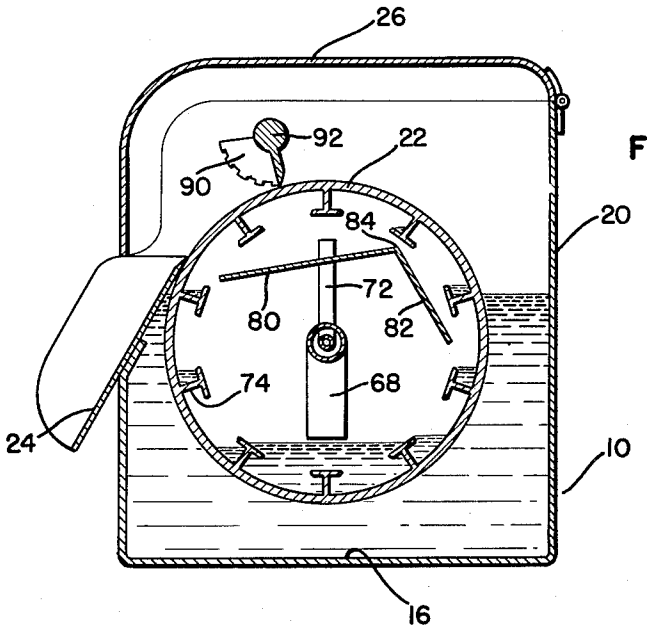


FIG. 4

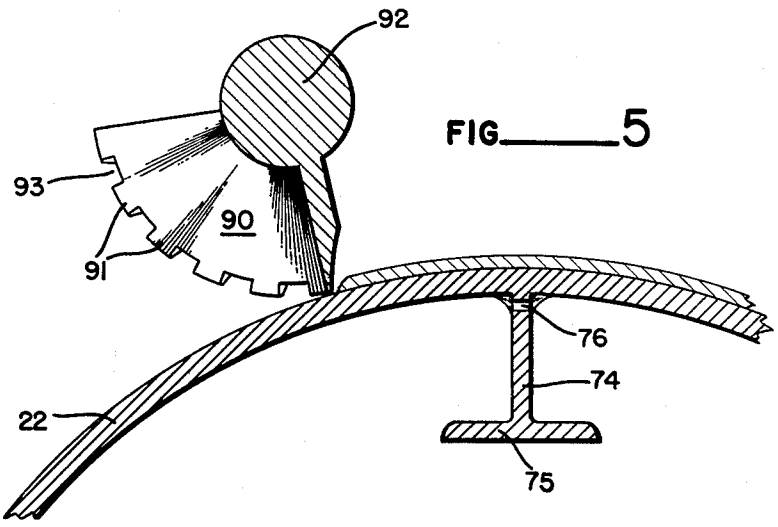


FIG. 5

FRANK W. KNOWLES
INVENTOR

BY Smith & Tuck

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2,749,722

APPARATUS FOR MAKING ICE IN SMALL PIECES

Frank W. Knowles, Seattle, Wash.

Application September 19, 1952, Serial No. 310,446

8 Claims. (Cl. 62—106)

This invention relates to improvements in apparatus for making ice in small pieces and, more particularly, involves the manufacture of ice in a continuous manner upon a revolving rigid surface and its constant removal therefrom in flake-like pieces that have maximum refrigerating surface per unit of mass.

Among the more important objects of this invention are: the provision of simple and efficient apparatus for converting water into ice of sheet-like form having uniform thickness in a continuous manner on a moving rigid surface and for the continuous removal of ice in flake or small sheet form; to provide an improved apparatus for forming a continuous sheet of ice on a rigid surface to which the refrigerant is supplied by means which produce an increased efficiency in the heat transfer function; to create an improved apparatus for removing ice from a rigid moving surface whereby more uniform and better ice particles are obtained for improved cooling action when used; and to provide an ice making apparatus which is sturdy in construction, easy to produce, install, and maintain, and which is economical to operate.

This invention consists of the features of construction and operation and the combinations of elements and their arrangement into a workable entity as is more fully set forth and described in the following description and the accompanying drawings, the scope of application being set forth in the subjoined claims. The foregoing objects of this invention and others will be apparent from a reading of the accompanying specification and claims.

In the drawings:

Figure 1 is a perspective view, with portions broken away for convenience of illustration, of a refrigerating apparatus embodying my invention;

Figure 2 is a fragmentary view in perspective of a portion of the rigid ice-forming surface of my apparatus showing in detail the manner of ice in particle form that is produced and removed;

Figure 3 is a sectional view in upright plane of my refrigerating apparatus as viewed along the longitudinal axis;

Figure 4 is an upright cross-sectional view of the machine of Figure 1;

Figure 5 is an enlarged fragmentary sectional view showing the relative arrangement of the ice forming and ice removing means of my refrigerating apparatus.

My apparatus, shown in Figure 1 comprises a water tight housing or receptacle **10** including end-walls **12** and **14**, bottom **16**, front wall **18**, and rear wall **20**. Within the chamber thus formed is mounted refrigerable cylinder **22** with its axis horizontal and generally disposed beneath the normal water-level W maintained within the receptacle. The front wall **18** is provided with an elongated horizontal slit or discharge opening which receives ice on delivery chute **24** that extends into the chamber into proximate contact with the surface of the cylinder **22** and outward and downward therefrom for guiding ice particles or flakes away from the cylinder. Under certain conditions the apparatus includes the hood **26** which covers the

chamber and encloses the upper exposed portion of the cylinder **22** and certain ice removal apparatus to be more fully described.

Reference to Figure 3 of the drawings will disclose that the cylinder **22** comprises the hollow cylindrical shell **30** having ends **32** and **34** welded or otherwise secured therein. An insulating head **36** is fastened to head **32** by stud bolts **38** and clamp plate **40**. Trunnion shaft **42** extends outward through head **36** from head **32**. Shaft **42** on head **32** is journalled in a packed bearing **44** mounted upon end wall **12** and has gear **46** keyed thereto for transmission of power in the rotation of the cylinder.

At the opposite end of cylinder **22**, the head **34** has a hollow trunnion **46**, surrounded by insulating head **48**, which is rotatably mounted on fixed sleeve **50**, suitable seals **52**, **53** being provided within the trunnion and around the sleeve to retain water in the receptacle and to contain the refrigerant within the cylinder. Sealing fluid such as oil under pressure is supplied to, and withdrawn from the spaces between seals **52**, **53** in a continuous manner by the conduits **54**, **55**. Note that fixed sleeve **50** is chambered at **60** and that to this chamber, through conduits connected to couplings **62**, **63**, refrigerant is delivered and circulated in its passage from within the cylinder to the compressor unit. The purpose of this latter arrangement is to raise the temperature of the bearing and packing means that support the right end (as viewed in Figure 3) of the rotatable cylinder and prevent the formation of ice at this point. In such manner friction or drag is reduced and the free-rotatability of the ice-forming cylinder is maintained at a high level.

Two refrigerant conduits pass axially through chamber **60** between the interior of the cylinder **22** and the exterior of the machine. The larger conduit **66** forms the inner wall of chamber **60** and extends from a mid-point, where it has downturned end **68**, of the cylinder to without the apparatus where it is coupled with the return gas line **69**. Within conduit **66** is the refrigerant supply tube **70** which has the inner upturned end **72** forming a discharge nozzle for the more solid refrigerant delivered to the interior of the ice-forming cylinder **22**. Expanded refrigerant accumulates in the bottom of the cylinder where it is collected and withdrawn through the passage formed by parts **68**, **66** and **69**.

Upon turning to Figures 4 and 5 one will see that the inner face of the cylindrical wall forming cylinder **22** is provided with a plurality of instanding T-shaped fins **74** which have their legs rigidly welded or otherwise secured to the hollow cylinder. Fins **74** extend between the inner faces of heads **32** and **34** and adjacent their point of joinder with the cylinder wall are serially ported by openings **76** which are arranged along the length of the fins. These openings are relatively small and permit refrigerating fluids to pass through from one side to the other side of the fins **74**.

As cylinder **22** is rotated the fins **74** pass through the refrigerant which has accumulated in the lower zone of the hollow chamber within the cylinder. Due to their shape the fins are enabled to scoop up refrigerant and to carry it in the manner illustrated in Figure 4 upward to where it tends to overflow and discharge from the elongated cups formed by the cross-heads **75** of fins **74**. At the same time certain decrements of the refrigerant fluid in the cups is allowed to bleed away through the holes **76** and since these holes are located close to the inner face of cylinder **22** to flow downward across that face and keep it continually wet, increasing the heat absorbing effect through the cylinder wall. As the fins rise in their path of travel they reach a point where the entrapped fluid is spilled over the uppermost lip and discharged. This action is gradual as will be apparent in

Figure 4 and most of it occurs when the fins approach and finally reach the nadir of their travel.

Disposed on and supported by the upstanding tube **72** is formed the slightly sloping plate **80** which extends from end to end of the cylinder and includes the flange **82** which more abruptly slopes toward the rising wall of the cylinder from crest **84**. Members **82**, **84** form a baffle within the cylinder to distribute refrigerant poured from the cups formed by fins **74** and distribute the same toward leading and following fins with respect to those uppermost in the device. Such of the liquid as falls to the right of crest **84** in Figure 4 runs backward toward following fin cups and that which is deposited to the left in Figure 4 of the crest runs across and over the edge of plate **80** into the leading or preceding fin cups. The fins at any one time which overlie plate **80** are out of contact with liquid refrigerant and, thus, the heat transfer effect is somewhat less at the upper path of travel of the cylinder than on either side thereof. This means that the upper portion of the cylinder will have a slightly higher temperature and that the following ice sheet on the exterior of the cylinder will have a relatively lower temperature as it leaves the water in receptacle **12**, and that lower temperatures will likewise be initiated on the cylinder at about the point of re-entry of its surface into the pool. By this arrangement the removal of the ice film from the cylinder is facilitated since at the point of removal of the ice the latter is tending to absorb heat from the cylinder which is to a degree a loosening action.

It will be observed in Figure 4 that the trough bottom **24** is disposed at rather an upright angle and that it is substantially tangential to the outer face of the cylinder **22**. Also note that the point of tangency is quite close to the water level of the fluid in tank **12**. Since it is at the upper edge of trough **24** that the ice first makes contact as it leaves the cylinder and since such ice is extremely cold it will be seen that heat will be absorbed from the water immediately under or within trough **24** thus lowering its temperature at the point where its freezing onto the cylinder is initiated. This coincides with the point inside the cylinder where the free flowing refrigerant fluid passing across plate **80** is being returned to the cups of fins **74**. By this arrangement an increase of efficiency is obtained and substantial advantage is gained.

The removal of ice from the outer surface is obtained in this apparatus by means of a single helically shaped blade **90** mounted upon shaft **92** which is journalled for rotation in bearings **94** mounted upon the upper portions of walls **12** and **14** of the receptacle. Drive sprocket **96** receives power by means of chain **98** from motor **100**. Blade **90** is equal in length to the cylinder **22** and turns with relation thereto so that any point of the blade makes contact with the cylinder quite a few times during each revolution of the cylinder. For example excellent results and desirable ice particle size is obtained by rotating the cylinder **22**, which may be 10 inches in diameter, at a speed of 1 R. P. M. and rotating remover blade **90**, which has a radius of 1½ inches, at a speed of 48 R. P. M. By this arrangement blade **90** at any given point contacts the moving surface of drum **22** at intervals of about two-thirds of an inch and, when the blade is working on an ice film on the drum surface flakes approximately that width are stripped from the drum in the manner depicted in Figure 2 where both removed flakes are shown and, by dotted lines the next line of cleavage is indicated.

Blade **90** is characterized by being beveled rearward from its leading edge and the point of contact with the drum. This is to be seen in Figure 5. Also blade **90** is notched at spaced intervals along its length to leave sharp edged teeth **91** separated by notches **93**. It has been found that this blade edge design facilitates the chip or flake formation from the sheet of ice on the cylinder and tends to eliminate the stripping away of the ice in long slivers as before.

Rotation of cylinder **22** is had by means of gear **102** meshed with gear **46** and driven by reduced drive motor **104**.

What I claim is:

1. In combination, ice-making apparatus, comprising: a tank to contain water to be frozen; a cylinder rotatably mounted in said tank with its axis horizontal and positioned in partial immersion in the water in the tank; means including a nozzle to deliver refrigerant to the upper inner central portion of said cylinder to form ice on its outer surface; means for rotating said cylinder in a continuous manner whereby ice formed on the outer cylinder surface is constantly being elevated to above the surface of water in the tank; means for continuously stripping ice from said cylinder adjacent the upper path of travel of its outer surface; said cylinder having on its inner surface a series of circumferentially spaced instanding and invertible liquid refrigerant carrier members extending between the ends of the cylinder to receive liquid refrigerant and carry the same within said cylinder in close proximity with the coating of ice on the cylinder as the same is being formed and elevated from the water in the tank; and a generally horizontally disposed nonmovable baffle plate in the upper portion of said cylinder to receive refrigerant from said nozzle and elevators, said plate being of substantial width and having its edges located adjacent the ascending and descending walls of the cylinder to laterally distribute the refrigerant to the carriers and the cylinder walls.

2. The combination according to claim 1 in which the instanding liquid refrigerant carriers comprise T-shaped bars secured by their legs to the cylinder and their crossheads are disposed generally at abrupt angles to the radii of the cylinder.

3. The combination according to claim 2 in which the legs of the T-shaped bars are pierced adjacent the point of securement of the legs to the cylinder.

4. The combination according to claim 1 in which the instanding liquid refrigerant elevators comprise bar members having oppositely directed arms disposed on either side of a central member which is attached to the cylinder inner wall.

5. The combination according to claim 1 in which the means to refrigerate said cylinder includes a liquid refrigerant discharge nozzle having its outlet adjacent the upper surface of the baffle whereby the baffle distributes the incoming refrigerant laterally to the ascending and descending walls and carriers of the cylinder.

6. A rotatable evaporator having an external cylindrical freezing surface and comprising a shell casing mounted for rotation and having closed ends for the containment of refrigerant therein, conduit means to deliver refrigerant to the interior of said shell in the upper portion thereof, conduit means to withdraw refrigerant from said shell in the lower portion thereof, and a generally horizontally disposed plate baffle extending longitudinally within said shell beneath the outlet of said refrigerant delivery conduit means to receive fluid refrigerant therefrom, said plate being of substantial width with its edges adjacent the ascending and descending walls of the cylinder to distribute the delivered refrigerant laterally within said shell to the walls thereof.

7. A rotatable evaporator having an external cylindrical freezing surface and comprising a shell casing mounted for rotation having closed ends for the containment of refrigerant therein, conduit means to deliver refrigerant to the interior of said shell in the upper portion thereof, conduit means to withdraw refrigerant from said shell in the lower portion thereof and a generally horizontally disposed plate baffle extending longitudinally within said shell beneath the outlet of said delivery conduit, means to receive fluid refrigerant therefrom and comprising two

planar elements joined together along a common edge and disposed angularly to each other to distribute the delivered refrigerant laterally within said shell through the walls thereof.

8. The structure according to claim 7 in which one of the planar elements is disposed at a steeper angle to the horizontal than the other and the steeper element of said baffle is adjacent the ascending side of said shell casing.

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