CONTROLLED REFRIGERATION APPLICATION TO A METALLIC CONVEYOR BELT

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Filed: Oct. 26, 1970

Appl. No.: 84,022

U.S. Cl. ............................................. 62/201, 62/380, 165/86, 198/193, 198/203

Int. Cl. .............................................. F25d 17/02

Field of Search ..................................... 165/86; 62/201, 345, 378, 380; 198/203, 193, 184; 74/216.5, 233, 234, 240, 241

References Cited

UNITED STATES PATENTS

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ABSTRACT

Apparatus for controlling the flow of refrigerant in direct engagement with the bottom surface of a metallic conveyor belt. The apparatus includes an open-top trough the ends and sides of which are in contact with the bottom surface of the conveyor belt and the sides of the trough permit leakage and control the flow of refrigerant regardless of the change in viscosity due to varying temperatures of the refrigerant.

8 Claims, 10 Drawing Figures
CONTROLLED REFRIGERATION APPLICATION TO A METALLIC CONVEYOR BELT

BACKGROUND OF THE INVENTION

Invention

1. Field of the Invention
This invention relates generally to apparatus for modifying temperatures of various objects and relates particularly to refrigeration equipment using brine as a refrigerant in contact with a metallic conveyor belt to effect rapid transfer of heat from articles carried on said belt.

2. Description of the Prior Art
Hence, a brine solution of calcium chloride has been used in many freezer apparatus; however, most prior art devices have not been satisfactory, particularly at temperatures of minus 30° F to minus 40° F. Some efforts have been made to provide apparatus for accommodating changes in the rate of flow due to changes in viscosity of the refrigerant such as the patents to Allen U.S. Pat. No. 2,437,492; Field U.S. Pat. No. 2,610,476; Annerhed U.S. Pat. No. 2,844,359; Larsson U.S. Pat. No. 3,280,590; and Martin U.S. Pat. No. 3,387,464. These prior art devices rely on the lifting of the belt by fluid pressure from the top of an open trough or deflecting the side retainers to permit refrigerant to escape from the trough and thereby produce a refrigerant flow and, therefore, have not been satisfactory since the lifting of the belt or deflecting of the side members normally takes place at the center of the belt so that the refrigerant flow is not evenly distributed throughout the area intended for freezing purposes. Most of these prior art devices have required additional collecting tanks located exteriorly of the conveyor and connected to a drainage tank by relatively large insulated pipes. The auxiliary tanks must be relatively large and normally occupy a floor area approximately one-quarter that of the freezer unit. Also these prior art devices have been expensive to manufacture and maintain, and have not permitted sufficient flow of highly viscous refrigerant, have trapped air under the belt, particularly when starting the freezing operation and such air has acted as an insulator to reduce the transfer of heat from the product being frozen, and for other reasons have not been satisfactory.

SUMMARY OF THE INVENTION
The present invention is an apparatus for controlling the flow of viscous refrigerant through an open-top trough with the refrigerant in direct contact with the lower surface of a metallic conveyor belt and evenly distributing the flow of refrigerant throughout the area of the trough without lifting the belt from the trough and without trapping air or other insulating material between the refrigerant and the bottom surface of the belt. An overflow trough controlled by an adjustable weir is located along both sides of the open-top trough and discharges refrigerant into a drain pan. A collecting tank is located below and in communication with the drain pan to reduce the floor space requirements for the freezer system.

It is an object of the invention to provide a flow-control apparatus for a refrigerating system using highly viscous refrigerant in which the flow of refrigerant is distributed equally throughout the system and eliminates the entrainment of air or other insulating materials.

Another object of the invention is to provide a refrigerating system having an open-top trough with a metallic conveyor belt supported by the upper surfaces of the trough, a drain pan extending entirely around the open-top trough, and a refrigerant sump located between the upper and lower runs of the metallic belt conveyor.

BRIEF DESCRIPTION OF THE DRAWINGS
FIG. 1 is a side elevation illustrating one application of the invention.

FIG. 2 is an enlarged fragmentary section on the line 2—2 of FIG. 1.

FIG. 3 is a section on the line 3—3 of FIG. 2.

FIG. 4 is an enlarged section on the line 4—4 of FIG. 1.

FIG. 5 is an enlarged fragmentary top plan view of the central portion of the system with portions of the belt broken away for clarity.

FIG. 6 is a section on the line 6—6 of FIG. 5.

FIG. 7 is an enlarged section on the line 7—7 of FIG. 6.

FIG. 8 is an enlarged section on the line 8—8 of FIG. 4.

FIG. 9 is an enlarged section on the line 9—9 of FIG. 4.

FIG. 10 is a side elevation of the structure illustrated in FIG. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With continued reference to the drawings, a refrigerating system 15 is provided having a metallic conveyor belt 16 with a drive mechanism 17 at one end and an idler mechanism 18 at the opposite end. As illustrated, the conveyor belt 16 has a V-belt 19 bonded or otherwise attached thereto on the inner periphery adjacent opposite sides.

In order to drive the belt 16, the drive mechanism 17 and the idler mechanism 18 each includes a shaft 20 journaled in bearings 21 at opposite sides of the belt 16. A pair of spaced pulleys 22 are fixed to the shaft 20 and such pulleys are spaced apart a distance corresponding to the spacing of the V-belts 19 and are adapted to frictionally engage such belts. Intermediate the pulleys 22, at least one support and drive wheel 23 is mounted on the shaft 20 and such support wheel is provided with a frictional surface which engages the belt 16 intermediate the sides thereof. As illustrated in FIGS. 2 and 3, the support and drive wheel 23 includes a pulley 24 having a V-belt 25 bonded or otherwise attached around the entire periphery of the pulley in such a manner that the outer surface of the V-belt 25 will engage the inner surface of the conveyor belt 16 and support and drive the belt by frictional engagement. It is noted that the support and drive wheel 23 could be substantially solid with a flat periphery having a coating of rubber, neoprene or other frictional material which would engage the inner surface of the belt 16 and support and drive the same.

The conveyor belt 16 can be driven in any desired manner, such as by a power plant 26 disposed adjacent to one end of the conveyor belt 16 and connected by a shaft 27 to a speed reduction member 28. Such speed reducer includes an output shaft 29 on which a drive sprocket 30 is mounted and the drive sprocket is connected by a chain 31 to a driven sprocket 32 carried by the shaft 20 of the drive mechanism.

Between the drive mechanism 17 and the idler mechanism 18, an open-top trough 35 is provided which is mounted within a drain pan 36. The drain pan is relatively shallow and includes side walls 37, end walls 38 and a bottom wall 39. Spaced inwardly from the side and end walls of the drain pan, the open-top trough 35 includes side walls 40 and end walls 41 which are welded or otherwise attached to the bottom wall 39 of the drain pan. The side walls 40 and end walls 41 are adapted to engage and support the lower surface of the conveyor belt 16 and therefore, as illustrated in FIGS. 1 and 6, the upper surfaces of such side and end walls are disposed at an elevation slightly higher than the top of the drive and idler mechanisms 17 and 18.

In order to effect the rapid transfer of heat from articles carried on the upper surface of the upper run of the conveyor belt 16, a refrigerant such as a brine solution of calcium chloride is pumped under low pressure into the area defined by the side walls 40, end walls 41, bottom wall 39 of the drain pan and the bottom surface of the conveyor belt 16 so that the refrigerant is in direct contact with the bottom surface of the conveyor belt.

To provide flow of refrigerant from the open-top trough, the upper surfaces of the side walls 40 are provided with a series of equally spaced notches or serrations 42 in the area between the end walls 41. Refrigerant at a temperature of from minus 30° F to minus 40° F is pumped from a chiller (not shown) through an inlet pipe 43 (FIG. 4) into a header 44 located within the open-top trough to fill the trough. Within these
temperature ranges the brine solution is highly viscous so that as the trough is filled until the brine solution is in direct contact with the bottom surface of the conveyor belt 16, such brine solution will slowly flow out of the trough through the notches or serrations 42.

In order to control the amount of refrigerant flowing through the notches 43, a spacer 45 is connected to the outer surface of each of the side walls 46 and on each of such spacers is adjustably mounted a weir or gate 46 defining an overflow trough 47, the weir 46 extending along the side walls for the full length of the notches 42. The weir 46 is provided with a plurality of slots 48 along its lower edge in which bolts 49 carried by the spacers 45 are adjustably received. Up-and-down movement of the weir 46 controls the amount of refrigerant flow from the open-top trough 35.

Since the refrigerant is in direct engagement with the bottom of the conveyor belt 16, it is desirable to reduce the flow of refrigerant past the end wall 41 of the open-top trough 35. As illustrated in FIGS. 9 and 10, side walls 40 support the conveyor belt 16 and the end walls 41 terminate slightly below such conveyor belt. An adjustable seal or wiper blade 50 is mounted on the end wall 41 by means of fasteners 51 received within slots 52 in the wiper blade 50. As illustrated, the wiper blade extends upwardly above the end wall a distance sufficient to frictionally engage the bottom surface of the conveyor belt 16. It is noted that since the open-top trough is located within the drain pan 36, the top of the end walls 41 could extend upwardly to the same level as the top of the side walls 40 and directly engage the bottom surface of the conveyor belt. Any liquid refrigerant which passes the rearmost end wall 41 will fall by gravity from the conveyor belt into the drain pan.

In order to prevent a sharp bend in the conveyor belt after the belt passes the wall 41, the side walls 40 extend beyond the end wall 41 and the upper surfaces of such side walls curve downwardly about a radius starting approximately at the center line of the seal 50. The radius or curvature of the side walls is not less than the radius of bending at the drive mechanism 17.

Liquid refrigerant which overflows the weir 46 is collected in the drain pan 36 and flows through openings 53 in the bottom wall 39 and falls by gravity into a collection tank or sump 54 located directly below the drain pan 36. From the collection tank the refrigerant flows through a pipe 55 to the chiller (not shown) for recirculation through the inlet pipe 43 and header 44 into the open-top trough 35. To provide for drainage into the open-top trough 35, when desired a drain line 58 having an off valve 59 therein extends through the bottom wall 39 and provides communication between the open-top trough 35 and the collection tank 54. The valve 59 is accessible through one of the openings 53 in the drain pan.

With reference to FIG. 8, it is desirable that a pressure relief mechanism be provided for the open-top trough so that pressure within the trough will not raise the conveyor belt 16 out of engagement with the side walls 40. This is done by providing a sleeve 60 extending through the bottom wall 39 of the drain pan within the confines of the open-top trough 35. The sleeve includes an internal bore having a valve seat 61 at its lower end. A valve member 62 mounted on one end of a shaft 63 normally engages the valve seat 61 to prevent flow of refrigerant fluid through the sleeve 60.

In order to maintain the valve 62 in intimate engagement with the valve seat 61 until a predetermined pressure has been reached, a spring 64 is disposed about the shaft 63 and has one end in engagement with the bottom surface of the valve 62 and the other end in engagement with a support member 65. Preferably the support member is provided with an opening or guideway 66 through which the shaft 63 extends to maintain the valve 62 in alignment with the sleeve 60. If desired the amount of tension applied to the spring 64 could be adjusted by making the support member in two overlapping portions connected together by fasteners received within slots carried by at least one of the overlapping members. Movement of the lower member toward the upper member would increase the tension on the spring 64 and movement of the lower member away from the upper member would decrease such tension.

The pressure relief valve is particularly useful during the initial operation of the refrigeration system since the viscosity of the brine refrigerant is substantially less due to its warm condition when starting. The brine refrigerant normally flows through preset pressure-regulating valves which are set to provide a predetermined pressure when the brine is at a temperature of minus 30°F to minus 40°F. Since the pressure of the refrigerant is in direct proportion to the viscosity, a refrigerant with less viscosity will flow through the pressure-regulating valves at a greater velocity and at a greater pressure than a more viscous refrigerant and therefore the greater pressure may cause harmful damage to the conveyor belt if the relief valve is not present.

In the operation of the device, a brine refrigerant of calcium chloride is cooled in a chiller and then introduced through the inlet pipe 43 and the header 44 into the open-top trough 35. As the refrigerant level rises within the open-top trough, air is forced through the notches 42 in the side walls 40 until the refrigerant engages the bottom surface of the conveyor belt 16. The notches 42 extend substantially the full length of the open-top trough and therefore refrigerant will flow through such notches and provide equal distribution of refrigerant fluid throughout the entire trough. When the refrigerant within the open-top trough has reached a predetermined temperature of from minus 30°F to minus 40°F, articles to be frozen are placed on the conveyor belt 16 and such belt is moved over the top of the open-top trough by the drive mechanism 17. As the heat from the product being frozen is absorbed by the refrigerant adjacent to the belt, the refrigerant with the absorbed heat will flow through the notches into the overflow trough 47 and over the weir 46 into the drain pan 36, and from the drain pan the refrigerant will flow through the openings 53 into a collection tank 54 located directly below the drain pan 36. From the collection tank the refrigerant again flows to the chiller for removing and dissipating the absorbed heat and reintroducing the refrigerant into the open-top trough.

We claim:

1. Controlled refrigeration apparatus comprising an endless metallic conveyor belt, a drive mechanism at one end of said belt and an idler mechanism at the opposite end thereof, an open-top trough located between said drive mechanism and said idler mechanism, said trough including side and end walls with the upper portion of said side and end walls being disposed at an elevation higher than the top of the drive and idler mechanisms, said side walls adapted to engage the bottom surface of the upper run of said conveyor belt, a drain pan disposed below and around the sides and ends of said trough, the upper portion of the side walls of said trough having a plurality of notches in the area between said end walls, an adjustable weir spaced from and generally parallel with each of said side walls and defining an overflow trough, said weirs being adjustable during operation, means for adjusting each of said weirs in a generally vertical direction, means for introducing a viscous brine refrigerant having a temperature between approximately minus 30°F and minus 40°F into said open-top trough, whereby the refrigerant is in direct contact with the lower surface of said conveyor belt and flows through said notches in the upper portion of said side walls into the overflow troughs and thereafter flows over said weirs into the drain pan and said weirs control the refrigerant level within said trough.

2. The structure of claim 1 including seal means on said end walls, said seal means adapted to engage the bottom surface of said conveyor belt.

3. The structure of claim 1 in which said drive mechanism includes a drive shaft, a pair of spaced pulleys fixed to said shaft, a pair of spaced generally parallel V-belts fixed to the inner periphery of said conveyor belt, said pulleys adapted to frictionally engage said V-belts, and means for driving said
shaft, whereby the rotating of said shaft causes movement of said conveyor belt.

4. The structure of claim 3 including an auxiliary drive wheel fixed to said shaft intermediate said pair of pulleys, said drive wheel having a frictional surface engageable with said conveyor belt to assist in driving said conveyor belt.

5. The structure of claim 1 including a collection sump located directly below said drain pan, said drain pan having at least one opening providing communication between the drain pan and the collection sump.

6. The structure of claim 5 including a pressure relief valve providing communication between said open-top trough and said collection sump for discharging refrigerant from said trough into said sump when the pressure of the refrigerant within the trough exceeds a predetermined amount.

7. The structure of claim 1 in which the side walls of said trough extend substantially beyond said end walls and the upper surfaces of the outwardly extending portions are curved downwardly to provide a smooth discharge support for said belt.

8. Controlled refrigeration apparatus comprising an endless metallic conveyor belt, a pair of spaced generally parallel V-belts connected to the inner periphery of said conveyor belt, a drive mechanism at one end of said conveyor belt and an idler mechanism at the opposite end thereof, each of said drive and idler mechanisms including a shaft, a pair of pulleys fixed to said shaft, said pulleys being spaced apart a distance corresponding to the spacing of said V-belts, said pulleys adapted to receive said V-belts and drive said conveyor belt thereby.

9. The structure of claim 8 wherein said conveyor belt has an intermediate support and drive wheel located between said pulleys, said drive wheel having a frictional surface adapted to engage and drive said conveyor belt intermediate said pulleys, means for driving the shaft of said drive mechanism, an open-top trough located between said drive mechanism and said idler mechanism and between the upper and lower runs of said conveyor belt, said trough including side and end walls with the upper portion of said side and end walls being disposed above the top of the drive and idler mechanisms, the upper portion of said side walls having a plurality of notches disposed between said end walls, a weir located outwardly of and generally parallel to said side walls and defining an overflow trough, said weirs being adjustable during operation, means for adjusting each of said weirs relative to the upper surface of said side walls, the upper portion of said side walls adapted to engage and support the bottom surface of the upper run of said conveyor belt, a drain pan having a bottom wall located below said trough and having side and end walls outwardly of the side and end walls of said trough, means for introducing a viscous brine refrigerant having a temperature between approximately minus 30°F and minus 40°F into said trough, whereby the refrigerant is in direct contact with the lower surface of said conveyor belt and flows through said notches into the overflow trough and from said overflow trough into said drain pan, said weirs controlling the refrigerant level within said trough, a collection sump located directly below and in communication with said drain pan in a position to receive liquid refrigerant therefrom.

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