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A. GRUHN
METHODS AND MACHINES FOR MAKING
AN ARTIFICIAL ICE PRODUCT
Filed Jan. 7, 1941

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4 Sheets-Sheet 1

Fig. 1.

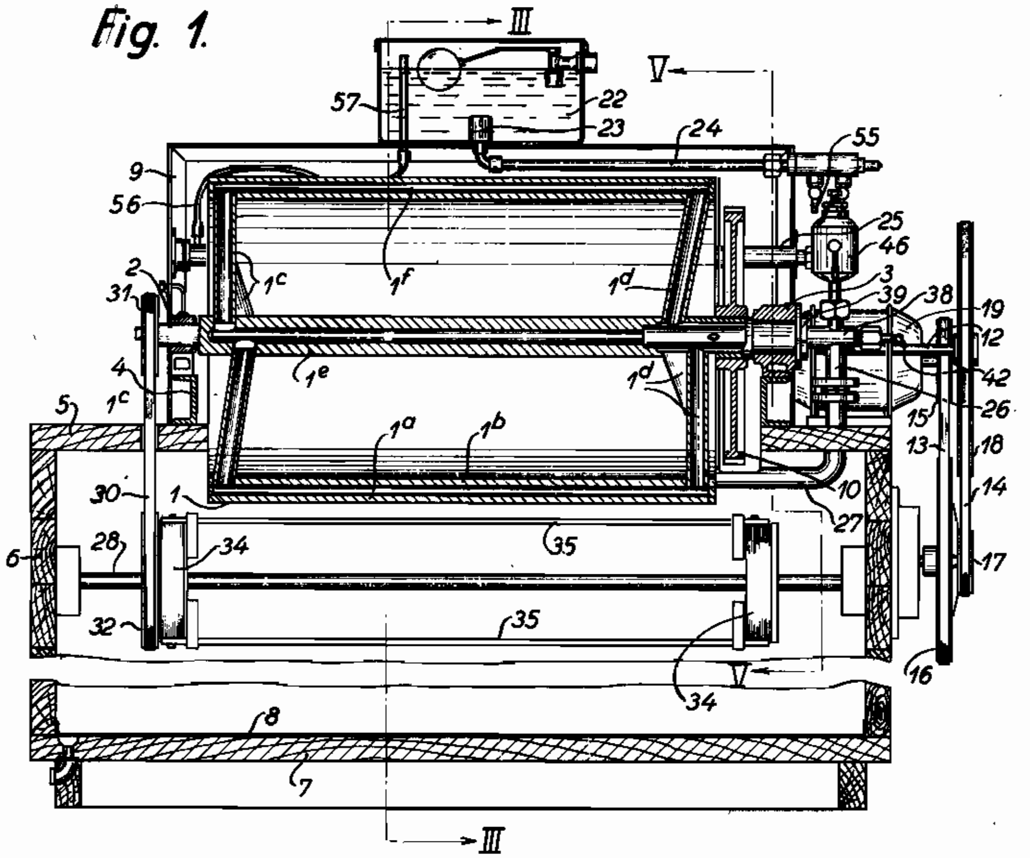

Fig. 2.

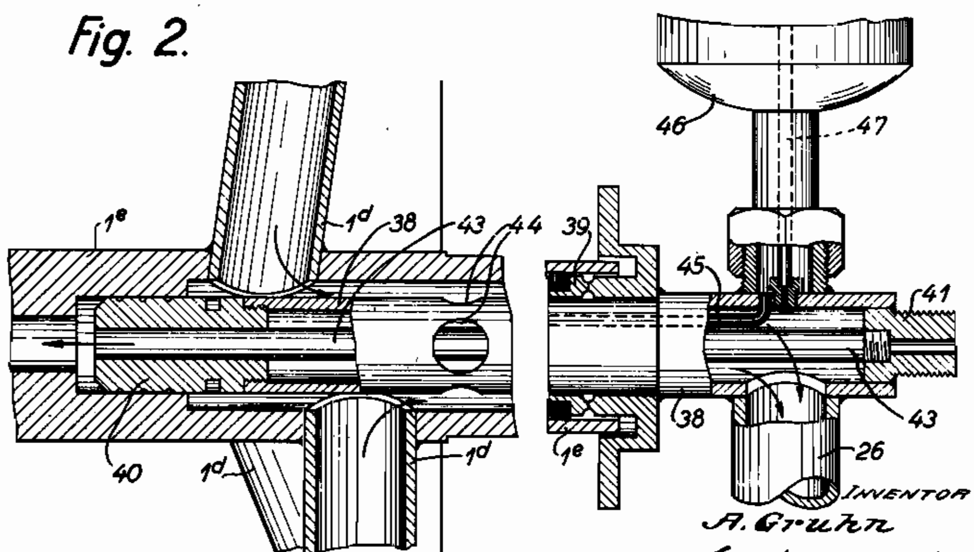

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Fig. 3.

Fig. 4.

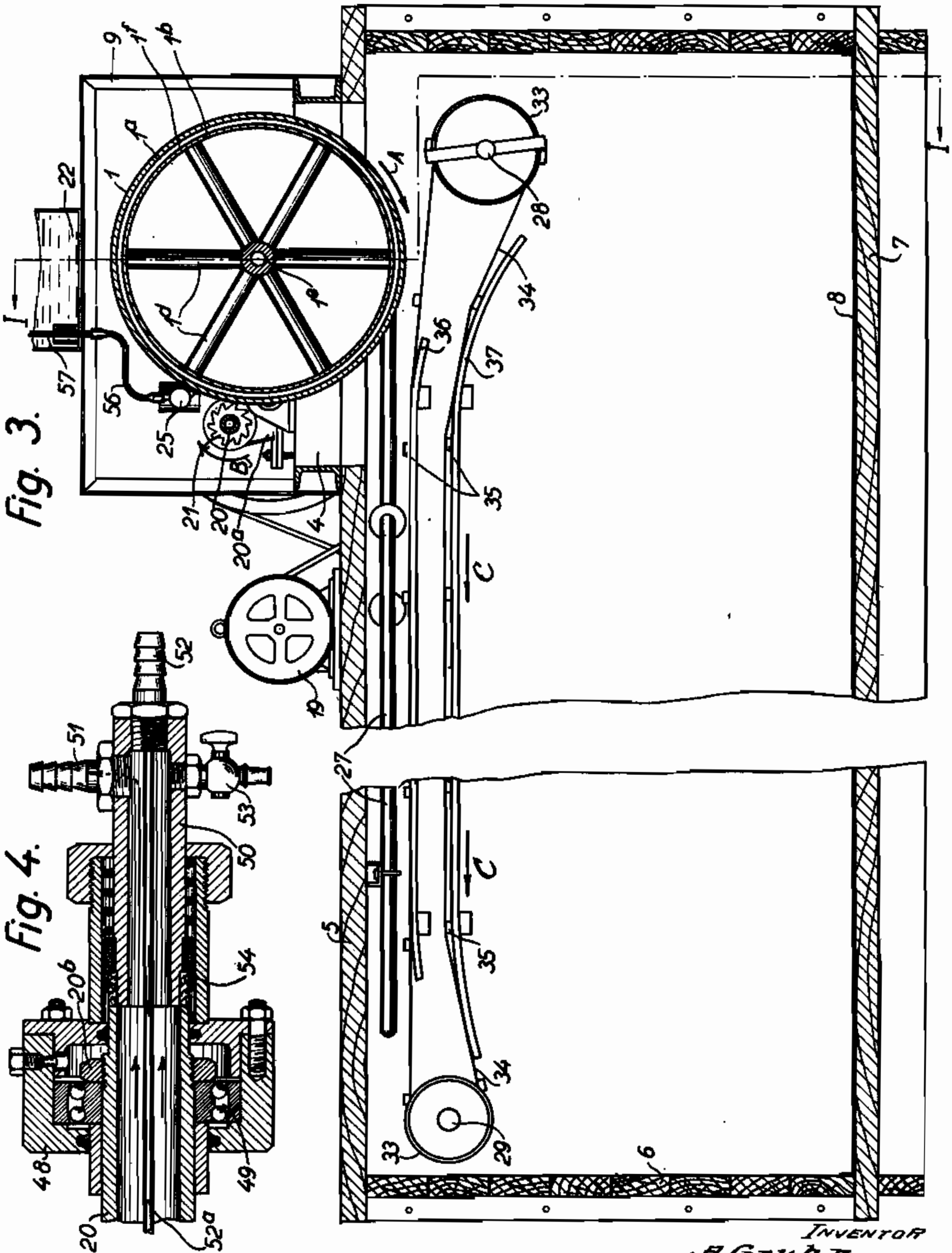

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Fig. 5.

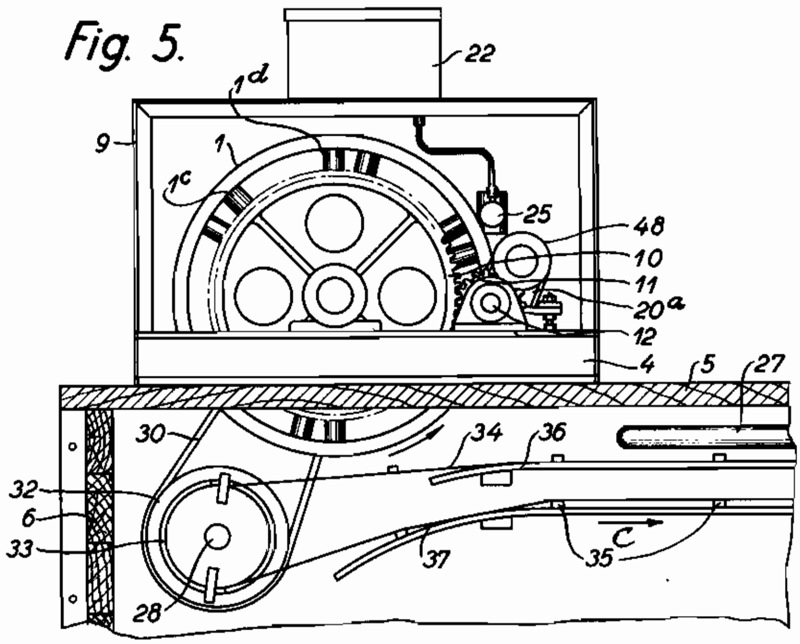
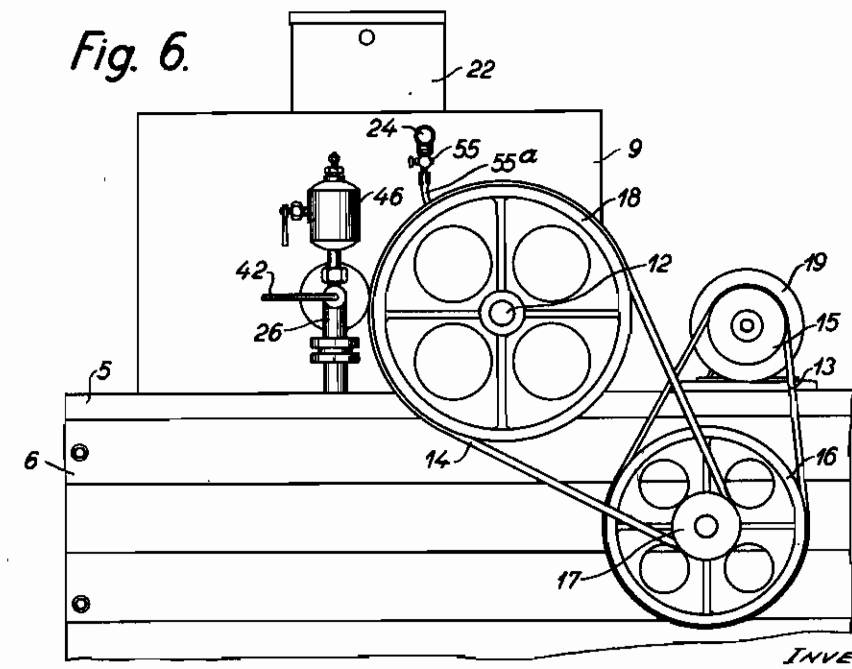


Fig. 6.



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4 Sheets-Sheet 4

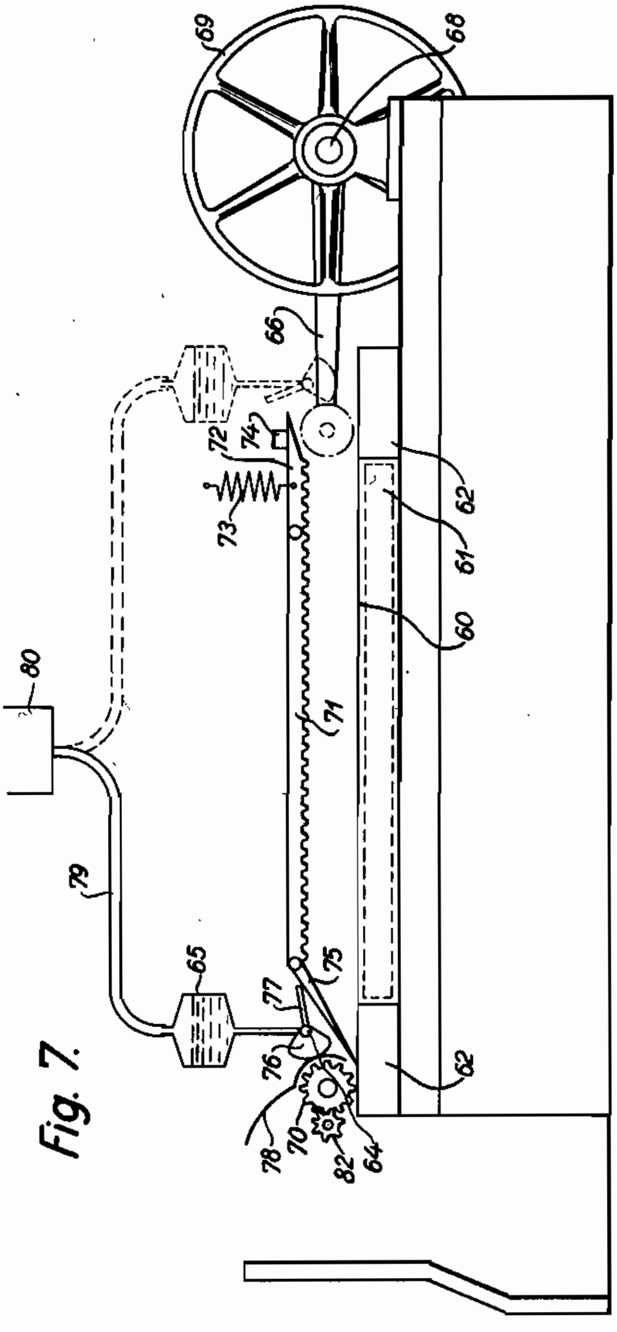

Fig. 7.

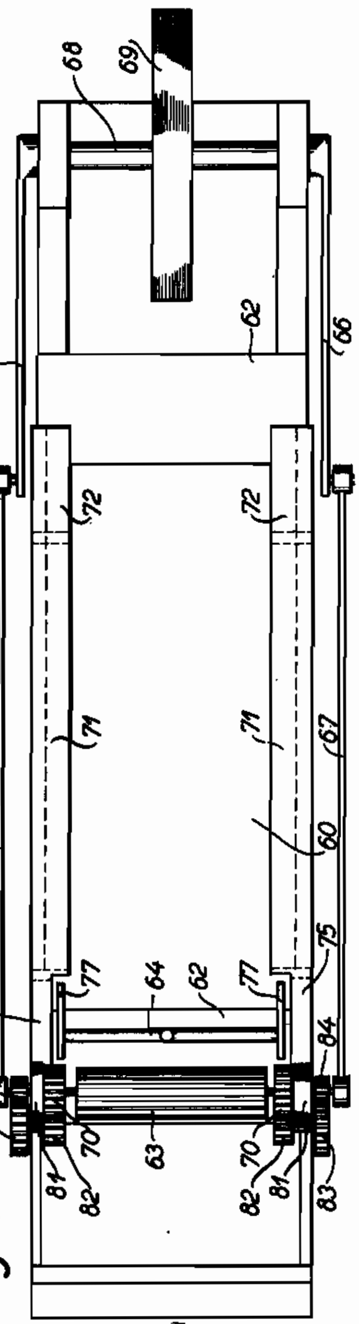

Fig. 8.

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ALIEN PROPERTY CUSTODIAN

METHODS AND MACHINES FOR MAKING AN ARTIFICIAL ICE PRODUCT

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Application filed January 7, 1941

The present invention relates to methods and machines for making a new artificial ice product to be used primarily, but not exclusively for cooling purposes, such as packing of articles of food or of refreshment or as ice for frigorific mixtures.

It is previously known to continuously produce ice on the cold surface of a rotatable thin-walled elastic freezing drum submerged in a water bath, and from which the congealed material is removed by a violent breaking action, the elastic wall during the rotation being locally deformed, whereby the ice cracks into large shells, or the ice is broken into such shells by a rotating spiky roller.

Furthermore it is known by supplying a large excess of liquid to the external surface or the internal surface of a rotating or stationary freezing drum or similar body to produce slush-ice which is scraped off and swept away with the liquid or dropped upon a screen to drain off some of the excess liquid.

However, shell-ice is not satisfactory for ice-packing of various goods as due to its sharp edges it may injure the goods. Thus for instance the mucous membrane of fish is damaged when packing fresh fish with such ice. Slush-ice is wet and plastic, and even if in some cases it is bricketted by a comparatively expensive process its range of utility is much restricted. Moreover, slush-ice is unsatisfactory in so far as its refrigerating power is reduced due to its contents of water.

The present invention has for its purpose to produce an artificial ice product of a special character more suitable for various uses, which result is accomplished by a new method comprising the steps of supplying a liquid to be congealed to a freezing surface and removing the ice formed thereon in a finely divided state, the amount of liquid delivered per unit of time to the freezing surface, the temperature of the freezing surface and the interval of time from the supplying of the liquid until the removal of the ice being so adjusted relative to each other as to form hard, dry ice which in this state is removed by consecutive real cutting actions, such as by means of a powerful milling cutter, in the form of thin cuttings or chips. These small cuttings look like scale of a fish, large flakes of snow or may even be still smaller.

With regard to the difference between the freezing point of the liquid in question and the temperature of the freezing surface it is remarked that the same depends upon various factors, such as the nature, the actual temperature and the freezing point of the liquid supplied, the period of time between the delivery of each liquid particle and the milling off of the ice and so on. For these reasons such difference can not be indicated generally, but it can easily be found in each particular case through experiments and must be so great that the ice besides being frozen uniformly throughout becomes very hard, so that by means of a powerful milling cutter an ice product of the character indicated above can be formed. However, by way of example it is named that for instance in the case of congealing of fresh water the temperature of the freezing surface as a rule should not be higher than −8 to −10° C. preferably between −15 and −20° C, depending upon the designed capacity of the ice making machine.

The artificial ice produced by the method according to the invention has the character of frost-snow with large, thin, scale-like crystals or as finely divided ice, at any rate dry and without sharp edges that could hurt the goods with which the ice comes into contact. This new artificial ice is much more lively and easily movable than are the known ice products referred to above and it can better be distributed over the goods, for the conservation of which it is to be used, for instance milk bottles, vegetables, flowers etc., and for instance when used for frigorific mixtures the necessary salt can more easily be uniformly distributed throughout the mass of ice of such a nature.

The invention can be applied not only to the freezing of pure water, but also of aqueous solutions of various salts, for instance of eutectic solutions for producing eutectic ice. Furthermore comes into consideration the freezing of liquids containing antiseptic or other substances assisting in keeping food articles fresh when cooled with such ice. Besides the present method can be used for congealing milk or other fluent articles of food which must be frozen in such a way, i. e. very rapid, that the material is not during the freezing process divided into its various components, and in which cases the characteristic nature of the ice as explained above is also useful.

In the case of the freezing surface forming the external surface of a rotatable cooling drum the latter may be partly submerged into a bath of the liquid to be congealed, or the liquid may be delivered to the freezing surface through nozzles, atomizers, perforated or finely slotted tubes or in other known or appropriate manner allowing a regulation of the amount of liquid delivered to the freezing surface per unit of time.

The invention also relates to a machine for carrying out the method, which machine is mainly characterized by the provision of one or more revolvable milling cutters capable of cutting the hard and dry, undercooled ice formed on the freezing surface into thin chips or cuttings. The milling cutter or cutters preferably is or are associated with heating means serving to maintain the same at a temperature equal to or above the freezing point of the liquid in order that the ice particles may readily leave hold of the cutter as otherwise the same would be clogged whereby its capacity would be reduced or stopping or damages of the machine occur. For this purpose the milling cutter may be formed with a cavity through which the liquid to be congealed is passed whereby the liquid is simultaneously precooled. Alternatively as heating medium may be used the comparatively warm liquid refrigerant of a compression refrigerating plant cooperating with the ice making machine for cooling its freezing surface.

The character of the ice product may be varied within certain limits by controlling the speed of rotation of the milling-cutter, by changing its direction of rotation relative to the motion of the freezing surface or by using milling-cutters of various constructions. Thus a cylindrical milling-cutter with straight or spiral grooves will give scale-like ice particles, whereas a cutter having cutting teeth arranged as one or more threads will make a more finely divided product. The milling-cutter is so adjusted as to leave a thin ice layer on the freezing surface, thereby protecting the latter.

The freezing surface in a known manner may be the external or internal circumferential surface of a rotatable or stationary body of revolution, for instance similar to the well known cooling drums, but instead it can be plane. In such case the freezing surface for instance is stationary whereas the liquid supplying means and the milling-cutter or cutters are moved to and fro over the freezing surface, preferably so that the milling-cutter travels in advance of the liquid supplying means and removes the ice formed while the cutter has performed its precedent return stroke or idle stroke in a path spaced from the freezing surface.

On the drawings two embodiments of ice making machines in accordance with the invention are shown.

Fig. 1 shows a vertical cross-section along the broken line I—I of Fig. 3 of one embodiment,

Fig. 2 on a larger scale is a longitudinal section of one end of the hollow shaft of the freezing drum with associated parts,

Fig. 3 is a longitudinal vertical section of the same machine along the line III—III of Fig. 1,

Fig. 4 on a larger scale is a longitudinal section of one end of the hollow shaft of the milling cutter of the machine,

Fig. 5 is a vertical cross-section of the upper part of the machine taken on the broken line V—V of Fig. 1,

Fig. 6 is a side elevation of one upper corner of the machine seen from the right side of Fig. 1,

Fig. 7 somewhat diagrammatically shows an elevation of a second embodiment of the ice making machine and

Fig. 8 shows a top view of the same.

Figs. 1-6 show a continuously working ice making machine, the freezing surface **1** of which is the external cylindrical surface of a rotatable double-walled drum consisting of an outer shell 1^a and an inner shell 1^b both carried through hollow spokes 1^c and 1^d by a hollow shaft 1^e journalled in bearings **2** and **3**. Between the two coaxial cylindrical shells 1^a and 1^b a narrow annular cooling chamber 1^f is formed.

The bearings **2** and **3** are mounted on a rigid metal frame **4** carried by the top wall **5** of a large and long wooden tank **6** adapted to receive the scale-ice produced in the machine. The bottom wall **7** of said tank is covered by a thin metal plate **8**.

The freezing drum with associated parts are housed within a sheet metal casing **9** arranged on the top of the wooden tank **6**. On the hollow shaft 1^e of the freezing drum a gear wheel **10** is secured which meshes with a pinion **11** carried by a shaft **12**. This shaft **12** through belts, cords or chains **13** and **14** running over pulleys or wheels **15**, **16**, **17** and **18**, Figs. 1 and 6, is driven from an electric motor **19** mounted on the top wall **5** of the wooden tank **6**. The freezing drum is hereby caused to rotate comparatively slowly in the direction of the arrow A in Fig. 3.

Said shaft **12** also carries a gear meshing with a second gear secured on the hollow shaft **20** of a cylindrical grooved milling cutter **21** which is hereby revolved rapidly in the direction of the arrow B shown in Fig. 3. This milling cutter has a length equal to that of the freezing drum, and its axis of rotation as shown in Fig. 3 is slightly above the level of the shaft of said drum. The hollow shaft **20** of the milling cutter is journalled in bearings carried by brackets 20^a, Figs. 3 and 5, which are rigidly secured on the metal frame **4**.

The liquid to be congealed is supplied from the bottom of a container **22** through a strainer **23**, Fig. 1, a pipe **24** and further connections to be described in the following to the right hand end of a jet pipe or nozzle member **25** placed parallel to the axis of the freezing drum slightly above the milling cutter **21** as shown in Fig. 3, said jet pipe or nozzle member **25** spreading the liquid as fine jets or sprays or in another appropriate way over the entire length of the freezing surface **1**.

In operation a refrigerating medium, such as liquid ammonia, is supplied to the right hand end, Fig. 1, of the hollow shaft 1^e of the freezing drum, from which it flows through the hollow spokes 1^c to the narrow cooling chamber 1^f where the liquid is evaporated thereby cooling the drum. The refrigerant gas flows through the hollow spokes 1^d at the opposite end of the freezing drum to a refrigerant gas pipe **26** preferably continued as a cooling coil **27** which is suspended from the top wall **5** of the wooden tank **6** as more clearly shown in Figs. 3 and 5 to thereby prevent thawing of the scale-ice accumulated in said tank.

When the freezing drum is rotated as above described and liquid is spread over the same the liquid will be thoroughly congealed and form a film or layer of hard dry ice of such thickness that part thereof can be removed by the rapidly revolving cutter **21** which in the present case is assumed to have straight parallel cutting edges. As the milling cutter is angularly spaced more than 300° from the jet pipe or nozzle member **25** measured from the latter in the direction of rotation of the drum and the liquid is supplied in a moderate quantity only the liquid gets sufficient time to be frozen uniformly throughout to form a very hard, dry layer of ice. Another factor important in obtaining this result is that the particular construction of the freezing drum ensures that all of the refrigerating medium is forcibly passed through the narrow annular cooling chamber 1f and thereby kept in close contact with the outer shell 1a of the drum. The thin ice scale or chips cut off by the milling cutter 21 are slung into the wooden tank 6 where they are collected as a heap, from which the dry ice appearing as frost snow can be removed through a door not shown, which is preferably placed at the left end of the wooden tank, Fig. 3, in one of the longitudinal walls thereof. As above stated the cooling coil 27 prevents thawing of the accumulated ice.

The ice making machine is provided with a conveying device serving to distribute the ice over the entire length of the wooden tank. At each end of the same near the top thereof there is rotatably mounted a shaft 28 and 29 respectively, one of which 28 through a cord or chain 30 and wheels 31 and 32 is driven from the shaft 1e of the freezing drum. Each of these shafts 28 and 29 carries two widely spaced pulleys 33 over which two equally spaced belts 34 are running. These belts are interconnected by a series of transversely arranged sticks or bars 35 which travel in the direction of the arrows C shown in Figs. 3 and 5. The ends of the sticks are sliding on and supported by upper and lower stationary guide rails 36 and 37 respectively which have downwardly curved ends as shown.

When the heap of scale ice accumulated in the wooden tank below the milling cutter becomes too high the top of the heap is shovelled away by the travelling sticks 35 whereby the ice is by and by carried towards the left end, Fig. 3, of the tank so as to be substantially uniformly distributed over the bottom thereof.

Some further details of the machine will now be explained with reference to Figs. 2 and 4 drawn on a larger scale.

Fig. 2 shows part of the hollow shaft 1e of the freezing drum at the refrigerant inlet and outlet end thereof. A stationary tube member 38 rigidly secured to the above named refrigerant gas pipe 28 projects into the open end of the rotating shaft 1e and is sealed thereagainst by a stuffing box 39 of any standard type. The inner end of the tube member 38 is screwed onto a plug 40 sealed against the inner cylindrical wall of the shaft 1e whereas the outer end of the tube member is closed by a plug 41 connected with a liquid ammonia supply pipe 42, Fig. 1, said plug carrying a thin pipe 43 passing through the interior of the tube member 38 and sealed at its other end in the plug 40. Through this pipe 43 the liquid refrigerant flows into the hollow middle portion of the shaft 1e, whereas the refrigerant gas coming from the hollow spokes 1d flows through apertures 44 into the tube member 38 and thence away through the pipe 26 as indicated by the arrows.

For sealing purposes oil is supplied to the interior of the stuffing box 39 through a small pipe 45 from an oil receptacle 46. Through a vertical pipe 47 refrigerant gas has access to a space above the oil level in the receptacle 46 whereby in the stuffing box an oil pressure is established which is slightly higher than that of the refrigerant gas to prevent escape of the same to the outer atmosphere.

One end of the hollow shaft 20 of the milling cutter 21 is closed whereas the other end shown in Fig. 4 is open and supported in a housing 48 which receives a ball bearing 49 with back neck 20b for this end of the shaft. The opposite end of the same is journalled in a similar ball bearing. A stationary tube member 50 provided with two hose spigots 51 and 52 and a draining cock 53 is sealed against the end of the rapidly revolving shaft 20 by a stuffing box 54. The liquid to be congealed flows from the pipe 24, Fig. 1, through a cock 55 and a rubber hose 55a, Fig. 6, to the central spigot 52 of the tube member 50 in Fig. 4, wherefrom the liquid through an axial small pipe 52a is conducted to the opposite end of the cutter shaft 20 where the liquid reverses and returns through the hollow shaft 20 and the tube member 50 to the laterally disposed spigot 51. From this spigot the liquid through a second rubber hose not shown is passed to the right hand end of the jet pipe 25, Fig. 1, as indicated above. The opposite end of this jet pipe is vented by means of a rubber hose 56 and a small vertical pipe 57 carrying any air given off by the liquid into the space above the liquid level in the container 22.

By thus passing the liquid to be congealed through the hollow shaft 20 as above described the liquid is pre-cooled before being sprayed onto the freezing surface 1, but hereby said shaft and the milling cutter 21 itself are heated and thus maintained at a temperature equal to or slightly higher than the freezing point of the liquid whereby clogging of the cutting edges of the milling cutter by ice particles is prevented and the continued effective operation of the cutter ensured.

In the embodiment of the ice making machine thus described the ice is simultaneously removed throughout the entire width of the freezing surface by means of the milling cutter 21 having a corresponding great length as above stated. However, instead hereof a short revolving milling cutter may be used which is also reciprocated in the direction of the axis of rotation of the freezing drum. Alternatively, particularly in the case of larger drums, a plurality of milling cutters may be used or other modifications made. As above stated the character of the removed ice may be varied by altering the construction or the mode of operation of the cutter or cutters.

As a dry thin film of ice is left on the rotating freezing surface when passing the milling cutter it may be advantageous to even out the liquid supplied to the freezing surface by means of a smooth roller or strip, for instance of rubber, not shown, bearing against the drum shortly after the jet pipe 25.

Figs. 7 and 8 show somewhat diagrammatically an embodiment of an ice making machine having a stationary plane freezing surface and bodily movable milling cutter and liquid supplying device. The freezing surface 60 is the horizontal uppermost surface of a flat hollow cooling box 61 cooled in any appropriate manner. This box has extensions 62 serving as supports for the milling cutter 63 and the liquid supplying device 64 when these occupy positions outside the freezing surface. The milling cutter 63 and the liquid supplying device 64 as well as a container 65 feeding the same are all carried by a common slide or bracket not shown fixing their mutual distances and moved to and fro together with them. This unit is reciprocated in the longitudinal direction of the machine by means of cranks 66 and connecting rods 67. The said cranks are secured on a crank shaft 68 carrying a belt pulley 69 driven in a suitable manner.

During the working stroke, i. e. while travelling from the right to the left, the milling cutter 63 is rapidly rotated around its own axis by means of the gear wheel mechanism shown at the left end of Fig. 8, this mechanism including a pair of pinions 70 loosely mounted on the shaft of the milling cutter and meshing with a pair of stationary toothed rackets 71 during said stroke. At the end adjacent to the crank shaft 68 these toothed rackets are provided with pivoted links 72 normally held in horizontal position by a spring 73 against a stop 74. At the opposite end two pivoted links 75 likewise are provided which need not be provided with springs as these links by gravity are held in engagement with the extensions 62 of the freezing surface.

During the reciprocation of the milling cutter 63 it will alternately run above the toothed rackets in a direction towards the crank shaft 68 and below the toothed rackets in the opposite direction. This latter stroke constitutes the working stroke during which removal of the ice and delivery of liquid take place, whereas the return stroke is an idle stroke. In order to secure that liquid is only supplied to the freezing surface during the working stroke the liquid supplying device 64, such as a jet pipe or nozzle member, is provided with an interior sleeve valve which is kept closed by counter weights 76 when these are turned downward, whereas the sleeve valve is opened by levers 77 rigidly secured to the counter weights and said valve when these levers engage the pivoted links 72 when beginning the working stroke. During this stroke the sleeve valve is held open until the levers leave the toothed rackets 71 whereby the liquid supply is automatically cut off. 78 is a screen preventing the ice particles from being hurled around by the milling cutter.

As stated above the liquid supplying device 64 is fed with liquid from a container 65. This container by means of a flexible hose 79 is connected with a stationary tank 80 or a liquid supply conduit.

During the working stroke liquid is supplied to the freezing surface a short distance behind the revolving cutter 63. The liquid is congealed to a uniformly frozen, dry, hard ice layer from which the ice is removed as thin scale or chips as in the embodiment shown in Figs. 1–6.

During the idle stroke of the milling cutter and liquid supplying device a pair of smooth rollers 81 run on the upper surface of the links 75, the toothed rackets 71 and the links 72, until the milling cutter and said device arrive at the positions shown in dotted lines at the right end of Fig. 7. Then the working stroke commences.

The pinions 70 loosely mounted on the shaft of the milling cutter 63 mesh with small gears 82, on the shafts of which larger gears 83 are secured which in turn engage gears 84 rigidly secured to the shaft of the milling cutter. The latter shaft as well as the shafts of all these gear wheels are mounted in the slide or bracket referred to above, which also carries the container 65 with the liquid supplying device 64.

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