Feb. 13, 1962 G. W. HARRIS, SR 3,020,730

ICE MAKING APPARATUS

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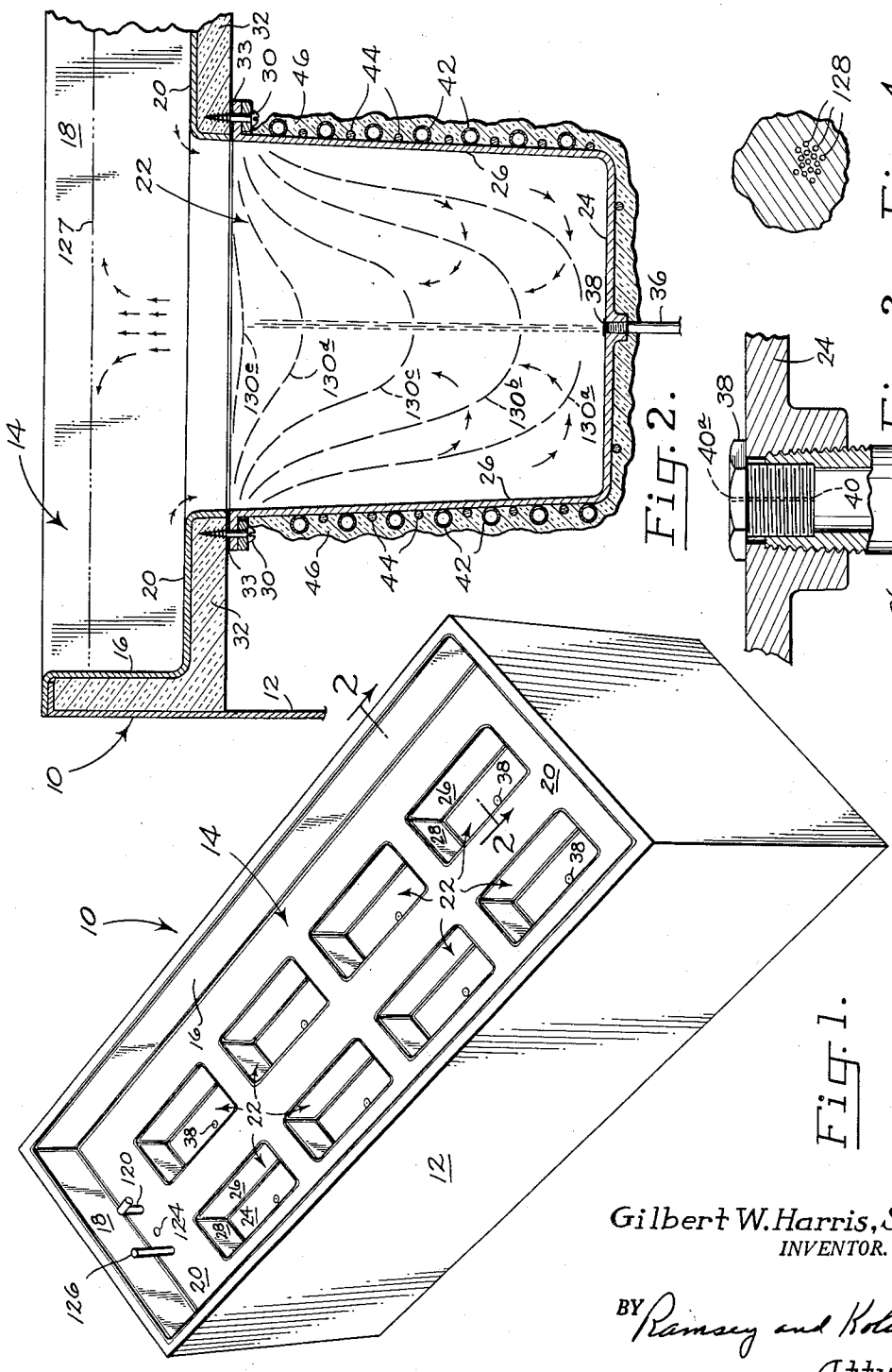


Fig. 1.

Fig. 4.

Fig. 3.

Fig. 2.

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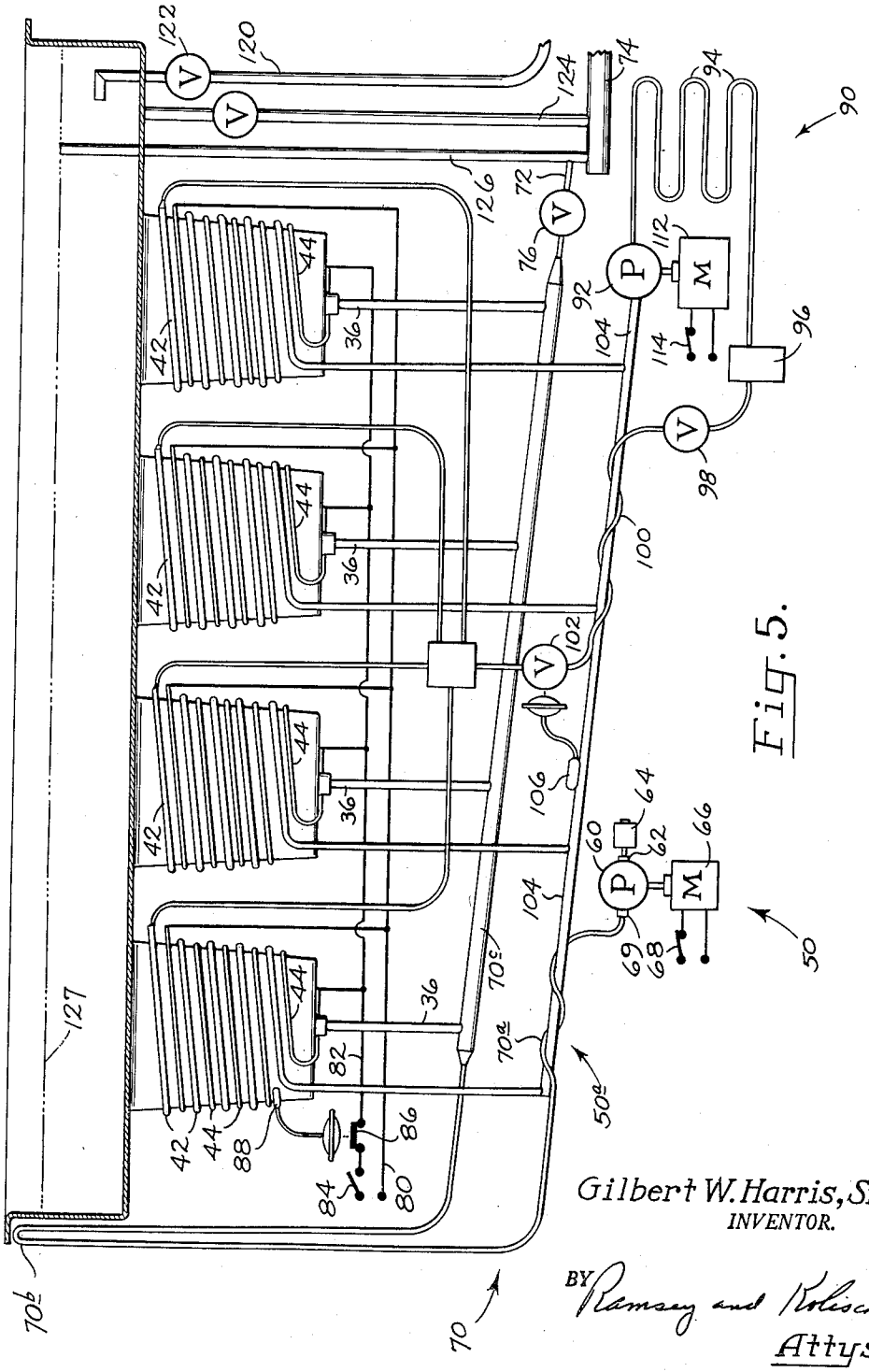


Fig. 5.

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3,020,730

ICE MAKING APPARATUS

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This invention relates to ice making machinery, and more particularly to apparatus for manufacturing blocks of ice of convenient size for handling using individual molds for each block. The invention is characterized by a number of novel features wherein blocks of ice of superior quality are produced, and produced rapidly and substantially automatically.

Generally, it is an object of this invention to provide improved ice making machinery that is considerably more compact and efficient in operation than apparatus previously known.

Another general object is to provide improved ice making machinery constructed and arranged so that a minimum amount of heat loss takes place in the apparatus, and enabling, as a result, the efficient production of ice.

A still further general object is to provide improved mechanism for eliminating impurities and turbidity from ice blocks.

There is a need for ice making machinery operable to freeze blocks of ice in a size permitting immediate sale without first having to cut up the blocks. The usual equipment employed in manufacturing block ice comprises ice cans, brine, brine tanks and conveyor systems. The blocks produced are relatively massive, and require cranes and the like for their handling. The blocks must be divided into blocks of smaller size before distribution. Further, the presence of the brine during the freezing process and handling of the ice has produced contamination problems. The manufacturing equipment has been bulky, inefficient and expensive to install.

According to this invention individual blocks of ice of a size convenient for sale or distribution are made in separate molds. Thus the blocks are ready for sale without cutting or extensive handling. The apparatus employed for producing the blocks is constructed to enable removal of the ice blocks from the molds by flotation. The constructoin also permits the forming of ice blocks with minimal amounts of water in excess of that going into the formation of ice subjected to the cooling process. As a result, savings in the energy used in the extraction of heat from the water results. The molds for making the ice are provided with novel means for cooling and heating them in sequence, whereby ice first may be formed and then loosened f-om the molds.

According to an embodiment of this invention, the ice-making unit comprises a frame, and a basin portion for holding water mounted on the frame. Depending downwardly from the bottom of this basin portion and joined thereto are a plural number of recessed molds. These are tapered toward their bottom ends, and have often top ends that connect with the interior of the basin portion. The bottoms of the molds are closed, and water is confined during manufacture of ice to the interior of the molds and the basin.

For aerating and removing impurities from the forming ice, each of the molds is provided with an air jet means that projects through the base of the mold and includes a constricted orifice for directing a regulated stream of air up through the mold. The diameter of the orifice is relatively small, and in the usual instance may range from 0.01" to 0.02". Compressed air (at relatively low pressure) is fed through the orifice to produce the air stream. The air aerates the ice, and thus removes

turbidity therefrom. It also causes impurities to float to the top of the mold and into the basin, where they may be removed. Relatively small amounts of air are used (due to the small diameter of the orifice feeding the air and the low pressure of the air), and any heating effect of the air is relatively minor.

Because of the small diameter orifice used, it has been found important that means be provided for condensing and removing moisture from the air. Moisture and foreign particles in the air quickly cause clogging of the orifice and stop the jet stream. Thus in an embodiment of the invention, a compressor is employed for compressing air, and the compressed air is sent through a condenser section where a coolant cools the compressed air to produce moisture condensation. The air, with moisture removed therefrom, is then sent through the jets, and continuous operation results. To remove condensed moisture from the conduit feeding air to the jets, a sloping header section is provided that slopes downwardly to a bleeder valve. This latter valve is left open during operation of the machine. The bleeder valve performs the function of allowing the draining of moisture from the header section. It also provides a means automatically for controlling the pressure of the air admitted through the jets. As ice forms in the molds, the air streams find increasing resistance to passage through the molds, and the pressure of the air increases. The bleeder valve prevents more than a moderate increase in pressure from occurring while permitting some slight increase.

Each of the molds is provided with side walls and a bottom. About the exterior of each mold are heating and cooling means. The side walls and bottom of a mold are made of heat-conductive material, and heat transfer to and from the contents of the mold takes place both at the bottom and sides, resulting in efficient forming of an ice block. An insulating strip around the top of each mold and between the mold and the basin prevents ice formation beyond a certain height in the mold. Columns of air encircle each depending mold and separate the molds. Water used in freezing is carried only in the mold cavities and in the basin above the molds. The construction is simple, employs air as part of the insulating medium in the apparatus, makes possible fast heating and cooling of the molds, and reduces substantially the overall charge of water required for the formation of a given quantity of ice.

Thus it is a more specific object of the invention to provide improved machinery for manufacturing block ice wherein any water in the apparatus to be transformed to ice is confined within a basin portion and the interiors of hollow mold portions depending downwardly from the basin portion and closed at their bottom ends.

Another object is to provide apparatus for making block ice comprising a basin portion and depending hollow mold portions wherein cooling and heating of the mold portions is done through means surrounding each, and wherein part of the insulating means separating the various mold portions comprises columns of air surrounding each.

Still another object of the invention is to provide improved ice making machinery wherein an air jet is admitted into the base of a closed mold for removing turbidity and impurities, and wherein said air jet exhausts exclusively into the mold cavity and maximum benefits are derived from minimum amounts of air

Still another object of the invention is to provide improved air jet means for removing turbidity in forming ice wherein the jet means is fed with filtered and dehumidified air, enabling the use of a small diameter jet means and compressed air at relatively low pressures, without incurring frequent clogging of the jet means.

A still further object is to provide an improved construction for supplying compressed air in streams to mold cavities for ice wherein means is provided automatically for removing condensed moisture from the compressed air and at the same time for stabilizing the pressure of the air in the air streams as ice forms in the molds.

These and other objects and advantages are attained by the invention, the same being described hereinbelow in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of an ice-making unit embodying the invention, showing the top of a cabinet for the unit and the basin and depending mold portions present in the unit;

FIG. 2 is a section view, generally along the line 2—2 of FIG. 1 and slightly enlarged, showing details of the basin and a mold depending therefrom, and illustrating by dashed lines how ice forms in the mold;

FIG. 3 is an enlarged view of the air jet means provided at the base of each mold;

FIG. 4 illustrates a portion of a typical piece of ice formed in the apparatus; and

FIG. 5 is a schematic illustration of the means for heating and cooling the ice molds and of the mechanism delivering compressed air to the air jet means.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, **10** indicates generally an ice making unit of the invention. As shown, this comprises a cabinet frame **12** of rectangular configuration mounting near the top of the unit and above the floor a basin portion indicated at **14**. The latter comprises side and end walls **16** and **18**, respectively, and a bottom **20**. Basin portion **14** has projecting downwardly from the base thereof recessed mold portions **22**. The mold portions are tapered, and have sides **26**, **28** that converge toward each other at the bottom of the molds. Bottoms **24** close off the bases of the molds. The mold portions are opened at their top ends, and their interiors connect with the interior of basin **14**.

The basin and mold portions may be made of one piece of material. Preferably the mold portions are comprised of heat-conductive material, such as aluminum and the like, to make efficient the transfer of heat to and from the molds. The basin portion, since it is not used as a heat conducting medium and is most efficient if insulated, may be made of material other than aluminum. Thus in the embodiment illustrated, the mold portions are separate from the basin portion and are joined to the basin portion by screws **30**. Extending along the sides and covering the base of the basin portion **14** outwardly of the molds is a layer of insulating material indicated at **32**. The molds are joined to portion **14** through a layer of insulating material **33**. Layer **32** inhibits the absorption of heat by water in the basin portion and contributes to greater efficiency. By separating the tops of the molds from the basin **14** with insulating material **33**, ice formation at the top of the molds is prevented, which makes possible the forming of regularly shaped ice blocks and contributes to easier removal of ice blocks after they are formed.

It has been found that during the manufacture of ice, unless the water being transformed to ice is aerated, the finished ice blocks will be turbid or cloudy. To aerate the ice and prevent this turbidity, and also to remove impurities from the water, provision is made for directing a stream of air into the bottom of each mold. Thus there is included at the base of each mold a conduit section or pipe means **36** for feeding compressed air to the mold. At the end of each conduit section **36** is a plug or air jet means **38**. Plug **38** is provided with a constricted passage **40** connecting the interior of the mold and the interior of conduit section **36**. The end of passage **40***a* that opens to the mold constitutes a constricted orifice in an air jet means that extends through bottom **24**. Passage **40** and aperture **40***a* have relatively small diameters. This serves to restrict the volume of air passing through each mold over a given time. A large volume of air is undesirable as it introduces heat and makes for less efficient operation. It should be noted that the stream of air is fed directly to the mold interior with bottom **24** closing off any escape of air around the outside of the mold.

Surrounding each of the depending mold portions is a system of cooling coils or windings **42** (that carry a circulated coolant) and electric heater coils of windings **44**. These are wrapped around the exterior of the molds with their inner surfaces contacting the heat-conductive mold walls. Over the coils **42**, **44** and providing a heat-conducting medium between outer portions of the coils and the mold is a layer of heat-conductive mastic material **46**. This mastic material contributes to better extraction of heat from the mold when using cooling coils **42**, and transfer of heat to the mold when using heater coils **44**. Note that by providing each mold with both walls and a bottom **24**, heat transfer may take place over an enlarged area. It should also be noted that the construction described confines water to a location within and above the molds. Each mold is surrounded by an air column. This minimizes the problem of insulating the molds.

Referring now to FIG. 5, the apparatus is provided with a means for supplying compressed air to jet means **38**, indicated generally at **50**. This is mounted in cabinet **12** below basin **14**. Ordinary atmospheric air may contain considerable moisture. The presence of moisture in the air has been found severely to impair operation of the apparatus when a small aperture **40***a* is used in the air jet means. This is for the reason that the moisture tends to crystallize as ice over the aperture and plug it up. Means **50** thus includes dehumidification means **50***a* for removing excess moisture from the air.

Specifically, and referring again to FIG. 5, **60** indicates an air compressor having an intake **62** for drawing air from the atmosphere. The latter is covered by an air filter **64** that removes solid foreign particles. Compressor **60** is driven by an electric motor **66** turned on and off by control switch **68**. Compressed air from compressor **60** passes from outlet **69** of the compressor through a conduit means **70** to the jet means **38**. Conduit means **70** includes section **70***a*, an inverted loop or trap section **70***b* and a header section **70***c*. Connections to the jet means **38** (by conduit sections **36**) are from header section **70***c*. The header section slopes downwardly from the connections with jet means **38** to an outlet or discharge end **72** connecting with sewer line **74**. At discharge end **72** the header section is provided with a bleeder valve, indicated at **76**.

Heater coils **44** are connected in parallel to source conductors **80**, **82**. One of the conductors connects to a switch **84** used for turning on and off the heaters. The circuit for coils **44** also includes a thermostat control switch **86** actuated by a thermostat **88**. Switch **86** normally is closed, but should the molds reach a certain temperature, the thermostat operates to open switch **86** and cut off the supply of electricity to heaters **44**.

Coolant or refrigerant is supplied cooling coils **42** by a refrigerator system indicated generally at **90**. This includes a compressor **92** which compresses refrigerant and discharges it through a heat exchanger **94**. Here air dissipates heat from the compressed refrigerant, and the refrigerant thence passes to a reservoir **96**. Proceeding from reservoir **96** the refrigerant passes through a control valve **98**, conduit **100**, and an expansion valve **102**. From valve **102** the refrigerant is distributed to the cooling coils. The refrigerant on leaving coils **42** is returned to compressor **92** through conduit **104**. Valve **102** is controlled by thermostat **106** sensitive to the temperature of conduit **104**. Electric motor **112** regulated by switch **114** drives the compressor **92**.

Section **70***a* of conduit means **70** is in the form of a winding wrapped around a portion of conduit **104** re-

turning refrigerant to compressor **92**. Thus conduit **104** is operable to extract some heat from the compressed air flowing through section **70***a*. Section **70***a* constitutes a condenser section where condensation of moisture in the compressed air takes place through cooling of the compressed air. Condensed moisture is carried along by air flowing in conduit means **70** to header section **70***c*, whence it flows by gravity down sloping header section **70***c* to valve **76** and out the valve to sewer **74**. The bleeder valve functions as a means for removing condensed moisture from the conduit means **70** supplying air to jet means **38**.

To complete the description of the apparatus, a water supply line **120** controlled by a valve **122** is used to fill the basin **14** and the various molds depending therefrom. Line **124** is a drain line connecting to the sewer, and line **126** is an overflow line also connected to the sewer and determining the maximum level of the water in the basin.

In operation, air is compressed by compressor **60** and thence delivered by conduit means **70** to the various air jet means. Bleeder valve **76** is left open. On traveling through condenser section **70***a*, water is condensed from the air, and this eventually travels through trap section **70***b*, header **70***c* and valve **76** to the sewer.

The molds and basin portion are then filled with water. Trap **70***b* is included to prevent water from flowing down through the various sections **36** and into the compressor **60** in the event the compressor is off and water is present within the interiors of the molds. Note that trap section **70***b* is at a higher elevation than the water line in the basin **14** determined by overflow line **126**, such water line being indicated in FIG. 5 at **127**. After the molds are filled with water, compressor **92** may be started, and refrigerant circulated through coils **42**.

During the formation of ice, the bleeder valve is effective to regulate the pressure of air flowing through the various air jet means **38**. As ice forms in the molds, it offers increasing resistance to air flow. Ice tends to form as shown in FIG. 2 by the dashed lines **130***a–e*. Initially ice covers the bottom and sides as shown at **130***a*. The ice then builds up in a mold with the top surface of the forming block passing through the positions of **130***b*, **130***c*, etc., until it levels off at **130***e*. Small passages resembling veins are formed in the ice, as illustrated in FIG. 4 at **128**. These passages accommodate air flow, but not as easily as water. The bleeder valve prevents air pressure from rising sharply when the ice forms, by providing an escape for larger and larger quantities of air. The valve permits a moderate increase in air pressure to occur, however, which is sufficient to assure that air flows through the forming ice. The bleeder valve, in passing off progressively more air, as ice forms, produces a reduction of heat loss in the apparatus, by cutting down on the quantities of relatively warm air passing through the forming ice.

The ice making machine may be used continuously for the production of ice blocks at regular intervals. Thus, after ice cakes or blocks are completely formed, the ice may be freed from the molds by turning off the compressor circulating refrigerant, and closing switch **84** to produce heating of the heater coils. This warms the molds and frees the ice blocks, enabling them to be floated out of the molds to prepare them for removal from the apparatus. After ice is cleared from the apparatus, the entire process may be repeated to form new ice blocks.

It should be noted that the apparatus is constructed and arranged so that the water for freezing is carried entirely in the basin or within the molds, and not around the sides of the molds. The water capacity of the unit is relatively small compared to the weight of ice produced. Cooling and heating of the mold exteriors is done efficiently using the heating and cooling coils described. The absence of any water around the molds simplifies mounting of the molds and makes for easier maintenance. The columns of air surrounding the molds provide some degree of insulation. The molds themselves are designed to promote efficient transfer of heat to and from the interiors of the molds.

The entire apparatus may be constructed as a unit mounted in a cabinet. Cranes are not needed to move the ice blocks, nor is machinery necessary to reduce the size of the ice blocks. The apparatus is particularly useful in locations where a steady supply of twenty-five or fifty pound blocks of ice is desired without having to make a large capital outlay for a plant.

It is claimed and desired to secure by Letters Patent:

1. In block ice making machinery having air jet means for producing a stream of air through a block of ice, air supply means for said air jet means comprising the combination of an air compressor for compressing air having an intake and an outlet, conduit means connecting the outlet of said compressor and said air jet means, and a bleeder valve with an outlet wasting said air jet means included in said conduit means providing for the bleeding through its outlet of controlled amounts of compressed air from the conduit means, said bleeder valve and air jet means in concert providing for the discharge of compressed air from said air compressor.

2. In ice making machinery for manufacturing blocks of ice having air jet means for producing a stream of air through a block of forming ice, air supply means for said air jet means comprising an air compressor for compressing air having an intake and an outlet, conduit means connecting the outlet of said compressor and said air jet means, said conduit means including a condenser section between the outlet of the air compressor and said air jet means where moisture is condensed from air flowing in the conduit means, and a bleeder valve connected to the conduit means on the outlet side of said condenser section providing for the passage of controlled amounts of compressed air from the conduit means, said conduit means having a section sloping substantially continuously downwardly from said air jet means to said bleeder valve whereby any moisture collecting in the section may flow out through said bleeder valve.

3. In machinery for making block ice having jet means for admitting a stream of compressed air into a block of forming ice, a compressor for compressing air having an intake and an outlet, conduit means connecting the outlet of said compressor with said jet means, said conduit means having an outlet end spaced below said jet means and an inclined section sloping downwardly continuously from said jet means toward said outlet end, a bleeder valve for the conduit means providing for the exhaust of controlled amounts of air therefrom and located at said outlet end, said bleeder valve also accommodating the discharge of moisture from said inclined section.

4. In ice making machinery for making blocks of ice from water having a basin portion for holding water, plural recessed mold portions joined to the bottom thereof and projecting downwardly therefrom, air jet means at the base of each mold portion for introducing into the bottom of the mold portion a stream of air, the improvement comprising a supply of air under pressure, means including a coolant conduit line for cooling each of said mold portions, conduit means connecting the supply of air under pressure and each of said air jet means, said conduit means including a condenser section in juxtaposition with said coolant line and constructed to enable heat transfer to take place between the two, said conduit means also including a header section below the various air jet means and means connecting the header section with each of said air jet means, said header section sloping substantially continuously downwardly toward an outlet end, and a bleeder valve provided at the outlet end of said header section, said bleeder valve providing for the constant discharge of air under pressure from the header section and also accommodating the outflow of moisture from the header section.

5. The machinery of claim 4 wherein the supply of

air under pressure comprises a compressor, and wherein at least a portion of the conduit means intermediate the compressor and the header section is at higher elevation than the normal water level in said basin portion.

6. In apparatus for the manufacture of block ice from water comprising a frame, a basin portion for holding water mounted in the frame having recessed mold portions laterally spaced one from another and projecting downwardly from the base of said basin portion, each of said mold portions having side walls and a bottom completely closing off the base thereof, and air jet means provided each mold portion projecting through the bottom thereof and including a constricted orifice for introducing a stream of air into the base of each mold portion, the improvement comprising air supply means for said air jet means comprising an air compressor having an intake and an outlet, and conduit means connecting the outlet of said compressor with each of said air jet means, said conduit means including a trap section intermediate the air jet means and compressor spaced at higher elevation than the normal water level in said basin portion thus to prevent the flow of water by gravity from the interior of a mold through an air jet means and said conduit means to said compressor, said conduit means also including a header section below the various air jet means and means connecting the header section with each air jet means, said header section sloping continuously downwardly from the connections with the air jet means to a discharge end, and a bleeder valve at the discharge end of said header section accommodating the discharge of moisture from said header section.

7. In ice making machinery, mechanism for producing a stream of air in a block of forming ice comprising air jet means; air compressor means for compressing air having an intake and an outlet; conduit means connecting said outlet with said air jet means; said conduit means having a condensor section between the outlet of the air compressor and the air jet means where moisture is condensed from air flowing through the same, a sloping section at the discharge end of the condensor section, and means joining the sloping section to the air jet means; and bleed means at the discharge end of said sloping section accommodating the discharge of water from the conduit means and also the discharge of controlled amounts of air.

8. In apparatus for manufacturing block ice from water, a frame; a basin portion mounted in the frame for holding water and having recessed mold portions extending downwardly from the base thereof; air jet means at the base of each mold portion communicating with its interior for the supply of a stream of air thereto; an air compressor having an intake and an outlet; a conduit connecting the outlet of the compressor with the air jet means; said conduit includnig a trap section intermediate the air jet means and the compressor spaced at higher elevation than the normal water level in the basin portion thus to prevent the flow of water by gravity from a mold downwardly through an air jet means and into the compressor, a header section, and means connecting the header section with each air jet means whereby the air jet means are supplied with air from the header section; and bleed means at the discharge end of the header section accommodating the discharge of water and controlled amounts of air therefrom.

9. In ice making machinery, an ice mold, and mechanism for producing a stream of air in a block of ice forming in said mold comprising air jet means, air compressor means for compressing air having an intake and an outlet, conduit means connecting said outlet with said air jet means, said conduit means having a section where compressed air is cooled followed, progressing from said outlet, by a sloping section having one end below its other end, bleed means connected to said one end of said sloping section accommodating the discharge of condensed moisture therefrom and the discharge of controlled amounts of air, and pipe means joining said sloping section and said air jet means and connecting with the sloping section at a location where moisture in the sloping section is diverted by gravity down the section to said bleed means rather than into said pipe means.

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