Jan. 5, 1937. J. A. STROMBERG 2,066,656

FLOOR FOR ICE SKATING RINKS

Filed Dec. 22, 1934

Fig. 1

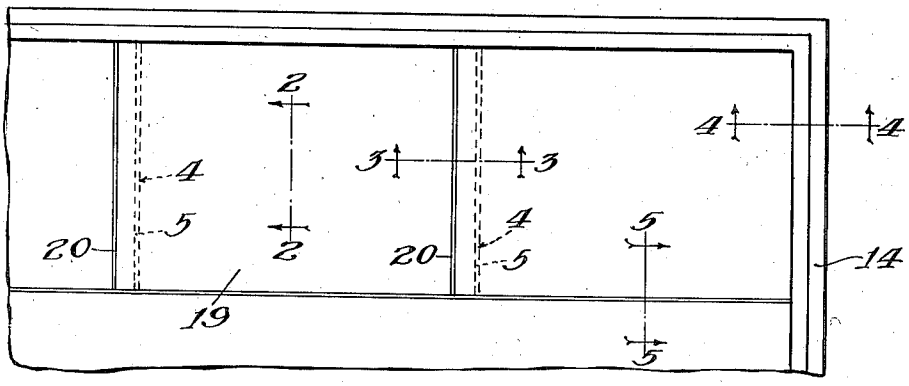


Fig. 2.

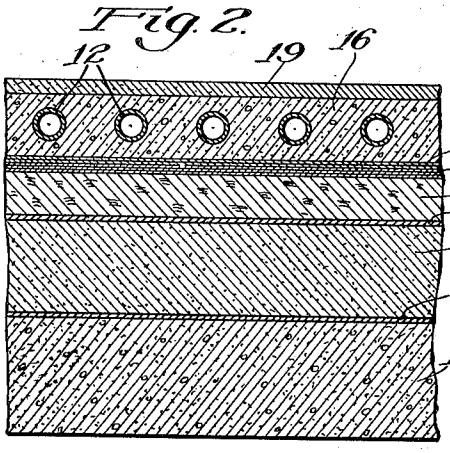


Fig. 3.

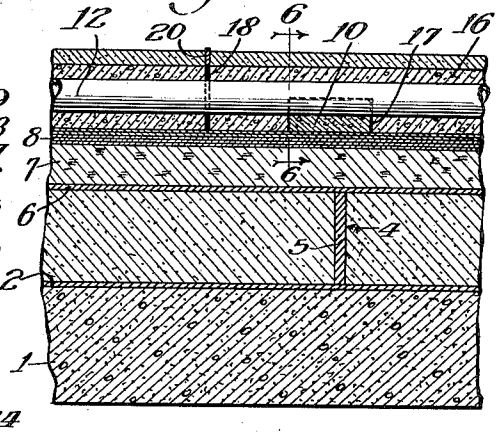


Fig. 4.

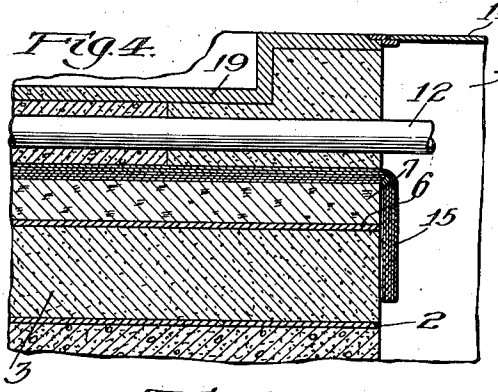


Fig. 5.

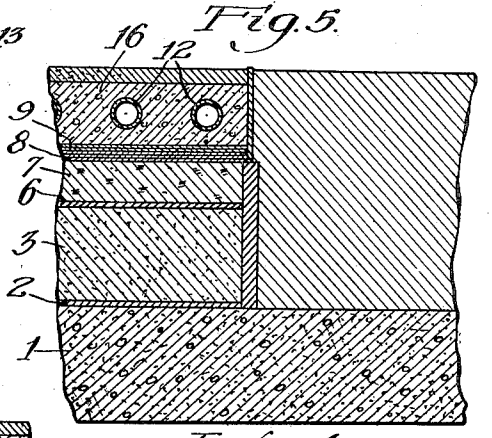
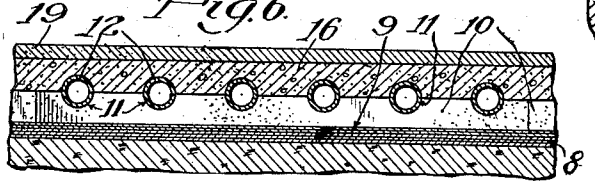


Fig. 6.



Inventor:
John A. Stromberg,
By: Lee J. Gary
Attorney.

Patented Jan. 5, 1937 2,066,656

UNITED STATES PATENT OFFICE

2,066,656

FLOOR FOR ICE SKATING RINKS

John A. Stromberg, Des Plaines, Ill.

Application December 22, 1934, Serial No. 758,785

6 Claims. (Cl. 94—3)

This invention relates to improvements in floor constructions used to support a film or layer of ice to serve as an ice skating rink or ice hockey floor. In one specific embodiment it relates particularly to floors used in large stadiums, arenas or the like, where at certain periods the floor may be used for ordinary purposes and at other times is used as an ice skating rink. The advantages of the floor construction of the present invention apply to any floor where ice is required whether used for other purposes or not.

One of the important objects of my invention is to provide a floor of the character above described, upon which ice may be quickly and efficiently formed and maintained, the freezing system being efficiently, thermally associated with the freezing surface and equally efficiently insulated from the foundation or substructure of the floor.

Another important object of my invention resides in the provision of a floor structure of the character described which minimizes and substantially eliminates the damaging effect of stresses in any part of the freezing system or floor structure due to rapid, frequent, and extreme variations in temperature to which such a floor is necessarily subjected.

A careful study of the problems presented in such floor constructions and of the troubles which have been heretofore encountered in this type of floor built according to the best practice heretofore known, clearly indicates that there are a number of precautions and principles which must be rigidly observed in any proposed design, if the floor is to function properly over a relatively long period of time without any damage to the system and at the lowest consistent cost of operation.

Substantially, the requirements of such a floor construction include suitable instrumentalities for rapidly converting water into ice of sufficient thickness on the floor, and as readily disposing of this ice upon the conclusion of its use, without damage of any kind to the floor structure, its component parts, or the structure of the building. Usually, cooled brine or other refrigerant at relatively low temperature is forced through a pipe system disposed immediately beneath the finished floor surface. As heat is drawn from this surface to the refrigerating system of pipes and the temperature of the floor falls to the freezing point, water is sprayed on the floor and converted into ice. Circulation of the brine is sustained for as long a period as the ice is to be used. When the ice is to be removed, the brine is warmed and recirculated, the heat passing upwardly to the floor surface, melting the ice, which is removed and the floor permitted to dry by evaporation of the moisture remaining. This cycle of operation is more or less frequent depending upon the individual case considered. In all events, however, economical and efficient operation depends upon the most rapid drawing of the heat downwardly through that part of the floor above the pipe system, and a minimum of heat loss wasted through the section of the floor beneath the pipe system.

It is important that these rapid, frequent, and extreme temperature changes of the pipe system and section of floor above and below the pipes, can be accomplished without damage from the resultant contraction and expansion of these component parts. The temperature variation in the pipe system is a maximum, and therefore the contraction and expansion of this portion of the system is greatest. As a feature of my invention means for allowing free longitudinal movement of the pipe is definitely contemplated in my invention, as damage to the pipe, its encasing concrete slab and other parts of the floor is almost certain to result if the pipe is longitudinally constrained in any manner. Difficulty has been encountered in other systems heretofore proposed where the above described precautions have been disregarded or not fully appreciated. The excessive stresses placed in the pipe system may crack the pipe or break the joint, or said stresses may be transferred to the encasing concrete slab which tends to crack under the strain. This damage is cumulative and results in leakage of the brine carried by the pipe, or of the water on the floor, through the encasing concrete down to the lower sections of the floor containing insulating materials, which in turn suffer the loss of their normal function by this liquid impregnation.

Another instance of misuse or misapplication of materials frequently found in systems heretofore proposed is in constructing the circulating pipe system to act as a reinforcement in the upper concrete slab of the floor, which must withstand independently the heavy loads imposed on the floor. It is contemplated in my invention that the top encasing slab of concrete be designed to uniformly distribute the ultimate floor loads, without any additional reinforcing therein, in addition in my invention provision is made to effectively prevent a bond from occurring between the pipes and their encasing concrete, thus permitting free longitudinal movement of these

pipes, but at the same time maintaining them in absolute true alignment, spacing and level.

Other advantages of my invention will be apparent from the accompanying drawing and following detailed description.

In the drawing, Fig. 1 is a fragmentary top plan view of a section of a floor constructed in accordance with the concepts of my invention.

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1.

Fig. 4 is a sectional view taken on line 4—4 of Fig. 1.

Fig. 5 is a sectional view taken on line 5—5 of Fig. 1.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 3.

Referring in detail to the drawing, 1 indicates a structural slab of reinforced concrete of suitable thickness and strength to carry all dead and live loads with ample safety. In the scope of this invention the slab 1 is presumed to be in place, either as a part of existing construction or under separate construction, on the area intended to be used for the skating rink.

The upper surface of the slab 1 is thoroughly cleaned and is permitted to dry. A cold asphalt emulsion is mopped on the surface of the base slab in the form of a film 2. By coating the upper surface of the slab 1 moisture is prevented from passing upwardly through slab 1 and passing to an upper structure hereinafter described. In addition, the film 2 serves more or less as an insulating medium against the downward passage of heat. As will be hereinafter described, another layer of concrete is positioned upon the film 2 and the presence of said film between the slab 1 and the layer above said film serves as a "slip-sheet" or joint permitting expansion or contraction of the two slabs of unequal degrees in a lateral plane to occur independently without any damage to either slab. It is preferable in the laying of the film 2 that the same be disposed upon slab 1 in the cold state, since hot asphalt will not adhere to the surface of the slab 1 if the same is damp or slightly wet, whereas the cold asphalt emulsion can adhere equally well to the dry or damp areas of the upper surface of the slab. Further, there is danger in using hot asphalt of boiling out certain essential oils contained therein if the temperature of the material becomes too high, which is often the case.

A second slab 3 of cellular, inert, insulative concrete may be poured in place upon the film 2, the top surface of the concrete slab 3 being "floated" smooth. The slab 3 may be constructed of cellular concrete having light weight aggregates or some similar material which possesses the characteristics of being cellular, inert and resistant to the passage of heat. By using a concrete of this type a lower coefficient of heat conductivity is obtained. In addition, the strength is greater per unit of weight and the concrete is relatively impermeable to the passage of moisture. Further, the cellular character of the slab 3 provides a very efficient insulating medium since the cells provided therein are not interconnected, that is, a plurality of dead-air cells are provided.

Concrete of this general description has an insulation value three times that of concrete made with ordinary aggregates of equivalent mix and thickness of slab. In addition, said concrete has about 10% less contraction and expansion under temperature changes than ordinary concrete of an equivalent mix and thickneess of slab. Further, the aggregate forming concrete of this type is inert and highly resistant to acid attack; is clean and free from any impurities or any combustible matter or matter which will shrink, swell, rust, shift or decompose when subjected to moisture or freezing conditions.

Expansion joints 4 are provided in the slab 3, a joint 4 being provided about every 20 feet in a transverse direction across the floor and about every 40 feet in a longitudinal direction. Of course, it is to be understood that said joints may be provided wherever desired and, consequently, I do not wish to be limited to any precise spacing of the joints. The joint 4 may be formed by disposing beveled strips of wood (not shown) in the positions of the contemplated joints and pouring the concrete 3 around said strips. Subsequently, said strips are removed and the spaces or joints 4 are filled with asphalt 5 or other suitable expansion compound. The surface of the cellular insulative concrete slab 3 is preferably "floated" smooth, and the upper surface thereof when the same has properly set, is mopped with a hot asphalt mopping. Before the asphalt film 6 is positioned upon the surface of the slab 3 said slab is permitted to thoroughly dry.

While the film or layer 6 of asphalt is still in a mobile or pliable state, sheets of compressed cork 7 are positioned upon said film, the individual sections of cork being set tightly against each other. By "floating" the upper surface of the slab 3 an exceptionally good bond for the asphalt coating 6 and for the cork insulation slab 7 is provided and the cork slab 7 is thereby thoroughly bonded to the supporting concrete slab 3. In addition, the film 6 waterproofs the cork and prevents permeation of the cork by moisture which may pass upwardly through the concrete layers 1 and 3. As a feature of my invention the layer 7 of cork comprises the principal insulating medium which prevents the upward passage of heat to the cooling system and is positioned as close as possible to the cooling pipes hereinafter described. That is, the cork layer occupies a position as high as possible in the structure comprising the floor as a whole. In this manner the energy or power consumed in cooling the upper surface of the floor is not unduly wasted by cooling large masses of material beneath the cooling pipes.

A fabric waterproofing membrane 8 comprising one or more and preferably at least three plies of asphalt saturated cotton-cord fabric may be positioned upon the upper surface of the cork layer 7. The membrane 8 functions to protect the cork from penetration of water or brine from above. In addition, it has sufficient toughness to protect the cork layer from any damage to it physically during the placing of the pipe system above as will be hereinafter more fully described. Further, the membrane 8 contributes to the insulation of the pipe system and the same will not be readily punctured because of the relatively high tensile strength of the cord fabric. A membrane thus constructed becomes in effect a homogeneous layer of asphalt reinforced with strong cotton-cord fabric and the useful life of the membrane is thus prolonged.

One or more dry sheets and preferably at least two sheets of oiled kraft paper 9 may be positioned immediately above the membrane 8. The paper suitable for the layer 9 preferably weighs in the neighborhood of fifty pounds per 100 square

feet. The layer 9 comprising the oiled kraft paper functions as a "slip-sheet" on which the slab of concrete which encases the pipes of the cooling system can freely move in a lateral direction as well as a longitudinal direction without any damage to the membrane 8 occurring. Further, said sheets protect the membrane 8 from damage while the freezing pipes (hereinafter described) are being installed.

The pipes comprising the cooling system and the concrete encasing said cooling pipes will be hereinafter more fully described. It can readily be seen that said pipes and encasing concrete when the system is to be used for alternately freezing and thawing the floor surface, will be subjected to relatively high stresses of contraction and expansion. However, due to the presence of the layer 9 this relatively great expansion and contraction can take place independently of the membrane 8 and the components of the floor positioned beneath said membrane. The layer 9, in addition, adds materially in preventing the permeation of moisture downwardly into the membrane 8 and cork layer 7.

After the layer 9 of oil kraft paper has been disposed in position, a plurality of pre-cast concrete supports 10 may be disposed upon said layer. The supports 10 may be placed end to end in contiguous fashion and each line of said supports may be spaced approximately ten feet from the next adjacent line of supports, said line of supports being disposed at right angles to the direction of the axes of the cooling pipes. The upper surfaces of each of the supports 10 may be provided with spaced notches or semi-cylindrical indentations 11, the spacing of said notches being in conformity with the desired spacing of the refrigerating pipes. After the supports 10 have been disposed in proper position as described hereinbefore, a series of pipes 12 may be positioned upon said supports, the pipes resting in the notches 11. The pipes 12 are preferably constructed of puddled wrought iron and the sections thereof are preferably electric resistance butt-welded and laid in continuous length across the entire floor. In so joining the unit sections of pipe the outside as well as inside surfaces of the pipe are substantially uniform throughout its entire length. As a feature of the invention, the outside surfaces of the pipes are coated with a film of separating material which serves two purposes. It permanently prevents the formation of a bond between the pipes and the encasing concrete and it coats the pipes with a water-resisting or moisture-resisting film preventing corrosion of said pipes due to water electrolytic action. This film may comprise any oil or oily material or compound or admixture capable of use for the purposes indicated and may be liquid, semi-liquid, semi-solid or solid at normal atmospheric temperatures. The film is preferably applied in liquid condition, being heated if necessary to liquefy it sufficiently for application. Materials such as relatively non-volatile hydrocarbon oils, greases, paraffin, graphite compositions, some oil base paints, conventional lubricants and the like may be used.

The ends of the pipes which transversely span the floor connect into risers from refrigerating headers (not shown) at each side of the floor, said headers being positioned in the sumps or trenches 13. This latter may be covered by removable closures 14. The outer edges of the membrane 8 and layer 9 may be turned downwardly along the defining edges of the concrete slabs 3 and 1 as shown best at 15 in Fig. 4. This, of course, contributes to the prevention of water or moisture permeating the layers 1 and 3.

By the provision of the supports 10 the pipes 12 are maintained in correct alignment and spacing, thus insuring even freezing of the ice upon the floor area above. In addition, the pipes 12 are maintained at a proper uniform level. The dimensions of the supports 10 are such with respect to the load carried by said supports that a relatively large area is presented to the layer 9 and, consequently, puncturing of said layer during the construction period is prevented. The supports 10 have no metal-to-metal contact with the pipes 12, nor do they contain metal as a constituent. Hence, thermocouples are prevented from forming and electrolytic action in the presence of moisture is prevented.

After the pipes 12 have been laid upon supports 10, the intervening spaces between the supports and the space above and below the pipes is filled with a relatively dense concrete 16 comprising Portland cement and inert aggregates. The concrete 16 comprises preferably the same ingredients which go to make up the supports 10 so that there will be no relative motion between said supports and the concrete due to unequal expansions and contractions of the supports and the concrete 16. In laying the concrete 16 the same is preferably mechanically vibrated to eliminate voids and provide a relatively dense mass, the surface of which is "floated". The mixture comprising concrete 16 is sufficiently rich to have a relatively high degree of heat conductivity and yet is not excessively rich to produce excessive contraction and expansion.

Prior to pouring concrete 16, the sides of the supports 10 may be coated with asphalt or the like as shown at 17 in Fig. 3 whereby a bond is prevented from being set up between the supports 10 and the layer 16. In addition, as has been hereinbefore described the pipes 12, coated with a film of separating material, will not adhere to the concrete 16, whereby free longitudinal movement of said pipes is permitted under relatively diverse conditions of temperature. Further, the presence of the film of separating material upon the pipes 12 prevents corrosion of said pipes. The fact that the concrete 16 contains nothing but inert components eliminates the possibility of electrolytic action or corrosion from taking place. The concrete layer 16 holds the pre-cast concrete supporting members 10 in perfect alignment, spacing and level, ensuring uniform freezing action on the floor surface and, having a "floated" finish of rough but even texture, and a surface is provided whereby a perfect bond may be obtained for the finished floor which is to be placed upon the upper surface thereof.

During the period of construction the pipes 12 are supported by supports 10, which, having a relatively large basal area, will not puncture or unduly locally compress the oiled paper 9 or membrane 8. In addition, said pipes are positively supported and prevented from being laterally or vertically displaced when the concrete layer 16 is poured. By electric resistance butt-welding, no projections are formed upon the outside of the pipes which would prevent said pipes from moving longitudinally, since the presence of such projections would function as keys whereby the pipes would be anchored in the encasing concrete. Further, in so butt-welding the pipes the inside surfaces of the pipes will be projectionless, thereby preventing the formation of gas pockets in the

pipe caused by the eddying passage of brine through the pipes. The presence of such gas pockets manifests itself by the unequal or imperfect freezing adjacent said gas pockets. Moreover, by so welding the pipes the introduction of any welding material foreign to the nature of the pipes is prevented, thus preventing the formation of thermocouples or electrolytic action.

The slab or layer 16 is constructed so as to rapidly conduct heat from the freezing surface to the pipes or vice versa, but no metallic substances are incorporated therein, which has frequently been resorted to in the past to accomplish this purpose. The presence of metal particles in this layer of concrete would tend to set up electrolytic action which would result in corrosion of the pipes 12. Moreover, water and air reaching said particles would cause the same to rust eventually causing disintegration of the concrete slab with damaging loss of strength and leakage.

As an important feature of my invention, the slab or layer 16 provides uniform distribution of floor loads over the entire supporting floor substructure without any assistance from the pipes 12 as reinforcing members. In some installations concrete blocks or "chairs" of relatively small basal areas transmit all floor loads to the substructure, thereby materially overloading the substructure at localized points. Where fabric or sheet metal membranes are used, the same are readily punctured by such blocks or "chairs". Further, no sand or other water absorbent, mobile material is used for supporting or "floating" purposes, the absence of which contributes to the stability and non-absorptive character of my structure.

Expansion and contraction of the layer 16 is compensated for by the provision of expansion joints 18 which may be provided parallel and at right angles to the axes of the pipes, such joints being filled with a suitable compound which is impermeable to water and can be readily compressed. The most suitable material for this purpose is one which will stretch and close any opening when the floor shrinks, and will offer no resistance when expansion again brings the floor to its normal position.

The upper surface of the floor structure may comprise a relatively light colored terrazzo or cement layer 19 which provides an ideal floor surface for numerous purposes including for use as a skating rink or for ordinary floor purposes. Expansion joints 20 comprising brass strips placed integrally with the surface 19 compensate for extreme temperature variations thereby preventing cracking, crazing or spalling of the finished surface. It is customary in freezing the skating surface to apply the water thereto after said surface has reached a substantially freezing temperature or below. When thawing the ice at the conclusion of the skating period the expansion of this top surface under the action of heat provided by the warmed brine will effectively close expansion joints at the top surface of the floor, squeezing out the water from these joints and allowing the water to evaporate or be otherwise removed.

It is apparent that herein is provided a floor structure comprising component portions having different characteristics as to heat conduction, expansion and contraction and strength; a structure which is normally intended to undergo extreme and rapid temperature variations and which will nevertheless not crack, become water absorbent or cause the rupturing or corrosion of the piping system, said floor being particularly characterized in that it does not possess any materials which are water absorbent, will rust, corrode, shift, swell, rot or otherwise deteriorate.

I claim as my invention:

1. A floor structure for ice skating rinks which comprises in combination, a substructure constructed of relatively poor heat conducting material, a superstructure constructed of relatively good heat conducting material, a plurality of interconnected pipes adapted to carry a temperature-changing fluid embedded in said superstructure, said pipes being joined end to end by electric resistance butt-welding to provide relatively uniform, smooth, projectionless interior surfaces whereby gas pockets are prevented from forming within the pipes incident to the flow of said temperature-changing fluid.

2. A method of making a floor structure for use as a support for an ice skating rink comprising, forming a substructure of relatively poor heat conducting material, supporting a temperature changing pipe system upon said substructure, electric resistance butt-welding the pipes in situ comprising said system end to end to form integral unit spans of pipe having relatively smooth uniform surfaces, embedding said pipes in a layer of poured-in-place concrete and, prior to pouring said concrete, coating the surfaces of said pipes with a film of separating material.

3. A floor structure for ice skating rinks which comprises, in combination, a relatively poor heat conducting substructure, and a relatively good heat conducting superstructure, a temperature changing system in said superstructure comprising a plurality of pipes, a layer of poured-in-place concrete encasing, but unbonded to said pipes, said pipes having substantially projectionless outer surfaces, whereby the pipes are free to expand or contract longitudinally independent of said encasing concrete.

4. A floor structure for ice skating rinks which comprises in combination, a substructure and a superstructure, said latter being constructed of poured-in-place concrete, a plurality of interconnected pipes adapted to carry a temperature changing liquid imbedded in but unbonded to the poured-in-place concrete of said superstructure, the connecting joints of said interconnected pipes being of substantially the same cross-section as that of the remaining length of the pipes whereby no obstruction is offered to the free longitudinal movability of the pipes.

5. A floor structure for ice skating rinks which comprises in combination, a substructure and a superstructure, said latter being constructed of poured-in-place concrete, a plurality of interconnected pipes adapted to carry a temperature changing liquid imbedded in said superstructure, the formation of a bond between the poured-in-place concrete and the pipes being prevented during the setting of the concrete by the presence of a bond destroying coating on the pipes, whereby said pipes are freely movable longitudinally in said superstructure, said pipes being joined end to end by electric resistance butt-welding to provide relatively uniform smooth projectionless exterior surfaces whereby no obstruction is offered to the free longitudinal movability of the pipes.

6. A floor structure for ice skating rinks which comprises in combination, a substructure, a temperature changing pipe system disposed above said

substructure, precast concrete supports upon which said pipes are mounted, poured-in-place concrete encasing said pipes and precast supports, the formation of a bond between the poured-in-place concrete and pipes being prevented during the setting of said concrete by the presence of a bond destroying agent on the pipes, the exterior of said pipes being substantially projectionless, whereby said non-bonded pipes are free to move substantially independent of said encasing concrete.

JOHN A. STROMBERG.