March 24, 1959 D. M. COMB 2,878,652

ICE-SKATING RINK

Filed Nov. 29, 1956 3 Sheets-Sheet 1

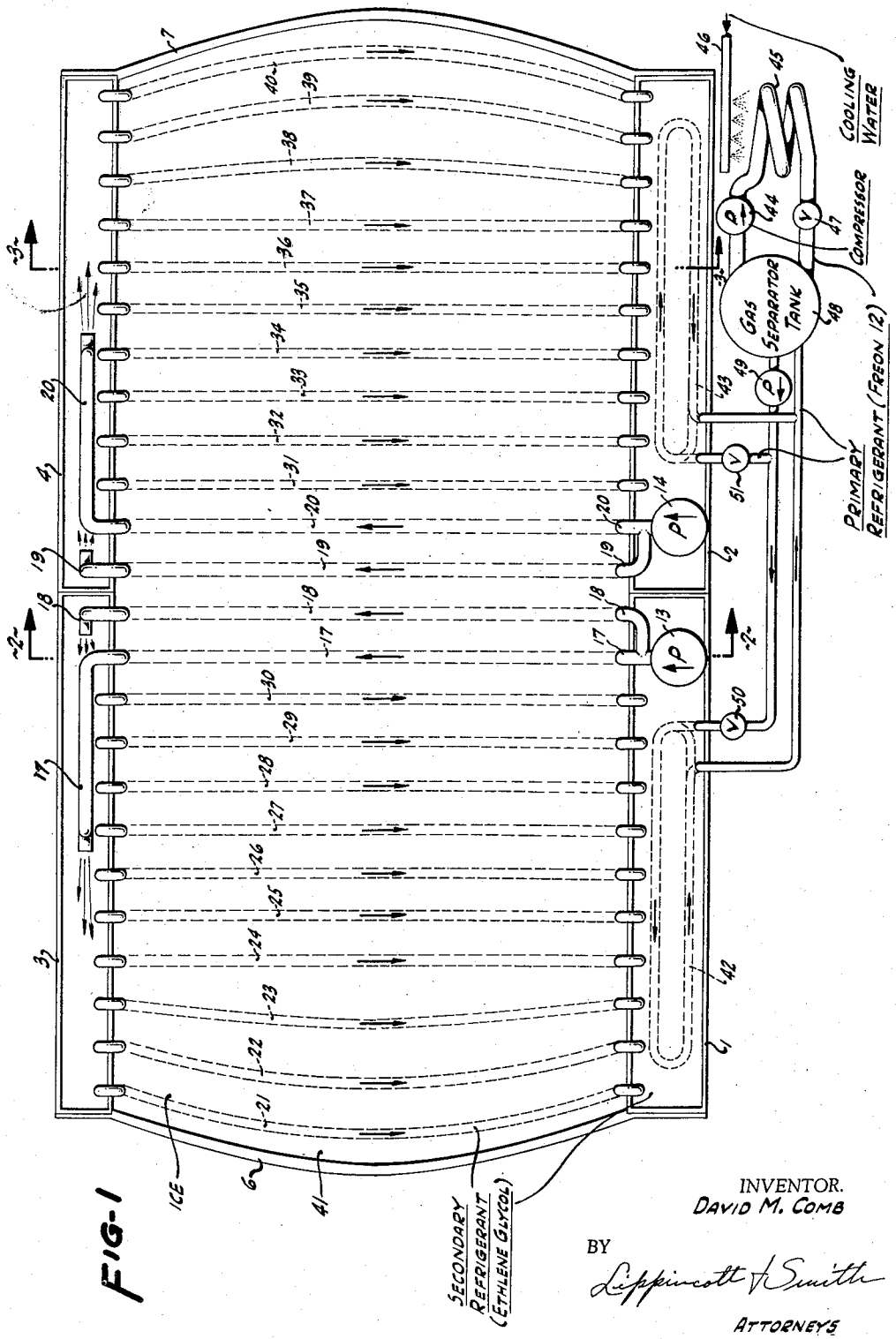

FIG-1

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FIG-2

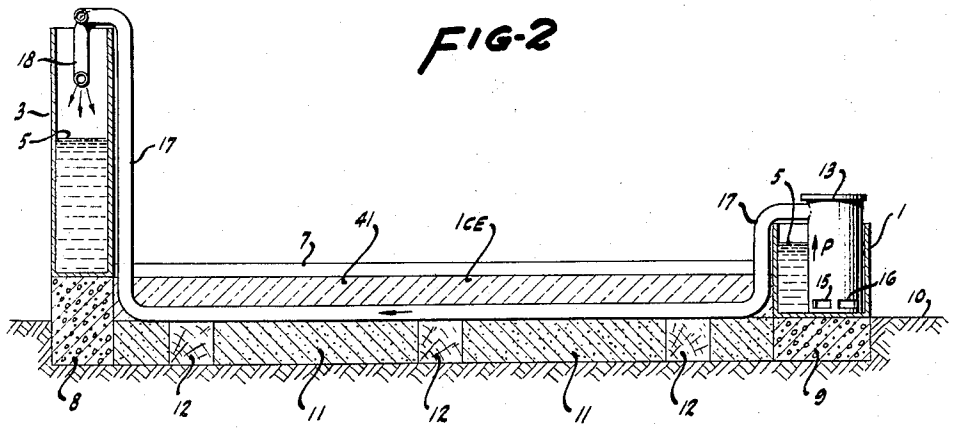
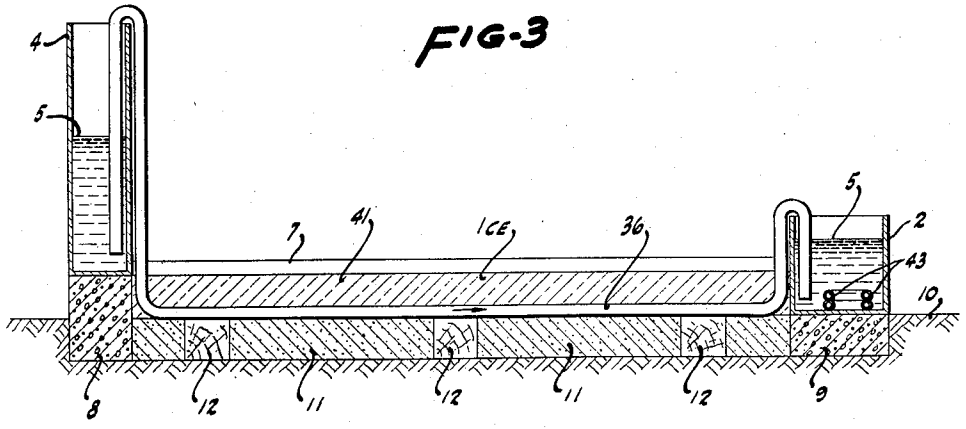


FIG-3



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Filed Nov. 29, 1956 3 Sheets-Sheet 3

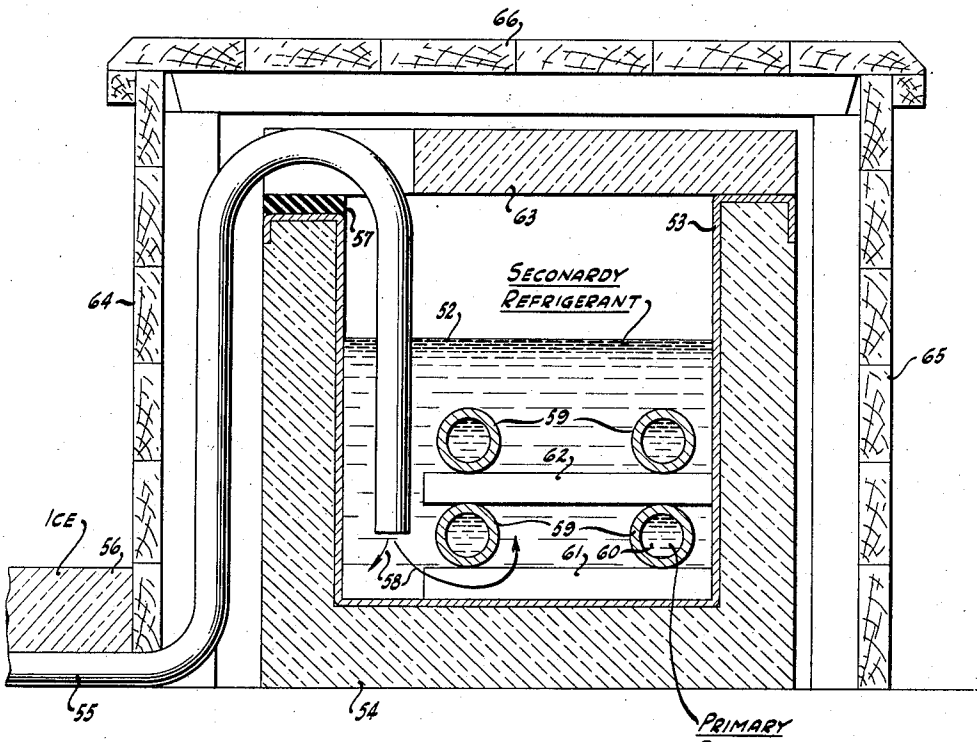

FIG-4

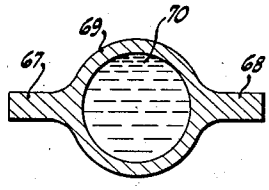

FIG-5

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ICE-SKATING RINK

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Application November 29, 1956, Serial No. 625,031

11 Claims. (Cl. 62—235)

This invention relates to refrigerated ice-skating rinks, and its chief object is to provide an improved ice-skating ring and refrigeration system therefor that is less expensive to construct and to maintain than refrigerated ice-skating rinks heretofore known. Other objects and advantages will appear as the description proceeds.

A conventional ice-skating rink has a sub-floor or ice floor, which may be a level bed of sand, for supporting the ice sheet that forms the skating surface. It has a plurality of pipes or tubes that extend across the ice floor. Such pipes or tubes may either be imbedded in the sub-floor or lie on top of the sub-floor underneath the ice sheet. A secondary refrigerant or cold brine is circulated through these pipes or tubes for refrigerating the ice sheet, which is formed by spraying water onto the refrigerated ice floor until an ice sheet of the desired thickness is built up. A conventional primary refrigeration system is used for cooling the secondary refrigerant or brine.

In such ice-skating rinks a major item of expense in the construction and maintenance of the rink is attributable to the many pipe connections required in the system for circulating the secondary refrigerant through the many pipes or tubes that extend across the ice floor. In the past, threaded or welded pipe connections have generally been employed. Both installation and maintenance are apt to be expensive, since the pipes are commonly spaced at intervals of three to four inches on centers and a rink of even moderate size involves a large number of pipe connections. Leaks are apt to develop at the pipe connections, particularly if threaded connections are used. Replacement of corroded or otherwise damaged pipes is difficult, especially if welded connections are employed. In the case of portable skating rinks that are frequently moved from place to place for exhibitions, ice shows, and the like, disassembly of the pipes for moving and reassembly at the new location are time-consuming as well as expensive.

Piping problems are further complicated by the necessity for insuring substantially the same flow rate of refrigerant at substantially the same temperature through all of the pipes extending across the ice floor, so that all portions of the ice sheet will be maintained at the same temperature. For a good skating surface, the ice must be neither too hot nor too cold. Consequently, the surface temperature of the ice must be carefully regulated and uniform over the entire skating area.

Briefly stated, in accordance with certain aspects of of this invention, the pipes that extend across the ice floor are metal tubes, preferably of aluminum, having inverted U-shaped end portions that extend downward into two troughs containing the secondary refrigerant, so that each tube forms a siphon for conveying liquid refrigerant from one trough to the other. Means are also provided for pumping the secondary refrigerant from one trough to the other to maintain a circulation of refrigerant through the tubes extending across the ice floor. In this way most of the pipe connections are eliminated and the

expense of constructing and maintaining the skating rink is materially reduced. In the case of a permanent rink, there is a substantial saving in capital cost, and, as is particularly important in cases where the rink is installed in a leased building owned by others, the entire mechanical installation can be placed within a general-purpose building without becoming a part of the building structure. In the case of a portable rink, there is in addition a great saving in the time and expense of disassembling and reassembling the piping when the rink is moved from one place to another. In both cases maintenance is greatly facilitated by the relative ease with which the pipes can be replaced when necessary. Furthermore, the novel trough-and-siphon system herein disclosed provides substantially uniform cooling of the ice sheet in an exceedingly simple and advantageous manner.

A further economy is effected by using one of the troughs as a heat exchanger between the primary and secondary refrigerants, which is accomplished by immersing in the secondary refrigerant contained in one of the troughs tubes through which the primary refrigerant is circulated.

The invention will be better understood from the following detailed description taken in connection with the accompanying drawings, and its scope is pointed out in the appended claims. In the drawings:

Fig. 1 is a simplified schematic plan view, not drawn to scale, of an ice-skating rink embodying principles of this invention;

Fig. 2 is a section taken along the line 2—2 of Fig. 1;

Fig. 3 is a section taken along the line 3—3 of Fig. 1;

Fig. 4 is a more detailed section of one of the troughs, drawn to a somewhat larger scale; and

Fig. 5 is a cross-section of one of the siphon tubes that extend across the ice floor.

With particular reference to Figs. 1 through 3 of the drawings, two similar troughs 1 and 2 are placed end-to-end along one side of an ice skating rink. Two similar troughs 3 and 4 are placed end-to-end along the other side of the skating rink. These four troughs contain a liquid secondary refrigerant 5 which is cooled by a primary refrigerating system hereinafter descirbed. The troughs conveniently become, or are enclosed within structures that become parts of the low wall or railing that usually surrounds an ice-skating rink. In the rink illustrated, the two parallel rows of troughs form the side boundaries of the ice-skating surface, while the end boundaries of the ice surface consist of low walls or curbs 6 and 7. The four troughs rest on any suitable supports, such as concrete footings 8 and 9. Earth is represented at 10.

The secondary refrigerant is a liquid having a sufficiently low freezing point so that it remains fluid at all times and a sufficiently low vapor pressure, that losses through evaporation of the refrigerant are small. For example, brine of the type long used in commercial refrigeration apparatus can be employed, although much more satisfactory results are obtained by using a non-corrosive liquid anti-freeze. A preferred secondary refrigerant is ethylene glycol, which has the desirable characteristics of being non-corrosive, having a low freezing temperature and a low vapor pressure, and having little tendency to evolve absorbed gases within the siphons hereinafter described.

Between the two parallel rows of troughs there is a conventional sub-floor or ice floor, which may consist essentially of a level bed of packed sand 11. A plurality of redwood sleepers 12 may extend through the sand bed, as shown, for providing supports to which may be fastened the pipes and tubes that extend across the ice

floor. The bottoms of the four troughs may be substantially level with the surface of the ice floor, so that no substantial excavation is required. The bottoms of troughs 3 and 4 may be elevated somewhat above the bottoms of troughs 1 and 2, for reasons hereinafter explained. The sides of the four troughs extend substantially above the surface of the ice sheet so that water from the ice floor cannot enter the troughs and dilute the refrigerant.

Two immersion-type pumps 13 and 14 fit inside of troughs 1 and 2 respectively, as shown. These two pumps have inlets near their bottoms, as shown in Fig. 2 at 15 and 16, so that the two pumps take in liquid secondary refrigerant from troughs 1 and 2 and pump it into troughs 3 and 4 through four pipes 17, 18, 19 and 20 connected to the pump outlets. Consequently, pumps 13 and 14 cause the liquid level in troughs 3 and 4 to rise above the liquid level in troughs 1 and 2. The liquid secondary refrigerant then flows from trough 3 and 4 back into troughs 1 and 2 through a plurality of siphon tubes identified in the drawings by reference numerals 21 through 40. Thus there is a continuous circulation of the liquid secondary refrigerant from trough 1 through pump 13 and pipes 17 and 18 to trough 3, and from trough 3 back to trough 1 through siphon tubes 21 through 30. Similarly, there is a continuous circulation of liquid secondary refrigerant from trough 2 through pump 14 and pipes 19 and 20 into trough 4, and from trough 4 back into trough 2 through siphon tubes 31 through 40. Pipes 17, 18, 19 and 20, and the siphons 21 through 40, all extend across the ice floor underneath the ice sheet. The cold secondary refrigerant flowing through these pipes and tubes cools the ice. Water is sprayed onto the refrigerated ice floor until an ice sheet 41 of the desired thickness has been built up to form an ice-skating surface.

In actual practice it is convenient to make each of the troughs 1, 2, 3 and 4 about 30 feet long. As many troughs as desired may be placed end-to-end to form skating rinks of various sizes from standardized components. The pipes and siphon tubes that extend across the surface of the ice floor are usually spaced about three to four inches on centers, so that there are about 90 to 120 pipes and tubes extending across the ice floor between each pair of opposite 30-foot troughs. Of these pipes and tubes between each pair of troughs, two are the pipes connected to the pump outlet and the remainder are siphons. In actual practice the number of siphons per trough is usually much greater than the number shown in Fig. 1.

The siphon tubes are preferably made from aluminum tubing of a size approximately equivalent to one-inch pipe. The pipes connected to the pump outlet may be somewhat larger, and may be made of a material having somewhat poorer heat-transfer characteristics, such as iron, so that the secondary refrigerant flowing through each of the larger pipes 17, 18, 19 and 20 cools the ice by about the same amount as the secondary refrigerant flowing through each of the smaller siphon tubes 21 through 40.

To maintain a smooth, level ice surface requires that all parts of the ice sheet must be equally refrigerated. This, in turn, requires that substantially equal amounts of secondary refrigerant of essentially the same temperature must flow through all of the siphon tubes 21 through 40. This will happen if the difference in liquid level between the two ends of each siphon is substantially the same for all of the siphons, and the secondary refrigerant in troughs 3 and 4 is of uniform temperature. The embodiment of this invention herein illustrated incorporates preferred means for accomplishing these ends.

It will be noted that troughs 1 and 2 are relatively shallow, wide troughs. Their volume is sufficient to provide adequate space for pumps 13 and 14, and for the refrigerating coils of a primary refrigeration system hereinafter described. Furthermore, the size and shape of

troughs 1 and 2 is such that there is little change in liquid level along the length of the troughs due to the flow of liquid therein from the siphon outlets to the pump inlets. Furthermore, because troughs 1 and 2 are wide troughs, there is relatively little drop in the liquid level within troughs 1 and 2 even though a substantial volume of liquid may have been pumped out of these troughs for raising the liquid level in troughs 3 and 4.

In contrast to troughs 1 and 2, troughs 3 and 4 are deep, narrow troughs. Consequently, any addition to the volume of liquid contained within trough 3 and 4 causes an appreciable increase in the liquid level within these troughs. Therefore, the operation of pumps 13 and 14 causes relatively small changes in the liquid level within troughs 1 and 2, but causes relatively large changes in the liquid level of troughs 3 and 4. The flow of liquid through the siphon tubes is therefore due chiefly to the rise in liquid level within troughs 3 and 4. Consequently, if the liquid in troughs 3 and 4 can be kept at substantially the same level along the length of the troughs, substantially equal amounts of the secondary refrigerant will flow through each of the siphon tubes 21 through 40.

A convenient way to keep the liquid at the same level along the length of troughs 3 and 4 is to supply substantially equal amounts of liquid to each lengthwise portion of these troughs, so that the outward flow of liquid through each siphon tube is substantially balanced by an inward flow of liquid to the same lengthwise portion of each narrow trough. When this is done, there is not much liquid flow along the length of troughs 3 and 4, and the liquid level is substantially uniform throughout the length of each trough. However, moderate inequalities in the liquid flow rates into different lengthwise portions of a narrow trough are balanced by liquid flow along the length of the trough without causing serious nonuniformity in the liquid level within the trough.

A preferred means for providing substantial equal rates of liquid flow into each lengthwise portion of troughs 3 and 4 is to terminate each of the pipes 17, 18, 19 and 20 in a nozzle or orifice that directs a stream or spray of liquid along the length of the troughs. For example, pipes 18 and 19 may terminate near the inside ends of troughs 3 and 4, as shown, with nozzles or orifices that direct streams of the liquid secondary refrigerant outward toward the lengthwise centers of trough 3 and 4 for supplying substantially equal amounts of liquid to each lengthwise portion of the inner lengthwise halves of the two narrow troughs. Pipes 17 and 20 terminate near the lengthwise centers of troughs 3 and 4 with nozzles or orifices that direct streams of liquid toward the outer ends of the two narrow troughs and supply substantially equal amounts of liquid to each lengthwise portion of the outer lengthwise halves of the two narrow troughs. Preferably, the four nozzles are somewhat below the tops of the narrow troughs to insure against any loss of the refrigerant, but are positioned substantially above the liquid level in the troughs to provide a substantially uniform distribution of the liquid supplied along the length of each trough.

With further reference to the siphon tubes 21 through 40, it will be noted that each of these tubes extends across the sub-floor or ice floor underneath ice sheet 41. Alternatively, the siphon tubes may be imbedded in the subfloor. At respective ends of each siphon tube there are two inverted U-shaped end portions that straddle the inner walls of the two rows of troughs, as is best shown in Fig. 3. The two open ends of each siphon tube extend downward into the liquid refrigerant within a wide, shallow trough and a narrow, deep trough, as shown, so that air cannot enter the siphons.

Each siphon is initially filled with the secondary refrigerant by temporarily attaching a portable suction pump (not shown) to one open end of the siphon tube and drawing liquid through the tube from the other trough. After the siphon tubes are filled with liquid, they then

operate by siphoning action to transfer liquid refrigerant from one trough to the other whenever there is a difference in liquid level between the two troughs at opposite ends of the tube.

The ends of the siphon tubes that extend into the wide, shallow troughs must extend below the lowest level that the liquid refrigerant reaches in that trough when pumps 13 and 14 are operating at their maximum pumping rates. The ends of the siphon tubes that extend into the narrow, deep troughs must extend below the equilibrium level of the liquid refrigerant when the pumps are not operating. Since operation of the pumps raises the liquid level in the narrow troughs and lowers the liquid level in the wide troughs, the ends of the siphon tubes within the narrow troughs may be somewhat higher than the ends of the siphon tubes within the wide troughs. Consequently, the bottoms of the narrow troughs may be elevated somewhat above the bottom of the wide troughs, as is shown in Figs. 2 and 3, thereby providing a saving in the amount of secondary refrigerant required.

If for any reason the flow of refrigerant through any of the siphon tubes stops while the system is in operation, this fact will soon become evident by a slight depression forming in the ice surface above the inoperative siphon tube. The inoperative siphon tube can be quickly placed back in operation by temporarily attaching the portable suction pump to one end of that siphon tube and drawing liquid through it to re-establish the siphoning action.

The secondary refrigerant is cooled by means of a primary refrigeration system that circulates a cold primary refrigerant through serpentine tubes or refrigerating coils 42 and 43 immersed in the secondary refrigerant contained in the wide, shallow troughs 1 and 2, respectively. Any of the well-known primary refrigerants may be used, such as Freon 12 (dichlorodifluoromethane).

The primary refrigeration system is of a substantially conventional type. The primary refrigerant in a gaseous or vapor phase is compressed by a pump or compressor 44 and cooled by passage through a coil or condenser 45 that is continuously sprayed with cold water by a cooling water system indicated schematically at 46. This condenses the primary refrigerant to the liquid phase, and it then passes through a valve 47 into a gas separator tank 48 within which there is maintained a supply of cold, liquid primary refrigerant. A pump 49 circulates the cold, liquid primary refrigerant through coils 42 and 43 that are immersed within the secondary refrigerant in troughs 1 and 2. Valves 50 and 51 may be provided for controlling the flow distribution of the primary refrigerant through coils 42 and 43.

With this arrangement, the wide, shallow troughs 1 and 2 serve a double purpose. These troughs not only are parts of the system for circulating the secondary refrigerant, but they also serve as heat exchangers between the primary and secondary refrigeration systems. This dual function of troughs 1 and 2 effects a substantial saving in the cost and in the space requirement of the refrigeration system. The cost and the space requirement of a separate heat exchanger are avoided. In addition, the amount of secondary refrigerant needed is minimized, which is particularly important when a desirable but expensive secondary refrigerant such as ethylene glycol is employed.

Another significant advantage of the arrangement herein illustrated and described is that all of the siphon tubes are supplied with secondary refrigerant at substantially the same temperature. By cooling the secondary refrigerant within troughs 1 and 2, and then pumping the cold refrigerant over to troughs 3 and 4 and distributing the liquid entering troughs 3 and 4 substantially uniformly along the lengths of the deep, narrow troughs, any portions of the secondary refrigerant that are at different temperatures are well mixed before they enter the siphon tubes, and the refrigerant entering the siphon tubes from the narrow troughs is quite uniform in temperature. This fact, together with the uniformity of flow rates through the different siphons tubes, insures substantially equal cooling of all parts of the ice surface.

In the preferred manner of operation, pumps 13, 14 and 49 are operated at constant pumping rates. The temperature of the ice is controlled by regulating the operation of compressor 44, either by manual or by automatic temperature-control means. For example, a conventional temperature sensing cable may be imbedded in the ice and may operate conventional control equipment for regulating the operation of compressor 44 to control the back pressure maintained in gas separator tank 48 by the compressor. Since the temperature of the primary refrigerant depends upon the back pressure maintained by the compressor, the control system will vary the temperature of the primary refrigerant in accordance with variations in the amount of cooling required to maintain the ice at a desired temperature. The variations in temperature of the primary refrigerant vary the rate at which the secondary refrigerant is cooled, which in turn varies the rate at which heat is extracted from the ice. By maintaining a constant and substantial circulation of the refrigerants, uniform cooling of the ice surface is assured.

As hereinbefore explained, the principles of this invention may be utilized in the construction of skating rinks of various sizes and shapes. For example, in a typical large installation, the ice sheet may be approximately 180 feet long by 88 feet wide, providing a skating surface of almost 16,000 square feet. Such an installation may use six pair of the wide and narrow troughs herein described to provide two parallel rows of troughs 180 feet long spaced 88 feet apart. Each of the wide troughs will contain a pump operable to pump approximately 90 gallons per minute of secondary refrigerant. Thus the total flow rate of secondary refrigerant for the entire 16,000 square foot rink will be in the order of 540 gallons per minute. The primary refrigeration system may advantageously have a capacity of about one ton of refrigeration for each 300 square feet of ice surface, or somewhat more than 50 tons of refrigeration for the entire rink. The temperature of the ice surface may be in the order of 28° F., plus or minus several degrees depending upon the skating conditions required. The temperature of the secondary refrigerant may have a typical value in the order of 18° F. to 22° F., and the primary refrigerant may be about 8° F. colder than the secondary refrigerant.

Because of the great flexibility of the refrigeration system provided by this invention, it is not necessary that the skating rink be rectangular or any other fixed shape. As shown in Fig. 1, outer ones of the siphon tubes may be bowed somewhat to provide graceful curved ends for the rink. Furthermore, the tubes may be bent in other ways to provide rinks of various shapes. Nor is it essential that the two rows of troughs be parallel and disposed along opposite sides of the rink, although this is an advantageous arrangement. For example, both rows of troughs could be placed along the same side of the ice surface, with bent siphon tubes extending outward from one trough and back into another. A particular advantage of this invention is that the same basic components can be put together in various ways to make skating rinks of various sizes and shapes.

Fig. 4 is a more detailed view showing a preferred construction and enclosure of one of the wide, shallow troughs. A trough for containing secondary refrigerant 52 may consist of a sheet-metal liner 53 surrounded by heat insulation 54. An aluminum siphon tube 55 extending under the ice sheet 56 has an inverted U-shaped end portion that straddles the inner wall of the trough, as shown. A strip of electrical insulation 57 covers the edge of the trough and prevents contact between the aluminum siphon tube and the metal trough liner 53 for reducing electrolytic action that might damage the siphon tube and the metal trough liner. The open end of siphon tube 55 is submerged below the liquid level of secondary refrigerant 52. Secondary refrigerant flowing through the siphon

tube from another trough enters the bottom portion of the trough illustrated as is indicated by arrows **58**.

For cooling the secondary refrigerant, a serpentine tube **59** containing primary refrigerant **60** is submerged in the secondary refrigerant contained within the trough illustrated. To provide good circulation of the secondary refrigerant around and between coils of the serpentine tube **59**, tube **59** is supported above the bottom of the trough by transverse bars **61**, and layers of the serpentine tube **59** are separated from one another by transverse metal bars **62**. These bars provide transverse passages that promote the circulation of the secondary refrigerant around and through the coils of tube **59**. As is indicated by the arrows, refrigerant flowing out of the end of siphon tube **55** tends to flow through these transverse passages around and through the coil containing the primary refrigerant, so that efficient heat transfer between the primary and secondary refrigerants is provided. Furthermore, metal bars **61** and **62** are cooled by direct contact with tube **59** and provide additional heat transfer surfaces for cooling the secondary refrigerant.

The top of the trough is substantially closed by a cover of heat-insulating material **63** containing cut-out slots that provide openings through which the siphon tubes can enter the trough. Other openings in the cover, not shown, are provided for the ends of serpentine tube **59** to enter the trough. Since all of the tubes enter the troughs from above, there are no openings into the troughs below the liquid level, and there is no problem of leaks where pipes enter the refrigerant-containing troughs.

It is desirable that the troughs and the pipes and tubes entering the troughs be hidden from view and be protected from accidental or intentional tampering. For this purpose, an enclosure can be built around the trough. This enclosure may consist of side walls **64** and **65** and a cover **66**. It can be made of wood or any other building material. If desired, the enclosure for the wide, shallow troughs can be made bench-high and can serve as a bench along one side of the skating rink. Alternatively, the enclosure may be higher and can serve as part of a rail or wall around the rink.

The wide, narrow troughs on the other side of the rink may be constructed in a similar manner, except that they may be higher and narrower and may not contain the serpentine tube **59**. The enclosure for the narrow, deep troughs may form a high railing or wall along that side of the rink. Although the coil containing primary refrigerant is not required within the deep, narrow troughs, such coils may be provided for extra cooling to freeze the ice faster during initial freezing period, or to take care of any other situation where exceptionally large cooling rates are required. The disadvantages of cooling by means of cooling coils within troughs **3** and **4** is that it may cause temperature differences between the refrigerant flowing through different siphons.

Fig. 5 is a cross section illustrating a preferred form of the siphon tubes. As shown in Fig. 5, the siphon tubes for conveying secondary refrigerant across the ice floor may be aluminum tubes having fins **67** and **68** extending out from each side of the main body **69** of the tube. The secondary refrigerant **70** flows through a hollow central portion of the tube. This type of tube has a relatively large surface, and thereby provides efficient heat transfer between the secondary refrigerant and the ice.

It should be understood that this invention in its broader aspects is not limited to specific embodiments herein illustrated and described, and that the following claims are intended to cover all changes and modifications that do not depart from the true spirit and scope of the invention.

What is claimed is:

1. An ice-skating rink comprising a floor, a plurality of tubes adjacent to said floor, two troughs each adapted to contain a liquid, each of said tubes having two ends extending into respective ones of said troughs from above the liquid level down into the liquid and forming a siphon for transferring liquid from one trough to the other, means for pumping said liquid from one to the other of said troughs, and means for cooling said liquid.

2. An ice-skating rink comprising a floor, two troughs on opposite sides of said floor each adapted to contain a liquid refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite ends extending into respective ones of said troughs from above the liquid level downward into the liquid refrigerant and forming a siphon for transferring liquid refrigerant from one trough to the other, and means for pumping said liquid refrigerant from one to the other of said troughs for maintaining a circulation of said liquid refrigerant through said tubes.

3. An ice-skating rink comprising a floor, two troughs on opposite sides of said floor each adapted to contain a liquid refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite ends extending into respective ones of said troughs from above the liquid level downward into the liquid refrigerant and forming a siphon for transferring liquid refrigerant from one trough to the other, a pipe extending across said floor from one trough to the other, a pump operable to pump said liquid refrigerant through said pipe for maintaining a circulation of said liquid refrigerant through said pipe and said tubes, and means for cooling said liquid refrigerant.

4. An ice-skating rink comprising a floor, a relatively wide, shallow trough and a relatively narrow, deep trough each adapted to contain a liquid refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite open ends extending into respective ones of said troughs from above the liquid level down into the liquid refrigerant and forming a siphon for transferring the liquid refrigerant from said narrow trough to said wide trough, means for pumping said liquid refrigerant from said wide trough to said narrow trough for maintaining a circulation of said liquid refrigerant through said tubes, and means for cooling said liquid refrigerant.

5. An ice-skating rink comprising a floor, a relatively wide trough and a relatively narrow trough disposed on opposite sides of said floor and each adapted to contain a liquid refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite ends extending into respective ones of said troughs from above the liquid level downward into the liquid refrigerant and forming a siphon for transferring the liquid refrigerant from said narrow trough to said wide trough, a pipe extending across said floor between said troughs, a pump within said wide trough, said pump having an inlet submerged below the liquid level within said wide trough and having an outlet connected to said pipe so that operation of the pump maintains a circulation of said liquid refrigerant through said pipe and said tubes, said pipe having a discharge orifice above the liquid level within said narrow trough for discharging a stream of liquid refrigerant into and lengthwise of the narrow trough, and means for cooling said liquid refrigerant.

6. An ice-skating rink comprising a floor, two troughs disposed on opposite sides of said floor each adapted to contain a liquid refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite ends extending into respective ones of said troughs from above the liquid level downward into the liquid refrigerant and forming a siphon for transferring liquid refrigerant from one trough to the other, two pipes extending across said floor from one to the other of said troughs, a pump having an inlet submerged below the liquid level within a first one of said troughs and having an outlet connected to said two pipes in parallel so that operation of the pump

maintains a circulation of said liquid refrigerant through said pipes and said tubes, each of said pipes having a discharge orifice above the liquid level within the second one of said troughs for discharging a stream of said liquid refrigerant into and lengthwise of said second trough, one of said streams providing a substantially uniform supply of said liquid refrigerant along one lengthwise half of said second trough and the other of said streams providing a substantially uniform supply of said liquid refrigerant along the other lengthwise half of said second trough.

7. An ice-skating rink comprising a floor, two troughs each containing a liquid secondary refrigerant, a plurality of tubes extending about said floor from one to the other of said troughs, each of said tubes having two opposite open ends extending into respective ones of said troughs from above the liquid level downward into the liquid secondary refrigerant and forming a siphon for transferring liquid secondary refrigerant from one trough to the other, means for pumping said liquid secondary refrigerant from one of the other of said troughs for maintaining a circulation of said refrigerant through said tubes, a tube submerged in said secondary refrigerant in one of said troughs, a primary refrigerant, and means for circulating said primary refrigerant through said last-mentioned tube for cooling said secondary refrigerant.

8. An ice-skating rink comprising an ice floor, a relatively wide trough and a relatively narrow trough disposed on opposite sides of said floor, each of said troughs being adapted to contain a liquid secondary refrigerant, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite ends extending into respective ones of said troughs from above the liquid level downward into the liquid secondary refrigerant and forming a siphon by conveying secondary refrigerant from said narrow trough to said wide trough, means for pumping said secondary refrigerant from said wide trough to said narrow trough for maintaining a circulation of said secondary refrigerant through said tubes, a tube immersed in said secondary refrigerant within said wide trough, a primary refrigerant, and means for circulating said primary refrigerant through said last-mentioned tube for cooling said secondary refrigerant.

9. An ice-skating rink comprising two troughs each adapted to contain a liquid, an ice floor, a plurality of tubes extending across said floor from one to the other of said troughs, each of said tubes having opposite end portions bent substantially to an inverted U-shape with the two ends of each tube extending downward into respective ones of said troughs forming a plurality of siphons for conveying said liquid from one trough to the other, said inverted U-shaped portions straddling side portions of said troughs that extend upward above the level of said ice floor, means for pumping said liquid from one to the other of said troughs, and means for cooling said liquid.

10. An ice-skating rink comprising a floor supporting an ice sheet, a row of relatively wide, shallow troughs disposed end-to-end along one side of said ice sheet, a row of relatively narrow, deep troughs disposed end-to-end along the other side of said ice sheet, each of said troughs having sides extending above the surface of said ice sheet, each of said troughs containing a liquid secondary refrigerant, a plurality of siphon tubes extending across said floor underneath said ice sheet between said two rows of troughs, each of said siphon tubes having an inverted U-shaped end portion that straddles a side of a wide trough and having an inverted U-shaped opposite end portion that straddles a side of the opposite narrow trough, the ends of said siphon tubes extending downward into the liquid secondary refrigerant within said troughs to form a plurality of siphons for conveying seconadry refrigerant from the narrow troughs to the wide troughs, means for pumping said secondary refrigerant from said wide trough to said narrow troughs for maintaining a flow of said secondary refrigerant through said siphon tubes, a plurality of serpentine tubes immersed in the secondary refrigerant within respective ones of said wide troughs, and means for circulating a primary refrigerant through said serpentine tubes for cooling said secondary refrigerant.

11. An ice-skating rink comprising a floor, a plurality of tubes overlying said floor in spaced relation to each other, troughs on opposite sides of said floor each adapted to contain liquid the level of which is above said floor, each of the said tubes having two ends extending into respective ones of said troughs from above the liquid level down into the liquid to form a syphon for the transferring of liquid from one trough to another, means for pumping said liquid from one to the other of said troughs, and means for cooling said liquid.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,878,652 March 24, 1959

David M. Comb

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 17, for "ring" read -- rink --; column 2, line 43, for "descirbed" read -- described --; column 6, line 1, for "siphons" read -- siphon --; column 9, line 20, for "from one of the other" read -- from one to the other --; column 10, line 23, for "seconadry" read -- secondary --; line 25, for "trough", read -- troughs --.

Signed and sealed this 29th day of September 1959.

(SEAL)

Attest:

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