

March 25, 1952

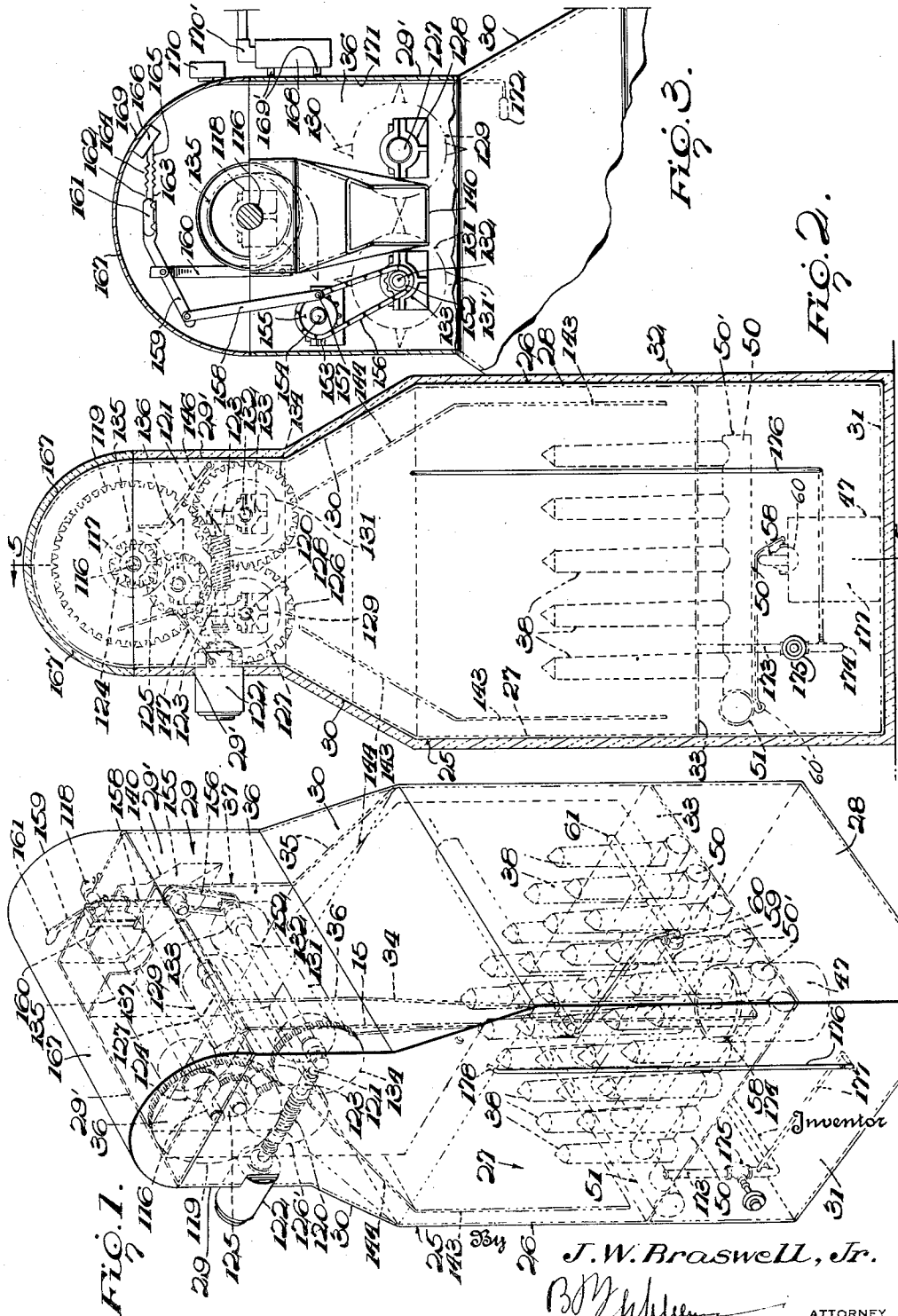
J. W. BRASWELL, JR

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ICE-MAKING MACHINE

Filed Jan. 18, 1949

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FIG. 6.

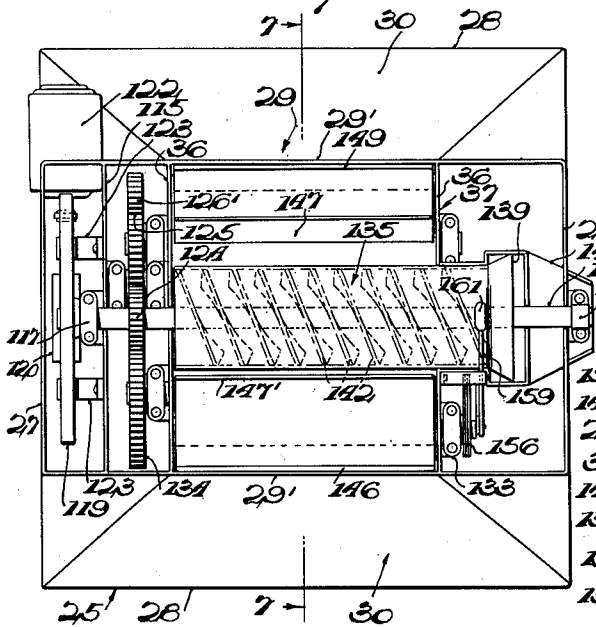


FIG. 7.

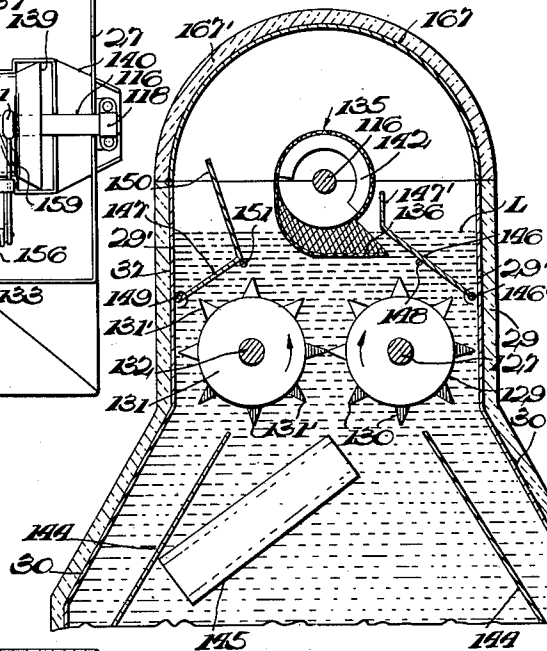
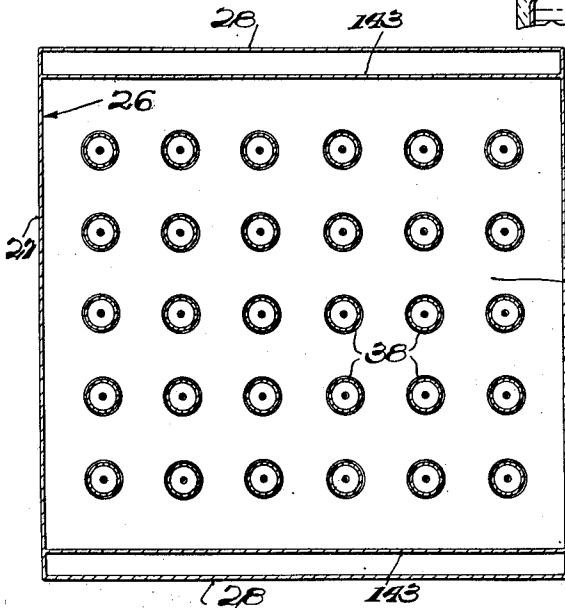


FIG. 8.

Inventor

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[Signature]

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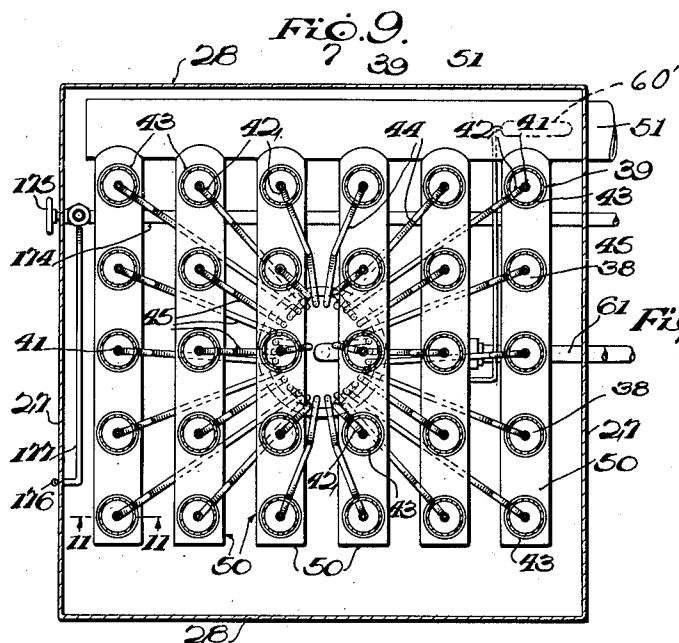
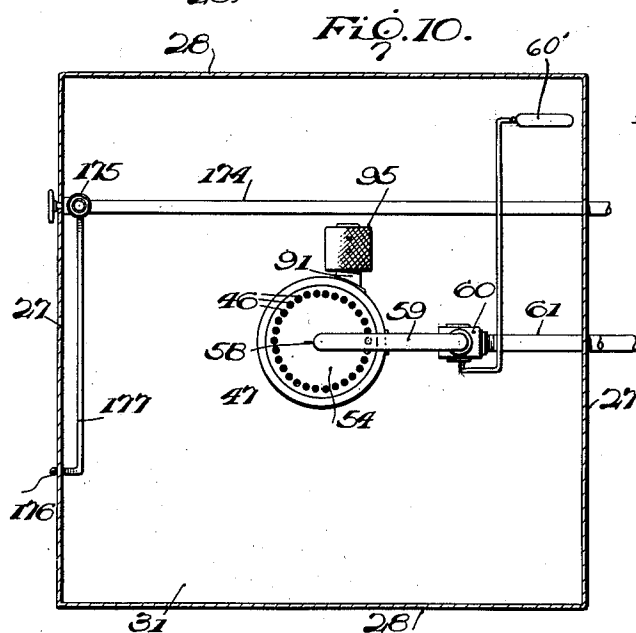
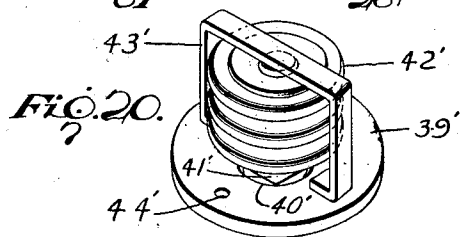
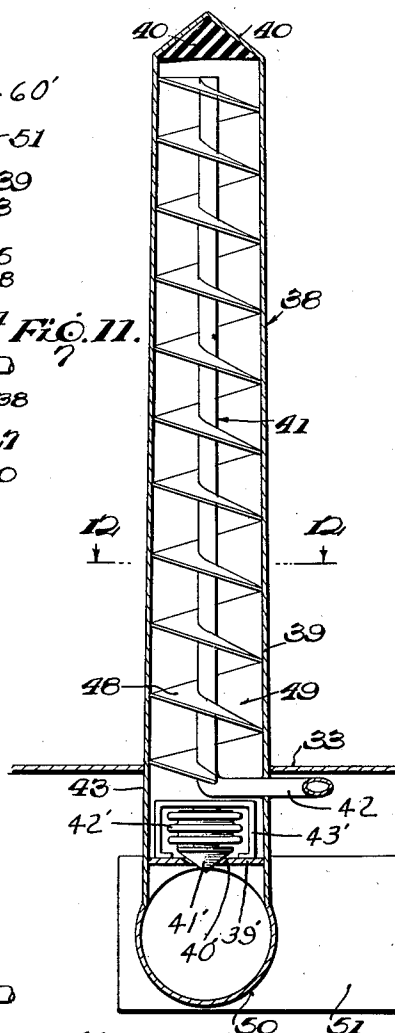
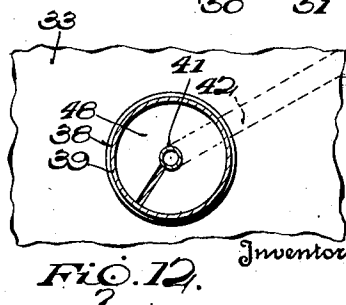
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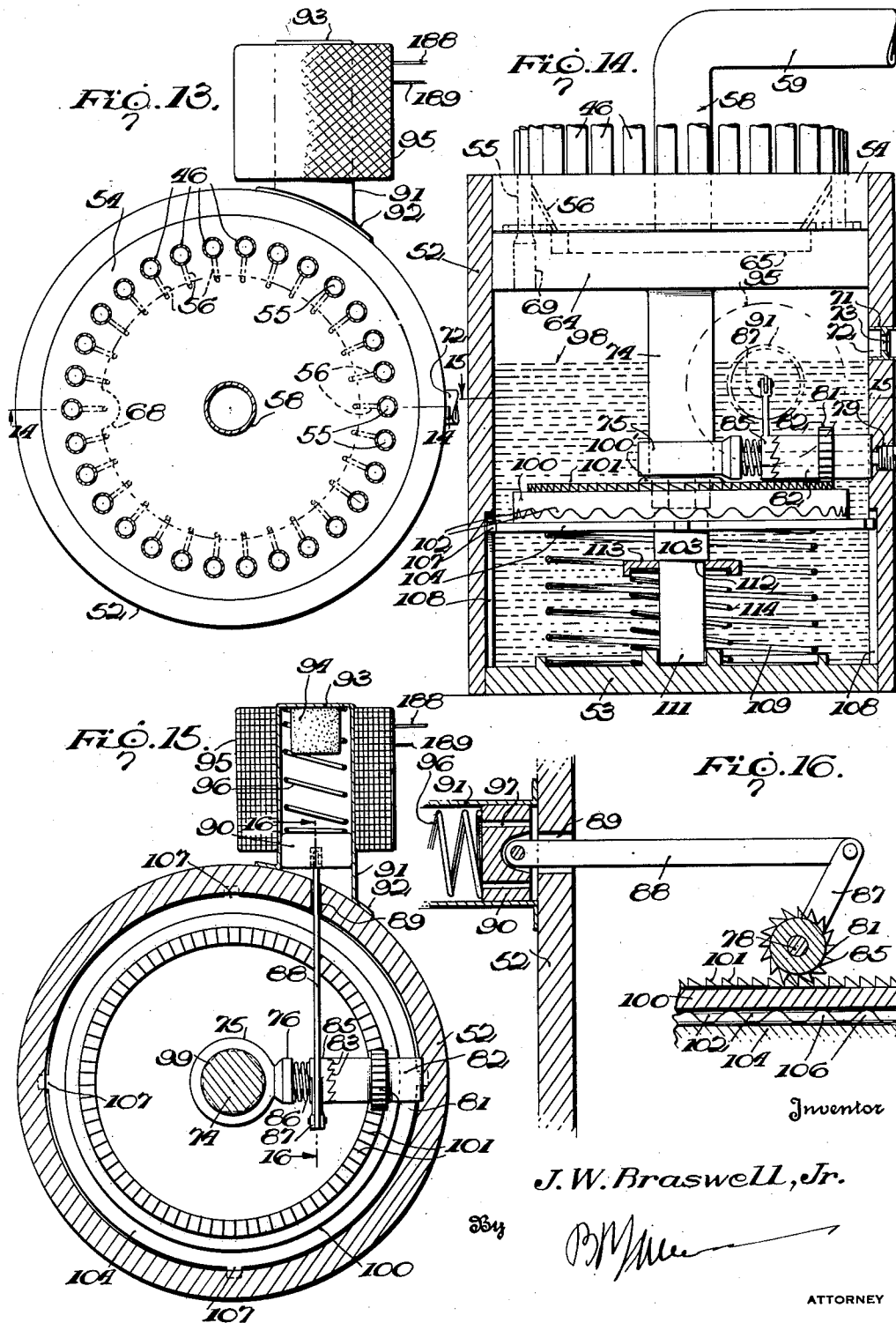
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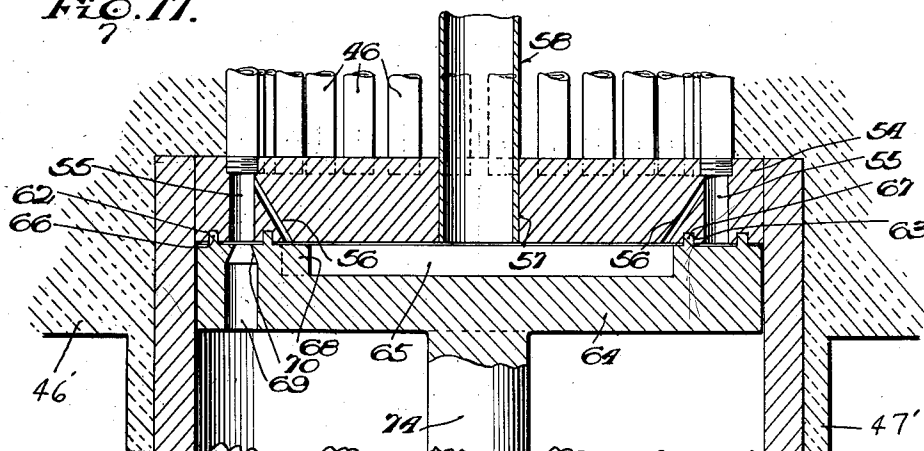
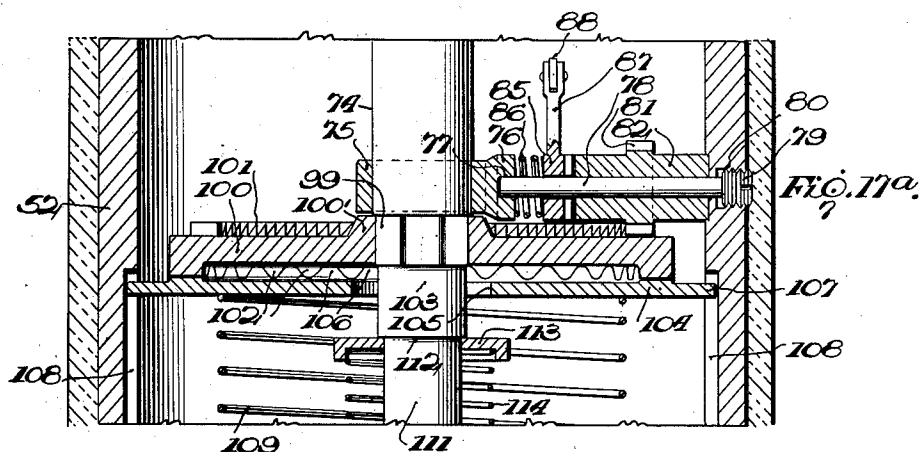
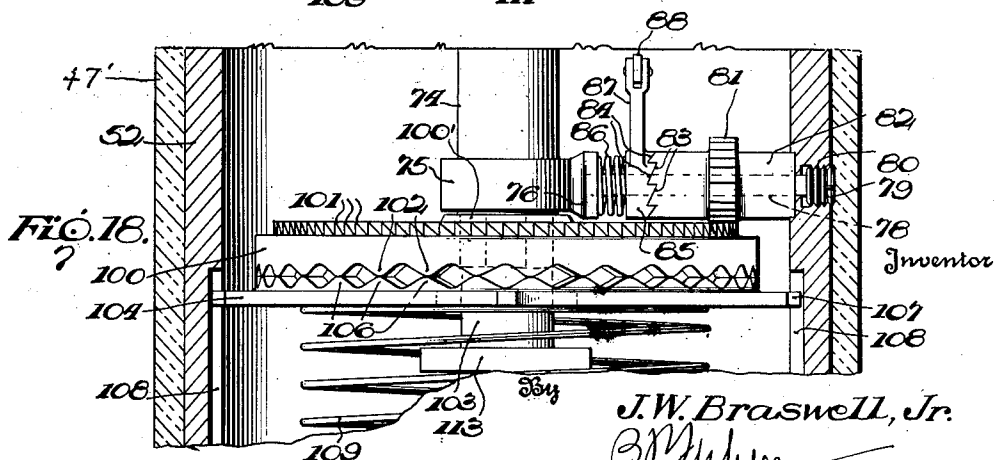
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FIG. 17.



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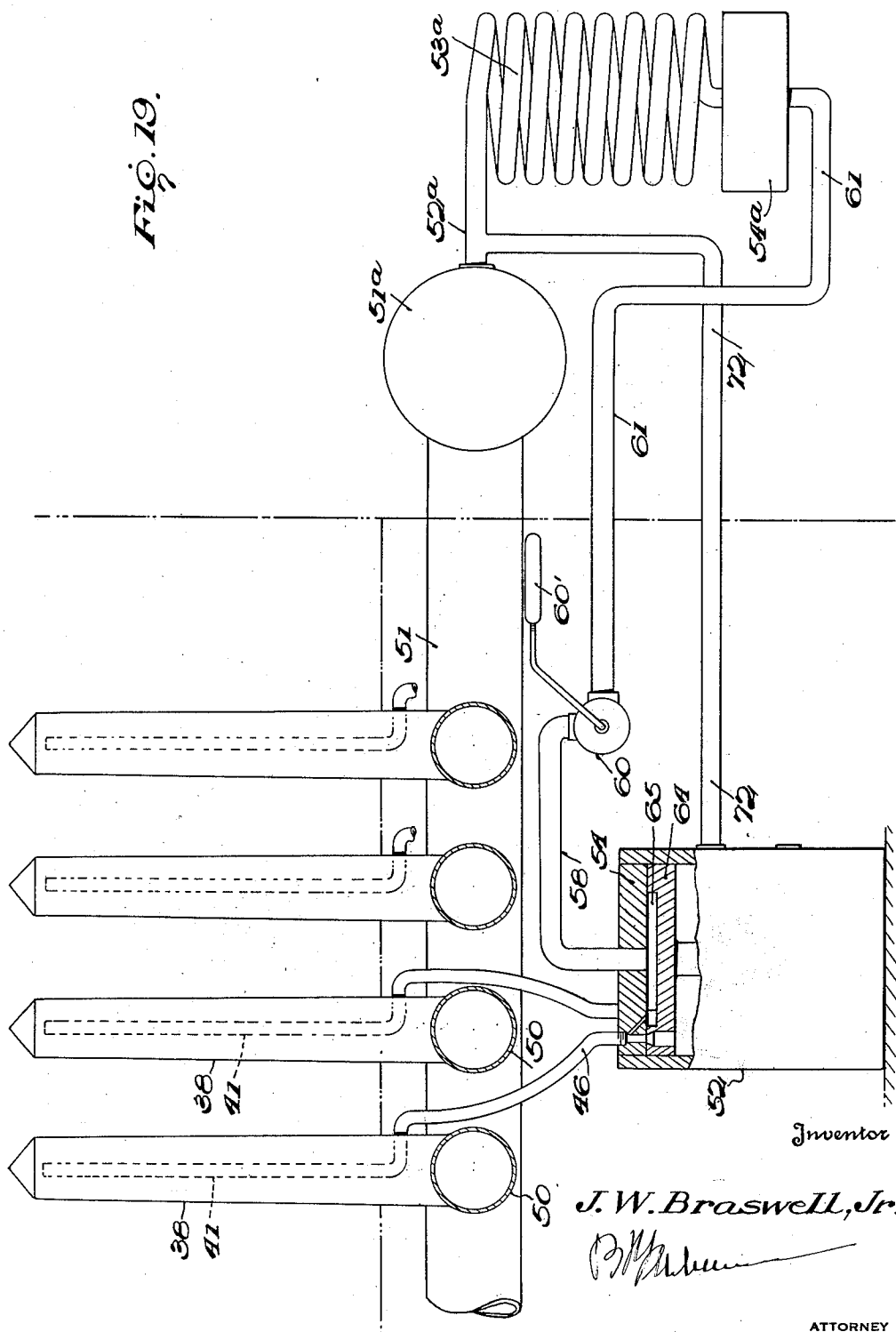
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Fig. 19.



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UNITED STATES PATENT OFFICE

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ICE-MAKING MACHINE

James W. Braswell, Jr., Wilmington, N. C.

Application January 18, 1949, Serial No. 71,435

12 Claims. (Cl. 62—105)

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My invention relates to an ice making machine.

An important object of the invention is to provide a machine for producing ice in chip or fragmentary form, such ice having a wide variety of commercial uses.

A further object of the invention is to provide an ice making machine which is completely automatic, continuous in its operation, and capable of producing large quantities of ice.

A further object is to provide a machine of the above mentioned character which employs a novel arrangement of evaporator elements for forming ice, and a novel master valve connected with the evaporator elements in such a manner that ice is formed upon certain of the evaporator elements while it is defrosted simultaneously and automatically from other evaporator elements.

A further object is to provide an ice making machine wherein ice is formed in relatively large pieces near the bottom of a tank, which is filled with water, the ice subsequently floating to the top of the tank, where it is crushed into small fragments and scooped up and conveyed automatically to suitable containers outside of the machine.

A further object is to provide an ice making machine of the above mentioned character including an electric circuit for automatically controlling the cycle of operation of the machine, and having a thermostatic switch, responsive to the temperature changes of the water in the storage tank.

A further important object is to provide a machine of the above mentioned type, including a master valve having a novel indexing mechanism for causing a defrosting cycle to occur in one evaporator element, while a freezing cycle occurs simultaneously in the other evaporator elements.

A still further object is to provide an ice making machine which is highly efficient in operation, and designed for a long life in operation, the parts of the machine being arranged in a highly compact manner, enclosed within a substantially unitary heat insulated casing.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are used to designate like parts throughout the same,

Figure 1 is a perspective view of an ice making machine embodying my invention,

Figure 2 is a side elevation of the machine, part in section,

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Figure 3 is an enlarged fragmentary side elevation, viewed from the opposite side of the machine, part in section,

Figure 4 is a side elevation of the machine, as viewed from the right hand side of Figure 2,

Figure 5 is an enlarged central vertical longitudinal section taken on line 5—5 of Figure 2, part broken away,

Figure 5a is a schematic view of an electrical circuit for the machine,

Figure 6 is a plan view of the machine,

Figure 7 is a fragmentary vertical section, taken on line 7—7 of Figure 5,

Figure 8 is a horizontal section taken on line 8—8 of Figure 5,

Figure 9 is a horizontal section taken on line 9—9 of Figure 5,

Figure 10 is a horizontal section taken on line 10—10 of Figure 5,

Figure 11 is an enlarged central vertical longitudinal section of a single evaporator element and associated parts,

Figure 12 is a horizontal section taken on line 12—12 of Figure 11,

Figure 13 is an enlarged plan view of a master valve removed, parts in section,

Figure 14 is a central vertical section taken on line 14—14 of Figure 13, parts in elevation,

Figure 15 is a horizontal section taken on line 15—15 of Figure 14,

Figure 16 is a fragmentary vertical section taken on line 16—16 of Figure 15,

Figure 17 is an enlarged fragmentary central vertical section taken substantially upon the same line as Figure 14, parts broken away,

Figure 17a is a similar section through the lower portion of the master valve,

Figure 18 is a view similar to Figure 17a, and showing different operating positions of elements of the master valve,

Figure 19 is a diagrammatic view showing refrigerating and defrosting cycles, and,

Figure 20 is a perspective view of a bellows thermostatic valve, removed.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 25 designates generally a unitary casing or housing for the machine. This casing 25 is rectangular in horizontal cross section and comprises a lower rectangular main body portion 26, and has pairs of opposed sides 27 and 28, Figures 1, 2, 4, 5 and 8. The casing 25 also includes an upper open rectangular extension or chimney 29, having inwardly offset sides 29', and extending for the full distance between the sides 27. The chimney 29

is substantially narrower than the distance between the sides 28, as shown, and the lower ends of the sides 29' are connected with the adjacent sides of the main body portion 26 by opposed inclined upwardly converging panels 30. The unitary casing 25 also includes a flat bottom 31, and the entire outer surface of the casing 25 is covered with a suitable heat insulating jacket 32.

Arranged a substantial distance above the bottom 31 is a flat horizontal rectangular plate 33, and this plate is rigidly secured around its marginal edge to the pairs of sides 27 and 28, and forms with such sides a water tight joint. The plate 33 and sides 27 and 28 above the plate, constitute a large rectangular water storage tank, wherein ice is formed. At the same elevation as the inclined panels 30, and extending inwardly of the sides 27 is a pair of opposed inclined upwardly converging inner panels 34 and 35, forming with the panels 30 an upper pyramid-shaped extension of the water storage tank. The panels 30, 34 and 35 form with the sides 27 and 28 a unitary water tight construction. The upper ends of the inclined panels 34 and 35 carry spaced vertical extensions or panels 36, integral therewith, and these panels 36 extend for the full width of chimney 29, between the sides 29' thereof, and form therewith an inner top reduced rectangular extension 37 for the water storage tank, which is open at the top end. The upper ends of panels 36 extend to the same elevation as the top edges of sides 29' and 27.

Rigidly secured within openings in the plate 33, is a group of vertical evaporator elements 38, Figures 1, 2, 4, 5 and 8. In the form of the invention herewith disclosed, I provide 30 of the evaporator elements 38, arranged in a rectangular group, the group having six straight rows of five evaporator elements each, the evaporator elements being arranged in spaced relation in each row, Figure 1. The evaporator elements 38 project above the plate 33 for a substantial distance. Each evaporator element 38 forms a water tight joint with the plate 33, and comprises an outer substantially cylindrical sleeve 39, Figure 11, provided at its top end with a conically tapered cap 40. The sleeve 39 is preferably tapered slightly toward its top end, and formed of suitable non-corrosive metal, which is a good conductor of heat. This sleeve has a tapered cap 40 which may be formed integral therewith and this cap has an inner lining 40' of heat insulating material. The purpose of the heat insulating lining is to prevent the formation of ice upon the cap 40, which formation would produce a vacuum, retarding the removal of the cylindrical ice tube to be formed upon each evaporator element 38. Each evaporator element 38 further includes a central vertically extending metal tube 41, arranged substantially concentric with the sleeve 39 and spaced radially therefrom. The tube 41 is open at its top end close to and beneath the cap 40, and extends for substantially the entire length of the sleeve 39, to a point just below the tank bottom or plate 33, where it is bent to form a radial arm or extension 42, Figures 5 and 9, which extends outwardly through an aperture provided in the sleeve 39, directly below the plate 33. The tube extension 42 forms a gas tight joint with the sleeve 39, and the tube extension is continued to form downwardly extending portions 44, bent at their bottom ends to form radially inwardly extending sections 45, which converge toward the center of the ma-

chine. At their inner ends the radial tube sections 45 are bent downwardly to form short vertical sections 46 which lead to a master valve 47, to be described. The various tube extensions including sections 44 are thoroughly heat insulated by means of insulation 46', preferably in the form of a continuous mass, and this insulation also extends about the master valve 47, as shown at 47'. The purpose of this insulation is to prevent any substantial or perceptible vaporization of the liquid refrigerant within the tubes exteriorly of the sleeves 39. Each evaporator element 38 further comprises a continuous spiral vane 48, Figure 11, surrounding the central tube 41 and contacting the side of each tube and the inner surface of the sleeve 39 and rigidly secured thereto, and forming a spiral passage 49 between the tube 41 and sleeve 39. The spiral vane 48 extends between the open top end of the tube 41 and the radial tube section 42, Figure 11.

Arranged within the bottom of each sleeve 39 is a horizontal plate 39' forming a gas-tight joint therewith and this plate has an opening forming a valve seat 40' to be engaged and disengaged by a valve element 41' arranged above the plate 39'. This valve element is carried by a bellows thermostatic element 42' containing an expansible liquid. At its top the bellows thermostatic element is secured to an inverted U-shaped bracket 43', attached to the plate 39', as shown. The bellows thermostatic element is biased to unseat the valve 41' during the freezing cycle and will seat the valve 41' during the defrosting cycle. As the hot gas passes through the tube 41 and enters the sleeve 39, it contacts with the bellows thermostatic element, causing the same to expand, whereby the sleeve 39 is closed during the major portion of the defrosting cycle whereby the hot gas remains under substantially its original pressure when within the sleeve 39 during the major portion of the defrosting cycle. At the end of the defrosting cycle the hot gas is cut off and the liquid refrigerant enters the sleeve 39 and this expanding liquid immediately acts upon the bellows thermostatic element, causing it to unseat the valve 41' so that the pressure is reduced in the sleeve 39. The plate 39' has a contracted discharge port 44', Figure 20, which permits of the draining of the liquid accumulating within the sleeve 39 when the hot gas condenses during the defrosting period. This drain port 44' has a much smaller diameter than the bores of the tubes 41 and hence does not materially reduce the pressure in the sleeve 39 when the valve 41' is seated. The port 44' has a larger diameter than the restrictor ports 56, to be described, Figure 17. I have found that satisfactory results can be obtained by having the ports 56 $\frac{2}{64}$ of an inch in diameter, while the drain port 44' is $\frac{3}{64}$ of an inch, while of course the invention is not restricted to these precise dimensions, but the arrangement should be such that the liquid can be drawn through the port 44' faster than it can be supplied through the restrictor port 56.

The evaporator sleeves 39 project for a short distance beneath the plate 33, as shown at 43, Figures 1, 2, 5 and 9, and the bottom ends of the sleeves 39 in each of the six straight rows lead into a horizontal return pipe or duct 50. The ducts 50 extend for substantially the full distance between the sides 28 and at one end lead into a common return duct or pipe 51, arranged at right angles to the ducts 50, and extending close to the adjacent side 28. The opposite ends

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50' of the ducts 50 are closed. The duct 51 extends through one side 27 of the casing and leads to a refrigerant compressing unit of conventional construction.

The master valve 47 is arranged centrally upon the bottom 31 of the casing, and comprises an upstanding cylindrical outer casing 52 having a flat bottom 53, Figure 14. Fixedly mounted within the top of the cylindrical casing 52 is a valve plate or disc 54, provided with 30 vertical ports or passages 55, arranged in an annular group near the outer periphery of the disc 54. The bottom ends of the inner vertical sections 46, of tubes 41, are securely mounted within the top ends of the ports 55. Inclined restrictor ports 56 lead from the inner sides of the ports 55 and extend through the bottom surface of the disc 54, Figure 17. These restrictor ports preferably have a diameter of $\frac{2}{64}$ of an inch, although this may vary. The stationary valve disc 54 is further provided with a large central opening 57 for receiving the bottom end of a liquid refrigerant inlet pipe 58, having, a horizontal section 59 arranged below the ducts 50 and leading to a thermostatic liquid control valve 60. This control valve is operated by a thermostatic device including a remote bulb 60' in thermal contact with the return duct 51. The arrangement is such that when the temperature rises in the duct 51 beyond a predetermined point the control valve 60 opens, thus admitting more liquid refrigerant. This insures the proper supply of the liquid refrigerant. This control valve and thermostatic device for operating it may be of any conventional construction.

Attention is now called to the diagrammatic view shown in Figure 19. As shown in this figure, the return duct or pipe 51 leads to the intake side of the compressor 51^a, the outlet side of which is connected with a pipe 52^a leading to a condenser coil 53^a, in turn leading into a receiver tank 54^a containing the liquid refrigerant. The pipe 61 leads to the bottom of the receiver tank 54^a. The bulb 60' of the thermostatic device is in thermal contact with the return pipe 51. The hot gas supply pipe 72 is connected in the pipe 52^a upon the discharge side of the compressor 51^a and by-passes the control valve 60 and condenser coil 53^a. A horizontal pipe 61 extends from the valve 60 outwardly through one side 27 of the casing, and leads to the refrigerant condenser unit. The pipe 61 constitutes the main liquid refrigerant line from the condenser. The stationary disc 54, Figures 13 and 17, is provided in its bottom face and upon opposite sides of the annular group of ports 55 with concentric annular recesses or grooves 62 and 63. Rotatably mounted within the cylindrical casing 52, and disposed directly beneath the stationary valve disc 54 is a rotatable valve disc 64, provided in its upper face with a main circular refrigerant holding recess or chamber 65, the periphery of which extends radially outwardly of the lower ends of the inclined radial ports 56, Figure 17. The central refrigerant chamber 65 is in direct communication with the vertical refrigerant inlet pipe 58. The rotatable disc 64 is provided upon its top surface with a pair of radially spaced concentric annular ribs or tongues 66 and 67, to engage in the grooves 62 and 63 for forming a seal between the central chamber 65, ports 55 and casing 52. The grooves and ribs also form a positive guide for the rotatable valve disc 64. At one point on the periphery of the chamber 65, the disc 64 is provided with a radially inwardly

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projecting boss 68, Figures 13 and 17, flush with the top face of the disc 64, and adapted to cover the open bottom end of any one of the ports 56, where they lead into the chamber 65. Adjacent to the boss 68 the rotatable disc 64 has a single vertical port 69 having a tapered orifice 70 at its top end, and the port 69 is arranged to be moved adjacent to the open bottom end of any one of the vertical ports 55 of the stationary disc 54. A slight distance below the disc 64, the cylindrical casing 52 is provided with a radial opening 71, Figure 14, having secured therein the end of a pipe or conduit 72, provided with an inwardly tapered orifice 73. The pipe 72 leads to the warm gas side of the refrigerant condenser unit, not shown, and through this pipe 72 the warm refrigerant gas enters the casing 52 below the rotatable valve disc 64, so that it may enter the single port 69. Formed integral with the disc 64 is a central depending stem or shank 74, extending to the bottom 53. Surrounding the depending shank 74 at a point near the vertical center of the master valve, and receiving the shank for free rotation within it, is a horizontal ring or collar 75, having a radially projecting head 76, Figures 7a and 18, provided with a recess 77 for receiving the inner end of a radial fixed shaft or pin 78, having an outer screw threaded head 79, secured within a screw threaded opening 80 in the side of the casing 52. The fixed pin 78 holds the collar 75 against rotation. Rotatably mounted upon the pin 78 inwardly of the side of casing 52 is a gear 81, Figures 14, 15 and 16, having an axially extending hub 82. The inner end of the hub 82 is provided with inclined teeth 83, Figure 18, to co-act with companion inclined teeth 84, formed upon the outer vertical face of a rotatable one-way clutch element or disc 85, Figures 15 and 18, having an opening to slidably receive the pin 78 therethrough. The one-way clutch element 85 is urged outwardly into engagement with the hub 82 by means of an expansible coil spring 86, which surrounds the pin 78 between the outer face of head 76 and inner side of element 85. This is a conventional one-way clutch construction for rotating the gear 81 with a step-by-step motion in one direction. The one-way clutch element 85 has a radial arm or crank 87, Figure 16, which extends upwardly within the casing 52 and is pivotally connected at its top end with a horizontal link or rod 88, extending through a radial opening 89 formed in the casing 52. The outer end of the link 88 is pivotally connected to a reciprocatory magnet 90 which operates in a horizontal cylindrical sleeve or casing 91, having a flange 92 which is secured to the outer periphery of the casing 52, Figure 15. The casing 91 has a closed outer end 93, having mounted thereon a stationary magnet 94, extending into the sleeve 91. An energizing coil 95 is mounted upon the sleeve 91, adjacent to the outer stationary magnet 94, Figure 15, and an expansible coil spring 96 is arranged between the inner movable magnet 90 and the outer end 93, as shown. The spring 96 serves to bias the magnet 90 inwardly, or away from magnet 94, when the coil 95 is de-energized, and each time coil 95 is energized the magnet 90 is drawn into contact with the stationary magnet 94, and through the one-way clutch element 85, the gear 81 is rotated counterclockwise, Figure 16, in a step-by-step manner. The magnet 90 has axial ports 97 which permits the slow passage of oil through the magnet, to produce a braking or dash-pot effect upon the movable magnet 90.

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the casing 52 being filled with oil to a lever 98 substantially adjacent to the bottom edge of the pipe 72. The oil will of course enter the casing or sleeve 91 through the opening 89. It is thus seen that the solenoid comprising magnets 90, 94, and associated elements, as well as the gear 81 and one-way clutch element 85, operate submerged in oil. Directly beneath the collar 75, the shank 74 is machined to provide a hexagonal portion 99, having mounted upon it for rotation with the valve disc 64, a large horizontal ring gear 100, having teeth 101 formed upon its top face and arranged in an annular group, and engaged by the teeth of gear 81. Adjacent to its outer periphery and upon its lower face the ring gear 100 is provided with an annular group of equidistantly spaced smoothly curved cam elements or teeth 102. Beneath the hexagonal portion 99, the rotatable shank 74 has a reduced cylindrical portion 103, and surrounding such portion is a vertically shiftable non-rotatable plate 104, having a large central opening 105, and provided upon its upper face with an annular group of raised equidistantly spaced smoothly curved cam elements or teeth 106, for co-action with the companion teeth 102. The plate 104 is provided at points on its periphery with radially extending lugs 107, which operate in vertical grooves 108 cut in the inner face of casing 52. A large expansible coil spring 109 is arranged between the bottom face of the plate 104 and the bottom 53, Figure 14, and serves to urge the plate 104 upwardly to maintain the teeth 106 in contact with the teeth 102. The ring gear 100 has a central upstanding hub 100' which engages the lower end of the collar 75 for supporting the same against downward movement. The shank 74 further includes a bottom reduced extension 111, forming an annular shoulder 112 engaged by a washer or disc 113. The washer 113 is urged against the shoulder 112 by an inner strong expansible coil spring 114, which has its bottom end engaging the bottom 53, Figure 14. The spring 114 serves to cushion the entire spindle or shank 74, and urges the rotatable valve disc 64 upwardly into sliding contact with the bottom of the fixed disc 54. The elements within the cylindrical casing 52 are assembled through the bottom end of the same when the bottom 53 is removed.

An intermediate upstanding panel 115 is secured at its bottom end to the inclined panel 34, Figures 1 and 5, and extends transversely between sides 29', and is rigidly secured thereto at its opposite side edges. The top edge of the panel 115 is arranged adjacent to the top edges of the sides 36. A horizontal shaft 116, Figures 1, 2 and 5, is journaled in fixed bearings 117 and 118, rigidly mounted upon the outer sides of panel 115 and one side 27, respectively, Figure 5. The shaft 116 has mounted upon its left end, Figure 5, and between panel 115 and the adjacent side 27, a large gear 119, Figures 1, 2 and 5, driven by a worm gear 120, mounted upon an armature shaft extension 121 of an electric motor 122. The armature shaft extension 121 is journaled in fixed bearings 123, mounted upon the outer face of the adjacent panel 115, Figure 4. The motor 122 is suitably rigidly mounted upon the adjacent side 29', Figure 6, and its inner end projects into the space or compartment between the panel 115 and adjacent side 27, Figure 4. Inwardly of the panel 115 and between such panel and the adjacent panel 36, the shaft 116 has secured to it for rotation therewith a gear 124, Figures

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1, 2, 4 and 19, which meshes with and drives an idler gear 125, mounted upon a shaft journaled in fixed bearings 126, mounted upon the opposed faces of panels 115 and 36, Figures 4 and 5. The idler gear 125 is arranged below the shaft 116 and to one side of the same, Figure 2. The idler gear 125 meshes with a gear 126', Figures 1, 2 and 5, mounted upon a shaft 127, journaled in fixed bearings 128, rigidly mounted upon the outer faces of panels 36, Figure 5. The shaft 127 extends entirely across the reduced tank extension 37, and has mounted upon it for rotation therewith, a cylindrical ice crushing drum 129, having radially projecting teeth or spikes 130, arranged in staggered spaced relation about the periphery of the drum. A companion ice crushing drum 131, having radially projecting teeth or spikes 131', is mounted upon a horizontal shaft 132, for rotation therewith, and the shaft 132 extends entirely across and through the tank extension 37 at the same elevation as the shaft 127, Figures 2 and 7. The shaft 132 is journaled in fixed bearings 133, Figure 2, rigidly mounted upon the outer sides of panels 36 and spaced laterally from the bearings 128. The shafts 127 and 132 are disposed equidistantly upon opposite sides of the vertical center line of the tank extension 37, Figure 7. Mounted upon the shaft 132, outwardly of the left hand panel 36, Figure 5, and adjacent to and meshing with gear 126' is a gear 134 of slightly larger diameter than the gear 126', so that the crusher drum 131 will rotate at a slightly slower speed than the crusher drum 129, Figures 1, 2 and 6.

Mounted upon the shaft 116 for rotation therewith is a conveyor scoop 135, Figures 1, 2 and 5, which is elongated and generally cylindrical. The conveyor scoop includes a generally radially offset elongated mouth or scoop 136 adapted to enter between the panels 36, Figure 5, as the conveyor scoop rotates counterclockwise, Figure 7. The conveyor scoop 135 is arranged at the transverse center of the reduced tank extension 37 and above and equidistantly spaced from the crushing drums 129 and 131. The longitudinal axis of the conveyor scoop and shaft 116 is adjacent to the top end of the tank extension 37, so that half of the generally cylindrical conveyor scoop projects into the top of the tank extension 37. The right hand panel 36, Figure 5, has a semicircular notch 137 to rotatably receive an axial cylindrical extension 138 of the conveyor scoop 135. The extension 138 has an open flared discharge end 139, so that the contents of the conveyor scoop may empty into an inclined chute 140, secured within an opening formed in the adjacent side 27, and having its lower end projecting laterally outwardly of the side 27, as at 141. The upper end of the chute 140 engages beneath and around the cylindrical extension 138, inwardly of the discharge end 139, so that the contents of the conveyor scoop 135 may discharge into the chute 140 and be delivered to suitable containers arranged outside of the machine and beneath the lower end 141. The entire conveyor scoop 135 is preferably formed of foraminous material, such as stainless steel wire mesh. Arranged generally diametrically opposite the scoop portion or mouth 136, is a plurality of axially spaced spirally curved segmental vanes 142, Figures 5 and 7. These vanes 142 are rigidly secured to the cylindrical side of the conveyor scoop 135 and form means to advance the chips of ice in the conveyor scoop toward the discharge end 139, as the scoop rotates counterclockwise, Figure 7.

Spaced inwardly from and near the sides 28 of the outer casing 25 and extending between the sides 27, and rigidly secured thereto, are flat vertical plates or baffles 143, Figures 1 and 2, bent at their upper ends to form inclined upwardly converging baffle extensions 144, spaced inwardly of and parallel to the panels 30, Figure 2. The top edges of the baffle extensions 144 terminate close to the peripheries of the drums 129 and 131, Figures 1, 2 and 7, and the baffle extensions serve to guide floating tubular ice cylinders 145, formed upon the evaporator elements 38, between the spikes of the crusher drums, where they are crushed into small fragments or chips. The inclined panels 34 and 35, which are arranged at right angles to the baffle extensions 144, also function to guide the ice cylinders 145 into the rotary ice crusher drums. The bottom ends of the baffles 143 terminate a short distance above the plate or bottom 33, Figure 2.

Arranged above the crusher drums 129 and 131, respectively are a pair of opposed swinging baffles 146 and 147. The lower end of the baffle 146 is pivotally connected with the adjacent side 29' as at 146', and the baffle 146 is freely swingable vertically within the tank extension 37. The baffle 146 extends for substantially the full width of the tank extension 37, between the panels 36, Figure 6, and is provided with an upturned end portion 147'. A pair of short stops 148 are rigidly mounted upon the panels 36, and are arranged beneath the baffle 146 and adapted to contact the baffle 146 so that it cannot swing below the inclined position of Figure 7. The baffle 146, however, is free to swing upwardly when struck by the outer edge of the scoop 136. The baffle 147 is pivotally connected in a similar manner to the opposite side 29', as at 149, and includes an upturned inclined extension 150. A pair of short stops 151 are rigidly secured to the panels 36, and are arranged beneath the baffle 147 to limit the downward swinging of the same. The baffle 147 is freely swingable upwardly, like the baffle 146. The swingable baffles 146 and 147 serve to yieldingly guide and convey the crushed ice into the scoop or mouth 136 of the conveyor scoop 135, as such ice is forced upwardly by the rotating crusher drums.

The shaft 132 extends axially outwardly of one panel 36, Figures 3 and 4, and between such panel and the side 27 having the chute 140, and is provided outwardly of the adjacent bearing 133 with a sprocket wheel 152, Figures 1 and 3. Arranged above the sprocket wheel 152 and mounted upon the adjacent outer face of panel 36 is a fixed bearing 153, rotatably supporting a shaft 154, having a sprocket wheel 155 mounted thereon for rotation therewith. A sprocket chain 156 operatively connects the sprocket wheels 152 and 155, Figure 3. The sprocket wheel 155 carries an eccentric pin 157, and pivotally connected with the eccentric pin is a rod or link 158 having its upper end pivotally connected with one end of a swingable arm or link 159, pivotally connected near its mid-point with a fixed upright bar 160, rigidly mounted upon the adjacent panel 36, Figures 3 and 4. The inner end of swingable arm 159 has secured to it a mercury switch 161, having a pair of terminals 162 and 163, connected with wires 164 and 165, respectively, which lead to a junction box 166 secured to the inner face of a removable semi-cylindrical cover or dome 167, having a heat insulating covering or jacket 167'. The action of the eccentric pin 157, and associated elements, swings the mercury switch 161, to make and break a circuit, to control the step-

by-step rotation of the valve disc 64, through the alternate energizing and de-energizing of the coil 95, as will be further explained.

An electric cable 169 leads to the junction box 166 to supply current to the machine. A manual switch may be connected with the cable at any suitable point. A conventional thermostat control switch 170 is mounted upon the cover 167 near the junction box 166, and a capillary tube 171 leads downwardly from the thermostat control switch 170 to the interior of the water storage tank beneath the crushing drums 129 and 131, Figure 3. At its bottom end the tube 171 is connected with a remote bulb 172, which remains submerged in the water of the storage tank. The switch 170 opens when the temperature of the water reaches a selected low degree, thus stopping the operation of the compressor 51^a. It should be mentioned here, that in operation the tank is maintained filled with water to the level L, Figure 7, and the level L is sufficiently high to enable the scoop 136 to dip into the water and scoop therefrom the ice chips which are propelled upwardly by the crushing drums 129 and 131.

A float control valve 168, Figure 3, is mounted upon the top of the casing extension 37 and is connected therewith by pipes 169' and a water supply pipe 170' leads into the float control valve 168 and is connected with a suitable source of water under pressure. The float control valve maintains the level of the water L within the casing constant.

The machine is provided with a vertical water drain pipe 173, Figures 1 and 2, having its upper end projecting through the bottom of the tank plate 33, and the pipe 173 is bent near and above the bottom 31, forming a generally horizontal drain line 174, Figure 9. A manual valve, 175 is connected in the pipe 173 above the line 174. A separate vertical drain pipe 176 extends downwardly along the outer surface of the adjacent side 27, Figures 1 and 2, and extends through such side 27, near the bottom of the same, and is bent to form a horizontal section 177, leading into the drain pipe 173, below the valve 175. The upper end of the drain pipe 176 projects through the adjacent side 27, and is bent to form a short inclined extension 178, which projects above panel 34 and into the space between the panel 115 and the adjacent side 27. The drain pipe 176 serves to drain off any water which might enter the space between the panel 115 and adjacent side 27, so that the space will not be filled with water, and interfere with the operation of worm gear 120 and gear 119. The panels 34 and 35, Figure 5, are provided with drain openings 179 leading into the compartments above these panels. The compartment inwardly of the panel 115 is filled with water up to the level L but the compartment outwardly of the panel 115 is not filled with water, but is adapted to receive overflow water through an opening 115' formed in the panel 115. This overflow water discharges through the pipe 176. The two side compartments 34^a and 35^a and the intermediate compartment are filled with water up to the level L.

Attention is now directed to Figure 5a showing the electrical circuit for the machine. The cable 169 includes wires 181 and 182 which lead into the main junction box 166, as stated. Wires 183 and 184 lead from the main junction box to terminals 185 and 186 of the electric motor 122. A wire 187 is connected at 188 to the wire 183, between the junction box 166 and the ter-

minal 185, and the wire 187 leads to the terminal 162 of the mercury switch 161, the other terminal 163 of which is connected with a wire 188', leading to one terminal of the coil 95. The opposite terminal of the coil 95 is connected with a wire 189, connected with the wire 184 at 190, between the junction box 166 and terminal 186 of the motor. A wire 191 is connected at 192 to the wire 183, between the point 188 and terminal 185, and this wire leads to one terminal of the thermostat control switch 170, the other terminal of which is connected with a wire 193 which leads to the control circuit of the refrigerant compressing unit, from which unit a wire 194 leads back to and is connected with the wire 184, at a point 196, between the point 190 and motor terminal 186. The remote bulb 172 has its tube 171 connected to the thermostat control switch 170 in a conventional manner, as stated.

The operation of the machine is as follows:

Current from the cable 169 enters through the main junction box 166, and passes through wire 183, terminals 185 and 186, and wire 184 to drive the motor 122 continuously. The motor, Figures 1 and 2, through worm gear 120 and gear 119 rotates the conveyor scoop 135 continuously, counterclockwise, Figure 7. Gear 124 drives idler gear 125, driving gears 126' and 134, to rotate the crusher drums 129 and 131 continuously in opposite directions, Figures 1 and 2. The crusher drum 129 rotates clockwise and the crusher drum 131 rotates counterclockwise, Figure 7. Since the gear 126' is smaller than the gear 134, the crusher drum 129 will be driven faster than the crusher drum 131, and this has proven to be desirable.

The sprocket wheel 152, Figures 1, 2 and 3, is driven by the shaft 132, and through the chain 156, drives sprocket wheel 155, oscillating link 158 and swinging arm 159 continuously about its pivotal connection with upright bar 160, continuously making and breaking the circuit through the terminals 162 and 163, Figures 1 and 3. Each time the circuit is closed through the terminals 162 and 163, current flows from the wire 183 through wire 187, through the switch 161, through wire 188', and through the coil 95, for energizing the magnet 94, and through the wire 189 back to the wire 184, Figures 5, 6 and 15. Each time the magnet 94 is thus energized, the magnet 90 is drawn to it, and the link 88 is pulled to the left, Figure 16, swinging the crank 87 counterclockwise, Figure 16. The one-way clutch element 85 and gear 81 are rotated counterclockwise, Figure 16, and the ring gear 100 is turned a distance limited by the travel of the crank 87 and by the coacting teeth 102 and 106, Figures 15 and 16. Figure 18 shows the action of teeth 102, 106, and associated elements, as the ring gear 100 is thus turned. Each time the coil 95 is de-energized, the spring 96 turns the crank 87 clockwise, Figure 16, and the one-way clutch disc 85 turns clockwise while the ring gear 100 maintains its advanced position, being held stationary by the teeth 102 and 106. It is thus seen that as the coil 95 is continuously alternately energized and de-energized, the ring gear 100 and valve disc 64 are rotated in a step-by-step continuous manner.

Simultaneously with this action, the liquid refrigerant from the receiver tank 54^a, Figures 17 and 19, passes through the pipe 61, control valve 60 and pipe 58 into the central refrigerant chamber 65. This liquid refrigerant passing through the pipe 58 is under pressure and passed

upwardly through the restrictor ports 56 into the ports 55, where it enters the extensions 46 of the evaporator tubes 41. The refrigerant then passes through tube extensions 45 and 44 into the evaporator units 38, where it passes upwardly through tubes 41, and downwardly through the spiral passage 49, where, in extracting heat from the water in the tank and freezing the tubular cylinders 145, it vaporizes and discharges from the bottom ends of the outer evaporator sleeves 39 into the ducts 50, Figures 12, 13 and 19. The vaporized refrigerant passes from the ducts 50 into the common duct 51 which takes it back to the intake side of the compressor 51^a. The restrictor ports 56 retain the desired pressure within the chamber 65. When the liquid refrigerant is injected into the ports 55 and tubes including the portions 45, no substantial or appreciable vaporization occurs until the liquid refrigerant enters the tubes 41 within the sleeves 39, because the master valve 47 and the tubes including the portions 45 are thoroughly heat insulated. When the liquid refrigerant enters the tubes 41 within the sleeves 39, the vaporization starts and continues in an increasing manner as the liquid refrigerant passes downwardly within the sleeves 39. The vaporized refrigerant now passes through the pipe 51, to the intake side of the compressor 51^a.

This cycle of operation of the refrigerant takes place simultaneously and continuously in all but one of the evaporator elements 38. One evaporator element has its tube 41 and associated port 55 in communication with the port 69 of the valve disc 64, Figure 17, and the boss 68 covers the single port 56 leading to the particular port 55. The warm gaseous refrigerant from the discharge side of the compressor 51^a is continuously introduced through the pipe 72 and into the master valve 47. From the master valve 47, the warm gaseous refrigerant passes through the port 69 and into the port 55 in registration with the port 69 and into the sleeve 39 of the corresponding evaporator unit to defrost the same. The gaseous refrigerant passes through the sleeve 39 in a manner similar to the travel of the liquid refrigerant and finally is discharged into the pipe 51. As soon as the warm gaseous refrigerant enters the sleeve 39, it contacts with the bellows thermostat 42', Figures 11 and 20, which expands and closes the valve 41' which remains closed during the major portion of the defrosting cycle. This retains the pressure upon the warm gaseous refrigerant within the sleeve 39 at substantially the same pressure that it had before being supplied into the sleeve 39. This enables the warm gaseous refrigerant to properly heat the sleeve 39 for effecting the defrosting so that the ice tube will free itself from the sleeve and float upwardly. At the end of the defrosting period, the supply of warm gaseous refrigerant is cut off from this sleeve 39 which was being defrosted and the liquid refrigerant introduced therein, which acts upon the bellows thermostat, causing it to open the valve 41', Figure 20. The liquid refrigerant within the sleeve 39, when the valve 41' is closed, escapes through port 44', Figure 20, and passes into the large pipe 50, and commingles with the expanded warm refrigerant in pipe 50, and pipe 51. The presence of the warm expanded gases will provide the heat for the re-expansion of the liquid refrigerant passing through the port 44', as stated. This is true notwithstanding the fact that the pipe 50 and a portion of pipe 51 are shown as heat insulated. However, pipe

51 extends beyond the heat insulation, Figures 5 and 19, and if any of the liquid refrigerant had not been reevaporized it would be free to vaporize in the uninsulated portion of the pipe 51, prior to its passage to the compressor 51^a. Thus, while the ice cylinders 145 are being continuously and simultaneously frozen about twenty-nine of the evaporator elements 39, the ice cylinder 145 of the one evaporator element is defrosted sufficiently so that the freezing bond between the ice cylinder and evaporator element is broken. When this occurs the single cylinder 145 thus defrosted floats upwardly through the tank filled with water, and is guided by the baffle sections 144, Figures 1 and 2, and panels 34 and 35 between the crusher drums 129 and 131, where the spikes 130 and 131' cut the ice cylinder 145 into the small fragments or chips. The drums 129 and 131 propel these chips upwardly toward the conveyor scoop 135, and the swinging baffles 146 and 147, Figures 6 and 7, tend to crowd or converge the mass of ice chips inwardly so that the scoop or mouth 136 can pick them up as the conveyor scoop rotates. The scooped up ice chips contact the spiral segmental vanes 142, Figures 5 and 6, and are fed to the discharge end 139, and into the inclined chute 140. This cycle of operation is continuous, and as the valve disc 64 rotates in step-by-step fashion, the port 69 is arranged adjacent to each of the tube sections 46 in succession, and each of the evaporator elements 39 has its ice cylinder 145 removed.

In the event that the continuous freezing cycle causes the water in the tank to approach freezing temperature, the bulb 172 opens the thermostat control switch 170 to open the circuit to the compressor, thus stopping the operation of the condenser and stopping the freezing. When the temperature of the water rises sufficiently, the bulb 172 causes the control switch 170 to again start the compressor.

Attention is called to the ice crusher drums which have their inner sides projecting inwardly beyond the baffles 144, and these inner sides travel upwardly. The outer sides of the drums project outwardly beyond the baffles 144 and travel downwardly, Figure 7. This arrangement tends to circulate the water upwardly upon the inner sides of the baffles, and downwardly upon their outer sides. This circulation aids the floating of the ice tubes 145 to the crusher drums. The water is therefore continuously circulated upwardly about and in contact with the sleeves 39 of the evaporator units and this materially increases the heat transfer between the refrigerant and the water in contact with the sleeves 39, thus increasing the efficiency of the machine.

It is evident that I have provided an ice making machine which is completely automatic and continuous in its operation. The construction is simple and rugged and the machine is capable of operating in a highly efficient manner to produce large quantities of ice.

The valve 175 may be opened manually when the machine is inoperative for completely draining the water storage tank.

The entire casing 25 and tank, including panels 36, 115, 30, 28', 34 and 35, as well as the cover 167, are all preferably formed of non-corrosive metal such as stainless steel.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without

departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, I claim:

1. An ice making machine, comprising a tank to contain water, freezer elements mounted within the tank and submerged in the water and adapted to have pieces of ice formed thereon which float toward the top of the tank, rotary crusher elements mounted within the tank above the freezer elements and submerged in the water and adapted to crush the pieces of ice into fragments as the pieces float upwardly between the rotary crusher elements, guide means mounted within the tank for conducting the floating pieces of ice between the inner sides of the rotary crusher elements and forming outer water circulating passages with the sides of the tank and adjacent to the outer sides of the rotary crusher elements, driving means to rotate the rotary crusher elements so that their inner sides travel upwardly and their outer sides travel downwardly, and a rotary conveyor element mounted upon the tank above the rotary crusher elements and adapted to receive the fragments of ice as they float upwardly from the rotary crusher elements for conveying the same from the rotary crusher elements.

2. An ice making machine, comprising a tank for holding water, the tank including a lower main body portion, a tapered intermediate portion, and a top reduced extension, evaporator elements mounted within the main body portion of the tank and submerged in the water and adapted to form pieces of ice which float upwardly in the tank, rotary ice crusher drums mounted within the reduced extension of the tank and submerged in the water and adapted to crush the pieces of ice into fragments as the pieces float upwardly between the crusher drums, the tapered intermediate portion of the tank guiding the pieces of ice into the crusher drums, and a rotary conveyor scoop mounted upon the reduced extension of the tank above the fragments of ice which float upwardly from the crusher drums, the conveyor scoop having a spiral element and an open discharge end, the spiral element serving to convey the fragments of ice to the open discharge end as the conveyor scoop rotates.

3. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a set of first restrictor ports and a set of second ports, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a heating fluid receiving chamber, the first ports leading into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, means to effect a relative turning movement between the valve elements, and a set of evaporator elements, each evaporator element including an outer sleeve adapted to have ice formed thereon and an inner tube discharging into the sleeve and having one end in communication with the first and second ports.

4. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a set of first restrictor ports and a set of second ports, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and

forming with the casing a heating fluid receiving chamber, the first ports leading into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, means to effect a relative turning movement between the valve elements, a water storage tank, a set of evaporator elements mounted within the storage tank and submerged in the water, each evaporator element including a part adapted to have ice formed thereon and a tube connected with the last named part for conducting the refrigerant to the same, the tube having an end in communication with the first and second ports.

5. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a set of first restrictor ports and a set of second ports, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a heating fluid receiving chamber, the first ports leading into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, means to effect a relative intermittent turning movement between the valve elements, a water storage tank including a plate, a set of evaporator elements mounted upon the plate and projecting into the tank and submerged in the water, the evaporator elements including outer sleeves adapted to have ice formed thereon and inner tubes extending into the sleeves for conveying the refrigerant to the sleeves and having ends in communication with the first and second ports, and ducts connected with the outer sleeves of the evaporator elements and in communication therewith for conveying the refrigerant away from the evaporator elements after it is volatilized.

6. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a set of first restrictor ports and a set of second ports, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a heating fluid receiving chamber, the first ports leading into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, a member connected with the second valve element to turn it, mechanical means including a one way clutch device and gearing to effect an intermittent turning of the member, an electrical solenoid connected with the mechanical means to actuate the same, a water storage tank, a set of evaporator elements mounted within the water storage tank and submerged in the water, the evaporator elements including refrigerant conducting tubes in communication with the first and second ports, a prime mover, a rotary shaft connected with the prime mover and driven thereby and extending into the tank, mechanism mounted within the tank and connected with the rotary shaft and including an oscillating element, and a switch mounted upon the oscillating element and electrically connected in series with the solenoid and adapted

to open and close a circuit through the solenoid when the oscillating element is actuated.

7. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a set of first restrictor ports and a set of second ports, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a heating fluid receiving chamber, the first ports leading into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, mechanical means to effect an intermittent turning of the second valve element, an electrical solenoid connected with the mechanical means to actuate such means, a water storage tank, evaporator elements disposed within the tank and adapted to have ice formed thereon, refrigerant conducting tubes connecting the evaporator elements and first valve element and in communication with the first and second ports, a switch having terminals electrically connected with the solenoid, and automatic means to open and close the switch for alternately energizing and de-energizing the solenoid.

8. An ice making machine comprising a sleeve to be at least partly submerged in the water and having an outlet opening, a valve to cover and uncover the outlet opening, a thermostatic device which is biased to hold the valve unseated during the freezing period and automatically operated by the heating fluid within the sleeve during the melting period to seat the valve, and means to alternately introduce a refrigerant and heating fluid into the sleeve.

9. An ice making machine, comprising a substantially vertical sleeve to be at least partly submerged in the water and provided near its bottom with an outlet opening, a valve to cover and uncover the outlet opening, a thermostatic element within the sleeve and biased to hold the valve unseated during the freezing period and to close the valve during the melting period, an inlet tube leading into the sleeve and having its outlet end arranged near the upper end of the tube, and means to alternately supply a refrigerant and a heating fluid into the tube.

10. A machine for making ice, comprising a casing, a first valve element within the casing and having a substantially annular set of first ports and a substantially annular set of second ports having their intake ends arranged in substantial concentric relation, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a heating fluid receiving chamber, the first ports being arranged to lead into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the second ports in succession, means to effect a relative turning movement between the valve elements, a water storage tank, a plurality of evaporators mounted within the storage tank and at least partly submerged in the water, the evaporators including sleeves to have ice formed thereon, each sleeve being provided with an outlet opening, a valve to cover and uncover the outlet opening, a thermostatic element connected with the valve and biased to hold the

valve unseated during the freezing period, the thermostatic element being actuated by heating fluid within the sleeve to seat the valve, tubes leading into the sleeves and having their inlet ends in communication with the first and second sets of ports, means for supplying a refrigerant to the refrigerant receiving chamber, and means for supplying a heating fluid into the heating fluid receiving chamber.

11. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a first substantially annular set of contractor ports and a second substantially annular set of ports, the inlet ends of the first set of ports and the second set of ports being arranged in spaced substantially concentric relation, a second valve element within the casing and forming with the first valve element a refrigerant receiving chamber and forming with the casing a separate heating fluid receiving chamber, the first set of ports being arranged to lead into the refrigerant receiving chamber, the second valve element having a part to cover the second set of ports and a port to be brought into communication with the second set of ports in succession and a part to cover the first set of ports in succession, means to effect a relative turning movement between the valve elements, a set of evaporator elements including sleeves adapted to have ice formed thereon, means to bring water into contact with the evaporator elements, tubes discharging into the sleeves and having their intake ends in communication with the first and second sets of ports, a compressor, a conduit connected with the intake side of the compressor and in communication with the interior of the sleeves, an outlet pipe connected with the outlet side of the compressor, a condenser coil connected with the outlet pipe, a liquid refrigerant receiving tank connected with the condenser coil, a liquid refrigerant supply pipe connected with the tank and leading into the refrigerant receiving chamber, and a pipe connected with the outlet pipe of the compressor between the compressor and the condenser coil to receive heated gasses from the compressor and leading into the heating fluid receiving chamber.

12. A machine for making ice, comprising a casing, a first valve element connected with the casing and having a substantially annular set of first contractor ports and a substantially an-

nular set of second ports, a second valve element within the casing and forming with the first valve element a refrigeration chamber upon one side of the second valve element and forming with the casing a heating fluid receiving chamber upon the opposite side of the second valve element, the first ports being arranged to lead into the refrigerant receiving chamber, the second valve element having a part to cover the second ports and a port to be brought into communication with the second ports in succession and a part to cover the first ports in succession, means to effect an intermittent turning movement of the second valve, releasable means to hold the second valve in position during the dwell, a tank for holding water, evaporator elements at least partly submerged in the water, tubes discharging into the evaporator elements and in communication with the first and second ports, a pipe for supplying the refrigerant to the refrigerant receiving chamber, a pipe for supplying heating fluid to the heating fluid receiving chamber, and conduit means connected with the evaporator elements for receiving the expanded refrigerant therefrom.

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