

April 21, 1942.

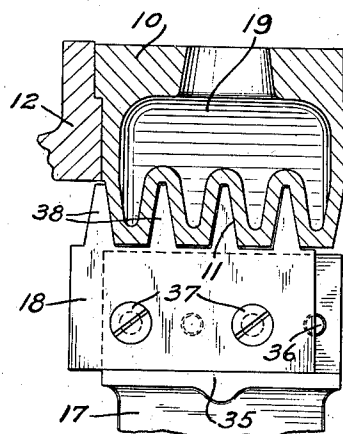
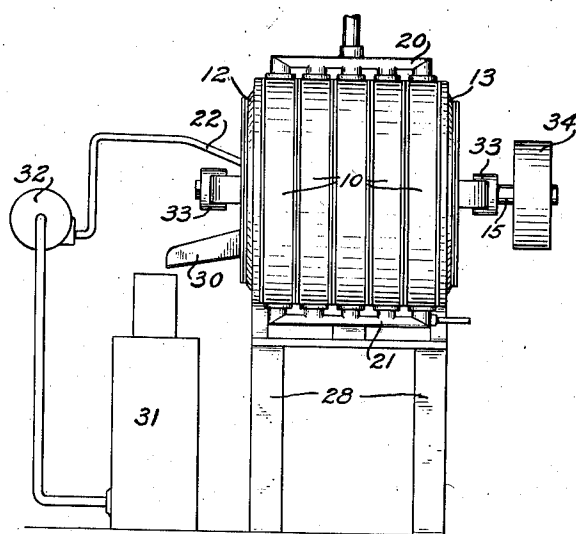
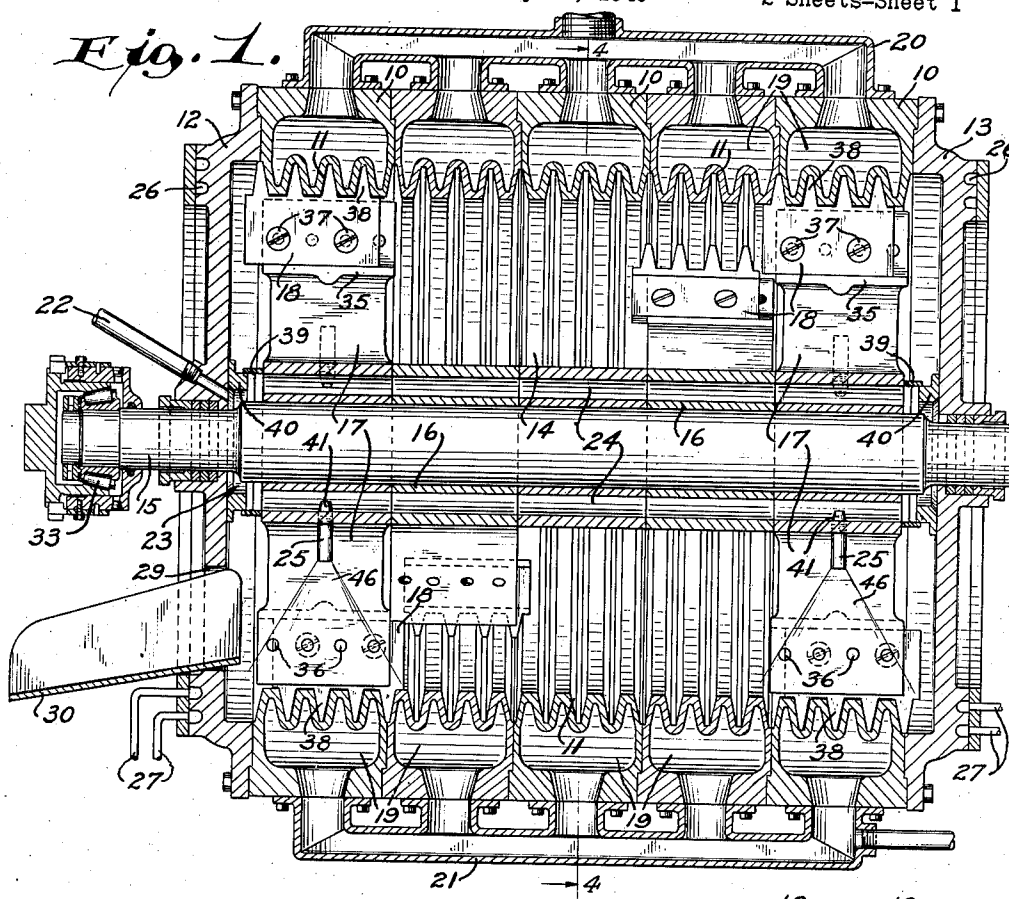
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2,280,320

ICE MACHINE

Filed May 20, 1940

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4.

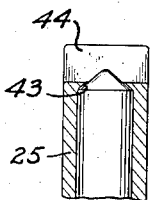
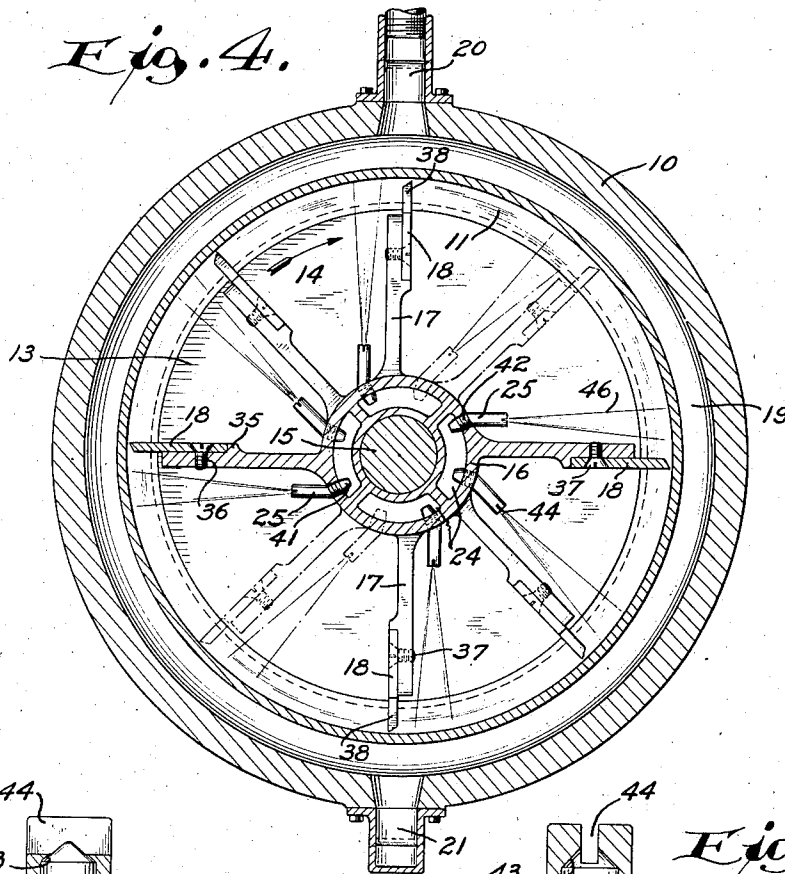


Fig. 6.

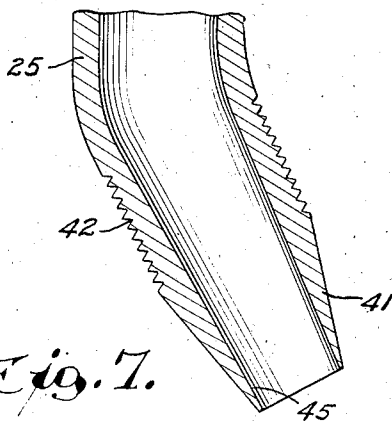
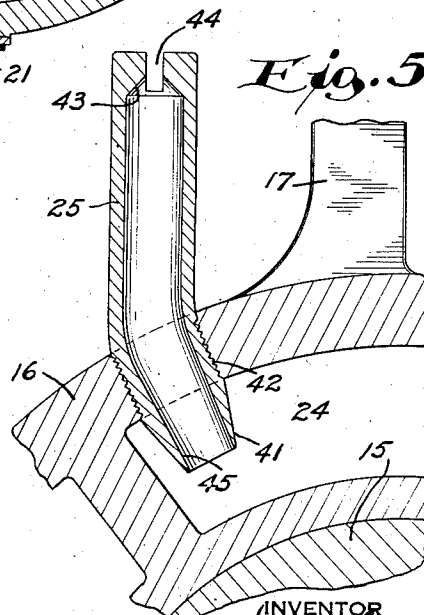


Fig. 7.

Fig. 5.



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UNITED STATES PATENT OFFICE

2,280,320

ICE MACHINE

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Application May 20, 1940, Serial No. 336,113

15 Claims. (Cl. 62—107)

My invention relates generally to improvements in the art of making ice, and relates more particularly to various improvements in the construction and operation of machines for continuously converting flowing liquid into ice.

An object of the invention is to provide an improved machine for continuously and automatically producing ice in a most efficient manner.

Ice machines of the type comprising a casing forming a freezing zone and having an annular corrugated or grooved inner surface subjected to the direct action of the refrigerant, and a rotor provided with corrugated or toothed cutters movable along the grooves of the freezing surface so as to constantly remove the film of ice therefrom, have been in relatively successful commercial use for a number of years for the purpose of continuously and automatically producing slush ice which is subsequently pressed into briquets. In these prior machines, the rotor was provided with two diametrically opposite parallel serrated or toothed cutting edges lying in approximately the same longitudinal plane of the rotor axis and coacting with both sides of the adjacent portions of the freezing surface grooves, so that the ice film was removed from the grooved freezing surface twice during each complete revolution of the rotor; and the rotor was revolved at relatively high speed in order to secure the desired capacity. This required considerable power, and I have discovered that the power consumption can be materially reduced and that the capacity can be increased by disposing successive laterally adjacent sections of the cutters in staggered relation around the rotor axis, by causing the diametrically opposite cutter portions to coact with different parts of the grooved freezing surface so as to effect removal of ice film only once during each revolution, and by considerably reducing the speed of rotation so as to increase the freezing periods. In the prior machines, rotating at high speed, it was also customary to admit the fresh liquid directly into the freezing chamber so that the revolving rotor was depended upon to carry the liquid with a swirl along the parallel grooves of the freezing surface, and the slush discharge opening was located considerably above the horizontal rotor axis and high enough so as to avoid undesirable escape of liquid with the ice particles. I have also discovered that by proper delivery of the fresh liquid to the freezing surface in the form of a relatively fine film or spray and immediately following the removal of ice film by the cutter, more effective film formation is made possible, and quicker removal of ice without un-

desirable escape of liquid may be accomplished by lowering the discharge opening to a point near the bottom of the freezing zone. In the former machines of this type, considerable difficulty was also encountered due to the formation of ice layers and lodging of ice particles on the casing end walls and in relatively small liquid conducting passages, and I have found that this objectionable ice accumulation can be readily eliminated by heating portions of the casing walls and by properly forming the liquid distribution conduits of the system.

It is therefore a more specific object of my present invention to provide various improvements in the details of construction of ice machines of the corrugated freezing surface and revolving cutter type, whereby the power consumption may be reduced to a minimum while the capacity and efficiency is enhanced to a maximum.

Another specific object of the present invention is to provide an improved rotor structure having cutters spaced around the rotor axis so as to uniformly distribute the cutting torque and thereby enhance the smooth operation of the machine.

A further specific object of this invention is to provide an improved blade or cutter structure for rotary ice machines, wherein the cutters located at diametrically opposite portions of the rotor, coact with different portions of the freezing surface, so that film removal is effected only once during each complete rotation or revolution of the cutters.

Still another specific object of my invention is to provide an improved system for distributing fresh liquid along the freezing surface, by causing the liquid to be delivered in the form of a relatively fine film or spray against the surface immediately following the film removal.

An additional specific object of the invention is to provide improved instrumentalities for preventing accumulation of ice and ice particles on different portions of an ice forming machine, so that continued and most efficient operation of the assemblage is assured at all times.

A further specific object of the present invention is to provide an improved nozzle structure for effecting delivery of fresh liquid to the grooved freezing surfaces of an ice machine, in a manner whereby uniform distribution of the liquid and formation of the ice film, is assured.

Still another specific object of the invention is to provide an improved ice machine assemblage of the horizontal type, wherein most efficient discharge of the slush ice may be effected without undesirable discharge of excess quantities of fresh liquid.

These and other specific objects and advantages of my present invention will be apparent from the following detailed description.

A clear conception of the several features constituting my present improvement, and of the mode of constructing and of operating an ice machine built in accordance with the invention, may be had by referring to the drawings accompanying and forming a part of this specification wherein like reference characters designate the same or similar parts in the various views.

Fig. 1 is a central vertical longitudinal section through a typical ice machine embodying my invention;

Fig. 2 is a diagram of a typical system in which my improved machine may be utilized;

Fig. 3 is an enlarged fragmentary longitudinal section through a portion of the casing and showing one of the cutters of the improved machine;

Fig. 4 is a transverse vertical section through the improved machine shown in Fig. 1, the section being taken along the line 4—4 of Fig. 1;

Fig. 5 is an enlarged fragmentary section showing one of the improved liquid distributing nozzles of my improved machine;

Fig. 6 is another section through one of the liquid distributing nozzles the section being taken at right angles to that of Fig. 5; and

Fig. 7 is a further enlarged fragmentary section through one of the nozzles, showing the formation of the liquid receiving end thereof.

While my invention has been shown and described herein as being particularly applied to an ice machine of the corrugated annular freezing surface and revolving cutter type, especially adapted to continuously and automatically produce slush ice from liquid sprays or films, it is not my desire or intent to thereby unnecessarily restrict or limit the scope or usefulness of the several features, some of which may obviously be generally applicable.

Referring to the drawings, the improved rotary ice making unit shown therein comprises in general, a main stationary casing consisting of five interconnected annular sections 10 having internal corrugated or grooved ice film forming surfaces 11, and opposite end heads 12, 13 coacting with the end sections 10 and with the annular corrugated surface 11 to form an enclosed freezing zone 14; an ice film removing member or rotor supported centrally within the freezing zone 14 by means of an approximately horizontal rotary shaft 15, and having a hollow sectional hub 16 secured to the shaft 15 and arms 17 radiating from the hub 16 and carrying a series of sets of diametrically opposite scraper blades or cutters 18 coacting with the corrugated or grooved casing surface 11; annular passages 19 formed within the casing sections 10 and communicating with conduits 20, 21 for the purpose of distributing refrigerant around the freezing surfaces 11 so as to maintain the latter at freezing temperatures; one or more fresh liquid supply pipes 22 communicating through the end head 12 and through a sealing space 23 with internal passages 24 in the hubs 16, to constantly supply liquid to individual nozzles 25 carried by the hubs 16 and directed outwardly toward the surfaces 11 rearwardly of the advancing revolving cutters 18; and spiral passages 26 formed in the end heads 12, 13 and communicating through pipes 27 with a source of warm liquid supply so as to maintain the casing heads heated adjacent to the ends of the cutters 18.

The main stationary casing may be supported

upon a suitable foundation or frame 28, and the end head 12 nearest the sealing space 23 may be provided with a discharge opening 29 having a slush ice discharge spout 30 therein, both preferably located beneath the axis of the rotor shaft 15 and near the bottom of the freezing zone 14. The slush ice discharged from the chute or spout 30 may be delivered by gravity to a briquet forming press 31 as shown in the typical system of Fig. 2, and the excess cold liquid expressed by this press may be returned to the ice producing unit by a pump 32 having its discharge connected to the supply pipe or pipes 22. Refrigerant may be introduced into the casing chambers 19 in any suitable manner so as to maintain the grooved wall or surface 11 at or near freezing temperatures at all times while the system is operating.

The rotor propelling shaft 15 is preferably journaled for rotation about an approximately horizontal axis and at relatively slow speed, in bearings 33 associated with the main casing, and may be rotated by power applied to a pulley 34. As clearly shown in Fig. 1, the rotor consists of five interchangeably similar sections, one of which is disposed within and coacts with each of the annular casing sections 10. The hub sections 16 of the successive rotor sections have snug end coaction with each other so as to provide a continuous passage 24 throughout the rotor length; but these hub sections are secured to the shaft 15 in such manner that the arms 17 of the adjacent rotor sections are located forty-five degrees in advance of each other, thus spacing the cutters 18 uniformly about the shaft axis. Each rotor arm 17 has a projection 35 thereon, against which the corresponding blade or cutter 18 abuts, and each arm 17 is moreover provided with two sets of threaded openings 36 adapted to interchangeably align with corresponding openings in the scraper blades. The blades or cutters 18 are all firmly secured to their respective carrier arms 17 by means of bolts or screws 37. It is to be noted that one blade of each set carried by each rotor section, has teeth 38 which coact only with the right side surfaces of the V-grooves comprising the surface 11 of the corresponding casing section 10, while the other blade 18 of the same set has teeth 38 which coact only with the left side surfaces of the same V-grooves, so that ice film is removed from these groove surfaces 11 only once during each complete revolution of the rotor, see Fig. 1. The number of casing and rotor sections may of course, be varied to produce the capacity desired, and it is to be noted that while each rotor arm 17 is provided with four blade attaching openings 36, only two of these are utilized for attachment of the cutter 18 in a selected position.

The sealing space 23 through which the fresh liquid is supplied to the longitudinal hub passages 24 from the supply pipes 22, is formed by a ring 39 carried by the end of the rotor hub 16 coacting with an annular member 40 fixedly secured to the end head 12. While only one end of the machine has been shown as being provided with liquid supply pipes 22, such pipes may also be provided at the opposite end of the unit, and the fresh liquid which is admitted under pressure to the passages 24 is delivered from these passages to the film forming surface 11 through the improved individual nozzles 25. As shown in Figs. 5 to 7 inclusive, each of the nozzles 25 comprises a tubular body having its inlet end provided with a tapered sharp-edged annular projection 41, its medial portion provided with screw threads 42, and its outer end pro-

vided with a conical internal surface 43 the apex of which is severed by a transverse slit 44. The screw threads 42 are adapted to coact with threaded radial openings formed in the hub sections 16 rearwardly and centrally of each rotor arm 17, and the annular projections 41 extend into the passages 24 a considerable distance, so that liquid from these passages 24 will be withdrawn from the centers thereof and slush ice will tend to hug the outer surfaces of the passages and will not enter and clog the nozzle conduits. The interiors 45 of the nozzles 25 adjacent to the projections 41, may also be tapered so that the liquid passing through the nozzle conduits will have an opportunity to expand slightly, and thus also prevent clogging by ice particles; and the slits 44 which communicate with the outer ends of the nozzle conduits at the conical surfaces 43, should be disposed parallel to the rotor axis so as to produce spreading or fan sprays 46 which overlap and impinge against the freezing surfaces 11 for the full width of the adjacent cutters 18, see Figs. 1 and 4. These jets or sprays 46 of fresh liquid should be delivered to the surfaces 11 as near to the trailing sides of the cutters 18 as possible, and should be of sufficient width to subject the entire freezing surface to liquid spray.

Some of the admitted fresh liquid will naturally drop to the bottom of the freezing zone 14 and will mingle with the ice particles removed from the surfaces 11 by the cutters 18, to thus produce slush ice which will flow by gravity through the opening 29 and along the chute 30 to the briquet press 31. However, by placing the discharge opening 29 below the shaft 15 and near the bottom of the zone 14, less slush ice will be permitted to accumulate in this zone, than with the discharge opening at the top as heretofore, thus permitting the freezing surfaces 11 to act more effectively. Since some of the fresh liquid spray will also come in contact with the end heads 12, 13 and will tend to cause ice formation on the interiors of these heads near the blades 18, it is preferable to pass warm liquid through the spiral passages 26 during normal operation of the machine, so as to prevent such possible ice accumulation.

During normal operation of the improved ice making machine, the shaft 15 and the rotor suspended therefrom are being revolved at relatively slow speed by power applied to the pulley 34, and refrigerant is being admitted to the casing chambers 19, while the pump 32 is operating to deliver fresh liquid from the press 31 through the pipes 22 to the nozzles 25 through the passages 24. The liquid delivered from the nozzles 25 in the form of a fan-shaped jet or spray, strikes the surfaces 11 and is converted into films of ice. The advancing cutter projections 38 cooperating with the grooves of the surface 11, constantly remove the ice films and deposit the removed ice into the bottom of the freezing zone 14, where the ice mingles with the excess fresh water and forms slush ice. The slush ice constantly flows by gravity through the discharge opening 29 and along the chute 30 to the briquet press 31 where it is converted into solid blocks of ice. The excess liquid expressed from the briquets is returned to the pump 32 for recirculation, and additional liquid may be supplied as needed. In this manner the ice producing unit constantly forms films of ice, removes the films, and mixes the removed ice with water to form slush ice, and the ice making operation will con-

tinue so long as the machine is maintained in proper operation.

From the foregoing detailed description it will be apparent that my present invention provides various improvements in the construction and operation of ice making machines, whereby the capacity and efficiency of such machines is enhanced to a maximum while the liability of having the machines become inoperative is reduced to a minimum. The formation of the cutters 18 and the disposition of these cutters and of the rotor arms 17 about the main shaft 15, permits manufacture of maximum quantities of ice with minimum power expenditure, and also permits relatively slow rotation of the rotor. This disposition of the rotor arms 17 also equalizes the torque and provides for smooth operation of the machine. The formation of the nozzles 25 and the disposition thereof with respect to the rotor, insures most effective distribution of the fresh liquid, and the location of the discharge opening 29 at the lower portion of the freezing zone 14, permits quick escape of the newly formed slush ice. The heating of the end heads, and the sharp edges of the projections 41 break up pieces of ice while the internal tapers thereof also assist in preventing clogging and excess accumulations of ice, and the present improvement has proven highly successful in actual commercial use and has vastly improved the capacity and efficiency of ice machines of this type.

It should be understood that it is not desired to limit the present invention to the exact details of construction or to the precise mode of use, herein shown and described, for various modifications within the scope of the claims may occur to persons skilled in the art.

I claim:

1. In an ice machine, a casing having internal annular grooves the surfaces of which are maintained at freezing temperature, and an ice film removing member having diametrically opposite cutters one of which coacts only with corresponding surfaces on one side of said grooves while the other coacts only with the opposite corresponding side surfaces of the same grooves.

2. In an ice machine, a casing having internal annular V-shaped grooves the surfaces of which are maintained at freezing temperature, and an ice film removing rotor having peripheral cutters spaced from each other about the rotor axis, one of said cutters having teeth coacting only with corresponding surfaces on one side of said grooves and another of said cutters having similar teeth coacting only with the opposite corresponding side surfaces of the same grooves.

3. In an ice machine, a casing having internal annular V-shaped grooves the surface of which are maintained at freezing temperature, and an ice film removing rotor having interchangeably similar reversely disposed detachable peripheral cutters spaced from each other about the rotor axis, one of said cutters having teeth coacting only with corresponding surfaces on one side of said grooves and another of said cutters having similar teeth coacting only with the opposite corresponding side surfaces of the same grooves.

4. In an ice machine, a stationary casing having end heads cooperating with an annular wall to form a freezing zone, a rotor having cutters cooperable with said wall to remove ice therefrom, a hollow rotary support for said rotor forming a sealed liquid chamber, and means cooperating with one of said end heads and with said rotor support for conducting liquid under pres-

sure into said chamber from a stationary source.

5. In an ice machine, a fixed casing having end heads cooperating with an annular wall to form a freezing zone, a rotor having cutters co-operable with said wall to remove ice therefrom, a hollow rotary support for said rotor forming a sealed liquid chamber, means cooperating with one of said end heads and with said rotor support for conducting liquid under pressure into said chamber from a stationary source, and nozzles for projecting local jets of liquid from said chamber outwardly against said wall.

6. In an ice machine, a fixed casing having internal annular parallel V-shaped grooves maintained at freezing temperature, and an ice film removing rotor revolvable centrally within said casing and having diametrically opposite cutters each providing with a series of V-shaped teeth movable along and within said grooves, the teeth one of said cutters coacting only with one of the side surfaces of the adjacent grooves and the teeth of the other cutter coacting only with the other side surfaces of the same grooves.

7. In an ice machine, a fixed casing having internal annular parallel grooves maintained at freezing temperature, and an ice film removing rotor revolvable centrally within said casing and having several elongated series of teeth extending along the rotor axis and movable along and within said grooves, the teeth of one of said series coacting only with one portion of each of said grooves and the teeth of the other series coacting only with other portions of the same grooves so that ice film is removed from said groove portions only once during each complete revolution of said cutters.

8. In an ice machine, a casing having internal annular grooves the surfaces of which are maintained at freezing temperature, and an ice film removing member having interchangeably similar reversely disposed detachable cutters one of which coacts only with corresponding surfaces on one side of said grooves while the other coacts only with the opposite corresponding side surfaces of the same grooves.

9. In an ice machine, a casing having an axis surrounded by a series of grooves the opposite side surfaces of which are maintained at freezing temperature, means for spraying liquid against said surfaces to form ice films thereon, and an ice film removing member revolvable about said axis and having several cutters one of which coacts only with corresponding side surfaces of said grooves while another coacts only with the opposite corresponding side surfaces of the same grooves.

10. In an ice machine, a casing having an axis surrounded by a series of grooves the surfaces of which are maintained at freezing temperature, and an ice film removing member revolvable about said axis and having cutters one of which

coacts only with corresponding surface portions of said grooves while another coacts only with other corresponding surface portions of the same grooves.

11. In an ice machine, a casing having an axis surrounded by a series of grooves the surfaces of which are maintained at freezing temperature, an ice film removing member revolvable about said axis and having cutters on of which coacts only with corresponding surface portions of said grooves while another coacts only with other corresponding surface portions of the same grooves, and means revolvable about said axis with said member for constantly spraying liquid against said surface portions.

12. In an ice machine, a casing having an annular wall and fixed end heads cooperating therewith to provide a freezing zone, a rotor having cutters cooperable with said wall to remove ice therefrom, a hollow support for said cutters forming a sealed revolving liquid chamber, and means cooperating with one of said fixed heads and with said cutter support for conducting liquid under pressure into said revolving chamber from a stationary source.

13. In an ice machine, a casing having an annular wall and fixed end heads cooperating therewith to provide a freezing zone, a rotor having cutters cooperable with said wall to remove ice therefrom, a hollow support for said cutters forming a sealed revolving liquid chamber means cooperating with one of said fixed heads and with said cutter support for conducting liquid under pressure into said revolving chamber from a stationary source, and nozzles for projecting local jets of liquid from said chamber against said wall.

14. In an ice machine, a casing having an annular wall and end heads cooperating therewith to provide a fixed freezing zone, cutters cooperable with said wall to remove ice therefrom, a hollow support for said cutters forming an annular revolving liquid chamber, and means including fixed and revolving sealing rings carried by one of said heads and by said support respectively for conducting liquid under pressure into said chamber from a stationary source.

15. In an ice machine, a casing having an annular wall and end heads cooperating therewith to provide a fixed freezing zone, cutters cooperable with said wall to remove ice therefrom, a hollow support for said cutters forming an annular revolving liquid chamber, means including fixed and revolving sealing rings carried by one of said heads and by said support respectively for conducting liquid under pressure into said chamber from a stationary source, and nozzles carried by said support for projecting local jets of liquid from said chamber against said wall near said cutters.

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