Dec. 3, 1946. F. J. ZAMBONI 2,411,919

ICE RINK

Filed Sept. 16, 1944 4 Sheets-Sheet 1

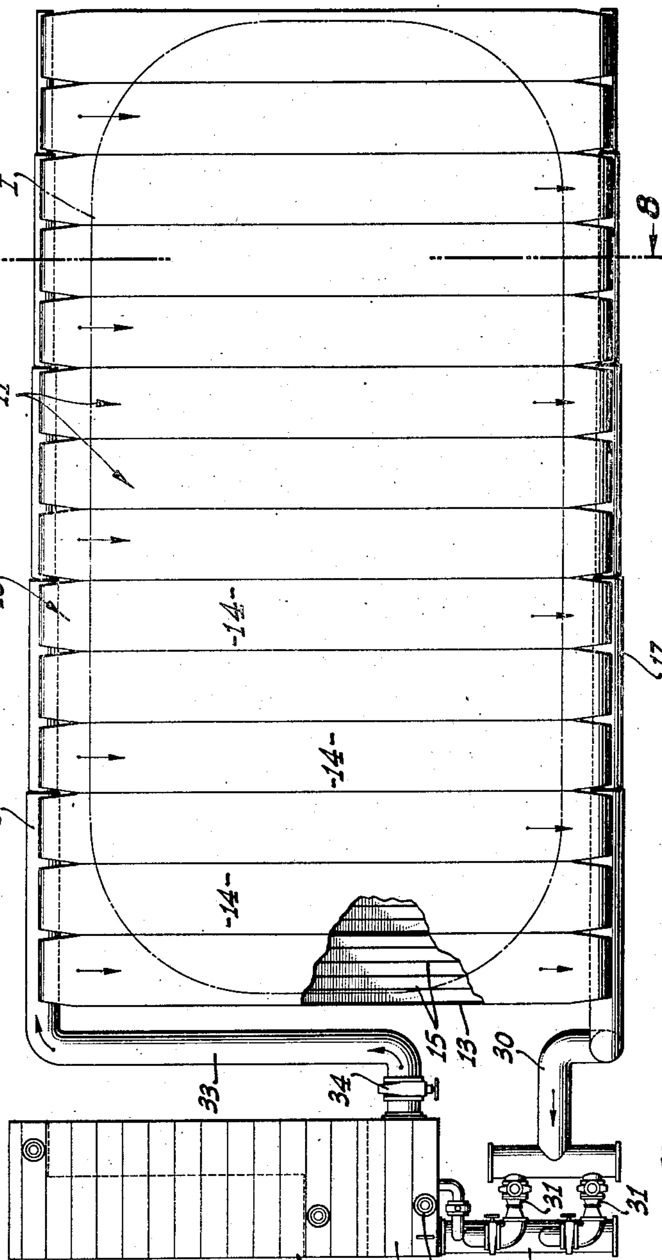

Fig. 1.

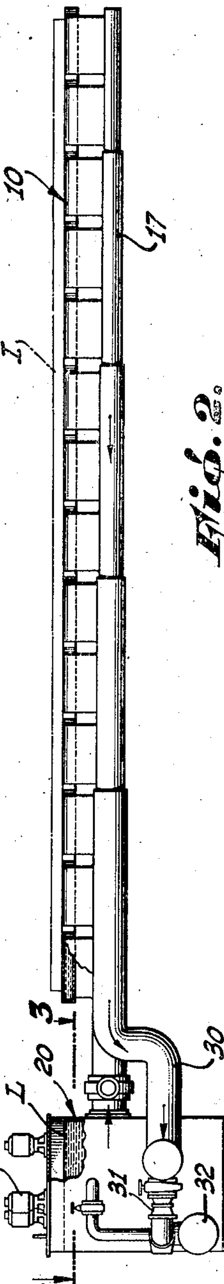

Fig. 2.

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Dec. 3, 1946. F. J. ZAMBONI 2,411,919

ICE RINK

Filed Sept. 16, 1944 4 Sheets-Sheet 2

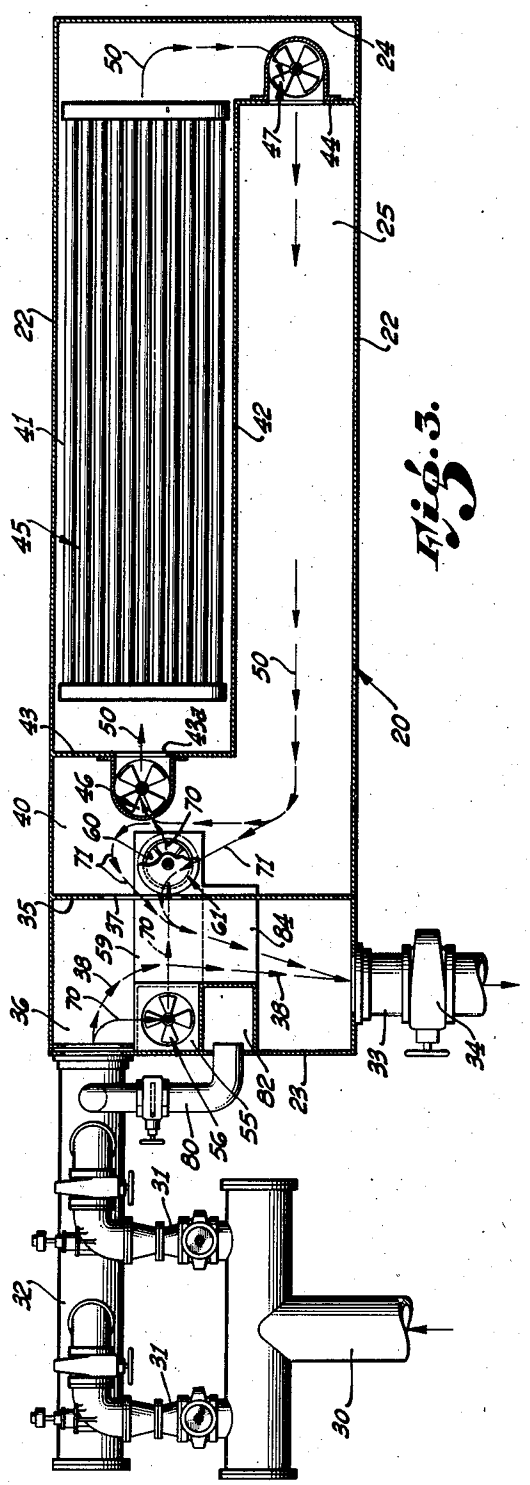

Fig. 3.

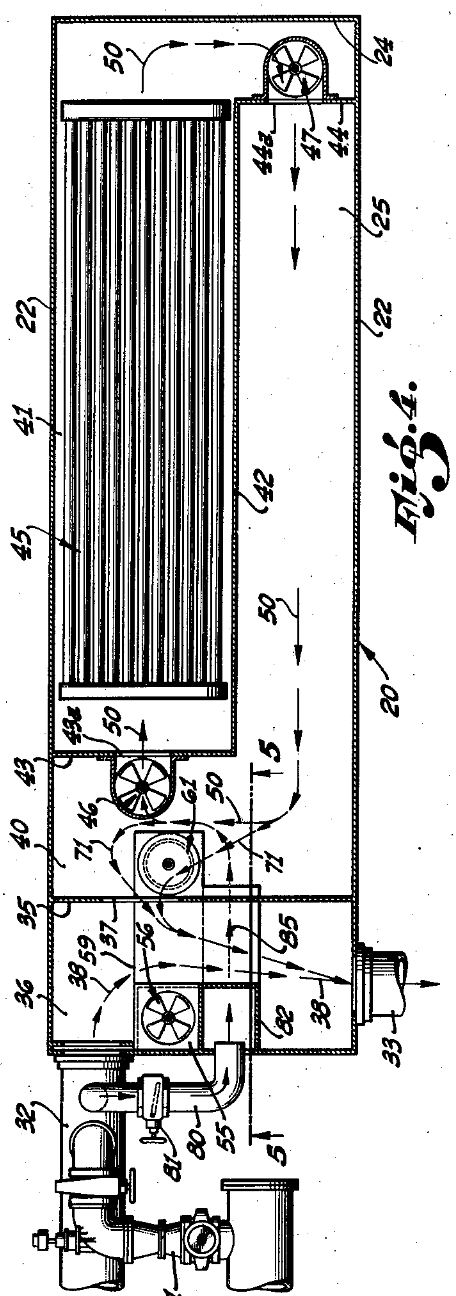

Fig. 4.

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Dec. 3, 1946. F. J. ZAMBONI 2,411,919

ICE RINK

Filed Sept. 16, 1944 4 Sheets-Sheet 3

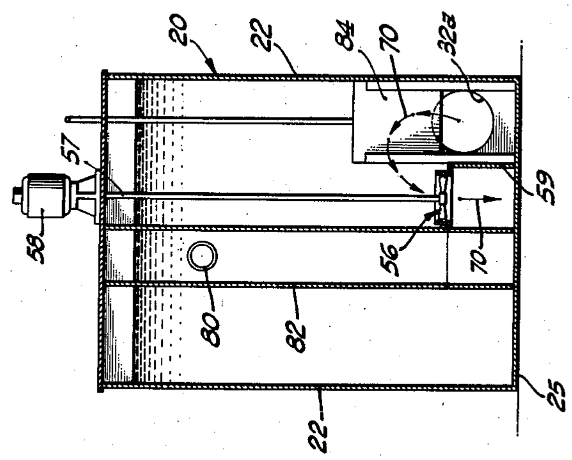

Fig. 7.

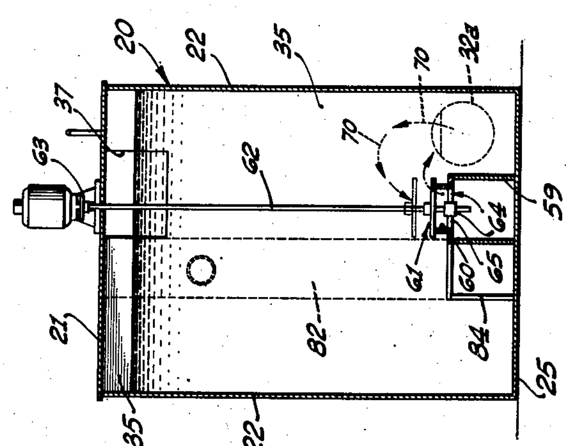

Fig. 6.

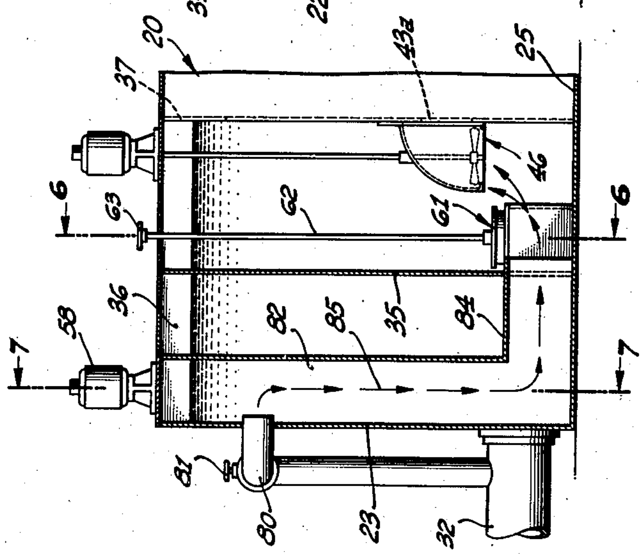

Fig. 5.

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Dec. 3, 1946. F. J. ZAMBONI 2,411,919

ICE RINK

Filed Sept. 16, 1944 4 Sheets-Sheet 4

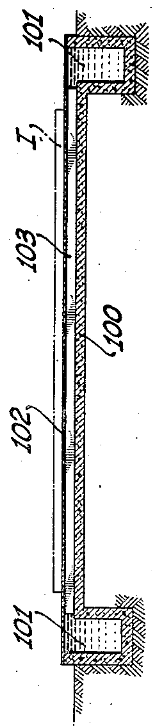

Fig. 11.

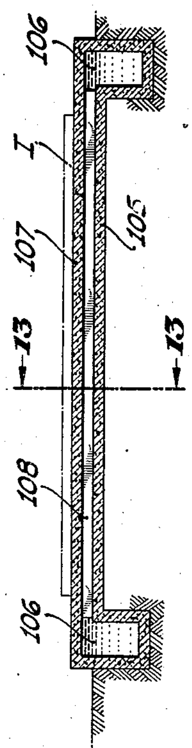

Fig. 12.

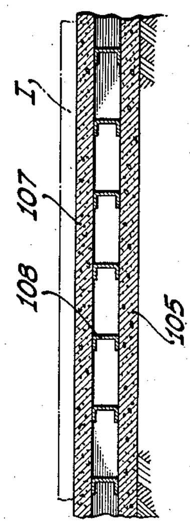

Fig. 13.

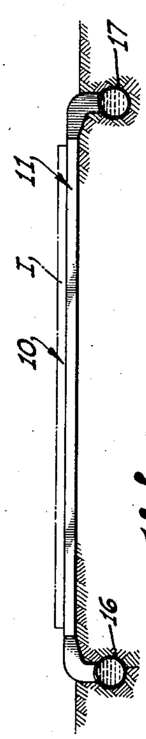

Fig. 8.

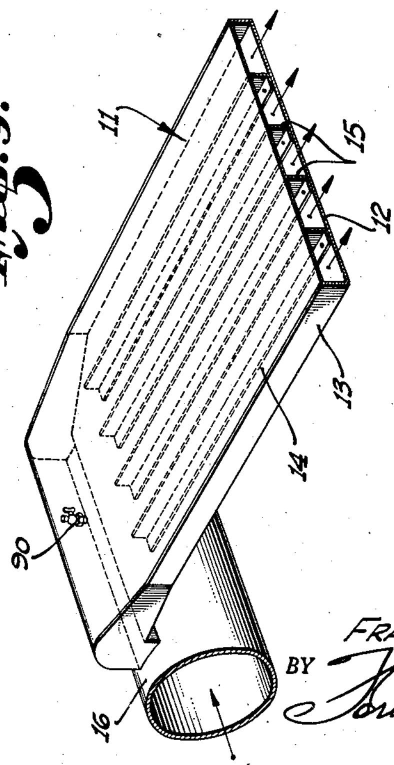

Fig. 9.

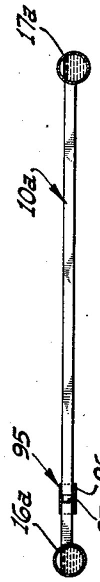

Fig. 10.

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2,411,919

UNITED STATES PATENT OFFICE

2,411,919

ICE RINK

Frank J. Zamboni, Hynes, Calif.

Application September 16, 1944, Serial No. 554,481

14 Claims. (Cl. 62—12)

1

This invention relates generally to ice skating rinks, particularly to the type involving a hollow floor adapted to support a thin sheet of ice and through which brine is circulated, and relates further to systems for circulating cooled brine to and from such a floor, and for regulating the temperature of the brine so circulated.

In a rink of the class mentioned, the brine is fed by a force pump to and through a fabricated sheet-metal hollow rink floor, braced internally by I-beam or equivalent spreaders, and secured together by spot or seam welding. The brine within the floor is hence at a pressure above atmospheric pressure, and in consequence of this internal pressure there is a constant tendency for the hollow floor to expand. This construction tends to suffer more or less constantly from failure of the spot welds or weld seams, and consequent leakage of the brine. The trouble is heightened by the fact that a very great number of such spot welds are required to tie the structure together securely because of the above-mentioned internal pressure exerted by the pressure circulated brine.

A major object of the invention is accordingly to provide a skating rink and brine circulation system of the general class mentioned which does not suffer from either leakage or tendency for the hollow floor to be spread apart by internal brine pressure.

In accordance with the invention, considered in one of its major aspects, the hollow floor of the skating rink is equipped with a brine circulation system which creates within it a sub-atmospheric pressure, the result of which is to eliminate external leakage from the floor in the event of failure of any spot weld, or fracture of any kind, and a further result of which is to tie the plates and faces of the floor together by the external and internal pressure differential.

A further purpose and accomplishment of the invention is the provision of a brine circulation and cooling system characterized by the maintenance of a relatively small volume of brine cooled to a substantially lower temperature than that necessary for the purpose of circulation through the rink floor, and which is intermittently drawn upon, under either manual or automatic control, to maintain the liquid circulated through the rink floor at the desired temperature.

A still further purpose and accomplishment of the invention is the provision of an improved hollow rink floor construction capable of overcoming the expansion and contraction difficulties

2

encountered in rink floor structures of the class mentioned.

The invention will be best understood by referring without further preliminary discussion to the following detailed description of certain present preferred illustrative embodiments thereof, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a somewhat diagrammatic plan view of a skating rink and brine cooling and circulation system in accordance with the invention;

Fig. 2 is a side elevation of the system shown in Fig. 1;

Fig. 3 is a section taken as indicated by line **3—3** on Fig. 2;

Fig. 4 is a view similar to Fig. 3, but showing an alternative method of operation;

Fig. 5 is a vertical section on line **5—5** of Fig. 4;

Fig. 6 is a vertical section on line **6—6** of Fig. 5;

Fig. 7 is a vertical section on line **7—7** of Fig. 5;

Fig. 8 is a transverse section in accordance with line **8—8** on Fig. 1;

Fig. 9 is a perspective detail showing the connection of a typical floor section to a header;

Fig. 10 is a section similar to Fig. 8 but showing a modification;

Fig. 11 is a section similar to Fig. 8 but showing another modification;

Fig. 12 is a view similar to Fig. 8 but showing another modification; and

Fig. 13 is a section on line **13—13** of Fig. 11.

I proceed now to a detailed description of one typical illustrative system capable of carrying the invention into effect, and from which a full understanding of the practice of the invention will be obtained. It will, of course, be understood that this is for illustrative purposes only, and that various changes and modifications in the particular system herein explained in certain detail are possible without departure from the spirit and scope of the invention.

In the drawings, numeral **10** designates generally the hollow skating rink floor, which in the instance of Figs. 1, 2, 8 and 9 is comprised of a plurality of transverse floor sections **11** positioned edge to edge and each embodying a sheet iron base plate **12** having upturned longitudinal edge portions **13**, a sheet iron platform **14** abutting and welded to edge portions **13**, and spreaders **15** positioned on base plate **12** parallel to edge portions **13** and supporting the platform **14**, in the manner clearly indicated in Fig. 9. The spreaders **15** may be of any suitable section, though they are of angle section as shown in Fig. 9. The plate or platform **14** is welded to edges **13** and may be spot welded in a few places to spreaders 15, which are in turn spot welded to base 12. As will hereinafter appear, an advantage of the present system is that no great amount of such spot welding is required. It is sufficient in fact if the spreaders are only tacked in place by a very few spot welds, and it is not even necessary that the platform 14 be spot welded to the spreaders, as it may merely rest thereon. This follows from the fact that the present system avoids the creation of internal pressure within the floor.

Inlet and outlet heads 16 and 17 extend lengthwise of the floor below the end portions of the sections 11, which latter are turned downwardly to make connection with the headers in the manner that will be readily understood from an inspection from Figs. 1 and 9. These end portions may converge somewhat, as seen in plan, in order to provide a desirable clearance space therebetween, but the thickness is preferably commensurately expanded in order to avoid a flow constriction (see Fig. 9). The headers 16 and 17 may converge in diameter from one end of the floor toward the other, as indicated in Fig. 1 for an obvious purpose.

The sectionalized fabricated sheet metal floor construction as thus described has several advantages, among which may be mentioned the fact that expansion and contraction of the floor is not cumulative over the length of the floor. Each section is laid in close proximity to the sections adjacent to it, but in a somewhat loose or free arrangement, whereby each section may expand or contract without any substantial effect upon those adjacent to it. The construction has the further advantage of simplicity and relatively low initial cost. By reason of the novel brine circulation system to be described presently, the pressure within the floor does not exceed atmospheric pressure, so that, as previously mentioned, there is no occasion for the use of a large number of spot welds to tie the floor structure together against bursting strains, as would otherwise be found necessary in this class of construction.

It will, of course, be understood that cooled brine will be circulated from inlet header 16 upwardly into the floor sections 11, across the floor through said sections, and thence downwardly and outwardly via outlet header 17. The brine having been reduced to an appropriate temperature, e. g. 20° F., or within the approximate range of 15° to 25° F., depending upon use and atmospheric temperature, water sprayed on the surface of the floor will freeze and form the layer of ice I (Fig. 2).

The brine cooling and circulation system, shown more particularly in Figs. 3 to 7, inclusive, includes a compartmented cooling tank 20 positioned rather low with respect to the rink floor 10. The requirement is that the liquid level L in the tank 20 be at no time substantially higher than the liquid level within the hollow floor (see Fig. 2). The tank 20, shown more or less diagrammatically, may have a sectionalized top 21 in addition to sides 22, ends 23 and 24 and a bottom 25. In the construction here indicated, some of the top sections may serve to support agitator motors, and may hence be welded to the tank structure. The remaining ones, however, may be loose and removable for access to the tank. Such loose arrangement of the top sections 21 permits atmospheric pressure to prevail in the tank 20.

The outlet header 17 leading from floor 10 is connected by line 30 to a pair of pumps 31 which deliver to a pipe 32 connected into the lower portion of one end 23 of tank 20. An outlet pipe 33, fitted with a control valve 34, leads from the side of tank 20 near end wall 23 and connects with inlet header 16.

A transverse vertical partition 35 is placed in tank 20, so as to form a compartment 36 into which the pipe 32 discharges, and from which leads the pipe 33 that delivers the brine to the rink floor. Normally, brine discharged into this compartment as indicated by access 38 and leaves via pipe 33. The partition 35 is formed near or at the top with a liquid port 37 (Figs. 3 and 6). However, unless the brine being circulated from compartment 36 requires that its temperature be further reduced, no substantial flow takes place through this port.

The space between partition 35 and tank end 24 is divided into a cooled liquid supply compartment 40 and a cooling compartment 41 by a longitudinal vertical partition 42, and walls 43 and 44 joining opposite ends of the latter with the opposite side walls 22 of the tank. Within the cooling compartment 41 is placed any suitable refrigeration or cooling unit 45, only diagrammatically indicated, since it may be of any well known or desired type. It should be capable of reducing the temperature of the brine circulated around it to a temperature substantially below that desired within the rink floor, e. g. to a temperature of from 5° to 15° F., depending upon circumstances such as weather, amount of use, relative volumes of brine in the circulatory system and in supply, etc. Continuous circulation is induced between the compartments 40 and 41 by means of continuously motor driven impeller or agitators 46 and 47 mounted on walls 43 and 44, respectively, and arranged to cause liquid flow through the respective ports 43*a* and 44*a* formed in said walls. These agitators, which may be of a conventional type, will be understood to circulate brine in a closed ring circulation as indicated by the arrows 50; that is, from one end of compartment 40 through wall 43 to the corresponding end of compartment 41, thence longitudinally of cooling unit 45, through wall 44 into the other end of compartment 40, and thence longitudinally back to the first mentioned end of said compartment 40. This ring circulation takes place continuously, with the temperature of the brine being continuously reduced by the cooling unit 45 and with no substantial outflow via port 37, until or unless a call is made upon the system for an additional quantity low temperature brine, as will presently be more fully described. The brine contained within and circulating between the two compartments 40 and 41 thus constitutes a supply source of low temperature brine. The volume of this supply source may be only a relatively small fraction of the total brine contained within the entire system.

When, however, it becomes necessary to reduce the temperature of the brine circulated to the rink floor, provisions are made for drawing the extreme low temperature brine from the compartment 40 into the compartment 36 via the port 37, and to induce this flow, means are provided to establish a counterflow of relatively warmer brine into the compartment 40. The present illustrative embodiment of the invention provides for accomplishing this result in either of two ways shown in operation in Figs. 3 and 4, respectively.

In the arrangement of Fig. 3, brine discharged into compartment 36 from pipe 32 is caused to enter into the end of a conduit 55 by an agitator or impeller 56, driven for example through a shaft 57 from an electric motor 58 (Figs. 3 and 7). The inlet end of this conduit 55 is adjacent the inlet 32a from pipe 32, so as to take the returning relatively warm brine directly from said inlet. The conduit 55 extends horizontally through the lower end portion of partition 35, so as to discharge in the lower region of compartment 40. This discharge is shown as taking place upwardly via a port 60, which is normally closed by a check valve 61. The latter is here shown as provided with a vertical extension rod 62, passing upwardly through tank top 21 and furnished at its upper extremity with a handle 63 by which the valve may be manually unseated, if desired. The valve 61 is guided vertically by means of a bearing 64 slidably receiving the lower end portion of the rod 62, said bearing being carried by a spider 65, suitably mounted within port 60.

If now the temperature of the brine being circulated to the rink floor should rise, and there should therefore be a call for lower temperature brine from supply compartment 40, impeller drive motor 58, which may be under manual control, or under automatic thermostatic control from the rink, is set into operation. A fraction of the brine discharged into compartment 36 from pipe 32, and which will be understood to be the highest temperature brine of the system, is then diverted by the pump-driven impeller 56 into conduit 55, whence it flows downwardly to the bottom of the tank, across via conduit extension 59 into the lower portion of low temperature supply compartment 40, and discharges from the latter past check valve 61, all as indicated by the arrows 70 in Figs. 3, 6 and 7. This introduction of warm brine into the bottom of compartment 40 induces a like flow of the low temperature brine from the upper regions of compartment 40 through port 37 in the upper portion of partition 35 and into compartment 36 (as indicated by arrows 71 in Fig. 3) where it mixes with the relatively higher temperature brine being circulated to and from the rink floor, and accordingly reduces the temperature thereof.

Fig. 4 shows the alternative method of operation. In this instance, to reduce the temperature of the circulated brine, use is made of a by-pass pipe 80 controlled by a manual valve 81 and leading from pipe 32 into a vertical conduit 82 in compartment 36. Conduit 81 does not communicate with compartment 36, as may be seen in Fig. 5. Its lower end is continued by a horizontal extension 84 which passes through the lower portion of partition 35 and discharges into the lower region of compartment 40.

When valve 81 is opened, relatively warm brine is diverted from pipe 32, and flows through pipe 80 and conduit 82 into compartment 40, as indicated by arrows 85 in Figs. 4 and 5. To assure that flow will be diverted through the relatively small by-pass pipe 80, a gate valve 84 is provided at pipe inlet 32a, and may be closed down as desired. Fig. 5 shows further how the relatively warm brine discharged into the lower region of compartment 40 rises in the colder brine contained in the latter to be drawn through wall 43 by the impeller 46 and so subjected to cooling action within compartment 41.

The advantage of the system is that it is only necessary to cool a relatively small volume of brine to a relatively low temperature. It will be seen that two circulation rings are maintained, one from compartment 36 to the floor and back again, and the other between the supply compartment 40 and the cooling compartment 41. When the temperature in the first circulation ring rises above a predetermined maximum, a quantity of cooler brine from the second ring is exchanged for a like quantity of relatively warmer brine from the first. The main advantages are that a smaller cooling unit is required and control over floor temperature is much greater. That is to say, there is always available a supply of brine at a very low temperature, and this may be called upon at a moment's notice to effect a quick temperature reduction at the rink floor at any time the ice should give indication of deterioration.

As previously indicated, the brine is filled into tank 20 to a level such that the hollow floor 10 is completely filled with liquid, but not substantially higher, so that with no circulation taking place, there will be no substantial hydrostatic head on the floor. In other words, the pressure inside the floor will not exceed the pressure outside the floor, and there will be no bursting strains, i. e. no tendency to lift the platform 14. Actually, a little liquid elevation in the tank above the floor level will do no harm in the way of lifting the platform by hydrostatic pressure, because the platform will stay down of its own weight, even though not spot welded to the spreaders, under a small head. The actual requirement therefore is that the liquid level in the tank is kept sufficiently low that there is no tendency for the hydrostatic head created to elevate the platform. And this condition is generally described herein by the statement that the liquid level in the tank is maintained not substantially higher than the floor level. To permit the floor sections to initially fill with liquid, they may be provided with pet-cocks such as indicated at 90 in Fig. 9. When the floor is full of brine, these are closed. No further brine is then introduced to tank 20, and conditions are as indicated in Fig. 2.

When the circulation pumps 31 are started, the friction on flow resistance of the pipe 33 and header 16 between tank 20 and the floor causes a loss of head, so that the pressure within the floor will be reduced below the atmospheric pressure on the brine within the tank 20. The pumps 31 thus function as suction pumps, and create a subatmospheric pressure condition within the floor. This is an advantage of the utmost importance. First of all, any fracture in the floor, e. g., failure of a spot weld, will not result in leakage of brine, and possible spoilage of a substantial area of ice. At the worst, a little air will leak into the circulation system, which will be carried away by the flowing brine. Next, the entire floor structure is tied together by external pressure, eliminating the necessity for a great deal of internal bracing and spot welding heretofore believed essential. Since the brine level in the tank is maintained no substantially higher than the brine level in the floor, no internal pressure is exerted on the floor even though the circulation pumps should accidentally stop, as by power failure.

Fig. 10 shows, in transverse section, a modified hollow sheet floor 10a in which the headers 16a and 17a are on the level of the floor, so that no difficulty in initially filling the floor with brine is encountered. This view also shows the incorporation of an expansion joint at 95, consisting of a rubber band 96 tightly fitted over the floor section around a break or interruption 97 in the latter. This same expedient, or any other found suitable, may of course be incorporated in the form of Figs. 1, 2, 8 and 9.

Fig. 11 shows, in transverse section, a modified hollow floor structure which may be used and wherein base **100** and headers **101** are constructed of concrete. A sheet metal platform **102** is used, together with spreaders **103**, similar to the spreaders of the first-described embodiment.

Figs. 12 and 13 show a further modification, in which the base **105**, headers **106** and platform **107** are all formed of concrete, spreaders **108** being used as before.

I claim:

1. In a brine supply system for a hollow skating rink floor, the combination of: means for establishing a ring circulation of brine to and from said floor, a brine cooling unit, means for establishing a ring circulation of brine to and from said brine cooling unit, and means for diverting brine from each of said ring circulations and introducing it to the other.

2. In a brine supply system for a hollow skating rink floor, the combination of: a brine-containing chamber, a brine supply line between said chamber and said hollow floor, a brine return line between said floor and said chamber, a circulation pump in one of said lines, a storage chamber for low temperature brine, a liquid connection between said storage chamber and said first-mentioned chamber, and means for introducing brine returned from said floor via said return line to said storage chamber.

3. In a brine supply system for a hollow skating rink floor, the combination of: a brine-containing chamber, a brine supply line between said chamber and said hollow floor, a brine return line between said floor and said chamber, a circulation pump in the last-mentioned of said lines, a storage chamber for low temperature brine, a liquid connection between said storage chamber and said first-mentioned chamber, and means for introducing brine returned from said floor via said return line to said storage chamber.

4. In a brine supply system for a hollow skating rink floor, the combination of: a brine supply line leading to said floor, a brine return line leading from said floor, means associating the ingoing end of the first-mentioned line and the discharge end of the second-mentioned line in a manner for liquid returned by the latter to be taken by the former, a circulation pump in one of said lines, a storage chamber for low temperature brine, means for diverting brine returned by said return line into said storage chamber, and means establishing communication between said storage chamber and said supply line.

5. In a brine supply system for a hollow skating rink floor, the combination of: a brine supply line leading to said floor, a brine return line leading from said floor, means associating the ingoing end of the first-mentioned line and the discharge end of the second-mentioned line in a manner for liquid return by the latter to be taken by the former, a circulation pump in said return line of said lines, a storage chamber for low temperature brine, means for diverting brine returned by said return line into said storage chamber, and means establishing communication between said storage chamber and said supply line.

6. In a brine supply system for a hollow skating rink floor, the combination of: a brine supply line leading to said floor, a brine return line leading from said floor, means associating the ingoing end of the first-mentioned line and the discharge end of the second-mentioned line in a manner for liquid returned by the latter to be taken by the former, a circulation pump in one of said lines, a storage chamber for low temperature brine, a brine cooling unit, means for circulating brine from said chamber through said cooling unit, means for diverting brine returned by said return line into said storage chamber, and means establishing communication between said storage chamber and said supply line.

7. In a brine supply system for a hollow skating rink floor, the combination of: a brine tank, a partition dividing said tank into a mixing chamber and a cooled brine supply chamber, a port in the upper portion of said partition, a brine supply line leading from said mixing chamber to said floor, a brine return line leading from said floor to said mixing chamber, a circulation pump in one of said lines, and means for diverting a portion of the brine returned by said return line and introducing it to said supply chamber.

8. In a brine supply system for a hollow skating rink floor, the combination of: a brine tank, a partition dividing said tank into a mixing chamber and a cooled brine supply chamber, a port in the upper portion of said partition, a brine supply line leading from said mixing chamber to said floor, a brine return line leading from said floor to said mixing chamber, a circulation pump in one of said lines, and means for diverting a portion of the brine returned by said return line and introducing it to a lower region of said supply chamber.

9. In a brine supply system for a hollow skating rink floor, the combination of: a brine tank, wall means partitioning said tank into a mixing chamber, a cooled liquid supply chamber adjacent to said mixing chamber, and a cooling chamber adjacent to said supply chamber, the wall means between the first and second-mentioned of said chambers having a liquid port in its upper portion, and the wall means between the second and third-mentioned of said chambers having two liquid circulation ports, means for establishing a ring circulation of brine through said ports between said supply and cooling chambers, a brine supply line leading from said mixing chamber to said floor, a brine return line leading from said floor to said mixing chamber, a circulation pump in one of said lines, and means for diverting a portion of the brine returned by said return line and introducing it to said supply chamber.

10. In a brine supply system for a hollow skating rink floor, the combination of: a brine tank so located that its liquid level will be no higher than the floor level, a partition dividing said tank into a mixing chamber and a cooled brine supply chamber, a port in the upper portion of said partition, a brine supply line leading from said mixing chamber to said floor, a brine return line leading from said floor to said mixing chamber, a circulation pump in said return line, and means for diverting a portion of the brine returned by said return line and introducing it to said supply chamber.

11. In a skating ring, the combination of a rink floor, a brine receiving container, a suction pump arranged to discharge into said container, a brine circuit including a supply line and a return line and a portion interposed between said lines, said portion having the top thereof arranged to form said rink floor, said supply line having an inlet end portion communicating with said container, said return line being connected to the intake of said suction pump, and means for lowering the temperature of the brine circulating through said circuit, the parts being so constructed and arranged that the pressure in

the line in heat exchange relation with said floor is maintained at sub-atmospheric pressure.

12. In a skating rink, the combination of a rink floor, a tank having a receiving compartment containing brine to a level not substantially exceeding the level of the rink floor so that when the brine is not circulating through the rink floor the pressure inside the floor will not exceed the pressure outside the floor, a suction pump arranged to discharge into said compartment, a brine circuit including a supply line and return line and a portion interposed between said lines, said portion having the top thereof arranged to form said rink floor, said supply line having an inlet end portion communicating with said compartment, said return line being connected to the intake of said suction pump, and means for lowering the temperature of the brine circulating through said circuit, the parts being so constructed and arranged that the pressure in the portion of the line in heat exchange relation with said floor is maintained at sub-atmospheric pressure.

13. In a skating rink, the combination of a rink floor, a tank having a receiving compartment communicating with the atmosphere and containing brine to a level not substantially exceeding the level of the rink floor so that when the brine is not circulating through the rink floor the pressure inside the floor will not exceed the pressure outside the floor, a suction pump arranged to discharge into said compartment, a brine circuit including a supply line and a return line and a portion interposed between said lines, said portion having the top thereof arranged to form said rink floor, said supply line having an inlet end portion communicating with said compartment, said return line being connected to the intake of said suction pump, and means for lowering the temperature of the brine circulating through said circuit, the parts being so constructed and arranged that the pressure of the brine circulating through the line in heat exchange relation with said floor is maintained at sub-atmospheric pressure.

14. In a skating rink, the combination of a rink floor, brine receiving means, a suction pump, a brine circuit including a supply line and a return line and a portion interposed between said lines, said supply line having an inlet end portion communicating with said brine receiving means, said return line communicating with the intake of said suction pump, means communicating said pump with said brine receiving means, and said brine receiving means communicating with the atmosphere and containing brine to a level not substantially exceeding the level of the rink floor so that when the brine is not circulating through the rink floor, the pressure inside the floor will not exceed the pressure outside the floor.

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