Oct. 17, 1933. W. H. TAYLOR 1,930,570

ICE MACHINE

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Fig. 1.

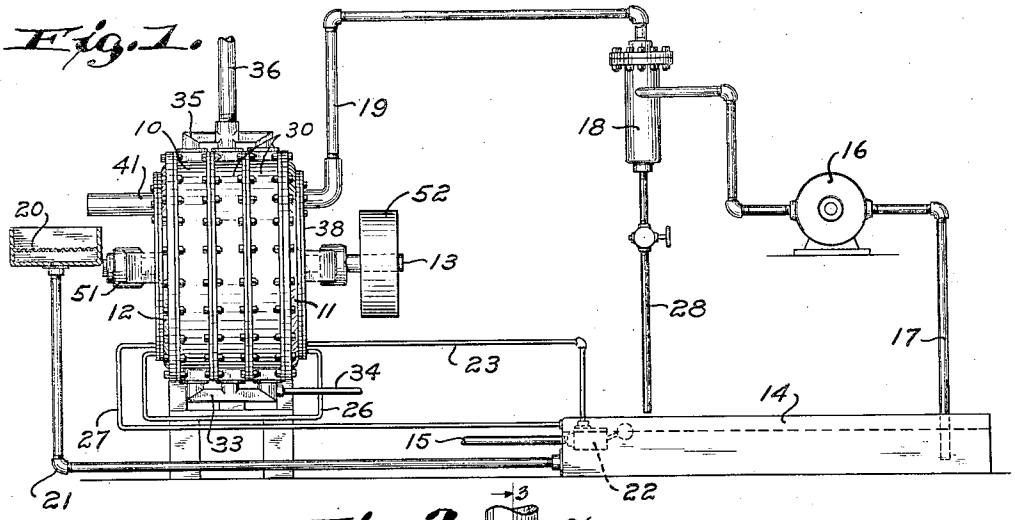
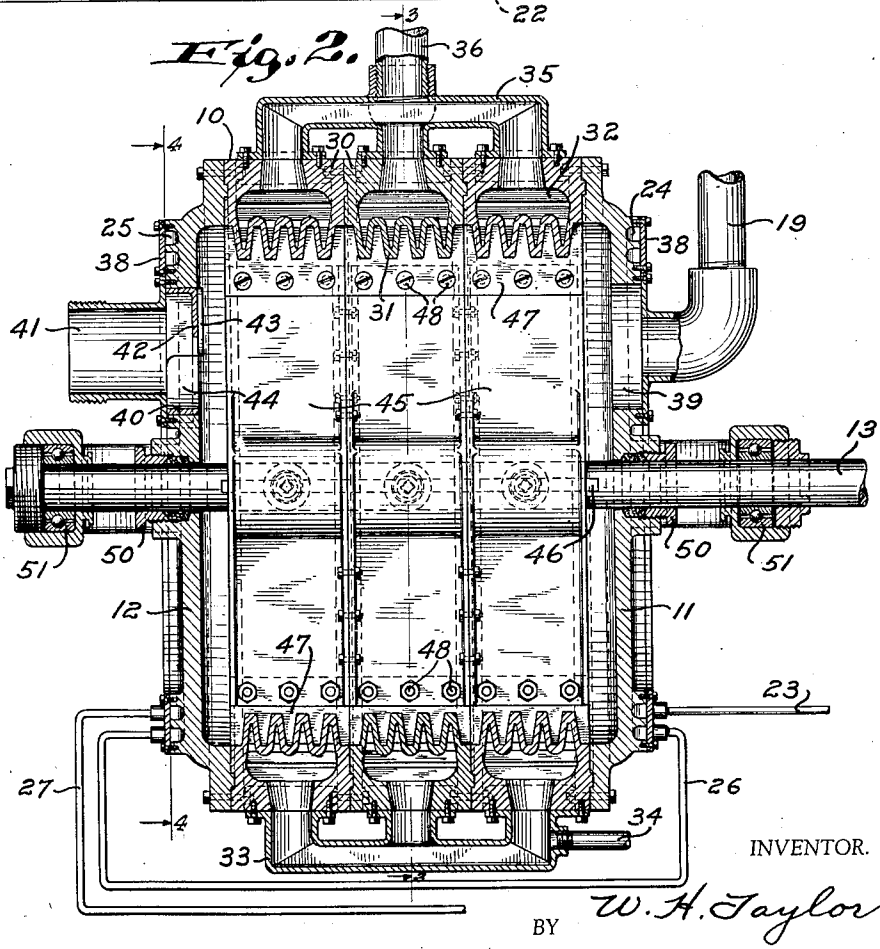


Fig. 2.



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Fig. 3.

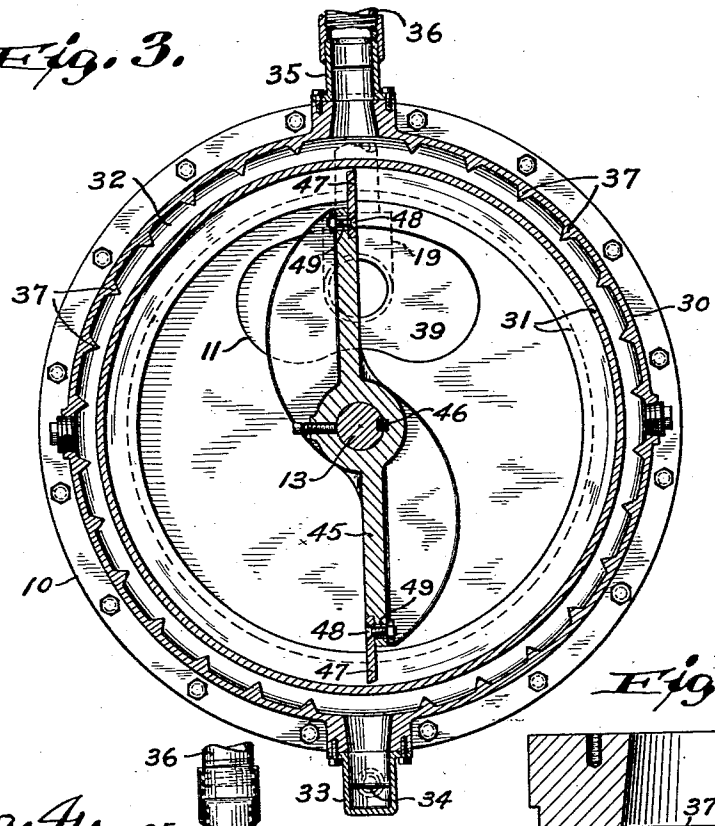


Fig. 4.

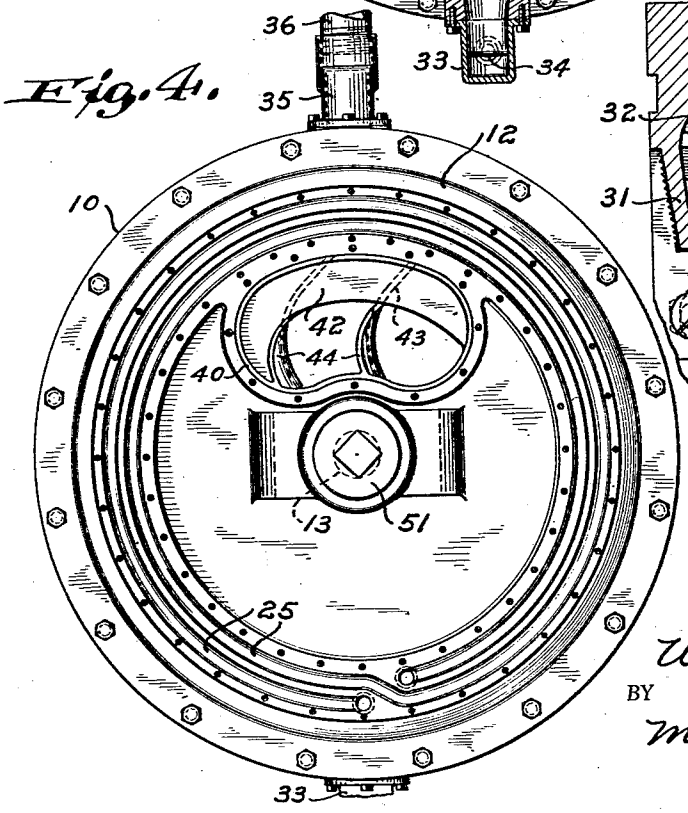
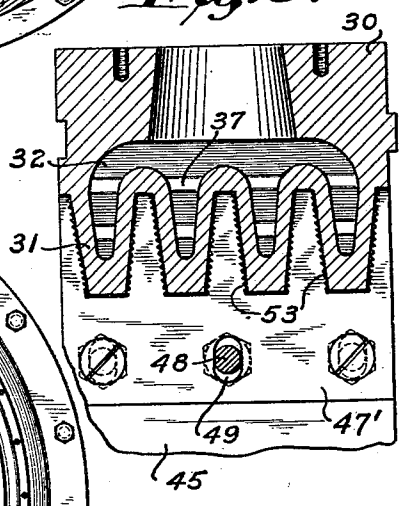


Fig. 5.



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Fig. 7.

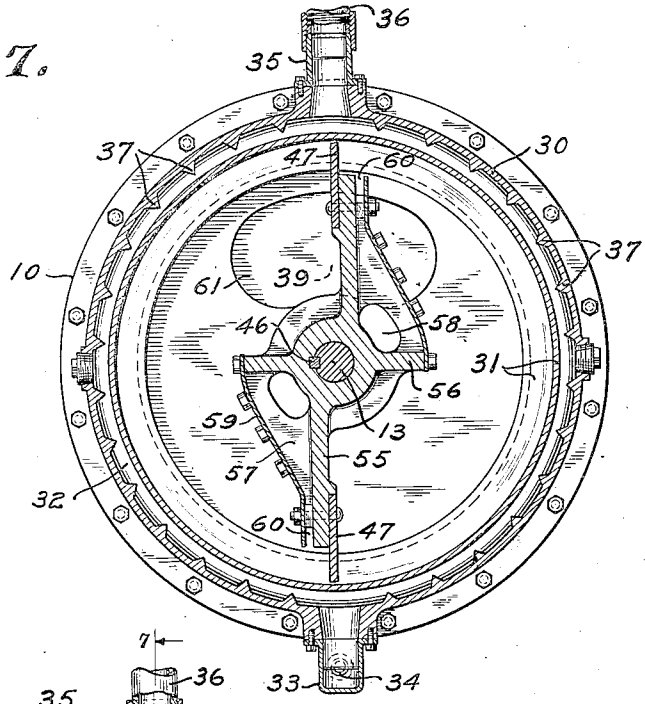
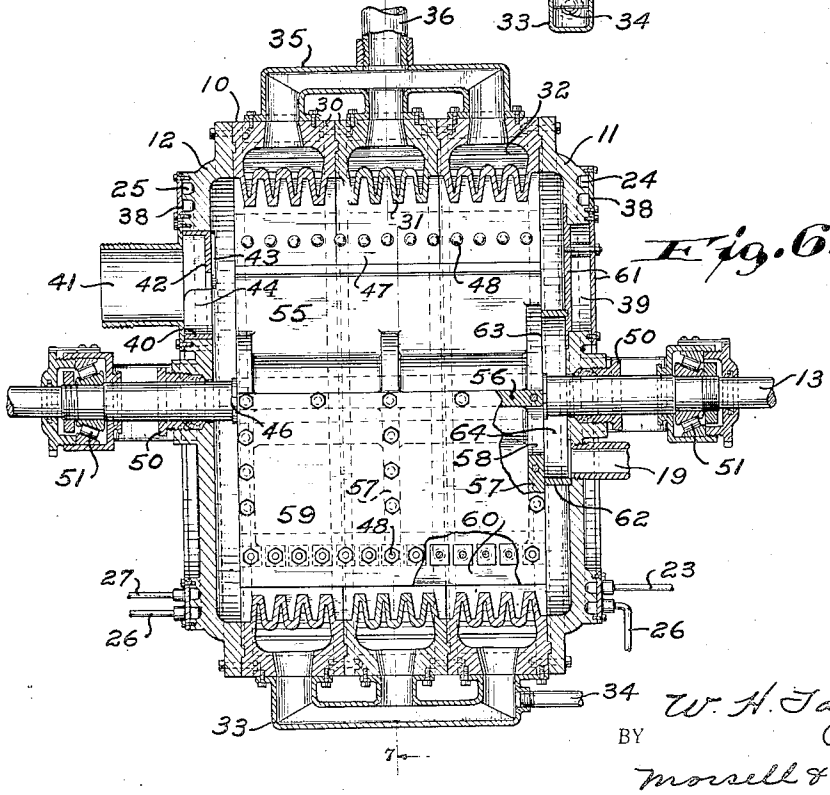


Fig. 6.



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UNITED STATES PATENT OFFICE

1,930,570

ICE MACHINE

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Application January 23, 1932. Serial No. 588,261

20 Claims. (Cl. 62—106)

This invention relates in general to improvements in the art of producing congealed substances, and relates more specifically to improved apparatus for manufacturing ice or other solid material from water or other congealable liquid.

Generally defined, an object of the invention is to provide an improved method of and machine for automatically and continuously producing congealed substance such as ice.

It has heretofore been proposed, as shown and described in copending application Serial No. 488,295, filed October 13, 1930, to make ice by continuously feeding water against a cold surface to thereby cause a thin film or layer of ice to congeal upon the surface, and by promptly removing the ice film from the surface in order to permit subsequent formation of more ice films. In this prior machine, the ice films are removed from the cooled annular internal surfaces of a casing, by means of a film remover which revolves about the axis of annularity of the surfaces, and the ice particles are mixed with water to produce slush ice which upon being removed from the casing may be utilized as desired.

It is a more specific object of the present invention to provide various improvements in the details of construction and in the mode of operating ice making apparatus of the above described type, whereby the ice may be more economically produced for commercial purposes.

Another specific object of the invention is to provide a slush ice producing machine which is simple and compact in construction, and which may be manufactured and commercially operated at minimum cost.

A further specific object of the invention is to provide an ice manufacturing machine the capacity of which may be readily varied by virtue of the sectional construction of its casing and rotor, and in which similar parts are interchangeable so as to permit convenient assembly of machines of different capacities from a relatively small supply of stock parts.

Still another specific object of the invention is to provide an improved ice machine of the rotary type wherein the cutting edges of the film removers are adjustable to vary the film thickness, and in which maximum film surface is available in a relatively small space.

Another specific object of the invention is to provide an ice film producing structure wherein the film forming surfaces are most effectively cooled, and in which undesirable accumulation of ice is positively prevented.

A further specific object of the invention is to provide simple and effective means for pre-cooling the film producing liquid, and for most effectively delivering the same against the film forming surfaces of a slush-ice machine.

Still another specific object of the invention is to provide improved structure for quickly and effectively removing the ice from an ice producing machine, and for effecting most efficient distribution and application of the refrigerating medium to the film producing surface.

Another specific object of the invention is to provide an improved film remover having serrated cutting edges adapted to facilitate and enhance the removal of ice layers and the formation of subsequent layers or films.

A further specific object of the invention is to provide a slush-ice producing machine which is entirely automatic in operation, which is durable in construction, and which is operable with minimum power consumption.

These and other objects and advantages will be apparent from the following detailed description.

Some of the novel features of slush-ice machine construction, disclosed but not specifically claimed herein, form the subject of said copending application Serial No. 488,295, filed October 13, 1930.

A clear conception of the several features of the invention and of the mode of constructing and operating slush-ice making machines built in accordance with the improvement, may be had by referring to the drawings accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in the various views:

Fig. 1 is a general view showing a slush-ice forming system embodying one of the improved ice making machines;

Fig. 2 is a longitudinal central vertical section through one of the improved machines;

Fig. 3 is a transverse central vertical section through the machine, taken on the line 3—3 of Fig. 2;

Fig. 4 is an end view of the machine on the line 4—4 of Fig. 2, with the end plate and ice discharge spout removed;

Fig. 5 is an enlarged fragmentary longitudinal section through a modified form of casing and rotor;

Fig. 6 is a longitudinal central vertical section through a machine having a modified type of rotor therein; and

Fig. 7 is a transverse central vertical section

through the machine of Fig. 6, taken on the line 7—7.

While the improved machine will be described herein as being especially adapted to produce slush-ice from water, it will be understood that this specific disclosure should not be considered as an intent to limit the scope, since the machine is obviously capable of more general application and use.

Referring to Fig. 1, the ice producing system comprises in general an ice machine consisting of an annular casing 10 having end heads 11, 12 and forming an enclosure for a film removing member or rotor supported upon a horizontal shaft 13; a liquid storage and supply reservoir 14 having a fresh water supply pipe 15 associated therewith; a pump 16 for withdrawing pre-cooled liquid from the reservoir 14 through a suction pipe 17 and for delivering the same through a purifier 18 and an inlet pipe 19 to the interior of the casing 10; and a separator 20 for receiving the slush-ice from the casing 10 and for removing and returning the excess liquid to the reservoir 14 through a pipe 21.

The quantity of fresh liquid delivered to the system is regulated by a float operated valve 22 controlled by the level of the liquid within the reservoir 14, and which is interposed between the delivery end of the supply pipe 15 and a pipe 23 communicating with the inlet end of a pre-cooling conduit 24 in the end head 11. The discharge end of the pre-cooling conduit 24 communicates with the inlet end of another pre-cooling conduit 25 in the head 12, through a pipe 26, and another pipe 27 connects the discharge end of the pre-cooling conduit 25 directly with the interior of the reservoir 14, so that all of the fresh liquid admitted to the reservoir 14 is pre-cooled. The liquid returned to the reservoir 14 from the separator 20 through the pipe 21 is also in pre-cooled condition by virtue of its direct contact with the ice. The purifier 18 may be of any suitable type, and removes impurities from the pre-cooled liquid delivered to the casing 10, discharging the same to a valve controlled impurities delivery pipe 28.

Referring specifically to Figs. 2, 3 and 4, it will be noted that the casing 10 of the ice machine comprises three similar annular sections 30 each having an internally grooved wall 31 of substantially uniform thickness surrounded by a cooling jacket 32. All of the jackets 32 of the section 30 communicate at the bottom with a refrigerant supply manifold 33 to which liquid refrigerant such as ammonia may be admitted from a supply pipe 34, and the tops of the jackets 32 communicate with a refrigerant exhaust manifold 35 from which the gaseous refrigerant is adapted to escape through a discharge pipe 36. As clearly shown in Fig. 3, the outer walls of the casing sections 30 are provided with deflectors 37 projecting into the jackets 32 so as to distribute and constantly urge the seething or boiling refrigerant vapor against the adjacent surfaces of the film-forming walls 31 and to maintain the inner corrugated surfaces thereof at freezing temperature. The casing sections 30 are rigidly interconnected to each other and to the end heads 11, 12 to form a complete enclosure.

The end heads 11, 12 are likewise of similar construction and the annular pre-cooling conduits 24, 25 formed directly in these heads, are accessible by virtue of removable annular plates 38 (omitted on Fig. 4) through which the pipes 23, 26, 27 communicate with the conduits. The liquid supply pipe 19 communicates with the interior of the casing 10 through an opening 39 in the end head 11, and the opposite end head 12 has a similar opening in which a special ice discharge element 40 is located and which communicates with a slush-ice discharge spout or nozzle 41. The discharge element 40 is shown in detail in Figs. 2 and 4, and comprises a baffle wall 42, ribs 43 projecting inwardly from said wall, and a series of curved vanes 44 which effectively guide or conduct the mixture of water and ice from the interior of the casing 10 into the spout 41 for delivery to the separator 20, thus eliminating undesirable accumulation of slush-ice within the casing 10.

As shown in Figs. 2 and 3, the film-removing member or rotor comprises three similar sections 45 secured to the main shaft 13 by means of keys 46. The sections 45 are formed as paddles having toothed cutters 47 adjustably attached to their outer ends and cooperating with the tapered grooves of the walls 31 to remove the ice films from the groove surfaces. The cutters 47 are secured to the sections 45 by means of bolts 48 coacting with holes in the sections 45 and with slots 49 in the cutters, so that the cutter teeth may be set to operate with variable clearances relative to the groove surfaces of the walls 31. The rotor drive shaft 13 extends through stuffing boxes 50 in the end heads 11, 12 and coacts with anti-friction bearings 51 supported by but spaced from these heads so as to avoid undesirable cooling of the bearings. The main shaft 13 may be driven by a belt applied to a pulley 52, or by any other suitable means.

In the modified form of cutter 47' shown in Fig. 5, the cutter projections are provided with serrations or teeth 53 which are cooperable with the tapered side surfaces of the annular tapered grooves of the wall 31. The cutter 47' is adjustable to vary the depth of cut and hence the film thickness, in the manner previously explained, and the rotor sections 45 are likewise the same as in Figs. 2 and 3.

Referring to the modified rotor structure of Figs. 6 and 7, the cutter carrier element 55 may be formed either in one piece or in sections, and the same is true of the cutters 47. The carrier element 55 of this modification is provided with ribs 56 radiating from the hub, and also has partitions 57 lying in planes perpendicular to the hub axis and having openings 58 therethrough. Plates 59 secured to the ribs 56 and to the partitions 57 form converging passages 60 for conducting sheets of pre-cooled liquid entering through the openings 58, outwardly against the film forming surfaces of the walls 31 directly in back of the cutters 47. The pre-cooled liquid is admitted from the supply pipe 19 through the end head 11 near the shaft 13, and the opening 39 in the head 11 is sealed by means of removable closure plates 61. A ring 62 is secured to the stationary end head 11 concentric with the shaft 13, and coacts with the revolving end surface 63 of the cutter carrier element 55 to provide a chamber 64 communicating directly with the pipe 19 and with the end opening 58. With this construction, all of the pre-cooled liquid admitted through the supply pipe 19, must pass through the chamber 64, openings 58, and passages 60, before reaching the film forming surfaces, and undesirable accumulation of ice upon the rotor is thus eliminated.

During normal operation of the improved ice producing system, pre-cooled liquid is being de-

livered from the reservoir 14 to the interior of the casing 10 by the pump 16, and the film forming surface is maintained at freezing temperature by the admission of refrigerant such as liquid ammonia to the jackets 32 through the pipe 34 and manifold 33. The shaft 13 is being constantly rotated at any desired speed by the application of power to the pulley 52 and the cutters 47 are being advanced rapidly along and in close proximity to the surfaces of the tapered grooves in the wall 31. The pre-cooled liquid delivered into the interior of the casing 10 is carried outwardly by the revolving rotor and some of this liquid congeals to form the ice film while the balance of the liquid is urged toward the discharge end of the machine and carries with it the ice film removed by the cutters 47. The slush ice thus formed, upon reaching the discharge end of the machine, is conveyed by the ribs 43 and vanes 44 through the discharge opening and into the discharge spout 41 from whence it is delivered to the separator 20 where the major part of the liquid is removed from the ice particles and is returned in pre-cooled condition to the reservoir 14. The fresh liquid admitted through the supply pipe 15 in quantities regulated by the float controlled valve 22, is circulated through the conduits 24, 25 and is likewise eventually delivered to the reservoir 14 through the pipe 27 in pre-cooled condition. Depending upon the setting of the cutters 47, the removed ice film may be of any desired thickness, and the deflectors 37 in the jacket 32 effectively distribute the cooling medium and insure contact thereof with all portions of the serrated wall 31. It will thus be apparent that the system operates automatically throughout, and that all liquid admitted to the casing of the machine is pre-cooled before such admission.

With the rotor construction specifically illustrated in Fig. 5 the ice film which is formed in the grooves of the wall 31, is cut in serrated form by virtue of the teeth 53, and in some cases such a construction may be advantageous in that it will tend to decrease the power required for the removal of the film. In all cases, the cutters 47, 47' may be readily adjusted toward or away from the axis of the shaft 13, in order to vary the film thickness and thereby increase or decrease the power consumption as well as the capacity of the machine.

In the improved construction shown in Figs. 6 and 7, the pre-cooled liquid admitted to the machine from the pump 16, is delivered directly against the film forming surfaces through the passages 60. The water thus discharged against the surfaces, strikes the same in the form of a sheet and directly after the film has been removed by the cutter 47. This construction, therefore insures uniform distribution of the entering liquid upon the film forming surfaces, and also cooperates with the conduits 24, 25 in the end heads 11, 12 to prevent undesirable accumulation of ice cakes upon the interior of the machine.

From the foregoing description it will be apparent that the present invention provides an extremely simple and compact ice producing machine which may be manufactured and operated at minimum cost. The sectional construction of the casing 10 in the form of identical sections 32, and the similar construction of the end heads 11, 12, permits convenient assembly of machines of greater or less capacities from a relatively small supply of stock parts. The interchangeability and similarity in construction of these elements, moreover reduces the cost of machining to a minimum, and the rotor characteristics may likewise be readily varied by forming the rotor in sections corresponding in length to the sections of the casing 10. The adjustability of the cutters 47, 47' is of considerable importance since variation in the film thickness is desirable, and the tapered formation of the grooves and cutters, makes it possible to effect convenient adjustment of the cutters. The deflectors 37 serve to maintain effective cooling of the film forming surfaces, and the discharge element 40 has been found extremely effective in removing the slush ice from the machine. Upon removal of the ice from the machine, and separation of the excess liquid therefrom, the ice particles may either be utilized without the application of pressure, or by forming briquettes therefrom. The ice particles may also be utilized to produce brine ice which may be used as desired. The machine has proven highly successful in actual operation and has extremely large capacity considering the space occupied thereby.

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

It is claimed and desired to secure by Letters Patent:

1. In an ice machine, a casing having a wall provided with internal annular tapered grooves the surfaces of which are maintained at freezing temperature, an ice-film removing member having tapered projections movable along and in close proximity to said groove surfaces, and means for circulating liquid along and across said grooves.

2. In an ice machine, a casing having a wall provided with internal annular grooves the surfaces of which are maintained at freezing temperature, and an ice-film removing member rotatable within said casing about the axis of annularity of said grooves and having projections adjustable at oblique angles relative to and movable along said groove surfaces.

3. In an ice machine, a casing having a wall provided with internal annular surfaces maintained at freezing temperature, a rotary ice-film removing member cooperating with said surfaces, and means for delivering liquid to said surfaces through said member.

4. In an ice machine, a casing having a wall provided with internal annular grooves the surfaces of which are maintained at freezing temperature, a rotary ice-film removing member having cutters movable along said surfaces, and means cooperating with said rotor to deliver liquid directly against said surfaces immediately after the removal of film therefrom by said cutters.

5. In an ice machine, a casing having an internal surface maintained at freezing temperature, an ice-film removing member movable along and in close proximity to said surface, and means for pre-cooling and for circulating pre-cooled liquid along and across said surface to deliver the removed ice-films from within said casing.

6. In an ice machine, a casing having end heads and an internal surface the latter of which is maintained at freezing temperature, an ice-film removing member movable along and in close proximity to said surface, means associated with

said heads for pre-cooling liquid, and means for delivering said pre-cooled liquid to the interior of said casing and against said surface.

7. In an ice machine, a casing having a corrugated wall of substantially uniform thickness provided with an annular surface, means for subjecting said wall to the direct action of refrigerant to maintain the same at freezing temperature, and a rotor having cutter projections movable along and extending into the wall corrugations in close proximity to said surface.

8. In an ice machine, a casing having an annular wall surrounded by a jacket, means for admitting and discharging refrigerant to and from said jacket, means comprising a projection within said jacket for deflecting said refrigerant against one side of said wall while permitting free passage of refrigerant across said projection, and an ice-film removing member movable along and in close proximity to the opposite side of said wall.

9. In an ice machine, a casing comprising inner and outer walls forming an intervening jacket, means for admitting refrigerant to said jacket, means comprising a barrier within said jacket for deflecting said refrigerant away from said outer wall and against said inner wall while permitting passage of refrigerant across said barrier, and an ice-film removing member having cutters movable along and adjustable toward and away from said inner wall.

10. In an ice machine, a casing comprising a plurality of identical end-connected annular sections each having a jacket therein, means for delivering refrigerant to and from the jackets of all of said sections, and an ice-film removing member rotatable within said sections, said member comprising sections of substantially the same length as said casing sections.

11. In an ice machine, a casing comprising an annular portion having a cooling jacket therein, identical end heads coacting with opposite ends of said annular portion, an ice-film removing rotor rotatable within said casing between said heads, and means for delivering liquid through said head jackets and into said casing.

12. In an ice machine, a casing comprising a plurality of identical end-connected annular sections each having a cooling jacket therein, identical end heads coacting with the opposite ends of said casing to form an enclosure, and an ice-film removing member rotatable within said enclosure and having cutters movable along and in close proximity to the interior of said casing, said member comprising sections of substantially the same width as said casing sections.

13. In an ice machine, a casing having an internal annular surface maintained at freezing temperature, an ice-film removing member movable along said surface, means for admitting liquid to said casing and against said surface, and a slush-ice remover at an end of said casing comprising ribs for directing the ice away from said surface and vanes for subsequently directing the ice outwardly.

14. In an ice machine, a casing having internal annular grooves with tapered side surfaces, means for maintaining said surfaces at freezing temperature, a cutter having tapered projections movable along and within said grooves, and means circulating an abundance of liquid along and across said grooves.

15. In an ice machine, a casing having internal annular grooves with tapered side surfaces, means for maintaining said surfaces at freezing temperature, a cutter having tapered projections movable along and within said grooves, the tapered edges of said projections being serrated, and means for inducing a free and rapid circulation of liquid along and across said grooves.

16. In an ice machine, a casing having internal annular grooves with tapered side surfaces, means for maintaining said surfaces at freezing temperature, a cutter having tapered projections movable along and within said grooves, means for effecting adjustment of said cutter projections toward and away from said grooves, and means for circulating liquid along and across said grooves.

17. In an ice machine, a casing having internal annular grooves, a rotor having projections movable along and within said grooves, and means for delivering liquid against said grooves through said rotor.

18. In an ice machine, a casing having a corrugated wall provided with annular grooves, means for subjecting said wall to the direct action of refrigerant to maintain the same at freezing temperature, a rotor having cutter projections movable along said grooves, and means for effecting adjustment of said projections toward and away from said grooves.

19. In an ice machine, a casing having an annular wall generated about a horizontal axis, means for maintaining the surface of said wall at freezing temperature, an ice film removing member rotatable at high speed within said casing about the axis of annularity of said wall, means for admitting liquid horizontally into the path of said rotor member whereby said liquid is delivered against said wall by centrifugal force, and means for effecting discharge of slush ice horizontally from within said casing.

20. In an ice machine, a casing having a wall provided with internal annular grooves generated about a horizontal axis, means for maintaining the surfaces of said grooves at freezing temperature, an ice film removing member rotatable within said casing about said axis and cooperable with said grooves, means for delivering liquid horizontally into the path of said rotor member whereby said liquid is delivered against said grooves by centrifugal force and is subsequently carried therealong, and means for effecting discharge of slush ice horizontally from the end of said casing remote from the liquid inlet.

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