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3 Sheets-Sheet 1

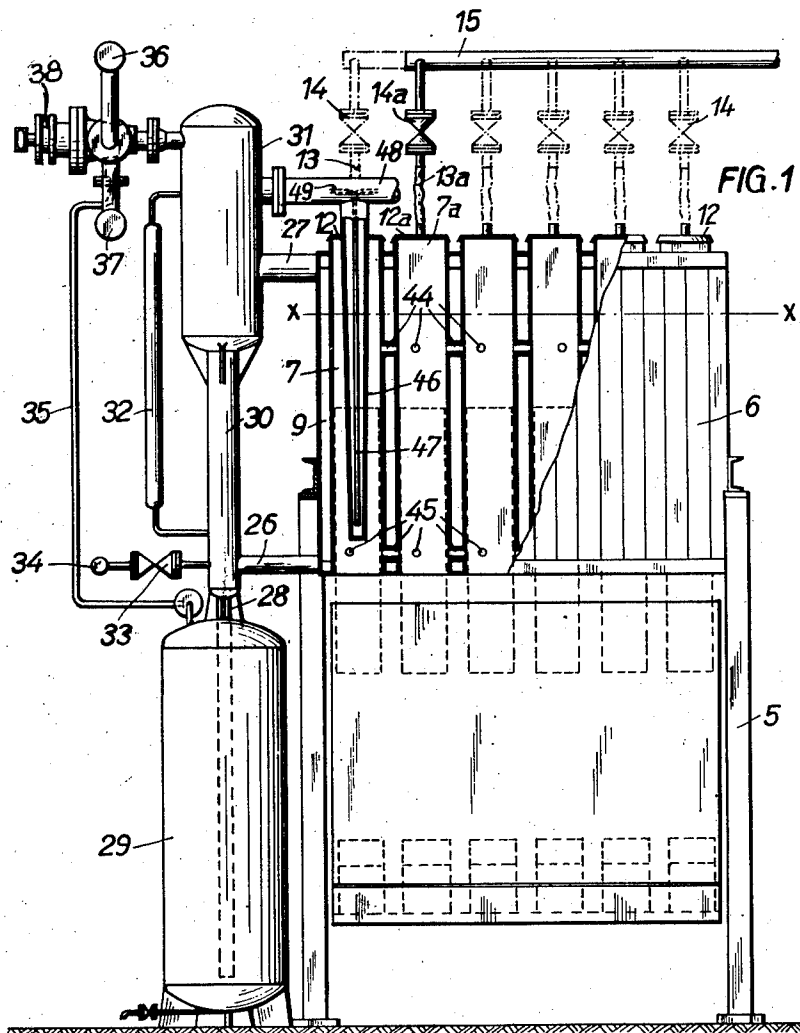
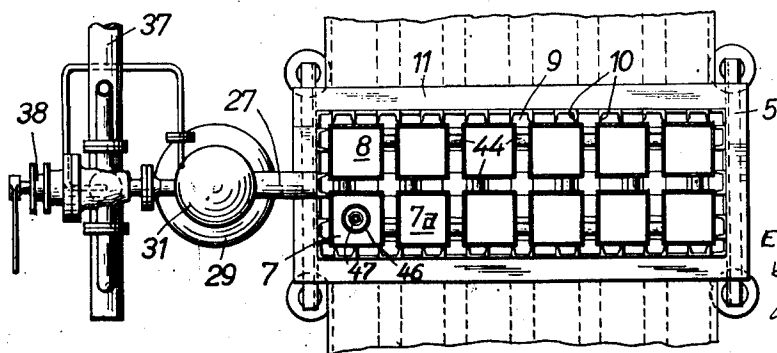


FIG. 2



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June 30, 1953

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FREEZING PLANT

Filed June 8, 1951

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FIG. 3

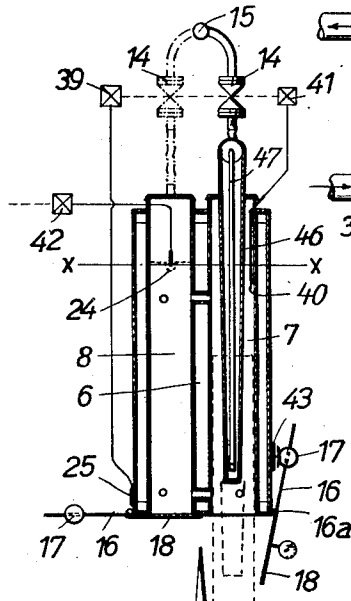


FIG. 5

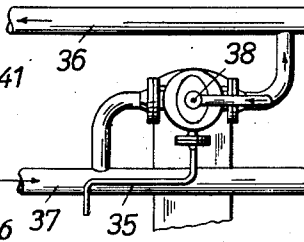
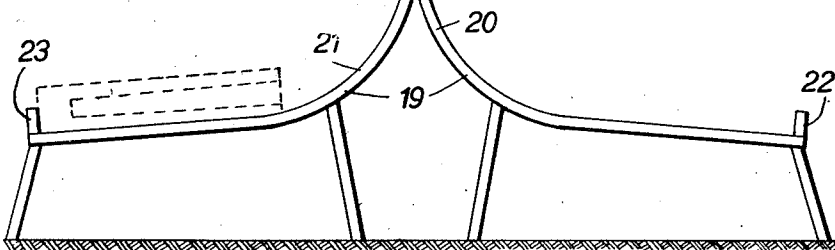
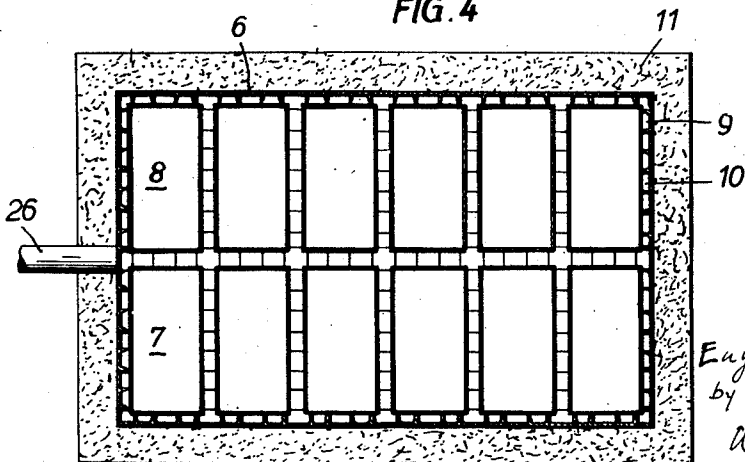


FIG. 4



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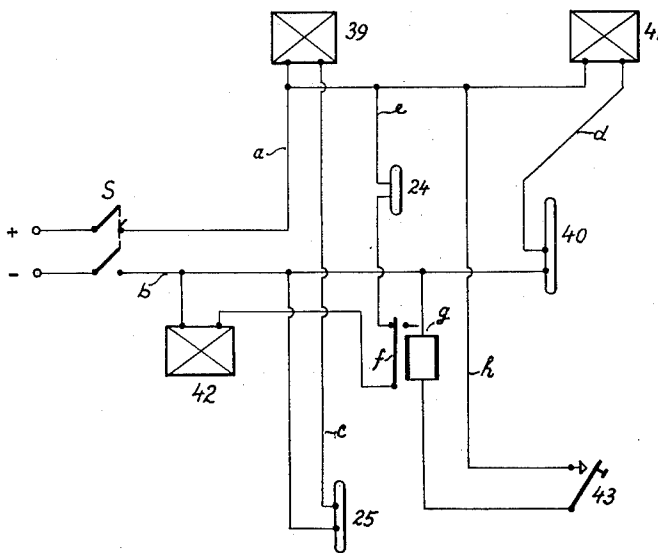
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FREEZING PLANT

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FIG. 6



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FREEZING PLANT

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Application June 8, 1951, Serial No. 230,634

In Israel May 30, 1950

6 Claims. (Cl. 62—3)

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The invention relates to a process of production of ice in blocks and to the devices for operating the process.

According to a known process of production of ice in blocks a set of receptacles filled with water is lowered into a brine refrigeration bath, which the receptacles cross horizontally in vertical position, after which the receptacles are taken out of the brine bath, plunged into a tank of hot water in order to thaw each block of ice from its receptacle and finally the set is inverted in order to make the finished blocks reach the outlet. According to another process known under the name of "rocket" process or Fechner process, the evaporator provided with cooling cylinders is placed in a bath of water. In these cylinders the water is frozen directly by the effect of the evaporation of the refrigerant. After the freezing the hot gases of the refrigerant are conducted into the evaporator by reversing a tap, and the blocks loosened from the mould are, thanks to their specific gravity less than that of the water, projected to the surface of the bath from where they can be taken out.

According to still another process a plurality of stationary cylindrical tubes of small cross-section and filled with water are immersed in a liquid refrigerant, and the ice which is formed in the interior of the tubes is continually detached in pieces at their lower end. This process cannot be applied to the production of ice in blocks.

The present invention relates to the production of ice in blocks. It aims in the first place at producing a process and the devices by which the production of ice in blocks is accelerated in comparison with the known processes. Furthermore, the aim of the invention is to establish a process and the devices by which the production of ice in blocks can be effected entirely automatically. Lastly another aim of the invention consists in producing the devices ensuring the wholly automatic operation of the plant producing the ice in blocks in the simplest manner possible.

The process of producing ice in blocks in stationary moulds and with the aid of a refrigerant surrounding the moulds, which constitutes the object of the present invention consists in the fact that the refrigerant is decanted into a special receptacle after the freezing of the blocks, that the said blocks of ice are detached from the moulds by means of a thawing liquid introduced into the spaces surrounding the moulds, then removed from the moulds by the bottom under

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the action of gravity after which the refrigerant is again introduced into the spaces surrounding the moulds.

Without departing from the scope of the invention the operations of freezing and detachment of the blocks can be effected by means of the same fluid, in particular by the introduction of hot refrigerant vapours into the spaces surrounding the moulds, from where they act as thawing fluid.

Also within the scope of the invention the control operations which cause the interruption of the admission of the refrigerant, the evacuation of the same and the introduction of a thawing fluid can be made to start from at least one member sensitive to temperature disposed in the middle of the upper end of the one of the blocks of ice. Moreover, according to another feature of the invention the moulds can be furnished with movable bottoms, especially rocking bottoms. One can use the movements of one or more of these bottoms for giving the impulses which initiate the control operations. In this order of ideas and in accordance with a special realisation of the invention the movement of a bottom can cause the reintroduction of the refrigerant into the space surrounding the mould.

Furthermore the invention aims at improving the process of refrigeration of the liquid to be frozen. Thus the object of the invention involves the possibility of producing an at least partial vacuum in the moulds intended for the reception of the liquid to be frozen.

Always within the scope of the invention, the admission and the interruption of the admission of the liquid to be frozen can be controlled automatically. For this purpose and in conformity with the invention the members sensitive to temperature can be disposed the one at the bottom of at least one of the moulds and the other near the level provided for the liquid to be frozen. Of these members, the one provided at the bottom of the mould can effect by means of suitable controlling devices the opening of the one or more obturators of the admission of the liquid, whereas the member placed near the level provided for the liquid to be frozen effects the closing of the obturator or obturators of admission when the liquid reaches this level.

The invention comprises also the devices intended to put into operation the processes which constitute the one of its objects.

One embodiment of the device according to the invention is shown in the attached drawing by way of example.

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Fig. 1 is a diagrammatical side view of a plant for the production of ice in blocks;

Fig. 2 is a plan view of the same plant, in which a set of moulds for receiving the liquid to be frozen is shown in horizontal section;

Fig. 3 is a front view of the plant view in which the installation for distributing the refrigerant is not shown;

Fig. 4 is a horizontal section in larger scale of a set of moulds for the production of ice in blocks;

Fig. 5 is a partial view of the means for the distribution of the refrigerant.

Fig. 6 is a diagram of connections of electric controls.

The plant (Fig. 1) has a foundation marked as a whole by 5 and which supports at a certain distance above the ground a set of moulds intended to receive the liquid to be frozen; this set is marked as a whole by the reference 6. It contains several separate moulds, spaced one from the other, in which a liquid is conducted for freezing and which can be of any cross-section, for example, square (Fig. 2) or rectangular (Fig. 4). It will be advantageous to give each mould a shape somewhat widened towards the bottom. Each mould of the set, of which the one is marked by 7 and another by 7a and a third by 8, is surrounded by spaces 9 in which a liquid can circulate between the moulds and around them. As will be seen from Figs. 2 and 4, these spaces can be subdivided by the ribs, perforated for example with orifices not shown in the figures. The ribs can be helicoidal in order to ensure an equal circulation around all the moulds 7, 7a, 8 etc., of the set. These means of channelling or guiding the flow of refrigerant liquid are indicated as a whole by the reference 10 in Figs. 2 and 4. The set of moulds, 7, 7a, 8 and the spaces 9 reserved for the refrigerant liquid are enclosed laterally by insulating walls marked as a whole by 11. This additional insulation of the set serves to prevent the transfers of heat between the refrigerant medium and the ambient atmosphere.

Each mould, such as 7, 7a, or 8 is connected to each of the neighbouring moulds by two pipes crossing the spaces 9, of which the one marked 44 makes the upper parts and the other, marked 45 the lower parts of the two adjacent moulds communicate. The moulds 7, 8 are individually covered with lids 12. The lid 12a of the mould 7a is furnished with an opening to which is connected a tube 13a, preferably flexible, the other end of which is connected by means of an obturator or tap 14a, to a pipe 15 by which the set is fed with liquid to be frozen. It can be fed either directly, for example from a water pipe when the plant serves for the production of ice from water, or indirectly by means of a reservoir (not shown on the drawing) disposed above the tape 14a.

According to a modification of the embodiment shown in dot-dash line in Fig. 1, the separate connection pipes 13 and the individual taps 14 can be provided for each mould 7, 8 in order to connect it to the feed pipe 15. One could also provide individual reservoirs (not shown) above each of the taps 14, for example when it is desired to freeze separately and simultaneously different fruit juices. In this case the pipes 44 and 45 connected between the moulds 7, 7a, 8 etc., will naturally be removed. This disposition also permits of putting out of service,

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at will, the one or other of the moulds, for example if it is defective.

In the drawing one has shown for the mould 7 another modification lending itself especially to the production of ice intended to be broken into small pieces later. According to this variant of execution a supplementary evaporator is disposed in the longitudinal axis of the mould. This evaporator comprises an outer tube 46 which is fixed to the lid 12 and which extends from the latter nearly to the lower end of the mould and tapering towards the bottom. The lower end of the tube 46 is closed at the bottom. In the axis of the tube 46 there is an inner tube 47 of smaller diameter and ending by an open end situated a little above the bottom which closes the outer tube 46. Similar supplementary evaporators can be provided in all the moulds 7, 8 of the set. One can also dispose two or more supplementary evaporators of this kind in each mould, for example when these moulds are of oblong, horizontal cross-section as is the case in the example of Fig. 4.

Each of the moulds 7 or 8 is furnished with a bottom, which according to the embodiment shown in Fig. 3 is rocking. The bottom, which pivots about the axis 16a, has the form of a lever with two arms. The one of these arms is formed by a plate 18 able to close the bottom of the mould 7, 8 concerned, whereas the other arm 16 carries a counter weight 17. The movement of the bottom can be made to contribute for giving the impulses serving to control the operations which will be described below.

A carriage marked as a whole by 19 is provided below the moulds or a set. This carriage has discharge tables 20 and 21 curved in such a manner as to bring the frozen blocks by gravity from their vertical position to a position near the horizontal, indicated by broken lines in the left half of Fig. 3. In order to retain the discharged blocks the stops 22 and 23 border the tables 20 and 21.

The space or spaces 9 intended to receive a refrigerant communicate at their bottoms with a feed pipe 26 (Fig 1) for the liquid refrigerant. In the top of the set a pipe 27 is provided for evacuating the evaporated refrigerant. In order to ensure an equal distribution of the refrigerant into all the spaces surrounding the moulds, other pipes or branches, not shown, of the pipes 26 and 27 can be connected at the bottom and at the top respectively of these spaces. The feed pipe of the refrigerant 26 joints a pipe 30, which connects it to a separator 31 communicating itself with the evacuation pipe 27 and destined to separate the liquid refrigerant from the evaporated refrigerant. Through the bottom of the pipe 30 and by a pipe 28 the feed pipe 26 also communicates with a receptacle 29; the pipe 28 is extended to the interior of this receptacle to near its bottom. A branch pipe having a tube indicating the level 32 is connected to the pipe 30 on the one hand and to the separator 31 on the other hand. This indicator permits of ascertaining the level of the refrigerant in the interior of the set by means of the icing which is produced at the height of the level of the refrigerant. The bottom of the pipe 30 and consequently the feed pipe of the refrigerant 26 communicate through a stop valve 33 with a distributing pipe 34, which conducts to them the liquid refrigerant of the condenser of a refrigerating plant, with compressors for example. Finally, a pipe 35 for equalization of the pressures, which is used

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especially for the operation of detaching the frozen blocks (which operation will be described later), starts from the top of the receptacle 29.

The separator 31 can be put into communication with a suction collector 36 returning the evaporated refrigerant to the compressor of the refrigerating plant, whereas a distribution pipe 37 conducts the evaporated refrigerant from the compressor to the set. The suction collector 36 and the distribution pipe 37, to which several sets can be connected, are connected according to the requirements of the process, to the pipe for equalization of the pressures 35 and to separator 31 by a controlling device 38, for example a four-way distribution valve.

In the modification with supplementary evaporator disposed in the interior of the mould, as shown for the mould 7, the outer tubes 46 of the supplementary evaporators of the various moulds of a set are connected together by a collector tube 48 leading, as the evacuation pipe 27 of the main evaporators, 9, to a separator. The inner tubes 47 of the supplementary evaporators are connected together by a distribution tube 49 disposed in the interior of the collector tube 48. This distribution tube will be preferably branched in a manner not shown on to the feed pipe 26 for the liquid refrigerant.

The tap 14a or the taps 14 can be opened by an electromagnetic control device including solenoids 39 and 41. The opening is performed by the solenoids 39 in consequence of a momentary impulse produced by a temperature-responsive element 25 which is disposed near to the bottom of at least one of the moulds 7, 8 and conductively connected to the solenoid 39. The closing of the tap or taps is effected by the solenoid 41 and occurs when the fresh water, already cooled in the mould, reaches the predetermined high level in the mould and contacts another temperature-responsive element 40 disposed in the top part of at least one of the moulds and similarly connected to the solenoid 41.

In the centre and in the top of the one at least of the moulds 7, 8 there is a third element 24 reactive to temperature connected to an electromagnetic device indicated diagrammatically at 42, which actuates the control device or four-way valve 38 for effecting the operation of detaching the blocks, the description of which follows. As can be seen especially from Fig. 3 an impulse transmitter, diagrammatically shown at 43, cooperates with the movable bottom 16, 18 of each of the moulds. This transmitter causes the re-introduction of the refrigerant into the set, as soon as the detachment and the removal from the moulds of the frozen blocks is completed. Fig. 6 shows a diagram of connections of the electric controls mentioned hereinbefore.

A suitable source of direct current, indicated by the signs "plus" and "minus," is connected through a switch S with a wire a leading in parallel to the solenoids 39 and 41, and to wire b which leads in parallel to the electro-magnetic device 42, the temperature-responsive elements 25 and 40, and the impulse transmitter 43. Wire c leads from element 25 to solenoid 39, and wire d from element 40 to solenoid 41. The circuit e of the temperature-responsive element 24, connected between wire a and device 42, includes as an interrupter the armature f of a relay g which is connected to wire b in series with the impulse transmitter 43. The interrupter f keeps the circuit e closed when no current flows through the

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relay g and interrupts the circuit e when the relay is excited.

A plant according to the invention works in the following way:

Assuming that the blocks of ice have just left the set and that the oscillating bottoms 18 of the moulds have returned to the closed position indicated in the left part of Fig. 3, the compressor of the refrigerating plant will discharge from the condenser the liquid refrigerant towards the bottom of the spaces 9 through the distribution pipe 34, the stop valve 33 and the feed pipe 26. At the same time in the modification shown for the mould 7 the liquid refrigerant is injected into the interior of the tube 46 by means of the tubes 49 and 47. For this reason the temperature in the set decreases and the bottom 18 of each of the moulds 7, 8 is attached to the lower surface of the latter by the freezing of the adhering moisture. The decrease of temperature then sets into play the element 25, which by means of the control device causes the opening of the tap 14a or the taps 14 so that the liquid conducted by the feed pipe 15 is introduced into the moulds 7, 8 by the tap 14a and the pipes 13a, 44 and 45, or by the taps 14 and the pipes 18, as the case may be. One may provide devices (not shown) for distributing equally the liquid into the moulds; these devices may have, for example, the form of a watering can rose. The aforesaid attachment of the bottom 18 to the mould by freezing suffices to support the load of the inflowing water, the more so as the first portions of water quickly freeze and form a plug which adheres to the walls and bottom and is capable itself to carry the load of the column of water thereabove until this in turn freezes and adheres to the walls of the mould. In this way the moulds 7, 8 are filled with liquid up to the level indicated by the line X—X (Figs. 1 and 3). When the liquid reaches this level the element 40 sensitive to temperature comes into action and causes by the device 41 the closing of the tap 14a or the taps 14 in such a way that the admission of the liquid to be frozen is automatically interrupted. As the refrigerant, for example, ammonia, continues to reach the spaces 9 and to evaporate the columns of liquid contained in the moulds 7, 8, are frozen. Until they are quite frozen the liquid can be kept in movement or submitted to a partial vacuum. The evaporated refrigerant is evacuated by the upper pipe 27 and, where this applies, by the collector tube 48, and conducted into the separator 31. From the latter the evaporated refrigerant returns to the compressor of the refrigerating plant by the collector pipe 36, while the liquid refrigerant runs off towards the bottom by the pipe 30. The vapours of the refrigerant are then liquefied in known manner with the aid of the compressor and of the condenser of the refrigerating plant and return to the evaporation chambers 9 of the set through the pipe 34, the stop valve 33 and the feed pipe 26 and, where this applies, through the tubes 48 and 47. The refrigerant continues to run through this circuit until the liquid contained in the moulds 7, 8 is frozen.

The element sensitive to temperature 24 is disposed in such a way that its end is at the point where the freezing of the liquid finishes. One knows that the liquid freezes last of all in the centre of the upper surface of the block and that at this place a cavity filled with liquid remains. When the liquid is formed, for example, by water the salts contained in the water and

the impurities are concentrated in this cavity and lower there the freezing temperature in such a manner that it is this place that freezes last of all. At the moment when the freezing temperature is reached there the element 24 intervenes and, by means of the electro-magnetic device 42 actuates the control device 38 constituted by a four-way valve. The latter interrupts the evacuation of the evaporated refrigerant towards the suction collector 36, connects the separator to the distribution pipe 37 and by this reverses the circulation of the refrigerant in a manner that the compressor discharges into the spaces 9 through the collector 36, the separator 31 and the evacuation pipe 27 and, where this applies, into the outer tubes 46 of the supplementary evaporators by the tube 48 the evaporated and therefore hot refrigerant. At the same time the control device 38 connects the pressure equalization pipe 35 to the distribution pipe 37, thus establishing in the top of the receptacle 29 the same pressure as in the separator 31 and in the spaces 9. The liquid refrigerant still contained in the spaces 9 and the tubes 46 is then expelled from them into the receptacle 29 through the pipes 26 and 28 and the tubes 47 and 49. The pressure of the liquid refrigerant in the distribution pipe 34 being regulated at a value lower than that of the pressure in the distribution pipe 37 of evaporated refrigerant, the stop valve 33 is closed so that the liquid refrigerant flowing from the spaces 9 is directed into the receptacle 29 and cannot return to the condenser. By the introduction of hot refrigerant gases into the spaces 9 a process of thawing is initiated, therefore the blocks of ice situated in the moulds 7, 8 are detached from the walls of the latter. At the same time the bottom 18 is detached also on account of the thawing and the weight of the blocks of ice push the rocking bottom 16, 18 towards the bottom (Fig. 3, on the right). The blocks of ice are then released from the mould by gravity and run down on to the tables 20 and 21, the slightly inclined portions of which finally receive them (Fig. 3 on the left).

As has already been indicated, the movement of the bottom 16, 18, rocking in this particular case, is used to produce an impulse causing the reintroduction of the liquid refrigerant into the plant. In the embodiment shown the bottom 18 has just struck against the impulse transmitter indicated diagrammatically at 43. The latter makes the control device, in this case the four-way valve 38, return to its initial position, that is to say that it interrupts the communication of the distribution pipe 37 to the separator 31 and to the equalization pipe 35, and that it re-establishes that of the separator 31 to the collector 36. The high pressure prevailing in the receptacle 29 then makes the liquid refrigerant return into the spaces 9 and the pressure in the collector 36 being lower than that of the distributing pipe 26 of the liquid refrigerant, the stop valve 33 opens. The circulation of the refrigerant is then established anew in the manner described, that is to say by the pipe 34, the stop valve 33 and the pipe 26 to the spaces 9 and, where this applies by the tube 48 to the outer tubes of the supplementary evaporators. The refrigerant being re-introduced through the bottom of the plant, the bottom 16, 18 is again attached to the lower surface of the set by freezing of the adhering moisture and the cycle of operations involving the opening and closing of the tap 14a or the taps 14 etc., commences again.

It is also possible to obtain the impulse for the opening and closing of the tap 14a or the taps 14 starting from the movement of the bottom, in this case of the rocking bottom 16, 18 instead of using an element 25 sensitive to temperature, in such a way that the introduction of liquid into the individual moulds 7, 8 recommences a little after the bottom has taken up again its closing position and is attached by freezing.

I claim:

1. In a freezing plant adapted for operation by means of a refrigerating machine including a compressor and a condenser for a liquefiable normally gaseous refrigerant, the combination of a receptacle adapted to receive the refrigerant and to serve as an evaporator therefor during the freezing operation; at least one upright freezing mould within the receptacle and projecting downwards from the latter; a discharge flap hinged to the bottom part of the mould and adapted to be swung downwards, and means adapted to normally keep the flap up against the mould for sealing the bottom end of the latter; a refrigerant separator including a top space connected to the top part of the receptacle, and a bottom space connected to the bottom part of the receptacle; a collector vessel beneath the separator and connected to the bottom space of the latter by a conduit descending within the collector to the bottom part thereof; a conduit including a valve connecting the condenser with the bottom part of the separator for the supply to the latter of fresh liquefied refrigerant; and a four-way valve connected to the suction side of the compressor, to the delivery side of the compressor, to the top space of the separator and to the top part of the collector, for alternately establishing communication between the top part of the receptacle with the suction side of the compressor, or between the delivery side of the compressor with the top part of the receptacle and at the same time with the top part of the collector.

2. In a freezing plant, the combination of elements claimed in claim 1 and characterized further by electric control means for the operation of the four-way valve.

3. In a freezing plant, the combination of elements claimed in claim 1 and characterized further by electric control means for the operation of the four-way valve and thermostatically operated electric means for actuating the electric control means in accordance with predetermined variations of temperature within the freezing mould.

4. In a freezing plant, the combination of elements claimed in claim 1 and characterized further by electric control means for the operation of the four-way valve, thermostatically operated electric means for actuating the electric control means in accordance with pre-determined variations of temperature within the freezing mould, and impulse giver adapted to actuate the electric control means, and mechanical means secured to the discharge flap and adapted to strike the impulse giver in the swung-down position of the flap.

5. In a freezing plant, the combination of elements claimed in claim 1 and characterized further by at least one supplementary evaporator immersed in the freezing mould and including a tube closed at its bottom and connected at its top to the top space of the separator, and a second tube connected to the supply conduit for fresh liquefied refrigerant descending within the former tube to the bottom part thereof.

6. In a freezing plant adapted for operation by

means of a refrigerating machine including a compressor and a condenser for a liquefiable normally gaseous refrigerant, the combination of a receptacle adapted to receive the refrigerant and to serve as an evaporator therefor during the freezing operation; at least one upright freezing mould within the receptacle and projecting downwards from the latter; a discharge flap hinged to the bottom part of the mould, adapted to be swung downwards and including a counterweight designed to normally keep the flap up against the mould for sealing the bottom end of the latter; a refrigerant separator including a top space connected to the top part of the receptacle, and a bottom space connected to the bottom part of the receptacle; a collector vessel beneath the separator and connected to the bottom space of the latter by a conduit descending within the collector to the bottom part thereof; a conduit including a valve connecting the condenser with the bottom part of the separator for the supply to the latter of fresh liquefied refrigerant; a four-way valve connected to the suction side of the compressor, to the delivery side of the compressor, to the top space of the separator and to the top part of the collector, for alternately establishing communication between the top part of the recep-

tacle with the suction side of the compressor, or between the delivery side of the compressor with the top part of the receptacle and at the same time with the top part of the collector; electric control means for the operation of the four-way valve; temperature-responsive means in at least one of the moulds for actuating the electric control means of the four-way valve to connect the top part of the receptacle with the delivery side of the compressor, and an impulse giver adapted to be contacted by the counterweight of the discharge flap in the fully swung-down position of the latter and thereby to actuate the electric control means of the four-way valve to connect the top part of the receptacle with the suction side of the compressor.

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