

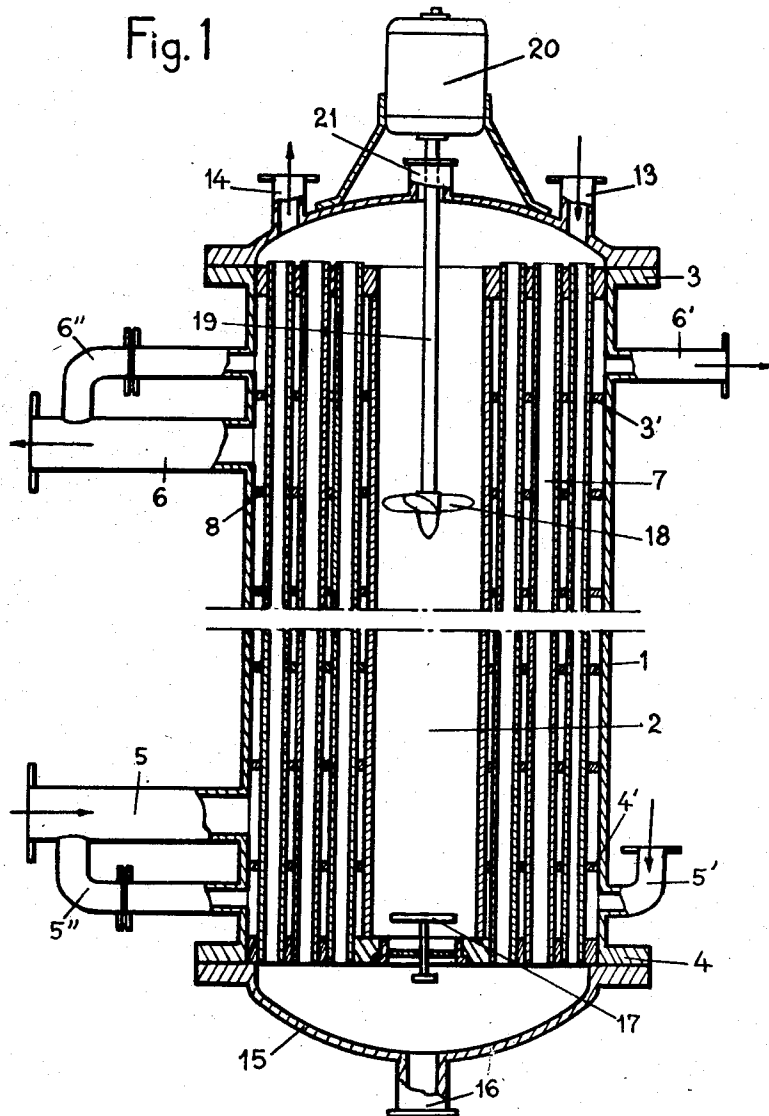
Dec. 22, 1953

G. TRÉPAUD
TUBULAR ICE-MACHINE

2,663,162

Filed Feb. 28, 1951

3 Sheets-Sheet 1



INVENTOR:
Georges Trépaud,

By *E. J. Freeman*,
HIS ATTORNEY.

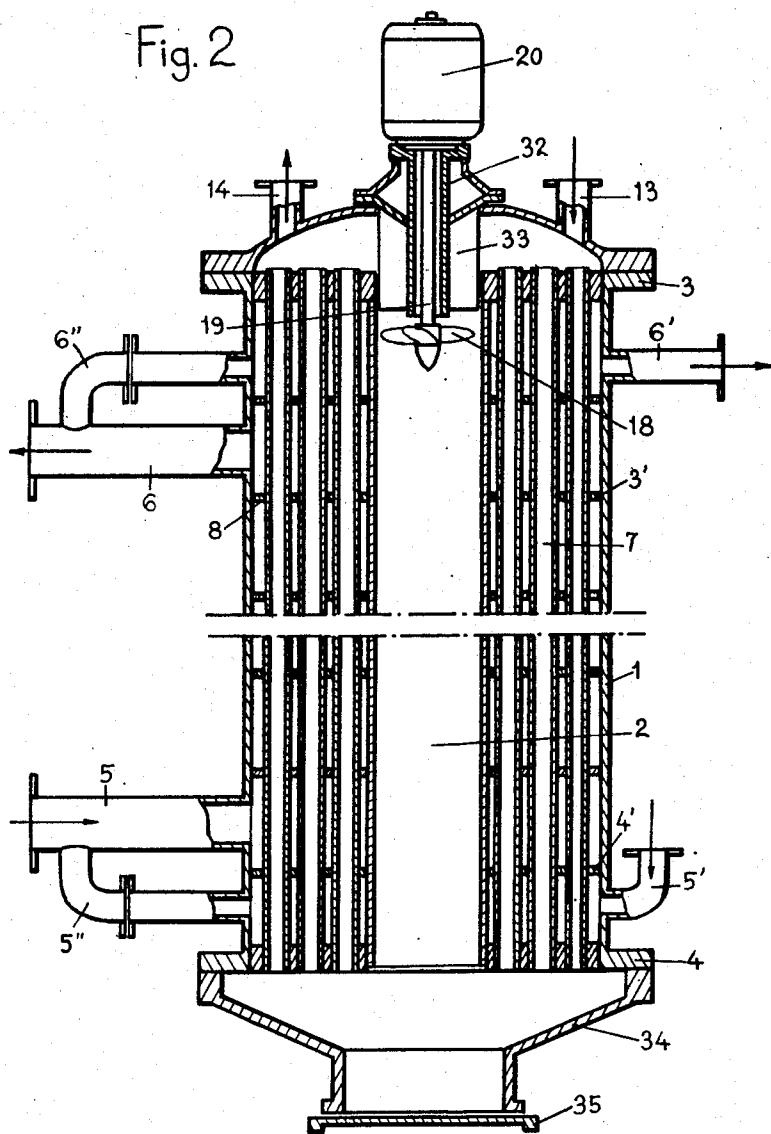
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3 Sheets-Sheet 2



INVENTOR:
Georges Trépaud,

By *L. J. Humeau,*
His Attorney.

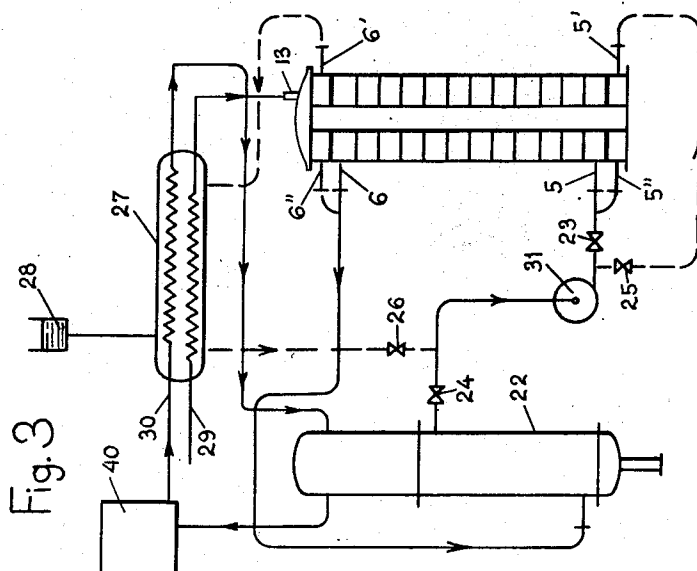
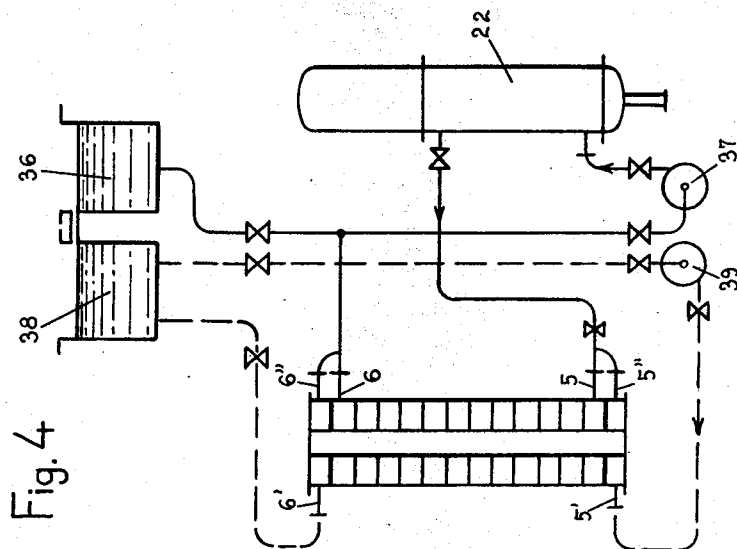
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INVENTOR:

Georges Trépaud,

By *J. J. Freeman,*
His Attorney.

UNITED STATES PATENT OFFICE

2,663,162

TUBULAR ICE-MACHINE

Georges Trépaud, Paris, France, assignor to The Society Refroidisseur Trepaud S. A. R. L., Paris, France, a corporation of France

Application February 28, 1951, Serial No. 213,203

Claims priority, application France March 1, 1950

5 Claims. (Cl. 62-106)

1

The invention relates to an apparatus for the manufacture of ice in cylindrical moulds of a small diameter, bathing externally in a refrigerating fluid and to improve the conditions of the calorific exchange between the water to be

congealed and the refrigerating fluid.

The tubular ice-machines known at the present time usually let the water to be congealed run down the internal surface of small vertical pipes externally refrigerated.

The tubular ice-machine, according to the present invention, is characterized in that it is provided with a cylindrical elongated casing comprising two watertight cross partitions by means of which said casing is separated in three compartments, in the central compartment, a large central tube and a plurality of freezing pipes, the lower and upper ends of which are fitted in the two partitions, connecting thereby the two extreme compartments, a driving shaft, the axis of which coincides with the axis of the central tube, a screw fastened on said shaft to secure a continuous flow of the water to be congealed in the closed circuit constituted by the central tube, the two extreme compartments and the freezing pipes, a piping for the refrigerating fluid, a piping for the defrosting fluid, means to connect at least partially the annular space provided between the casing, the central tube and the two cross partitions successively with said two pipings.

As examples, two embodiments of the invention are described hereafter and illustrated in the accompanying drawings, using cold brine as a refrigerating fluid.

The Figure 1 is a vertical section along the axis of the first embodiment.

The Fig. 2 is a vertical section along the axis of the second embodiment.

The Figs. 3 and 4 show diagrammatically the circuits for the cold brine and for the tepid brine, in the first and the second embodiments, respectively.

The first embodiment (Fig. 1) includes a vertical cylindrical casing 1 and an opened central tube 2, having preferably an insulating wall, between which is formed an annular space, limited at the upper and lower ends by plates 3, 4, in which the cold brine enters through the lower duct 5 and comes out through the upper duct 6. This annular space is equipped with small freezing pipes 7 opening over the plate 3 and underneath the plate 4 and with baffles 8 of the type described in the French Patent No. 797,552, granted to the same inventor, said

2

baffles forming an helical circuit around the central tube 2. The extreme plates of this system of baffles are not cut to allow the flow of the brine and form two watertight walls or false baffles 3' and 4' limiting at the top and bottom of the annular space two intervals in which the cold brine will not flow, but which communicate through the ducts 5', 6' with a tepid brine circuit and through the ducts 5'' and 6'' with the portion of the annular space within the false baffles 3', 4'.

The vertical cylinder 1 bears a cover 12 having a duct 13 for the water inlet and a duct 14 for the flowing out of the water when the freezing takes place whilst, at the lower portion of the cylinder 1, the small pipes 7 open, like the central tube 2, in a removable connection bottom 15 bearing a discharge valve 16. In addition, the central tube 2 is equipped, at its base, with a check valve 17 made of a flat and very light disc, whilst a screw 18, fast, axially with the central tube 2, on a shaft 19, is driven by a motor 21 disposed over the cover 12, equipped with a stuffing box 21': the revolving direction of the screw is such that a forced ascending flow in the central tube 2 and a forced descending flow in the freezing pipes 7 are created, in counter-current with the brine flow.

The apparatus works as follows: the pipes 7 are filled with water. As the surfaces of the baffles are very close to each other, the brine will flow upwards, with a great speed but a small output, in directions substantially perpendicular to the small freezing pipes 7, thus collecting the best conditions for a fast freezing of the water, with a small difference of temperature between the brine and the water, and without any danger of bursting the pipes. A core freezing, giving compact ice cylinders becomes possible. It is, of course, possible to stop the freezing process a little sooner to obtain hollow cylinders of ice. As the cold brine cannot enter in the extreme partitions, the freezing of the water at the ends of the pipes 7 is not complete, no ice is deposited on the plates 3 and 4 and thereby the ice removal becomes easier.

The forced circulation in closed circuit of the water to be frozen improves greatly the heat transmission coefficient, specially on the side where it is normally the smaller i. e. on the internal face of the freezing pipes 7, during the cooling of the water, or in contact with the ice layer in formation, when the freezing has begun.

When all the pipes are choked by ice plugs,

3

the screw keeps on to stir the water of the central tube 2 or, in an alternate embodiment, the engine is automatically stopped, through a device of a known type.

The removal of the ice is carried on by opening the discharge valve 16, dismounting the removable bottom 15 and sending tepid brine in contact with the crest of pipes through the ducts 5', 6', and the ducts 5'', 6'', in the whole annular space between the plates 3 and 4.

The check valve 17 keeps in the central tube 2 the water which it contains. The water of the upper part of the apparatus and the ice melting water can be collected to fill, through a pump, the freezing pipes 7.

In Fig. 3, the evaporator 22 produces cold brine by means of a primary refrigerating fluid such as ammonia. The cold brine circuit is connected to the tubular ice-machine through the pipes 5 and 6. This cold brine circuit comprises two valves 23, 24 and a pump 31 circulating the cold brine through the ice-machine. The circuit of tepid brine, used for thawing the ice-bars produced in the ice-machine to allow same to be discharged therefrom, is connected to the ice-machine through ducts 5', 6' and comprises valves 25, 26 and a tank 27, preferably under head and freely opening in the atmosphere through an expansion container 28, the same pump 31 serving to circulate the tepid brine as well as the cold brine as will be explained hereafter. In the tank 27 are arranged two coils 29, 30: the first coil 29, in which flows the filling water of the ice-machine, is connected at one hand to a water supply and, at the other hand, to this latter through duct 13 feeding the water to be frozen to the upper compartment of the casing 1, the filling water being thus pre-cooled due to the contact between the coil 29 and the brine in tank 27, which in its turn is heated to a temperature sufficient for thawing purpose, for instance +5° C. The reheating of the brine for thawing purpose becomes thereby costless as it allows the heat lost due to the melting of ice-bars during the discharging thereof to be recovered for precooling the filling water.

The second coil 30 arranged in the tank 27 is connected at one hand to the compressor-condenser 40 of the evaporator 22, i. e. to the liquid circuit of the primary refrigerating fluid, and at the other hand to the evaporator 22, said condensed refrigerating fluid flowing through the coil 30 also contributing to reheat the brine.

The operation of the device is as follows:

During the freezing phase in the ice-machine 1, the valves 23, 24 are opened and the valves 25, 26 closed, so that the pump 31 circulates through the ice-machine 1 the cold brine coming from the evaporator 22. Inversely, during the thawing and discharging phase, the valves 23 and 24 are closed, the valves 25 and 26 opened, and the pump 31 circulates through the ice-machine 1 the tepid brine coming from the tank 27.

The second embodiment (Fig. 2) includes also a vertical cylindrical casing 1, a central tube 2 and small freezing pipes 7 set in watertight plates 3 and 4. Baffles 8 are arranged round the central tube 2 to supplying for the cold brine, entering through 5 and flowing out through 6, a substantially helical path. Two watertight plates 3', 4' limit two extreme intervals communicating through the ducts 5', 6' with a circuit of tepid brine and through the ducts 5'', 6'' with the main median part included between the plates 3' and 4'.

4

On the other hand, the upper cover 12 has no stuffing box: the shaft 19 of the screw 18 is just surrounded with a plunger tube 32 equipped with small blades 33 and integral with the cover 12. This arrangement is possible since the screw 18 turns in such a direction that it creates a descending flow in the central tube 2 and an ascending flow in the freezing pipes 7. The pressure of the circulating water is in fact much higher at the inlet of the freezing pipes 7 as at the exhaust, whilst the loss of head in the central tube 2 is practically negligible. The pressure at the inlet in the pipes can even reach 2 meters of water when the pipes are closed by the ice. In the first embodiment (Fig. 1), said pressure is applied at the top of the apparatus and a stuffing box becomes necessary. In the second embodiment (Fig. 2), the said pressure is applied at the basis of the apparatus: the pressure at the top is very small and a stuffing box is not essential.

As the direction of the flow of the water to be congealed is inverted in this second embodiment, the valve 17 must be suppressed. The water contained in the central tube 2 is simply collected in a vat and sent by means of an ejector or a pump in an upper tank for a further filling of the apparatus. A closing plate 35 facilitates the fast opening of the bottom 34 of the refrigerator.

The circulating direction of the brines has not been inverted as the direction of the water to be congealed, since this apparatus provides for such a speed of the flow of water in the pipes 7 that the difference of the temperatures of the water at both ends of the pipes can be neglected and the advantage of a counterflow becomes negligible.

The Figure 4 shows diagrammatically the circuit of the brines in this second embodiment. The circuit of cold brine includes a tank 36 and a pump 37: also the circuit of tepid brine has a tank 38 and a pump 39: the reheating coils are suppressed, the temperature exchange between the brine to be reheated and the filling water to be pre-cooled being performed in the tubular ice-machine itself due to the double circulation of the water in the freezing tubes and of the brine in the central annular chamber of the ice-machine 1 wherein said tubes are arranged.

During the freezing, the ducts 5, 6 communicate with the circuit of cold brine of the evaporator-cooler 22, the pump 37 being operated and the pump 39 stopped. For the ice-removal, the pump 37 is stopped and the pump 39 is started: the tepid brine circulates in the annular space and gives up calories to the ice. After the ice-removal, the refrigerator is filled anew, the pump 39 is kept running and the pump 37 stopped. After a very short while, the filling water has heated the tepid brine to a temperature sufficient for the next ice removal: the pump 39 is stopped and the pump 37 started.

It must be noted that, although the two embodiments of the invention described as examples, use the brine as a cooling fluid, the invention applies also to a tubular refrigerator using the direct expansion of a refrigerating fluid such as ammonia.

What I claim is:

1. Tubular ice-machine, provided with a cylindrical elongated casing comprising two watertight cross partitions by means of which said casing is separated in three compartments, in the central compartment a large central tube and a

5

plurality of freezing pipes, the lower and upper ends of which are fitted in the two partitions connecting thereby the two extreme compartments, a driving shaft, the axis of which coincides with the axis of the central tube, a screw fastened on said shaft to secure a continuous flow of the water to be congealed in the closed circuit constituted by the central tube, the two extreme compartments and the freezing pipes, a piping for the refrigerating fluid, a piping for the thawing fluid, means to connect the annular space provided between the casing, the central tube and the two cross partitions successively with said two pipings, helical baffles arranged in said annular space, two watertight walls supplementing at each end the watertight partitions in said compartments, inlet and outlet ducts provided at both ends of each of said compartments, the inlet and outlet ducts of the median compartment connecting said compartment with the piping for the refrigerating fluid and the inlet and outlet ducts of the three compartments connecting said compartments with the piping for the thawing fluid.

2. Tubular ice-machine, provided with a cylindrical elongated casing comprising two watertight cross partitions by means of which said casing is separated in three compartments, in the central compartment a large central tube and a plurality of freezing pipes, the lower and upper ends of which are fitted in the two partitions connecting thereby the two extreme compartments, a driving shaft, the axis of which coincides with the axis of the central tube, a screw fastened on said shaft to secure a continuous flow of the water to be congealed in the closed circuit constituted by the central tube, the two extreme compartments and the freezing pipes, a piping for the refrigerating fluid, a piping for the thawing fluid, means to connect the annular space provided between the casing, the central tube and the two cross partitions successively with said two pipings, helical baffles arranged in said annular space, two watertight walls supplementing at each end the watertight partitions in said compartments, inlet and outlet ducts provided at both ends of each of said compartments, the inlet and outlet ducts of the median compartment connecting said compartment with the piping for the refrigerating fluid and the inlet and outlet ducts of the three compartments connecting said compartments with the piping for the thawing fluid, a piping for the filling water, a tank connected with the piping for the defrosting fluid, in said tank reheating coils forming a part of the piping for the filling water and means to connect at least partially the annular space provided between the casing, the central tube and the two cross partitions successively with said two pipings.

3. In a tubular ice-machine means for circulating in a closed circuit the liquid to be frozen flowing through the freezing tubes during the freezing process, said means comprising a vertical cylindrical casing provided with two transversal partitions whereby the casing is separated in three compartments, vertical freezing tubes arranged in the central compartment and having their upper and lower ends tightly fitted in said partitions respectively so as to freely open into the upper and lower compartments of the casing, means for feeding the liquid to be frozen to the upper compartment whereby said liquid is caused to flow under head through the freezing tubes, thereby completely filling the section thereof, a large central return tube arranged in the cen-

6

tral compartment and having its upper and lower ends tightly fitted in said partitions to connect the lower and upper compartment of the casing, a shaft arranged inside said return tube coaxially thereto, driving means located outside the casing to rotate said shaft, a screw fastened on said shaft to provide a forced circulation of the liquid to be frozen in the closed circuit formed by the upper compartment, the freezing tubes, the lower compartment and the central return tube, means for successively feeding a refrigerating and a thawing fluid to the annular chamber of the central compartment comprised between the central tube, the transversal partitions and the wall of the casing.

4. In a tubular ice-machine means for circulating in a closed circuit the liquid to be frozen flowing through the freezing tubes during the freezing process, said means comprising a vertical cylindrical casing provided with two transversal partitions whereby the casing is separated in three compartments, the lower compartment being provided with a removable bottom, vertical freezing tubes arranged in the central compartment and having their upper and lower ends tightly fitted in said partitions respectively so as to freely open into the upper and lower compartments of the casing, means for feeding the liquid to be frozen to the upper compartment whereby said liquid is caused to flow under head through the freezing tubes, thereby completely filling the section thereof, a large central return tube arranged in the central compartment and having its upper and lower ends tightly fitted in said partitions to connect the lower and upper compartment of the casing, a shaft arranged inside said return tube coaxially thereto, driving means located outside the casing to rotate said shaft, a screw fastened on said shaft to provide a forced circulation of the liquid to be frozen in the closed circuit formed by the upper compartment, the freezing tubes, the lower compartment and the central return tube, a check valve provided at the lower end of the central tube to retain the liquid contained therein during the discharging of the ice formed in the freezing tubes and when the circulating screw is at rest and the bottom of the lower compartment is removed, means for successively feeding a refrigerating and a thawing fluid to the annular chamber of the central compartment comprised between the central tube, the transversal partition and the wall of the casing.

5. In a tubular ice-machine means for circulating in a closed circuit the liquid to be frozen flowing through the freezing tubes during the freezing process, said means comprising a vertical cylindrical casing provided with two transversal partitions whereby the casing is separated in three compartments, vertical freezing tubes arranged in the central compartment and having their upper and lower ends tightly fitted in said partitions respectively so as to freely open into the upper and lower compartments of the casing, means for feeding the liquid to be frozen to the upper compartment, whereby said liquid is caused to flow under head through the freezing tubes, thereby completely filling the section thereof, a large central return tube arranged in the central compartment and having its upper and lower ends tightly fitted in said partitions to connect the lower and upper compartment of the casing, a shaft arranged inside said return tube coaxially thereto, driving means located outside the casing to rotate said shaft, a screw fastened on said

7

shaft to provide a forced circulation of the liquid to be frozen in the closed circuit formed by the upper compartment, the freezing tubes, the lower compartment and the central return tube, helical baffles arranged in the annular chamber of the central compartment comprised between the central tube, the transversal partitions and the wall of the casing, inlet and outlet ducts provided in the lower and in the upper part of said annular chamber, a source of refrigerating fluid, a source of thawing fluid and means to successively connect said ducts to said sources.

GEORGES TRÉPAUD.

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