United States Patent

MacCracken

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[45] **Jan. 25, 1972**

[54] APPARATUS FOR PREPARING AND MAINTAINING ICE SKATING RINKS

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[22] Filed: **Dec. 2, 1969**

[21] Appl. No.: **881,474**

Related U.S. Application Data

[60] Division of Ser. No. 786,603, Dec. 24, 1968, Pat. No. 3,495,415, which is a continuation-in-part of Ser. No. 561,308, June 9, 1966, abandoned.

[52] **U.S. Cl.** **62/235,** 62/261

[51] **Int. Cl.** **A63c 19/10**

[58] **Field of Search** 62/235, 74, 66, 261

[56] **References Cited**

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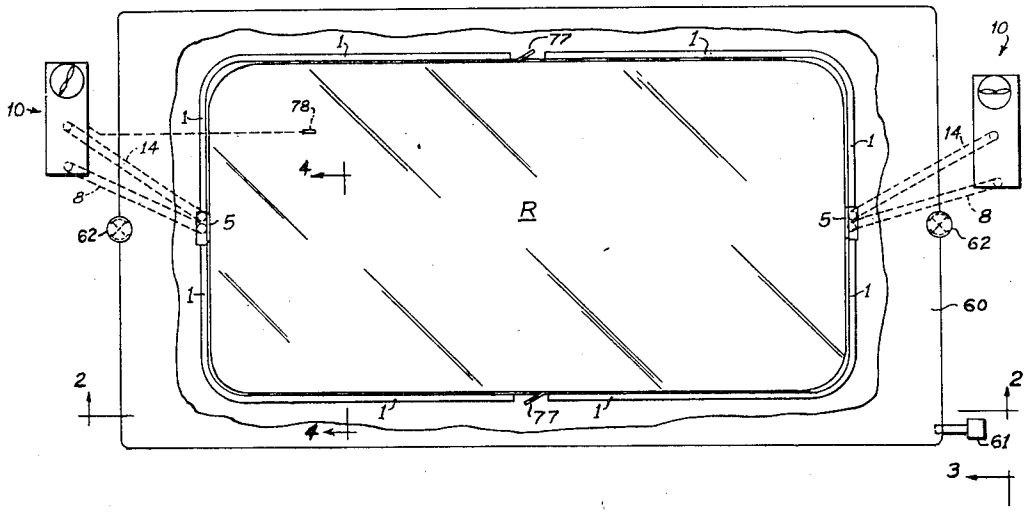
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[57] **ABSTRACT**

An apparatus for preparing and maintaining ice skating rinks in which air is refrigerated to a temperature in the range below 10° F. and preferably below 5° F. and above a lower limit of approximately 0° F. and is supplied at a low velocity from multiple outlets spaced around the major portion of the periphery of the skating area at a level closely adjacent to the surface of the ice to create an abruptly stratified blanket of cold air in contact with the ice. The velocity of the refrigerated air discharged from these outlets onto the ice is held to a low level which in one successful embodiment is about 5.0 feet per second to avoid the entrainment of ambient air from above, and the return air is drawn from a level below 8 inches and preferably below 6 inches above the surface of the built-up ice, so as to be withdrawn from the blanket mass thus maintaining an abruptly stratified blanket of cold air of low-moisture content in contact with the ice. It is not necessary to shave the ice to keep it less than 1 to 1½ inches thick, as is required in conventional rinks using subfloor piping grid refrigerating systems, and in fact the ice is allowed to build up to a thickness of at least 3 inches and preferably in the range from 3 to 8 inches thick. Conveniently portable modular dasher boards are interconnected to form the rink and layout the supply ducts and grilles for the refrigerated air. A special air-refrigerating coil and moisture-removing arrangement is disclosed, and an air-supported enclosure may be used to house the rink.

10 Claims, 8 Drawing Figures



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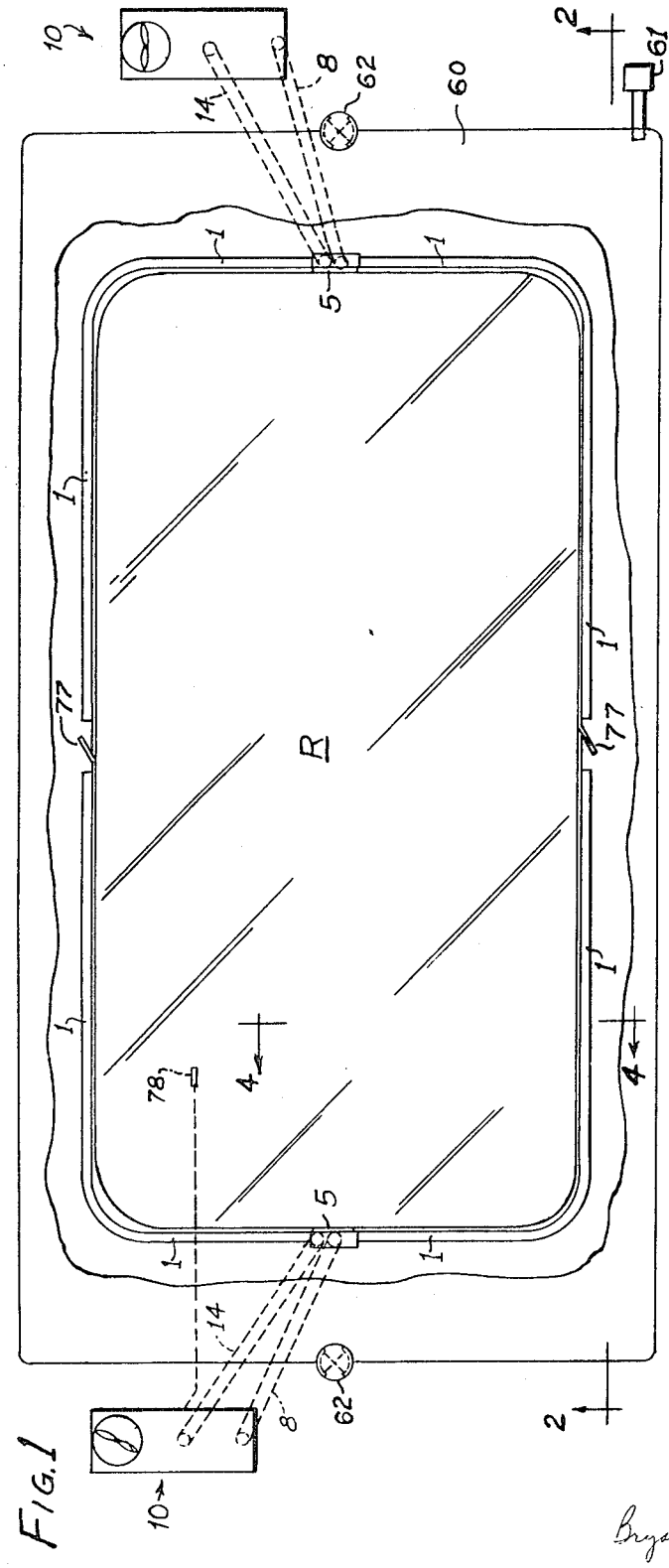


FIG. 1

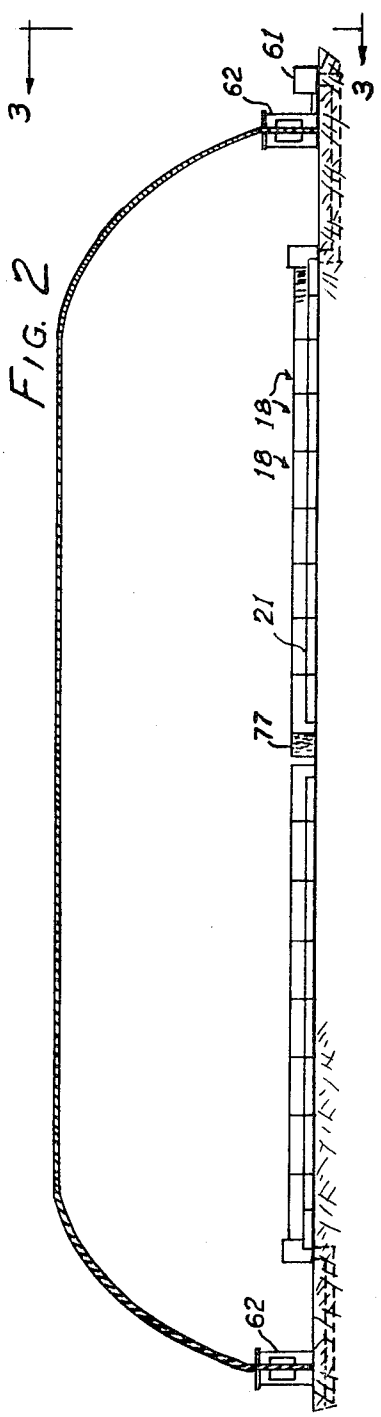


FIG. 2

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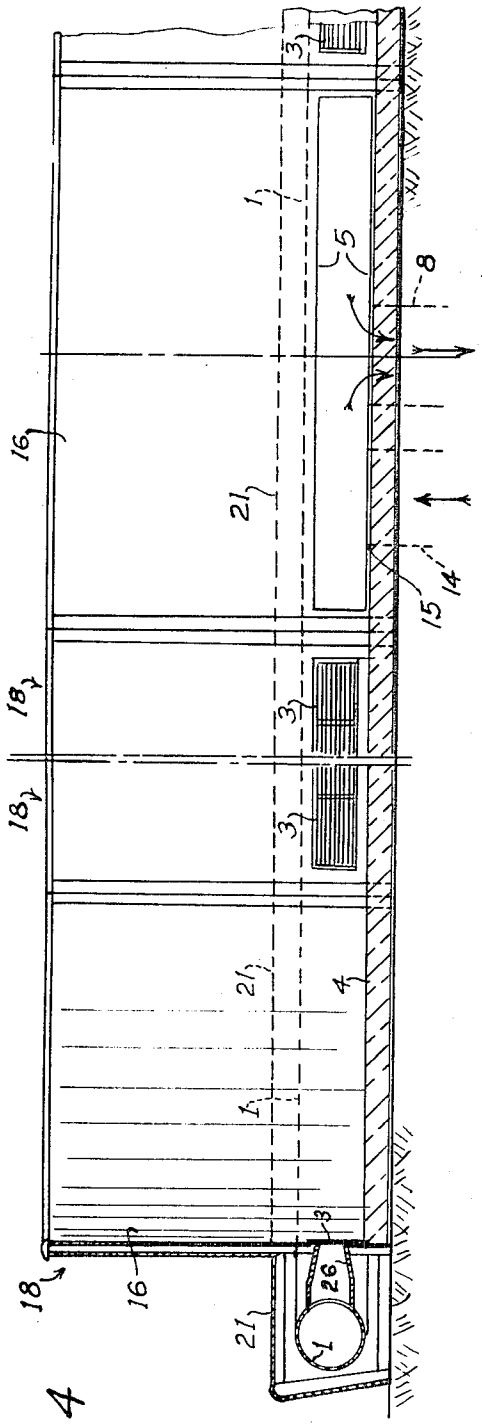


FIG. 4

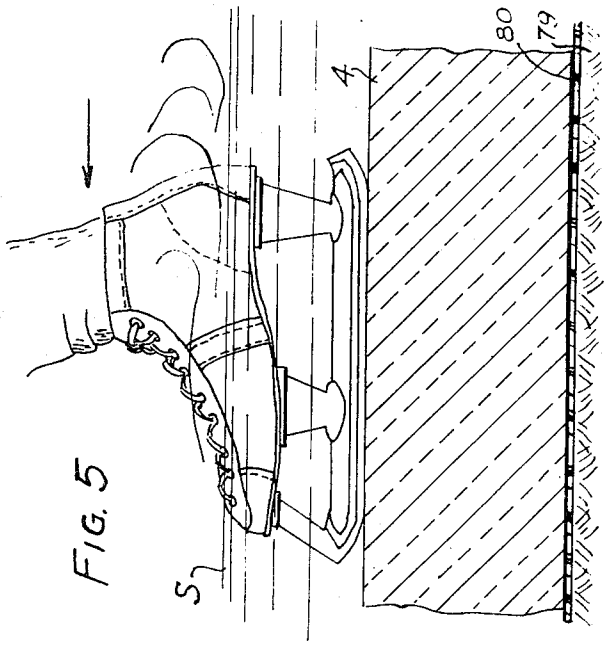


FIG. 5

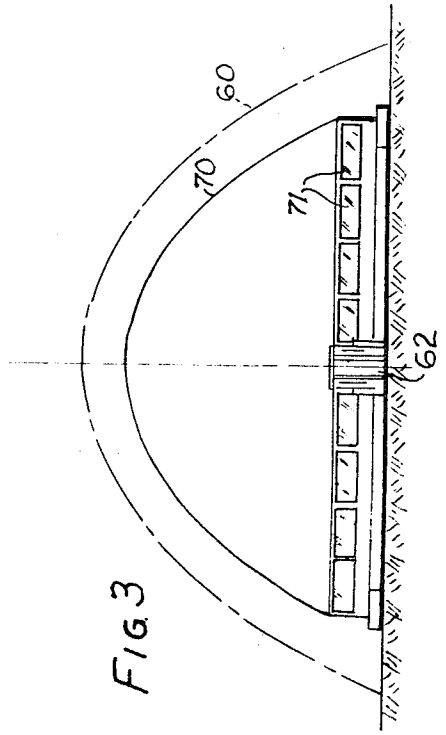


FIG. 3

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FIG. 7

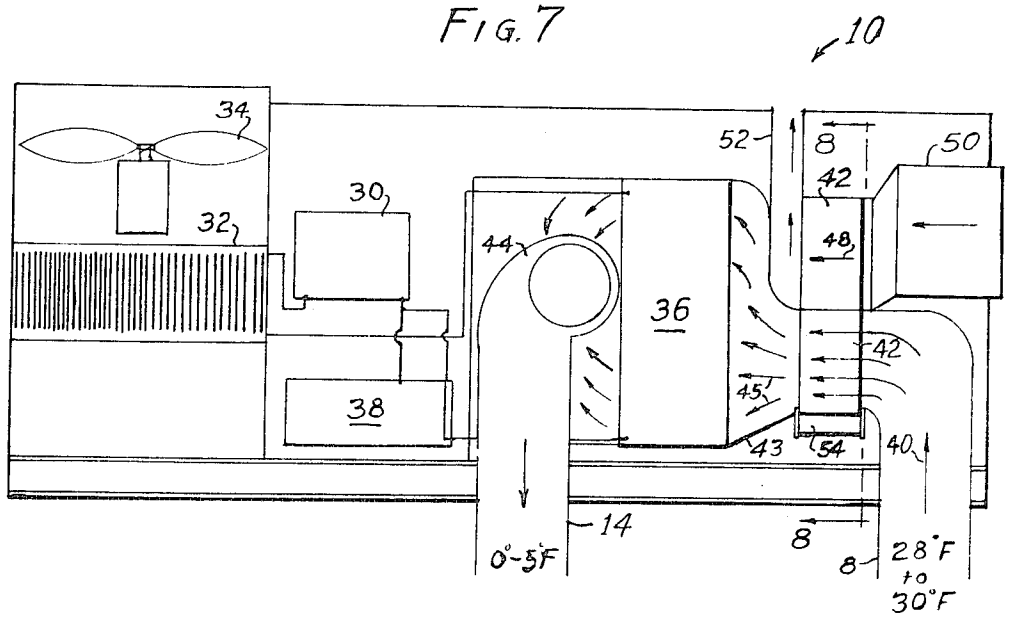


FIG. 6

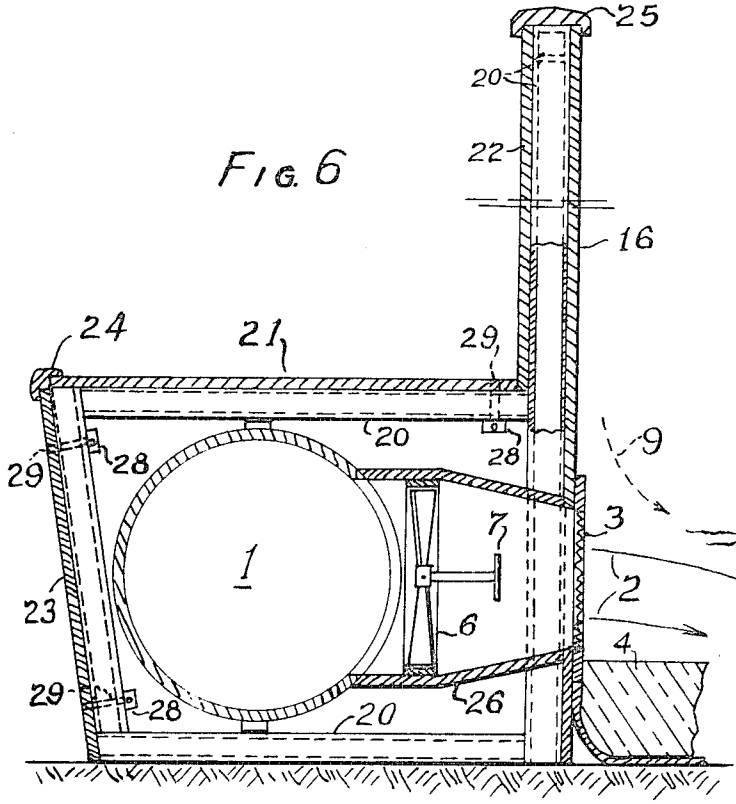
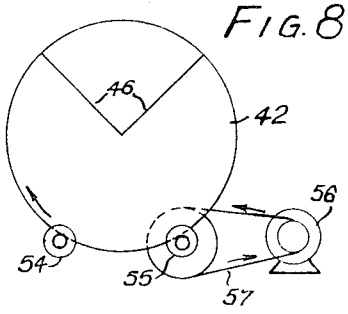


FIG. 8



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APPARATUS FOR PREPARING AND MAINTAINING ICE SKATING RINKS

This application is a division of application Ser. No. 786,603, filed Dec. 24, 1968, now U.S. Pat. No. 3,495,425, which in turn is a continuation-in-part of Ser. No. 561,308 filed June 9, 1966, now abandoned.

The invention relates to an apparatus for preparing and maintaining ice skating rinks.

It is usual in the construction of ice skating rinks to make the ice for the skating surface by a method which entails laying down a grid of piping which forms the cooling part of a conventional refrigerating system. The rink will ordinarily be housed in an arena type of building. This is virtually the whole story of the ice skating rink construction from the beginning. Such rinks have been so expensive that their use have been largely confined to large urban centers where they are used for professional hockey games or to parks in outlying areas where the costs can be defrayed by public funds or by private funds amortized through admission fees. Elsewhere the cost of constructing and maintaining ice skating rinks has, for the most part precluded their use by smaller municipalities or by schools and colleges with of course some exceptions where endowments of the institutions are sufficiently great.

Basically the principal cost burdens are those of building the sheltering arena and of providing the refrigeration plant with its extensive system of piping spreading under the entire skating area. In addition, it is necessary to use expensive shaving equipment periodically to shave the ice to make sure that the ice remains thin, usually 1 to 1½ inches thick, because the refrigeration occurs from the system of piping under the skating area. Thus, the layer of ice must be kept thin to facilitate heat transmission from the surface down through the ice to the grid of pipes in the floor.

SUMMARY

I have found a way of freezing and maintaining a skating surface without using such an expensive piping system, within a weatherbreak structure. Such weatherbreak may be only a flexible enclosure supported by pressurized air. If desired, a permanent structure may be used to house the skating area, while employing the present invention to advantage. In colder climates nature has known how to make a skating rink of a pond or lake or river for perhaps a few good days in the average winter through the ordinary freezing action of the ambient atmosphere.

The prior art has suggested that an ice skating rink can be maintained by insulating a building with insulation several inches in thickness and by refrigerating the entire interior of the building. Such a refrigerated building system is impractical because it requires a tremendous amount of refrigeration capacity, being an attempt essentially to duplicate cold weather indoors during warmer weather outdoors. Also, this refrigerated building system would be most uncomfortable to spectators and also uncomfortable to skaters because of the cold air throughout the building. In contrast to this prior art, the illustrative embodiment of the invention utilizes an uninsulated air-supported enclosure which is only about one-eighth of an inch thick. The present invention does not require an insulated building, and the temperature of the air throughout the enclosure generally is at a comfortable level above the ice temperature. It has been an object of my invention to discover the means of freezing a skating surface without the use of ice piping and in a manner to permit making and holding skating ice during the major portion of the winter in temperate climbs when temperatures of the ambient atmosphere may rise to as much as 50° F. or higher.

I have found it possible to accomplish these aims with a method that comprises the steps of

a. directing a controlled slow flow of refrigerated air over a predetermined area to reduce the temperature of the area below freezing,

b. applying water over said frozen area and freezing it,

c. directing controlled slow flow of refrigerated air over the surface of said area covered with ice, said refrigerated air being at a temperature in the range from 0° to 10° F. and substantially denser than the ambient air and being caused to flow at low velocity, less than 9.0 feet per second and preferably about 5.0 feet per second from outlets adjacent to the ice, said refrigerated air flowing slowly along the surface of the ice to form an abruptly defined stratified mass of cold air in contact with the ice,

d. withdrawing air from said stratified mass at a level closely adjacent to the surface of the ice,

e. confining the stratified cold air blanket within approximately the limits of said area which is to form the skating rink while shielding the stratified mass against disturbance by wind,

f. withdrawing moisture from said withdrawn air, and

g. refrigerating the air withdrawn from over the ice down to a temperature in the range below 10° F. for recirculation in freshly cooled controlled flow to blanket the ice in a stratified mass of cold air which is replenished.

When this method is followed, what happens is that the skating surface is frozen and maintained in its frozen state by the abruptly stratified blanket of cold air which, because it is relatively dry, produces added cooling by evaporation from the surface of the water or ice, as the case may be.

It was at first thought that such a method could not work, having regard especially to the fact that when large groups of skaters proceed around the rink in the same direction, their bodies must drag behind them a considerable mass of air which could disturb the stratified mass of replenished refrigerated air relied on for cooling and evaporation. It was also thought that the problem would be made worse by the stirring action of the feet and skates of the skaters. To any extent that the skates may break up the mass of stratified air, it becomes immediately replaced by the slow flow of dense, dry, refrigerated air. Thus, it has been found that by following the particular combination of steps outlined above, it is quite feasible to hold the ice by the confined abruptly stratified blanket of stratified cold air even when the temperature of the ambient air goes as high as 50° F. or more.

In its apparatus aspects my invention, first of all, comprises means for performing each of the steps outlined above. More particularly, the means for directing the controlled low-velocity flow of refrigerated air comprises discharge ducts extending along substantially the entire perimeter of the rink and arranged to discharge the refrigerated air laterally from the ducts immediately adjacent to the ice surface to create an abruptly stratified blanket of refrigerated cold air of low-moisture content lying upon the ice. The controlled flow of the refrigerated air used to replenish the stratified blanket occurs at low velocity so as to avoid the entrainment of any significant amount of warmer ambient air from above. I have found in practice that the method works to advantage when the discharge velocity at the outlets is below 9.0 feet per second. The return ducts extend immediately adjacent to the ice surface along limited portions of the rink's perimeter and the refrigerating means is connected to the discharge and return ducts. The stratified blanket of cold air is contained against outflow by means of a peripheral wall extending around the stratum of refrigerated air.

According to another aspect of my invention the enclosure may be uninsulated, such as one supported by pressurized air, to provide an effective protection against disturbance by wind of the stratified cold air blanket.

According to yet another aspect of my invention the supply ducts for the refrigerated air are located in dasher board modular units which are conveniently fastened together to form the perimeter of the ice skating rink.

Other features and advantages of the invention will appear in the description which follows:

FIG. 1 is a plan view of an ice skating rink constructed according to my invention;

FIG. 2 is a side elevational sectional view of the same taken on line 2—2 of FIG. 1;

FIG. 3 is an end elevational view of the same taken as indicated at 3—3 in FIG. 2, but showing a modified enclosure extending to the top of the dasher boards;

FIG. 4 is an enlarged elevational sectional view taken along the line 4—4 in FIG. 1, showing the dasher boards, refrigerated supply grilles and the return grille at one end of the rink;

FIG. 5 is an enlarged detail cross section of the thick ice layer on the ground with the stratified mass of refrigerated air resting on the ice;

FIG. 6 is a cross-sectional view, shown on enlarged scale, of one of the modular dasher board units containing an adjustable flow supply grille;

FIG. 7 is a side elevational view and schematic circuit diagram of one of the two air-drying and refrigeration units; and

FIG. 8 is a cross-sectional view taken at 8—8 in FIG. 7 and showing the revolving air-drying mechanism.

As shown in FIG. 1 my apparatus for preparing and maintaining ice skating rink R comprises a pair of systems of refrigerated air supply ducts 1 extending around substantially the entire perimeter of the rink for directing controlled low-velocity flow 2 (FIG. 6) of low-temperature refrigerated air over the surface of an area covered with water or ice. In each duct system the return grille is located at the center of one end of the rink, and the supply ducts for the refrigerated air are arranged in a U-shaped pattern extending across the end and along both sides toward the midpoints. This pair of systems of ducts 1 is formed by interconnecting modular dasher board unit around the perimeter of rink R, as will be explained in detail further below, each containing the apertures of grilles 3, FIG. 6, for causing such low-temperature air to stay directly upon and along the surface of the ice to form an abruptly stratified mass S of cold air in contact with the ice.

The temperature of the refrigerated air is low, being in the range below 10° and preferably below 5° F. and above a lower limit of approximately 0° F., as will be explained, so as to be a distinctly denser fluid than the ambient air. Also, the refrigerated air is delivered from multiple outlets extending along a substantial portion of the perimeter of the ice rink for replenishing the abruptly stratified mass S with a low-velocity flow of dry cold air. I have found out that the abrupt or sharply defined forced stratification principle utilized in this invention is vital to the working of the skating rink in practice. The rate of freezing of the ice depends mostly upon the differential in temperature between the ice 4 (FIG. 5) and the air in the abruptly stratified blanket S. Thus, I have found that the temperature of refrigerated air 2 issuing from the supply grilles 3 (FIGS. 4 and 6) should be in the range blow 10° and preferably below 5° F. and above a lower limit of approximately 0° F., and that this particular range is critical in order to obtain a sufficiently fast freezing rate for practical operation of a rink in spite of loads caused by crowds, sunshine on the enclosure, or warm ambient air. Thus, the refrigerated air temperature is at least 20° F. below the temperature of the ice slab.

The reason why approximately 0° F. is specified as a lower temperature limit is that in practice attempts to use lower temperatures are frustrated by unpleasant fogging conditions occurring near the interface between the warm moist ambient air above and the sharply defined stratified blanket S. By drying the refrigerated air so that it has substantially less than 100 percent relative humidity, it is possible to reduce the temperature a few degrees below 0° F. without causing undue fogging.

It is vital that the low-velocity supply of refrigerated air 2 be stratified and remain in contact with the ice surface. I have found that the upper limit of 10° F. is the maximum temperature at which a sharply defined and reliable stratification occurs in spite of the presence of a team of hockey players on the ice. The reasons why I prefer to hold the outlet supply temperature of the low-velocity refrigerated air 2 at a temperature of 5° F. or slightly less, as it begins to move across the ice, is that the stratification is even more pronounced, producing a thinner blanket S which is more sharply defined and more stable and more efficient in freezing the ice.

As a further critical factor in producing the stratified blanket S in a practical system, it is important to take the air into the return grille 5 (FIG. 4) at a very low level using a grille opening having a low height, extending no more than 8 inches above the ice surface and preferably 6 inches or less. The reason why the location level and overall height of the return grille is critical will now be explained.

I have attempted to use a return grille having an opening extending up to a level of 16 inches above the ice surface. I have found that the temperature of the air entering this 16-inch-high return grille varied by a differential of as much as 26° F. from its bottom to its top. When I reduced the overall height of this return grille to 8 inches, then I found that the temperature variation from bottom to top was cut down to 8° F. In addition, the average temperature of the return air entering the 8-inch return grille was 7° F. less than the average temperature of the return air entering the 16-inch return grille. This reduction in return air temperature has the feedback effect of reducing the temperature of the supply air in the ducts 1 by this amount, or usually more, thus making the whole effect cumulative in establishing and maintaining the stratified blanket S. The reason why the temperature of the air in the supply ducts is usually reduced by more than the amount of reduction in the return temperature is that the amount of moisture is reduced, thus reducing the amount of latent heat.

That is, a further important factor with respect to the level and height of the return grille is that taking colder air into the return grille reduces the absolute amount of moisture which must be removed, thereby reducing the amount of latent heat to be withdrawn, and hence allowing the freezing capacity to be utilized for reducing sensible heat. In the illustrative preferred embodiment an air drier is used, and by following this specification about the location and height of the return opening 5, the air drier becomes even more effective.

When the method and apparatus are put into practice in accordance with the present invention, it will be found that the average temperature of the air entering the two return grilles 5 is 28° to 30° F. and the temperature of the refrigerated air issuing from the supply grilles 3 is in the preferred range from 0° to 5° F.

For controlling the low-velocity flow 2 and for providing uniform distribution, there are adjustable multibladed dampers 6 having control handles 7 located for access behind each of the supply grilles 3. The reason for maintaining the velocity of the refrigerated supply air 2 low to avoid undue entrainment of the warmer air which lies above the stratified blanket S. This low velocity is to prevent undue ambient air entrainment as indicated by the dotted arrow 9. The specific velocity at which undue entrainment occurs may vary, depending upon overall rink size, ambient air temperature and usage of the rink. However, I have found that holding velocity below about 9.0 feet per second is an advantageous criterion for typical installations. I have found that an objectionable amount of air entrainment 9 occurs when the velocity of the flow 2 is above this value. It is preferable to be at about 5.0 feet per second.

When the refrigerated air is at a temperature, for example of 3° F. (approximately 463° F. above absolute zero), and the ambient air is at a temperature, for example at 40° F. (approximately 500° F. above absolute zero), then the low-temperature refrigerated air is a fluid having a density 8.0 percent greater than the ambient air (neglecting humidity). When the ambient air is at 50° F., the difference in density is 10.2 percent, thus further aiding in maintaining the stratified blanket (neglecting humidity).

The return openings 5 are located at the center of each end of the rink area R at a level down adjacent to the built-up ice surface, and they have an overall height of no more than 8 inches and preferably no more than 6 inches. The openings 5 are connected to return ducts 8 extending down beneath the floor and out to a pair of air refrigeration units (FIG. 7) outside of the enclosure 12. The aspects of the refrigeration units 10 and of the enclosure 12 will be explained in detail further below.

In an installation for a full-size hockey rink R, which measures 85 feet wide by approximately 200 feet long, the return openings 5 are each 90 inches long, and the return duct 8 has a diameter of 20 inches. The two units 10 in this preferred embodiment serve to dry and refrigerate the air down to a temperature in the range below 5° to about 0° F. and feed this air back through the respective supply mains 14, each of which has a diameter of 18 inches. These supply mains 14 are each connected through a tee connection at 15 (FIG. 4) to the respective systems of supply ducts 1 each extending in a U-shaped pattern around the major portion of the perimeter of one-half of the rink area R.

The apparatus further includes means for confining the stratified cold airmass S within approximately the limits of the surface which is to form the skating rink area R. In the embodiment illustrated, such confining means consists of a peripheral wall 16, FIGS. 1, 4 and 6, extending around the perimeter of the rink and upwardly for at least a few feet above the stratum of refrigerated air. This peripheral wall as shown also serves as the "hockey" or "dasher" boards of a rink to be used in hockey playing. Advantageously, these boards 16 are formed by interconnecting a series of portable, modular, dasher board units 18, the structure of which is most clearly seen in FIGS. 4 and 6.

Each unit 18 is 8 feet long and 4 feet high and has a frame 20 of welded square aluminum tubing to which marine grade plywood panels are bolted to form respectively the wall 16, a seat 21, a seat back 22, and a forwardly inclined riser panel 23 extending up from the floor to the edge of the seat. A molding strip 24 joins the rinser to seat, and a rubber capping strip 25 runs along the top of each modular unit 18.

In the space beneath the seat 21 there is a section of the duct 1 formed of glass fiber insulation material having an aluminum foil skin and an inside diameter of 12 inches with polyurethane gaskets at the end for making an airtight butt joint when the units 18 are connected end to end, as shown in FIG. 4. A lateral connection 26 joins the duct section 1 with the supply outlet opening 3. There is such a supply opening 3 in each of the dasher board units 18, and these openings have substantially the same height as the return openings. In this installation these openings measure 30 inches long and 6 inches high, while the two return openings 5 each measure 90 inches by 6 inches.

The individual dasher board units 18 are fastened together by quarter turn latches 28 which hook together, each having an access hole 29 for insertion of a tool to turn the latch. A rigid wall structure surrounding the rink R is effectuated to resist the impact of hockey players, because the width of the seat 21 forms an effective stiffening beam after the units 18 have been fastened together.

The refrigeration units 10 each include one or more compressors 30 and heat dissipation coil 32 through which the compressed refrigerant is to be cooled and condensed by outdoor air drawn by a fan 34.

There is a special air-cooling coil evaporator unit 36 in which the refrigerant is expanded as it returns to a compressor 30 with a receiver 38. The returning air 40 in the return duct 8 passes through a revolving dessicant drier wheel 42 and then is led by a plenum chamber 43 through the cooling coil 36 and is blown through the supply main 14 by means of a blower 44.

The cooling coil 36 is special in that it contains 17 rows of coils, i.e., it is 17 rows deep as measured in the direction of flow of the dry air 45 passing therethrough. It is possible to use fewer rows of coils, but I have found that a depth of 12 rows is only marginal to do the job for colling the air down to a temperature below 5° F. Each refrigeration unit 10 has a capacity to provide 7,500 cubic feet per minute (c.f.m.) of air at a temperature below 5°, and usually at 0° F. in the main line 14, when the returning air 40 has a temperature of 20° to 30° F., making a total of 15,000 c.f.m. from the two units 10. In most full-size rink installations it is advisable to use more than 12 rows of coils in the air cooler 36.

In a typical rink R the width is 85 feet and the length is 185 to 200 feet with rounded corners, thus providing an ice surface area of about 15,000 square feet. In actual practice using smoke bomb test devices I have found that the stratified blanket S (FIG. 6) is sharply defined having a top surface which occurs at the level of the top of the supply outlet openings 3, namely being about 6 inches thick, when the ice has built up as shown in FIG. 6. Thus, the combined capacity of the two refrigerating units 10 is sufficient to supply 1 cubic foot of refrigerated air per minute at a temperature below 5° F. for each square foot of ice surface. In view of the fact that the blanket S is about 6 inches thick when the ice has built up, this means that there is capacity to replenish the entire blanket every 30 seconds.

It is noted that the top of the sharply defined stratification blanket S occurs at the level of the top of the supply and return openings 3 and 5. Thus, before the ice 4 has built up the blanket S is correspondingly thicker.

As discussed above, the supply outlet openings measure 30 inches by 6 inches, providing 1.25 square feet of flow area. There are 48 of these openings spaced around a typical rink R, making a total supply flow area of 60 square feet. At a flow rate indicated at 2 (FIG. 6) of 4.17 feet per second (about 5) there are 250 cubic feet of air per second flowing through the openings 3. This amounts to 15,000 c.f.m. as discussed above, which is sufficient to replenish the entire blanket every 30 seconds.

In order to dry the returning air 40, the revolving drier wheel 42 has a honeycomb structure containing a dessicant drier which can be reactivated with hot air, and three-quarters of its volume is continuously being exposed to conduct the airflow 40. This dessicant wheel absorbs moisture from the air so that contains less than 10 grains of moisture per pound of dry air. The remaining quarter of the volume of the wheel 42, as indicated by the radial lines 46 is continuously being reactivated by a reactivating flow of hot air 48. This hot air 48 is heated in a gas furnace 50 and is blown out through a passage 52 carrying the removed moisture. The rim of the wheel 42 is supported on rollers 54 and 55, and an electric motor 56 drives the roller 55 through a belt drive 57. This type of dessicant drier can be obtained commercially from Cargocaire Engineering Company of Amesbury, Mass.

The rink is shown housed in a flexible enclosure 60 made of a suitable fabric such as glass fiber reinforced vinyl plastic that is substantially impervious to air and which is supported by pressurized air, provided by a blower 61, FIG. 1, to maintain a slightly higher pressure within the enclosure than without. Suitable means of access, such as provided by the revolving doors 62, make it possible to maintain the higher inside pressure which will hold the enclosure in its inflated state. Enclosure 60 is provided along its edges with anchoring means to make a seal with the ground. Alternatively, enclosure 60 can be replaced with a smaller enclosure 70, FIG. 3, secured directly to the peripheral wall 16 or to a frame forming an upward extension of such wall and provided with glassed-in viewing areas as at 71.

The enclosure 60 or 70 provides an effective windbreak against disturbances of the stratified airmass S within the confining and shielding peripheral wall 16. Efficacy of the confining and shielding wall 16 is further assured by the use of entry doors 77, so that the shield will be continuous.

Finally, such doors have sills which are located substantially above the level of the stratified mass. I have found that 10 inches is a good height for the sills.

A great advantage of this invention is that it is fast and responsive because it puts the cooling action at the upper surface of the ice 4. Cooling power is saved because it is not necessary to keep the units 10 operating all night long. They are turned off when the last skaters leave at night. In the morning there may be a layer of water one-sixteenth to one-eighth inch on top of the ice 4. By turning on the units 10 2 hours before use, the response is quick and the layer of water is refrozen to a glossy hard surface ready for use. A thermostat

78, FIG. 1, may be buried in the ice to keep the ice temperature below 28° F., if desired.

Another advantage of my invention is that a rink can be formed directly on a bare piece of ground 79, i.e., without any floor or foundation. If desired a plastic sheet 80 can be laid down, but this is not necessary. The formation of the rink can begin with a level area of ground in which the earth is well compacted and smoothed.

Using a system having the capacity of 15,000 c.f.m. of air at a temperature below 5° F., as discussed above, it requires about 1 day initially to freeze the ground. The ice is built up by spraying water onto the frozen ground, requiring about 1 day to build up one-half inch of ice. As soon as the ice 4 has built up to 1-inch thickness in the thinnest area (the ground is probably not precisely level) then it is ready for skating.

Due to condensation, the ice continues to build up at a rate of about one-eighth of an inch per day of use. When it has built up to 3 inches or more, the mass of ice provides a "flywheel" effect so as to maintain a skatable surface in spite of large crowds, sunshine and warm temperature.

With the utilization of the construction described, and by following the particular steps I have outlined, it has been found possible to hold good skating ice on a rink of a size large enough to accommodate an ice hockey game, i.e., approximately 85 ft. by 185 ft., using two units 10 of 30 tons each of refrigeration under conditions where the rink is to be used when the temperature of the ambient air at midday rises for short periods to a temperature of as much as 55° to 60° F.

The terms and expressions which I have employed are used in a descriptive and not a limiting sense, and I have no intention of excluding equivalents of the invention described and claimed.

I claim:

1. Apparatus for supplying refrigerated air to create an abruptly stratified blanket of refrigerated air on an ice skating rink comprising a system of modular dasher board units, each of said dasher board units including latch means for detachably connecting them together in end-to-end relationship defining a peripheral wall for the skating rink, an upstanding wall adapted to face the rink area, said wall having a long low-air outlet opening near the bottom and having a height of no more than 8 inches, a grille covering said outlet opening, a bench facing away from the rink area, a large insulated air duct section extending longitudinally beneath the bench, a connection from said duct to said outlet opening, means for supplying refrigerated air to said duct section at a temperature below 10° F., and adjustable means for controlling the airflow out of said outlet opening.

2. Apparatus for an ice skating rink as claimed in claim 1, in which said bench facing away from said rink area is adjacent to said upstanding wall and said bench has a substantial horizontal width, one of said latch means being near said upstanding wall and another being near the front edge of said bench for providing an effective stiff beam to resist horizontal deflection of said upstanding wall under impact of hockey players against said peripheral wall when said modular dasher board units are latched together in end-to-end relationship.

3. Apparatus for an ice skating rink as claimed in claim 1, in which said insulated air duct section includes gasket means at the end adapted to make an airtight connection between the respective duct sections when said modular dasher board units are latched together in end-to-end relationship.

4. Apparatus for an ice skating rink as claimed in claim 1, in which each of said modular dasher board units is 8 feet long, with a pair of said modular dasher board units being located at each end of the skating rink and having a return opening for withdrawing air from the edge of said abruptly stratified blanket, said return openings having the same height as said outlet openings, and said return openings extending substantially the entire length of the respective modular dasher board unit containing said return openings.

5. Apparatus for an ice skating rink as claimed in claim 4 in which said modular dasher board units are arranged to define a pair of supply ducts each extending in a U-shaped pattern around a respective end of the skating rink with the legs of the respective U-shaped patterns extending part way along the side of the rink toward the midpoint of the side.

6. A modular dasher board unit for installation adjacent to the perimeter of an ice slab for cooperation with other similar units for providing an abruptly stratified blanket of refrigerated air resting upon the ice slab, said dasher board unit being 8 feet long and 4 feet high and including an upright wall on the side thereof to face the ice slab, a bench extending along the outside of said upright wall to face away from the ice slab, a plurality of disengageable latch means at each end of said modular unit for detachably connecting said unit in end-to-end relationship with similar units, one of said latch means being located near said wall, another of said latch means being located near the front edge of said bench, a large-diameter insulated air duct section positioned outside of said wall and beneath said bench and extending the length of said modular unit, said insulated air duct section being adapted to carry refrigerated air at a temperature below 10° F., said wall having an elongated outlet supply opening near the bottom thereof, a removable grille extending across said outlet opening, said duct section being connected to said outlet opening, damper means for controlling the flow of refrigerated air from said duct section through said outlet opening, a control handle for said damper means accessible through said outlet opening, said opening having a height of several inches, and the top of said opening being no higher than the top of a skater's shoe for creating an abruptly stratified blanket of refrigerated air resting upon said ice slab with the top of said blanket no higher than the top of a skater's shoe as seen by mixing the smoke from a smoke bomb with the refrigerated air in said duct section.

7. A system for creating and maintaining an abruptly stratified blanket of refrigerated air on an ice skating slab comprising a peripheral wall several feet high surrounding said slab, a bench extending along the lower portion of the exterior of said peripheral wall, an insulated air duct extending along beneath said bench, said duct being adapted to conduct refrigerated air at a temperature below 10° F., said peripheral wall having a multiplicity of elongated outlet supply openings each being connected to said insulated air duct, manually adjustable damper means for adjusting the airflow from said supply openings, each of said supply openings having a low height to create an abruptly stratified blanket of refrigerated air on said slab having an upper level below the top of a skater's shoe, said outlet supply openings being located at spaced points along both sides of said ice slab, a plurality of said openings being located at the ends of said slab, said peripheral wall having an elongated return opening at the center of each end, said return openings having substantially the same height as said supply openings for withdrawing air from said abruptly stratified blanket, and air refrigeration and blower means connected to said return openings for withdrawing air therefrom, said air refrigeration and blower means being adapted to refrigerate the withdrawn air to a temperature below 10° F. and being connected to said supply duct for supplying the refrigerated air thereto at a temperature below 10° F.

8. A system for creating and maintaining an abruptly stratified blanket of refrigerated air on an ice skating slab as claimed in claim 7, in which said air refrigeration and blower means includes a refrigeration coil having a depth in the direction of airflow of more than 12 coils.

9. A system for creating and maintaining an abruptly stratified blanket of refrigerated air on an ice skating slab as claimed in claim 8, in which said air refrigeration and blower means has a capacity in cubic feet per minute approximately equal to the surface area of said ice skating slab in square feet.

10. A system for creating and maintaining an abruptly stratified blanket of refrigerated air on an ice skating slab as claimed in claim 7, in which said air refrigeration and blower means has a revolving drier wheel containing dessicant materi-

al for reducing the moisture content of the refrigerated air to below 10 grains of moisture per pound of dry air.

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