



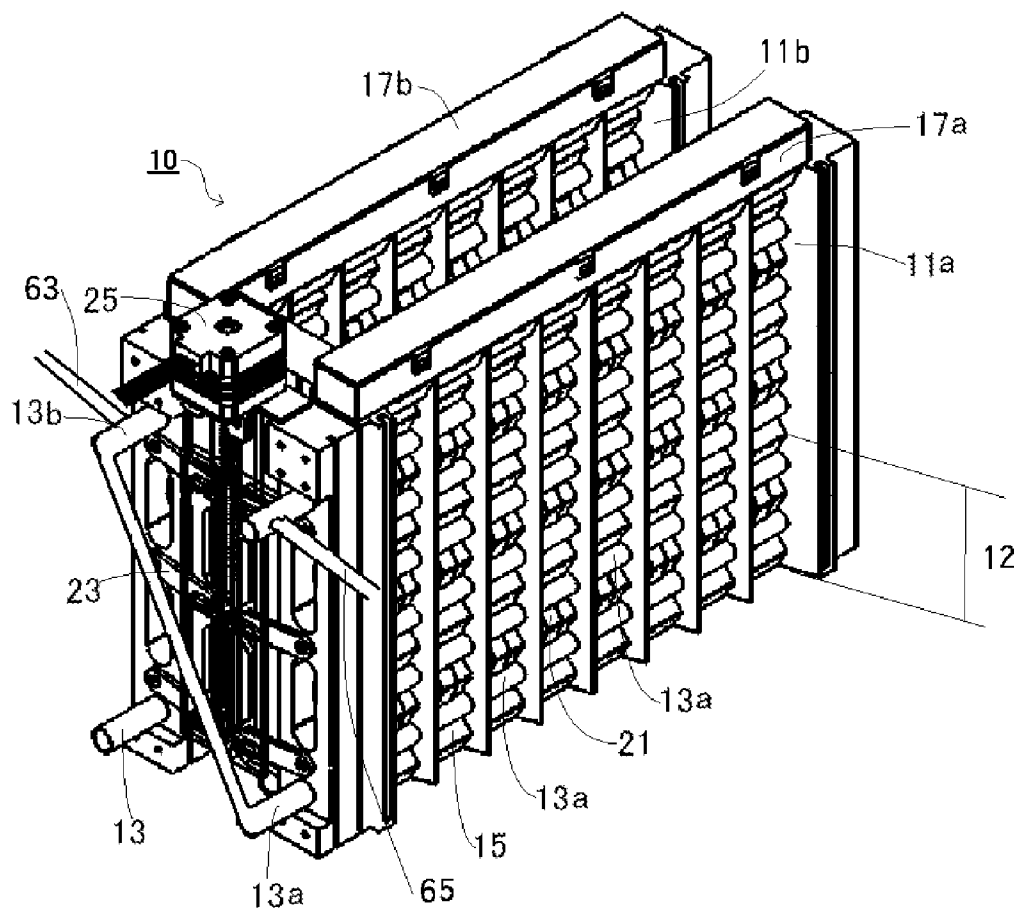
US 20160298894A1

(19) **United States**(12) **Patent Application Publication**
MATSUMOTO(10) **Pub. No.: US 2016/0298894 A1**(43) **Pub. Date: Oct. 13, 2016**(54) **FLOW-DOWN TYPE ICE MAKING
MACHINE AND OPERATION METHOD
THEREFOR**(52) **U.S. Cl.**
CPC . *F25C 5/10* (2013.01); *F25C 1/04* (2013.01);
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REIJIRO INAMORI, Tokyo (JP)(21) Appl. No.: **15/093,234**(22) Filed: **Apr. 7, 2016**(30) **Foreign Application Priority Data**

Apr. 12, 2015 (JP) 2015-081319

Publication Classification(51) **Int. Cl.**
F25C 5/10 (2006.01)
F25C 5/04 (2006.01)
F25C 1/04 (2006.01)(57) **ABSTRACT**

An ice making machine includes a freezing cycle in which a compressor, a condenser, a pressure reducing valve, an evaporator, and the compressor are successively coupled, and a melting cycle in which the compressor, the evaporator, and the compressor are coupled through hot-gas introduction tubes, and the freezing cycle and the melting cycle are switchable therebetween. The ice making machine includes at least two ice making racks arranged in series on evaporation coils of the evaporator, the ice making racks including ice molds, ice making water flow-down portions connected to upper parts of the ice making racks, the ice making water flow-down portions causing ice making water to flow down to the ice making racks, and ice cube release members releasing ice cubes formed on the ice molds, and the hot-gas introduction tubes are coupled to the evaporation coils, respectively, in front of the ice making racks.



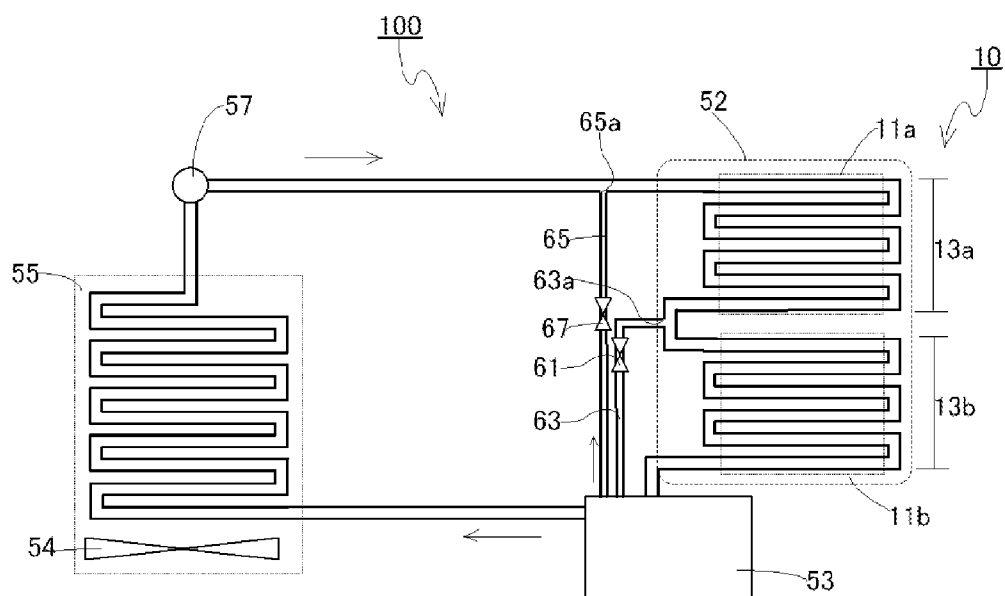


Fig. 1

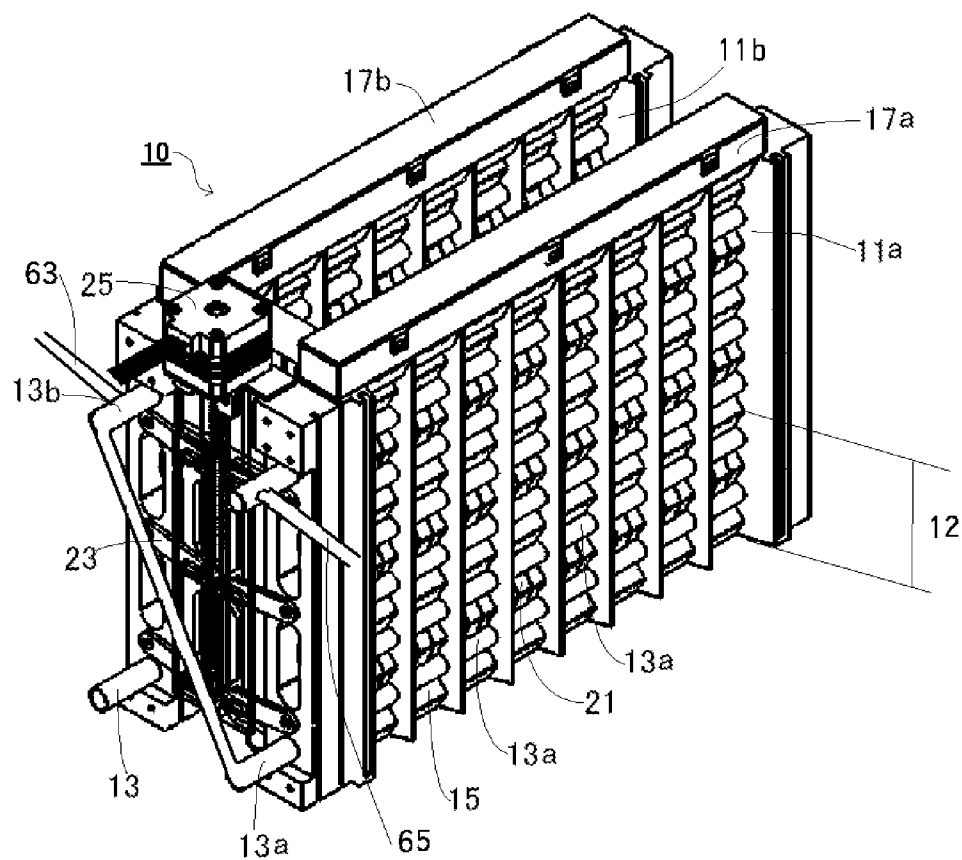


Fig. 2

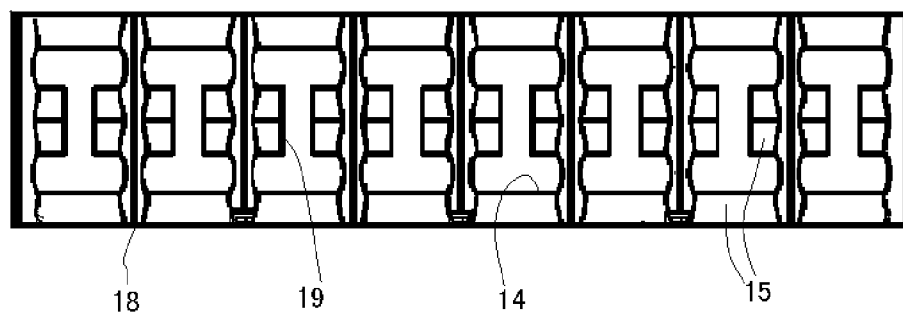


Fig. 3

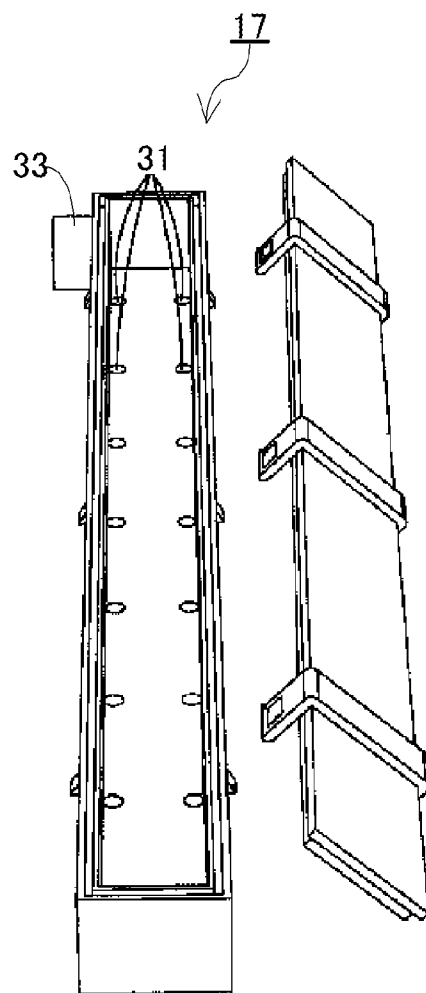


Fig. 4

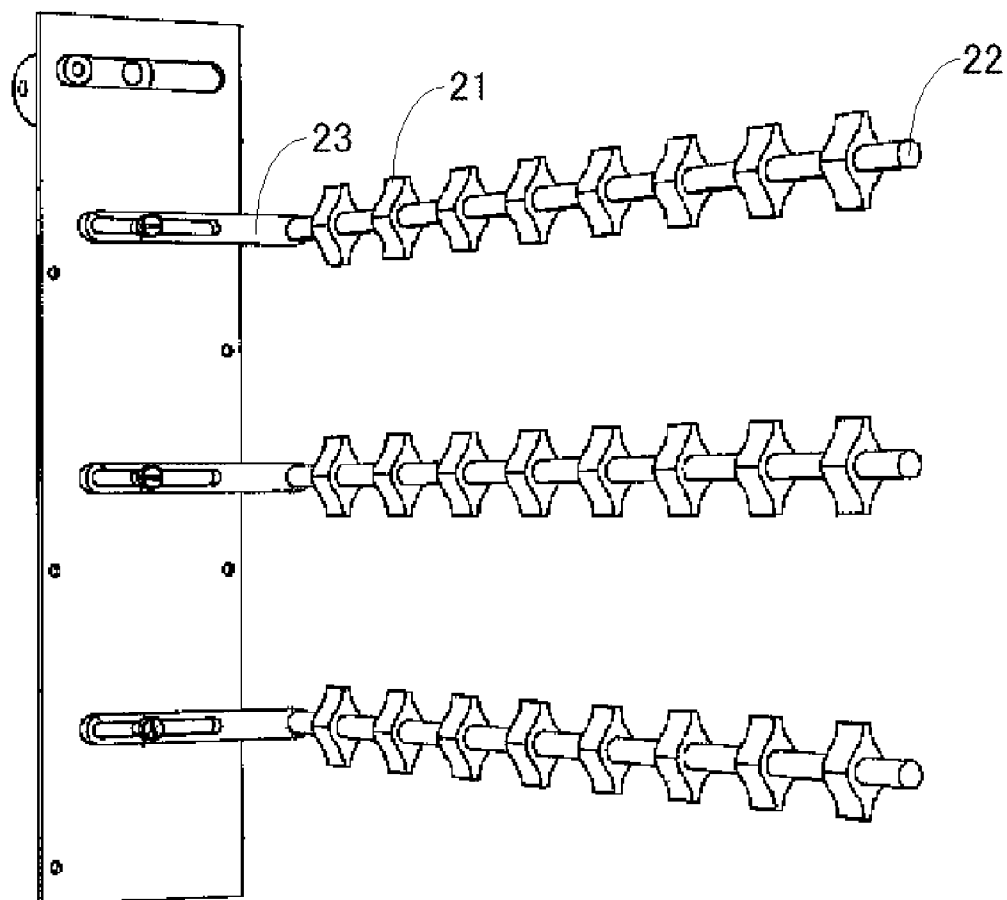


Fig. 5

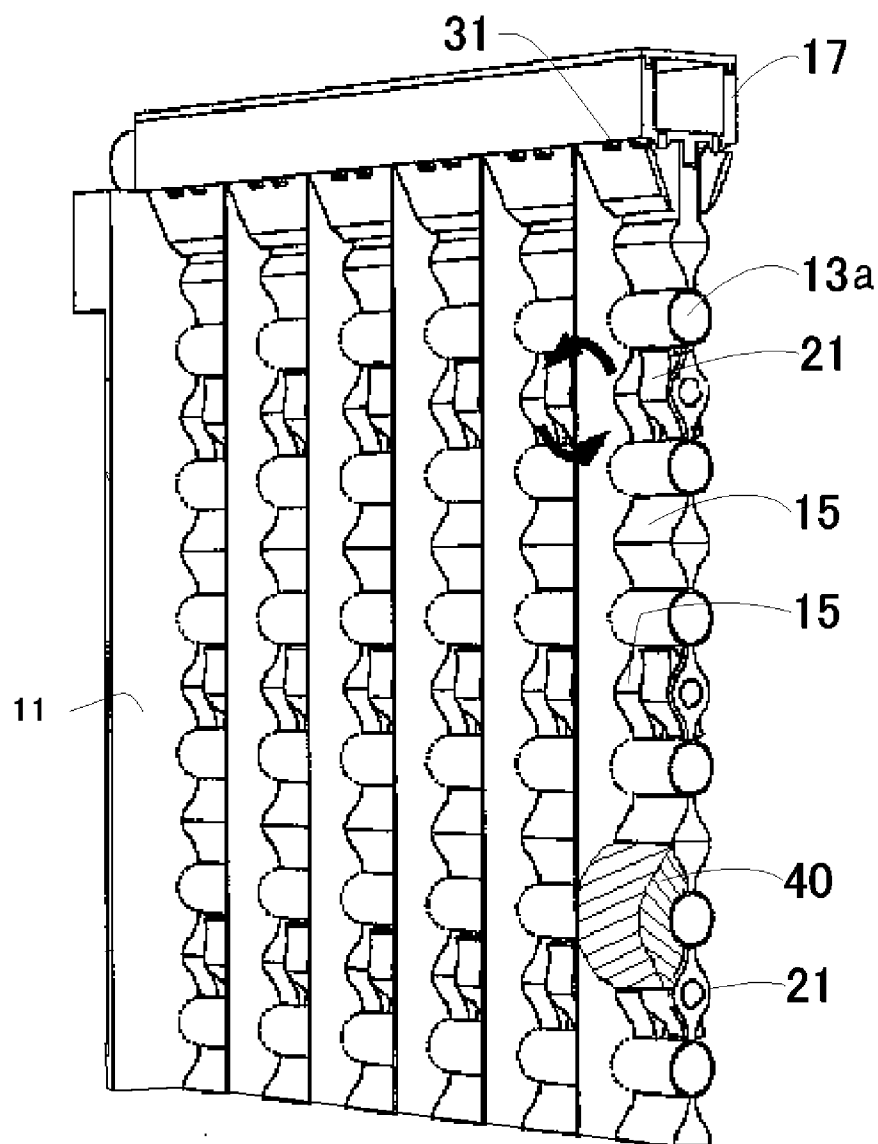


Fig. 6

FLOW-DOWN TYPE ICE MAKING MACHINE AND OPERATION METHOD THEREFOR

BACKGROUND

Technical Field

[0001] The present invention relates to a flow-down type ice making machine causing ice making water to flow down to ice making racks to form ice cubes in the ice making racks. In particular, the present invention relates to a configuration for releasing ice cubes formed on ice molds of the ice making machine.

[0002] The flow-down type ice making machine is an apparatus causing ice making water to continuously flow down to ice making racks for making ice cubes, and for example, an apparatus disclosed in WO 2014/105838 is known as the flow-down type ice making machine. In general, the flow-down type ice making machine is configured so that around a refrigerant tube in which a refrigerant is circulated, ice molds are arranged including the refrigerant tube to bring ice making water into contact with an outer peripheral side of the refrigerant tube having the ice molds thereon, for freezing.

[0003] For release of ice cubes formed on the ice molds, a configuration is generally employed in which ice near a boundary with the refrigerant tube is slightly melted. For melting ice, a method for circulating hot water in a pipe for melting ice provided near the refrigerant tube, or a method for circulating, in the refrigerant tube, hot gas generated by compressing the refrigerant can be employed.

[0004] However, conventional methods require a long time to melt all ice cubes to be released from the ice molds. Moreover, long time heat treatment causes excessive melting of ice cubes formed on the upstream side of the refrigerant tube into a reduced size, thus disadvantageously providing ice cubes of non-uniform size.

SUMMARY

[0005] An object of the present invention is to provide a flow-down type ice making machine which can release ice cubes formed on ice molds for a short time.

[0006] The present inventors improved a process for introduction of hot-gas, in an ice making machine configured to circulate hot gas in a refrigerant tube to partially melt ice cubes formed on an outer periphery of the refrigerant tube and release the ice cubes from the refrigerant tube, thus providing the present invention.

[0007] The present invention is configured as follows.

[0008] [1] A flow-down type ice making machine (100) including a freezing cycle in which a compressor (53), a condenser (55), a pressure reducing valve (57), an evaporator (52), and the compressor (53) are successively coupled, and

[0009] a melting cycle in which the compressor (53), the evaporator (52), and the compressor (53) are coupled through hot-gas introduction tubes (63, 65),

[0010] the freezing cycle and the melting cycle being switchable therebetween,

[0011] the flow-down type ice making machine (100) including

[0012] at least two ice making racks (11a, 11b) arranged in series on evaporation coils (13a, 13b) of the evaporator (52), the ice making racks (11a, 11b) including ice molds, [0013] ice making water flow-down portions (17a, 17b) connected to upper parts of the ice making racks (11a, 11b), the ice making water flow-down portions (17a, 17b) causing ice making water to flow down to the ice making racks, and [0014] ice cube release members (21) configured to release ice cubes formed on the ice molds,

[0015] the hot-gas introduction tubes (63, 65) being coupled to the evaporation coils (13a, 13b), respectively, in front of the ice making racks (11a, 11b).

[0016] [2] An operation method for a flow-down type ice making machine using the flow-down type ice making machine (100) according to [1], the method including successively repeating

[0017] forming ice cubes on the ice molds of the ice making racks (11a, 11b) by causing ice making water to flow down from the ice making water flow-down portions (17a, 17b) to the ice making racks (11a, 11b), and causing a refrigerant to successively pass the compressor (53), the condenser (55), the pressure reducing valve (57), the evaporator (52), and the compressor (53),

[0018] stopping ice making water flowing down after formation of the ice cubes,

[0019] introducing hot gas to the evaporation coil (13b) from the hot-gas introduction tube (63) connected in front of the ice making rack (11b) of the evaporation coil (13b) disposed on the downstream side of the evaporator (52), and [0020] introducing the hot gas from the hot-gas introduction tube (65) connected in front of the ice making rack (11a) of the evaporation coil (13a) disposed on the upstream side of the evaporator (52).

[0021] The flow-down type ice making machine according to an embodiment of the present invention can introduce the hot gas for each of the evaporation coils supporting plurality of ice making racks, respectively. Thus, the ice cubes formed on the ice molds can be melted and released for a short time. Moreover, the formed ice cubes have a substantially uniform size.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. 1 is an explanatory diagram illustrating a freezing cycle and a melting cycle of a flow-down type ice making machine according to an embodiment of the present invention;

[0023] FIG. 2 is a perspective view of a configuration of an ice making unit of the flow-down type ice making machine;

[0024] FIG. 3 is an explanatory diagram illustrating a configuration of a portion of an ice making rack;

[0025] FIG. 4 is an explanatory diagram illustrating a configuration of an ice making water flow-down portion;

[0026] FIG. 5 is an explanatory diagram illustrating a configuration of ice cube release members; and

[0027] FIG. 6 is an explanatory diagram illustrating a configuration of an ice making unit.

DETAILED DESCRIPTION

[0028] An example of the present invention will be described in detail below with reference to the drawings.

[0029] FIG. 1 is an explanatory diagram illustrating a configuration of a flow-down type ice making machine (100)

according to an embodiment of the present invention. In the flow-down type ice making machine (100), a compressor (53), a condenser (55), a pressure reducing valve (57), an evaporator (52), and the compressor (53) are successively coupled to constitute a freezing cycle. The compressor (53), the evaporator (52), and the compressor (53) are further coupled through hot-gas introduction tubes (63, 65) bypassing the condenser (55) and the pressure reducing valve (57) to constitute a melting cycle. The freezing cycle and the melting cycle are switchable therebetween by a switching device not illustrated.

[0030] In FIG. 1, reference sign (10) denotes an ice making unit. The ice making unit (10) has the evaporator (52) including evaporation coils (13a, 13b), a plurality of (two in FIG. 1) ice making racks (11a, 11b) respectively mounted to the evaporation coils (13a, 13b), ice making water flow-down portions (17a, 17b, not illustrated in FIG. 1) respectively mounted to upper parts of the ice making racks (11a, 11b), and ice cube release members (21, not illustrated in FIG. 1) configured to release ice cubes formed on ice molds of the ice making racks. The ice making unit (10) is normally housed in a box-shaped case, and the temperature in the case is maintained at a low temperature.

[0031] Valves (61, 67) are interposed respectively in the hot-gas introduction tubes (63, 65) to open/close hot-gas flow paths. The hot-gas introduction tube (63) is connected to a hot-gas introduction port (63a) formed on the upstream side from the evaporation coil (13b). Moreover, the hot-gas introduction tube (65) is connected to a hot-gas introduction port (65a) formed on the upstream side from the evaporation coil (13a).

[0032] In other words, the ice making machine according to an embodiment of the present invention is configured so that in the freezing cycle, the ice making racks are connected in series, but in the melting cycle, the ice making racks are connected in parallel.

[0033] FIG. 2 is a perspective view of a configuration of the ice making racks (11a, 11b) of the flow-down type ice making machine according to an embodiment of the present invention. The ice making racks (11a, 11b) are supported on the evaporation coils (13a, 13b). The evaporation coils (13a, 13b) have outer peripheral portions on which the ice molds (15) are formed, respectively. The ice cube release members (21) are fitted to the ice making racks (11a, 11b), respectively. The ice cube release members (21) are coupled to an arm (23) driven by a motor (25). The ice cube release members (21) respectively have axes parallel with axes of the evaporation coils (13a, 13b), and about the axes, the ice cube release members (21) are turned. The ice making water flow-down portions (17a, 17b) are connected to the upper parts of the ice making racks (11a, 11b). An ice making water supply tube, not illustrated, is connected to the ice making water flow-down portions (17a, 17b).

[0034] FIG. 3 is a front view of a portion (range denoted by reference sign 12 in FIG. 2) of one of the ice making racks (11a, 11b). The ice making rack (11a) and the ice making rack (11b) have an identical configuration. A plurality of partition walls (18) are formed in the ice making rack (11a), and the partition walls (18) partitions the ice making rack (11a). A coil support portion (14) configured to support the evaporation coil (13a) is formed in the ice making rack (11a). The ice molds (15) are formed along the coil support portion (14), in the ice making rack (11a). Each of the ice mold (15) is partially cut off to form an ice cube

release member-fitting portion (19) configured to fit each of the ice cube release members (21).

[0035] FIG. 4 is an explanatory diagram illustrating a configuration of one of the ice making water flow-down portions (17a, 17b). The ice making water flow-down portion (17a) and the ice making water flow-down portion (17b) have an identical shape. An ice making water supply tube-connecting hole (33) is formed in each of the ice making water flow-down portions (17a, 17b) having a box shape, and the ice making water flow-down portions (17a, 17b) each have a bottom surface in which a plurality of holes (31) are formed. Ice making water supplied from the ice making water supply tube-connecting holes (33) flows down to the ice making racks (11a, 11b) through the holes (31).

[0036] FIG. 5 is an explanatory diagram illustrating a configuration of the ice cube release members (21). The ice cube release members (21) are fixed on a turning shaft (22), and the turning shaft (22) is connected to the arm (23) driven by the motor. The arm (23) driven by the motor turns the ice cube release members (21) about the axes thereof parallel with the axes of the evaporation coils (13a, 13b). Thus, ice cubes formed on the ice molds (partially melting) are released and dropped.

[0037] FIG. 6 is an explanatory diagram illustrating a configuration of the ice making unit (10). Operation of the flow-down type ice making machine according to an embodiment of the present invention will be described below using FIG. 6.

[0038] First, the freezing cycle will be described. During ice making, a refrigerant compressed by the compressor (53) and condensed by the condenser (55) is supplied to the evaporation coils (13a, 13b) of the evaporator 52 through the pressure reducing valve (57). The evaporation coils (13a, 13b) are cooled by vaporization heat. The refrigerant in the evaporation coils (13a, 13b) is collected in the compressor (53), and this cycle is repeated.

[0039] The cooled evaporation coils (13a, 13b) are used for ice making. First, ice making water is supplied into the boxes of the ice making water flow-down portions (17a, 17b). The supplied ice making water flows down to the ice making racks (11a, 11b) through the holes (31). Part of the ice making water flowing down to the ice making racks (11a, 11b) is frozen on contact with the outer peripheral portions of the evaporation coils (13a, 13b) in which the refrigerant is circulated, and remaining ice making water further flows down to the lower sides of the evaporation coils (13a, 13b). Thus, ice cubes are formed on the outer peripheral portions of the evaporation coils (13a, 13b), along the shape of the ice molds (15). In FIG. 6, reference sign (40) denotes an ice cube formed on one of the ice making racks (11a, 11b). The ice cube is formed on all of the ice molds (15) formed in the ice making racks (11a, 11b), but only one is illustrated in FIG. 6.

[0040] When ice cubes formed on the outer peripheral portions of the evaporation coils (13a, 13b) grow to a predetermined size, circulation of the refrigerant is cut off in the evaporation coils (13a, 13b), and supply of ice making water is stopped from the ice making water flow-down portions (17a, 17b).

[0041] Then, hot gas is circulated in the evaporation coils (13a, 13b) to partially melt ice cubes adhering to outer peripheral walls of the evaporation coils (13a, 13b).

[0042] An operation method for an ice making machine according to an embodiment of the present invention is

characterized by a process of circulating the hot gas upon partially melting ice cubes adhering to the outer peripheral walls of the evaporation coils (13a, 13b). The process is carried out as described below.

[0043] First, the refrigerant (hot gas) compressed by the compressor (53) is supplied not to the condenser (55) but to the hot-gas introduction tubes (63, 65). This switching is performed by a switching device not illustrated. The hot gas is supplied from the hot-gas introduction port (63a) formed in front of the ice making rack (11b), to the evaporation coil (13b) supporting the ice making rack (11b), through the hot-gas introduction tube (63) having the valve (61) interposed therein. Upon supplying the hot gas, the valve (67) is closed to prevent supply of the hot gas to the hot-gas introduction tube (65). Thereby ice cubes adhering to the outer peripheral wall of the evaporation coil (13b) are partially melted in the ice making rack (11b). After the ice cubes adhering to the outer peripheral wall of the evaporation coil (13b) are melted to an extent that the ice cubes can be released by the ice cube release members (21), the hot-gas flow path is switched. That is, the hot gas is supplied from the hot-gas introduction port (65a) formed in front of the ice making rack (11a), to the evaporation coil (13a) corresponding to the ice making rack (11a), through the hot-gas introduction tube (65) having the valve (67) interposed therein. The hot gas having been supplied to the evaporation coil (13a) is supplied to the compressor (53) through the evaporation coil (13b). Thus, the ice cubes adhering to the outer peripheral wall of the evaporation coil (13a) are melted to the extent that the ice cubes can be released by the ice cube release members (21). The hot gas circulated in the evaporation coil (13b) may melt ice cubes formed on the ice making rack (11b), but the hot gas is reduced in temperature due to heat exchange upon melting the ice cubes formed on the ice making rack (11a), and very few ice cubes formed on the ice making rack (11b) are melted.

[0044] The hot gas is introduced successively from an ice making rack disposed in the most downstream position in a circulation direction of the refrigerant. After melting of the ice cubes formed on the ice making rack disposed in the most downstream position, melting of the ice cubes formed on the ice making rack in the second from the most downstream position is performed. Finally, melting of the ice cubes on the ice making rack disposed in the most upstream position is performed.

[0045] Next, the ice cube release members (21) are turned about the axes thereof parallel with the axes of the evaporation coils (13a, 13b), as indicated by arrows in FIG. 6, to release and drop down the ice cubes from the ice molds (15). The dropped ice cubes are stocked under the ice making racks (11a, 11b).

[0046] The ice making racks (11a, 11b) are made of a resin material. The resin material is not particularly limited, as long as the resin material employs a resin conforming to the Food Sanitation Act. For example, polyacetal (POM), polycarbonate (PC), EBS, PP can be employed.

[0047] The evaporation coils (13a, 13b) each have a metal pipe having a circular or oval cross-section. The metal pipe uses a metal material having high heat conductivity such as stainless steel, copper, aluminum, tin, nickel, or an alloy thereof. The evaporation coils (13a, 13b) have a metal surface with which ice making water makes direct contact. That is, the metal surfaces are not covered with a resin or the like. A combination of the resin material (ice making rack) and the metal material (evaporation coil) achieves both of

superior ice cube holdability of the ice making rack during making ice cubes, and superior ice cube releasability upon releasing the ice cubes.

[0048] An ice making water-collecting portion configured to collect ice making water flowing down from the ice making racks (11a, 11b) may be connected to lower parts of the ice making racks (11a, 11b).

[0049] The ice making unit (10) is disposed in an ice making chamber kept at a low temperature. The ice making chamber can be cooled by circulating the refrigerant in the evaporation coils (13a, 13b) or by a cooling system additionally provided.

[0050] A time required for circulation of the hot gas differs depending on the size of the ice making rack or temperature of the hot gas, but is 0.5 to 10 minutes for each ice making rack, and preferably is 1 to 3 minutes. The hot-gas flow path is preferably switched when an outlet temperature of the hot gas in the evaporation coil reaches 0 to 10° C.

[0051] The freezing cycle and the melting cycle may be manually switched therebetween, or may be automatically switched using a detection signal from a temperature sensor or weight sensor suitably disposed.

[0052] Two ice making racks are arranged in series in FIG. 6, but the number of ice making racks is not limited to this description, and approximately two to ten ice making racks can be arranged. The number of ice making racks to be coupled can be suitably changed according to a capacity of a freezing system. That is, in the flow-down type ice making machine according to an embodiment of the present invention, the number of ice making racks to be coupled can be changed to freely change the ice making capacity. The ice making machine according to an embodiment of the present invention includes the plurality of ice making racks, and the hot gas being heated can be introduced to each of the ice making racks. Thus, a time required for melting ice cubes can be reduced, and part of the ice cubes is prevented from being excessively melted. Thus, the formed ice cubes have a substantially uniform size.

[0053] The ice molds formed in the ice making racks may have an identical shape, or may have different shapes. Coupling ice molds of different shapes allows simultaneous formation of ice cubes of a plurality of shapes. Moreover, a time required for circulation of the hot gas for melting the ice cubes can be adjusted for each of the ice making racks.

EXAMPLE

[0054] The present invention will be described in detail below by way of an example.

Example 1

[0055] An ice making apparatus including the freezing cycle and the melting cycle illustrated in FIG. 1 was used to melt ice cubes formed on the ice making racks (11a, 11b). First, the hot gas was introduced from the hot-gas introduction tube (63) to the evaporation coil (13b). The outlet temperature of the hot gas in the evaporation coil (13b) exceeded 5° C., after 60 seconds from the introduction of the hot gas. At this moment, the hot-gas flow path was switched to the evaporation coil (13a). The outlet temperature of the hot gas in the evaporation coil (13a) exceeded 5° C. (Table 1), after 60 seconds from switching of the hot-gas flow path. Then, the release members were turned to release all of the ice cubes formed on the ice making racks (11a, 11b). Thus obtained ice cubes had little variation in mass (variation coefficient 0.02).

TABLE 1

		Time(s)										
Example 1		0	15	30	45	60	75	90	105	120	135	150
evaporation	inlet temperature (° C.)	-18.9	-5.3	-4.8	-4.2	-3.4	18.7	34.3	35.3	36.9	38.8	41.0
coil (13a)	outlet temperature (° C.)	-18.8	-5.1	-4.9	-4.7	-4.4	-0.8	0.2	3.3	5.2	7.0	9.0
evaporation	inlet temperature (° C.)	-19.0	29.3	43.8	49.6	52.1	-0.5	7.7	5.2	7.2	9	10.9
coil (13b)	outlet temperature (° C.)	-18.6	-4.6	0.1	4.1	7.7	-0.8	0.1	0.5	0.9	1.5	2.0

Comparative Example 1

[0056] The ice making apparatus including the freezing cycle and the melting cycle illustrated in FIG. 1 was used to melt ice cubes. The hot-gas introduction tube (63) was not used. First, the hot gas was introduced successively to the evaporation coil (13a) and the evaporation coil (13b). After the introduction of the hot gas, the outlet temperature of the hot gas in the evaporation coil (13b) reached approximately 5° C., after 300 seconds from the introduction of the hot gas (Table 2). Then, the release members were turned to release the ice cubes. Thus obtained ice cubes had a large variation in mass (variation coefficient 0.09).

TABLE 2

		Time(s)										
Comparative Example 1		0	30	60	90	120	150	180	210	240	270	300
evaporation	inlet temperature (° C.)	-21.4	29.2	44.1	37.5	33.1	35.0	40.6	44.1	45.4	46.3	48.2
coil (13a)	outlet temperature (° C.)	-21.2	-6.0	1.1	4.3	6.2	8.3	11.2	14.3	15.9	17.1	17.7
evaporation	inlet temperature (° C.)	-21.4	-5.0	2.3	6.3	8.3	10.4	13.6	15.8	17.6	18.6	19.2
coil (13b)	outlet temperature (° C.)	-19.9	-8.9	-4.6	-2.5	-1.2	-0.1	0.5	1.6	2.5	3.6	4.5

What is claimed is:

1. An operation method for a flow-down type ice making machine, the flow-down type ice making machine including:
 - a freezing cycle in which a compressor (53), a condenser (55), a pressure reducing valve (57), an evaporator (52), and the compressor (53) are successively coupled; and
 - a melting cycle in which the compressor (53), the evaporator (52), and the compressor (53) are coupled through hot-gas introduction tubes (63, 65) having valves (61, 67) interposed respectively in the gas introduction tubes, the freezing cycle and the melting cycle being switchable therebetween,
 the flow-down type ice making machine further including:
 - at least two ice making racks (11a, 11b) arranged in series on evaporation coils (13a, 13b) of the evaporator (52),
 - the ice making racks (11a, 11b) including ice molds;
 - ice making water flow-down portions (17a, 17b) connected to upper parts of the ice making racks (11a, 11b), the ice making water flow-down portions (17a, 17b) causing ice making water to flow down to the ice making racks; and
 - ice cube release members (21) configured to release ice cubes formed on the ice molds,

the hot-gas introduction tube (65) being connected on the upstream side from the ice making rack (11a) disposed on the upstream side of the evaporator (52), on the downstream side from the pressure reducing valve (57), the hot-gas introduction tube (63) being connected on the upstream side from the ice making rack (11b) disposed on the downstream side of the evaporator (52), on the downstream side from the evaporation coil (13a), the method comprising successively repeating:

- forming ice cubes on the ice molds of the ice making racks (11a, 11b) after causing ice making water to flow down from the ice making water flow-down portions (17a, 17b) to the ice making racks (11a, 11b), and causing a refrigerant to successively pass the compressor (53), the condenser (55), the pressure reducing valve (57), the evaporator (52), and the compressor (53);
- stopping ice making water flowing down after formation of the ice cubes; and
- introducing hot gas from the hot-gas introduction tube (65) to the evaporation coil (13a), after introducing the hot gas only to the evaporation coil (13b) from the hot-gas introduction tube (63).

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