This application is a continuation-in-part of my co-pending application, Serial No. 76,394 filed December 16, 1960, now abandoned.

This invention relates generally to ice making and more particularly to improvements in machines for making small pieces of ice suitable for use in drinks or the like.

It is known in the art to make ice by freezing water on the inside wall of a vertical cylinder and continuously scraping the ice from the inside vertical wall by means of a rotating screw or auger that has a pitch diameter almost equal to the diameter of the cylinder. The rotating screw or auger raises the ice in the shape of a hollow cylindrical column that has a helical cut or slot therethrough where the thread of the helix extends. This thread or cut in the vertically moving column of ice facilitates breaking of the column of ice into small pieces.

It is one of the objects of the present invention to provide an arrangement for facilitating the breaking of the upwardly moving column of ice at the top thereof. I have found that this can be accomplished by using a screw conveyor having multiple thread screws. One thread is of a maximum diameter as is required for scraping the ice from the interior wall of the cylinder. The remaining threads are of a smaller diameter but of the same pitch as the major diameter thread. These minor diameter helical threads thus form the upwardly moving column of ice into helical strips each of a vertical height equal to the pitch of the helix divided by the number of threads. All of the strips of ice are joined at their outer periphery by a column of ice and of a minimum thickness equal to the difference between the inside diameter of the freezing cylinder and the outside diameter of the helix. I have found that the threads that are of a smaller diameter than that of the major thread. The inner threads serve to form helically extending lines of weakness on the inside of the upwardly moving column of ice or tube of ice. Such a vertically moving column of ice is very easily broken into small particles as the column of ice reaches any obstruction or its upper limit of travel, which is at the discharge end of the ice forming cylinder.

The attainment of the above and further objects of the present invention will be apparent from the following specification taken in conjunction with the accompanying drawing that forms a part thereof. In the drawing:

Fig. 1 is an elevational view of an ice making machine constructed in accordance with and embodying the present invention.

Fig. 2 is a partial sectional view on an enlarged scale and taken along line 2-2 of Fig. 1.

Figs. 3, 4 and 5 are fragmentary sectional views taken along lines 3-3, 4-4 and 5-5 respectively of Fig. 2.

Fig. 6 is a fragmentary sectional view of the upper end of an ice making machine taken along the same line at which the section of Fig. 2 is taken, and showing a modified form of the present invention; and

Figs. 7 and 8 are perspective views of the ice nugget shaper shown in Fig. 6 and which forms part of the present invention.

Referring now in more detail and by reference characters to the drawing which illustrates preferred embodiments of the present invention, A designates a machine for making ice and comprises a cylindrical tube 1, which forms the side wall of a vertically extending cylindrical freezing chamber 2. Surrounding the central portion of the tube 1 are evaporator coils 3 which extend over a substantial portion of the length of the tube 1 and terminate at inlet and outlet lines 4, 5 that are connected to a conventional refrigeration compressor and condenser (not shown). The tube 1 and its evaporator coils 3 are located within a heat insulating casing 6.

The upper end of the tube 1 has a shoulder 7 for receiving a flanged tube-mounting ring 8, and the tube-mounting ring 8 is soldered at 9 to the tube 1. The mounting ring 8 is secured to a rigid plastic plate 10 by a plurality of screw and nut assemblies 11 (Fig. 4). As seen in Fig. 2, the plate 10 is secured to a support 13 in any suitable manner, for instance, by bolt and nut assemblies 12. The support 13 may form part of a base or stand upon which the entire machine A may be mounted.

Rotatably mounted within the tube 1 and coaxial therewith is an auger or screw conveyor 14 which comprises a sleeve 15 having on its outer periphery a multigroove helical screw. One thread 16 is of a major diameter and the remaining threads 17 (three in number) are of a smaller diameter. The helical thread 16 extends above the top of the evaporator coils 3 and below the bottom thereof and is in close proximity to the interior surface of the tube 1. The helical threads 17 are of the same pitch as the thread 16.

The sleeve 15 has a longitudinal bore 18 for receiving a coaxial drive shaft 19 which extends axially upwardly therethrough. The drive shaft 19 is coupled to the driver of a power driven conventional speed reducer 20. In accordance with the preferred form of the invention, the drive shaft 19 and speed reducer 20 may be considered as one unit so that the drive shaft 19 constitutes the output shaft of the speed reducer 20. The speed reducer 20 also has an input shaft 21 (Fig. 1) which may be drivenly connected to an electric motor (not shown) either directly or through a belt and pulleys.

As best seen in Fig. 4, the housing of the speed reducer 20 has a base flange 22 which has threaded holes 23, 24 for receiving screws 24, 24 which secure the speed reducer 20 to a plastic mounting plate 25 which rests upon the plate 10 and is secured thereto by a pair of bolt and nut assemblies 26, 26. The conveyor 14 is thus suspended from the speed reducer and extends downwardly therefrom into the tube 1.

Referring now to Figs. 2 and 5, the drive shaft 19 is coupled to the sleeve 15 by a drive pin 28 that projects diametrically through the drive shaft 19 and through slots 27, 27 at the bottom of the sleeve 15. The bottom of the sleeve 15 is turned down at 29 for receiving a cup-shaped ring 30 that retains the pin 28 in the slots 27, 27. Mounted on the drive shaft 19 directly below the ring 30 is a bushing 31 that is secured to the drive shaft 19 by a cotter pin 32. If desired, the sleeve 15 and drive shaft 19 may be secured together in the manner shown in my aforementioned co-pending application, Serial No. 76,394, filed December 16, 1960, to which reference may be had.

The bushing 31 has a diametrically enlarged flange 33 which forms a shoulder for receiving a lower bearing 35 that rotatably supports the lower end of the conveyor 14. The bearing 35 is formed on its periphery with an axially extending slot 37 which receives an indentation 39 formed in the tube 1 to limit or prevent turning of the bearing 35. A plurality of slots 37 may be provided for water inlet purposes.

Soldered or otherwise rigidly secured to the lower end
of the cylinder 1 is a fitting 41 which is connected to a water inlet line 42. Water from the line 42 passes through the slotted slots 37 into the freezing chamber 2. A constant water level is maintained in the freezing chamber 2 in a conventional manner, as by a float control valve, that level being maintained slightly below the top of the coils 3.

Adjacent to its upper end, the cylinder 1 is cut away to form an ice-discharge opening 43 that opens into a discharge chute 44. Referring to FIG. 3, a U-shaped sheet metal clamp 45 surrounds a portion of the cylinder or tube 1 behind the discharge opening 43 and has flanges 46, 47. Companion flanges 48, 49 are formed on the inner end of the discharge chute 44, and screws 50, 51 pass through the flanges 46, 47, 48, 49 to hold the discharge chute 44 onto the tube 1.

The upper end of the helical thread 16 terminates substantially at the upper edge of the discharge opening 43, and the downwardly and outwardly presented surface 52 on the upper end of the thread 16 constitutes a helical abutment. When the sleeve 15 rotates, the surface 52 will pass across the die plate and escape 43.

Directly above the sleeve 15 is a bushing 53 which constitutes a closure for the upper end of the cylinder 1. This bushing 53 has a bore 55 for rotatably receiving the drive shaft 19 and serves as a bearing therefor. The bushing 53 has a diametrically enlarged peripheral flange 56 at its upper end which is drilled and tapped at a plurality of places for receiving a plurality of screws 57 that secure the bushing and the mounting plate 25 together.

In use, water is maintained at a desired level, just below the top of the evaporator coils 3. The water freezes against the inside surface of the cylinder 1. The input shaft 21 operates through the speed reducer to drive the shaft 19, which, in turn, rotates the screw 16 which scrapes the ice from the tube wall and conveys it as a column of ice upwardly toward the opening 43. The helical threads 17 assist in raising the ice. The ice will then be discharged into the chute 44 through the opening 43 by the screw 16. It will be understood that the chute 44 conveys the ice to a suitable ice storage bin.

The column of ice that is moved upwardly by the screw conveyor 14 is of a cylindrical outer shape and has an inside bore the shape of which is a counterpart of the shape of the auger. The thread 16 extends to the periphery of the upwardly moving column of ice and thereby forms a helical slot in the ice column. The three central threads 17 of the conveyor 14 form in effect scallops on the interior surface of the column of ice so that between successive turns of the helix 16, the column is of reduced thickness at the three apices 17a of the threads 17 and is of increased thickness along the four roots 17b. The moving column of ice, when it reaches the region above the coils is, therefore, of the shape of four inter-engaged helical strips each of a pitch equal to the pitch of the screw and each of a vertical thickness equal to one-fourth of the pitch of the screw and with the four helical strips of ice joined at their outer periphery by a tubular column of ice that extends from the outside diameter of the ice column, which is the inside diameter of the cylinder 1, to the outside diameter 17a of the helical thread 17. Looking at it another way, the upwardly moving column of ice is in the form of a tube with a helical slot therethrough and with four helical grooves formed on the inner surface of the tube of ice which weaken the tube of ice between successive turns of the helical groove that extends through the thickness of the column of ice and thereby forms lines of weakness or cleavage to facilitate breaking of a column of ice as the ice is pushed upwardly at the top thereof and is free to break into the opening 43.

When it is necessary to clean the interior of the tube 1, it is a relatively simple matter to disassemble the bolt and nut assemblies 26, 26 whereupon the speed reducer 20, the plate 25, together with the drive shaft 19 and all parts mounted thereon, including the screw 14, may be lifted upwardly and bodily removed from the inside of the tube 1. The tube 1, together with the evaporator coil 3 and insulation 6 remain mounted on the support 13. Reassembly is accomplished by merely inserting the shaft 19 with all parts mounted thereon, as shown, into the tube 1 and thereafter securing the tube plates 10, 25, together with the bolt and nut assemblies 26, 26. In this reassembly the lower bearing 55 must be properly oriented, so that the groove 37 is in alignment with the indentation 39. The first time the shaft 19 rotates, the bearing 35 may also rotate in a short arc until the indentation abuts one side of the slot 37, as shown in FIG. 5.

The shaft 19 is driven from above the tube 1. The bushing 53 and bearings within the speed reducer 20 are all above the water level in the chamber 2. Furthermore, no fluid seal need be used across the lower bearing 35. Therefore, the use of water-tight packing or bearing seals is eliminated.

FIGURES 6, 7 and 8 illustrate a modified form of screw used in the apparatus of FIGURES 1 and 2. In this construction the upper part of the screw, illustrated as in FIGURES 7 and 8, is separate from the lower part, which lower part includes the helical thread 16 of FIG. 2 but lacks the intermediate threads 17 of FIG. 2. In this construction the lower part of the auger, indicated at 60, terminates, at its upper end slightly below the lower edge of the plate 25. The lower bearing 65 is cylindrical in shape with an externally projecting helical thread 61 thereon that is of a pitch and diameter the same as the thread 16 in FIG. 1. The lower sleeve or auger 69 is mounted at its lower end on the drive shaft 19 in the same manner as is the conveyor of FIG. 2 to which reference may be had. Resting upon the upper portion of the auger 69 is aucket ice shaper 63 that surrounds the shaft 19 and is keyed thereto for rotation thereupon by a pin 65 that projects diametrically through the shaft 19 and into opposed slots 67, 68 formed in the upper end 69 of the auger shaper 63. On its outer periphery the auger shaper has a multiple screw thread, in this instance four in number, indicated at 72, 73, 74, 75. These screws or helices are of the same pitch as the pitch of the helix 61 and they are uniformly spaced apart. They may extend through the wall of the cylinder 1. They are of an internal root diameter the same as that of the helices 17a, which is at least as great, and preferably greater, than the diameter of the auger 60 at the root of the helix 61.

Rotation of the drive shaft 19 causes the auger 60 to convey ice upwardly towards the rotating bucket shaper. The ice reaching the bottom of the auger shaper is of a shape and cross section which is the shape of the space between the cylinder. The cross sectional area of the flat bottom 78 of the nugget shaper 63 is greater than that of the top of the auger 60. When the ice reaches the bottom of the nugget shaper 63, it is restricted to a smaller cross sectional area, namely the area of the space between the tube 1 and the nugget shaper 63. This constriction results in compression of the upwardly moving tube of ice and results in squeezing of water therefrom. As the ice moves upwardly past the bottom of the nugget shaper, the nugget shaper in effect forms helical grooves on the interior surface of the upwardly moving tube of ice, which grooves form lines of cleavage facilitating breaking of the upwardly moving column of ice when the same passes upwardly below the bottom of the opening 43, as previously explained.

In compliance with the requirements of the patent statutes I have herein shown and described a preferred embodiment of the invention. It is, however, to be understood that the invention is not limited to the precise construction herein shown, the same being merely illustrative of the principles of the invention. What is con-
1. In an ice making machine, means forming a cylindrical chamber with said means including a chamber side wall having an opening adjacent to one end thereof, means forming a water supply inlet to the chamber, refrigeration means for freezing the water on the inside surface of said wall, a screw conveyor rotatably mounted within the chamber, the screw being in sufficiently close proximity to said inside surface to scrape off ice therefrom as said conveyor rotates and delivers a column of ice toward said opening, and auxiliary thread means of the same pitch as that of the screw and forming a plurality of helical lines of weakness in the column to facilitate breaking thereof.

2. In an ice making machine, means forming a chamber having a discharge opening, means forming a water supply inlet to the chamber, refrigeration means surrounding the chamber for freezing the water inside of the chamber, and a conveyor rotatable within the chamber and having a major helical screw thread for conveying a column of ice in the chamber toward said discharge opening, said conveyor also having at least one minor helical screw thread of the same pitch as that of said major screw thread and of a maximum diameter less than the maximum diameter of the major thread and forming at least one helical line of weakness in the column of ice between successive turns of the major screw thread.

3. An ice making machine comprising a tube forming a wall of a cylindrical chamber, said wall having an opening adjacent to one end of the chamber, means for supplying water to the chamber, refrigeration means surrounding the tube for freezing the water to the inside surface of the wall, a conveyor rotatably mounted within the chamber and being coaxial therewith, said conveyor having a shank with a helical screw thread in sufficiently close proximity to said wall to remove ice therefrom as the conveyor rotates and delivers a column of ice toward said opening, said conveyor shank also having at least one additional helical thread of approximately the same pitch as the thread and of a maximum diameter less than that of the first mentioned thread and forming at least one line of weakness in the column of ice, and means at the end of said conveyor serving repeatedly to break up the column of ice conveyed thereto prior to discharge of the ice through said opening.

4. An ice making machine comprising a tube having one end at a higher elevation than the other end, said tube forming a wall of a cylindrical chamber, means for supplying water to the chamber, refrigeration means surrounding the tube for freezing the water within the chamber, a screw rotatably mounted within the chamber for removing ice from the wall of the cylinder and delivering a column of ice upwardly, and a nugget shaper above and adjacent to the screw and being rotatable therewith, said nugget shaper having on its outer surface at least one helical thread that winds upwards from the lower end of said nugget shaper and terminates below the upper end thereof.

5. An ice making machine comprising a tube having one end at a higher elevation than the other end, said tube forming a wall of a cylindrical chamber, means for supplying water to the chamber, refrigeration means surrounding the tube for freezing the water within the chamber, a screw rotatably mounted within the chamber for removing ice from the wall of the cylinder and delivering a column of ice upwardly, and a nugget shaper above and adjacent to the screw and being rotatable therewith, said shaper having on its outer surface a plurality of threads each of which winds upwards from the lower end of said shaper and terminates below the upper end thereof, the cross sectional area of the space between the lower end of the shaper and the tube wall being less than the cross sectional area of the space between the tube wall and screw immediately below the shaper.

6. An ice making machine comprising a tube having one end at a higher elevation than the other end, said tube forming a wall of a cylindrical chamber, means for supplying water to the chamber, refrigeration means surrounding the tube for freezing the water within the chamber, a screw rotatably mounted within the chamber for removing ice from the wall of the cylinder and delivering a column of ice upwardly, a nugget shaper above and adjacent to the screw and being rotatable therewith, said shaper having on its outer surface at least one helical thread that commences at the lower end of the breaker and is open thereat in a direction facing the screw, said screw terminating below the upper end of said breaker and forming a helical line of weakness in the column of ice to facilitate breaking thereof.

7. An ice making machine comprising a straight tube having an upper discharge end and a lower end, means connected to the tube and forming a water supply inlet to the interior of the tube, refrigeration means surrounding the tube for freezing water inside of the tube, a conveyor rotatable within the tube and having a screw for removing ice from the inside surface of the tube and delivering said ice toward said discharge end, said conveyor having a drive shaft extending outwardly of the upper end of the tube for operative connection to a source of power, releasable means above the screw for mounting the conveyor in assembled relationship within the tube, bearing means for rotatably supporting the lower end of the conveyor, and cooperating means on the bearing means and conveyor for removing the bearing means with the conveyor when the mounting means is released and the conveyor is withdrawn through the upper end of the tube.

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