An apparatus for handling food products and the like, said apparatus comprising a first substantially closed compartment containing a reservoir of liquid coolant and a continuous multisectional, mesh-type conveyor having a lower portion extending below the surface of the liquid coolant and adapted to advance potatoes or other products under the liquid and deliver them to a second conveyor which extends through a second compartment containing means for re-heating the product and boiling off the liquid coolant remaining thereon. The first and second compartments are provided with banks of condensation coils for recovery of coolant in the gaseous state. Uncondensed gaseous coolant is recovered through a vacuum system which includes liquid seals on the inlet and discharge of the apparatus.
This application is a continuation-in-part of my earlier co-pending application, Ser. No. 176,539, filed Aug. 31, 1971, now abandoned.

The present invention is generally related to automated conveyor type apparatuses and, more particularly, to apparatuses utilized in coolant processes, such as fry potato sugar leaching.

In the processing of fry potatoes it is desirable to produce a uniformly, light-colored product which is more appetizing in appearance and, thus, highly desirable from a marketing standpoint. It has been found that by uniformly removing the surface sugars from the potato pieces, a most desirable uniform light-colored product may be obtained.

In the past, when potatoes were stored at low temperatures, the starch contained therein was converted to sugar. When the potato pieces were cooked in hot oil, the sugar caramelized producing a dark, undesirable fried potato product. It has been found that in most varieties of potatoes the amount of sugar content varies from one region of the potato to the other. For example, the stem end of a potato may contain 2 to 3 percent sugar while the blossom end contained less than one percent sugar. Thus, when french fry cut potatoes were produced, the sugar in one region caramelized forming a dark spot with other regions remaining relatively light.

In an effort to obtain color uniformity many fry potato producers have blanched their potatoes in hot water or steam for extended periods of time. The blanching process successfully removed some of the sugar from the potatoes, however, it also produced an undesirable softening and much of the flavor was removed. Furthermore, blanching processes, in many cases, did not assure light color uniformity, particularly in tubers with excessive sugar content.

A more recently developed process of fry potato sugar leaching includes the surface freezing of the potato pieces. In this process, only a fraction of a millimeter of the outer surface of the potatoes is frozen. If the potato pieces are frozen solid, or in depth, the result is a limp finished product with a lesser amount of flavor and greater oil absorption properties. For this reason, a liquid refrigerant is utilized which attacks the outer cells of the potato pieces and either bursts or stretches the cell membranes during surface freezing.

After the surface freezing, the potatoes are soaked and preferably, agitated in water at a temperature of 120°-129° Fahrenheit. At this stage of the process the potato sugars are leached out of the outer cells initially frozen by the liquid coolant. When the potato pieces are ultimately immersed in hot oil for frying, they produce a uniformly light finished product due to the sugar removal from the potato surfaces.

While the advantages of this process are many in number, control of the process and the depth of freezing is highly critical. It is desirable, therefore, to provide an apparatus for automatically performing the above described process under controlled conditions and at a minimum of cost.

It is an object of the present invention to provide a novel conveyor-type apparatus for automatically performing a critical portion of a sugar leaching process under controlled conditions and with a minimum amount of coolant loss.

Another object of the present invention is to provide a versatile apparatus for fry potato sugar leaching and the like which functions automatically without the need for an attendant, thereby reducing the process costs and the price of the product derived therefrom.

It is a further object of the present invention to provide a novel apparatus for automatically advancing products such as potatoes in a submerged manner through a reservoir of liquid coolant and subsequently reheating the products to terminate freezing and at the same time recover coolant adhering to the product surfaces.

Still another object of the present invention is to provide a highly efficient conveyor-type apparatus for the passage of products through a reservoir of liquid coolant, the apparatus including banks of condenser coils adapted to recover the coolant transformed to the gaseous state during the process, thereby substantially eliminating the loss of coolant and reducing the process costs.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts through-out, and in which:

FIG. 1 is a plan view of the apparatus of the present invention with sections removed to expose the interior.

FIG. 2 is a sectional view taken along section 2—2 of FIG. 1.

FIG. 3 is a sectional view of the apparatus of the present invention taken along sections 3—3 of FIG. 2.

FIG. 4 is a sectional view taken along sections 4—4 of FIG. 2.

FIG. 5 is an elevation view, with portions broken away, of the incoming conveyor system showing a liquid vapor seal on the inlet to the apparatus.

FIG. 6 is an elevation view, with portions broken away, of the discharge portion of the apparatus showing a liquid seal on the discharge thereof.

Referring now more specifically to the figures, the apparatus of the present invention is generally indicated by the numeral 10 and is comprised of an elongated housing 12, preferably, of rectangular cross section. The housing is substantially closed and the interior thereof is divided into a pair of compartments by way of a centrally located vertical wall 14 with a conveyor passageway 16 formed therein. The apparatus is adapted to receive potatoes or other food products by way of remote conveyor 18 or the like which discharges the products through an entrance opening 20 communicating with the interior of housing 12. The products fall onto a first continuous conveyor 22 and are advanced through a liquid coolant 24, after which they are discharged to a second continuous conveyor 26. The products are advanced through opening 16 into the second compartment, wherein they are subjected to heat by way of heating means 28 located below the second conveyor. Such heating means may comprise electrical resistance elements, such as those manufactured and sold under the trademark "Calrod". After the products have been reheated they are discharged from the apparatus through exit opening 30 where they are received by an appropriate vessel or hopper 32.
Preferably, the apparatus housing and compartments therein are defined by inner and outer layers of stainless steel 34 and 36, respectively, with an insulation layer 38 of styrofoam or the like. The dimensions of each compartment may be varied in relation to the B.T.U. load demand of the particular process for which the apparatus is being utilized.

The first continuous conveyor 22 is comprised of a belt, preferably, of stainless steel woven mesh wire which is advanced around a plurality of rollers 40 by way of a first drive motor 42 operatively coupled to at least one of the rollers and is driven by a variable speed control of a conventional type, not shown. A plurality of spaced partitions 44 are affixed to the mesh belt of conveyor 22 and extend in a direction substantially perpendicular to the belt surface. A shield-type guide panel 46 extends along a path substantially parallel to that of conveyor 22 in order to hold the potatoes or other products in position within the product carrying compartments defined by panels 44. This is assured by spacing shield 46 from the mesh belt by a distance approximately equal to the dimension of the partitions 44.

It has been found that many food products, particularly potato pieces, have a tendency to float in most liquid coolants, thereby producing nonuniform exposure to the coolant which hinders the process result. It has also been found that the above described potato sugar leaching process is most effectively carried out by total submersion of the potatoes in the leaching coolant. It will be appreciated that with the apparatus of the present invention, the mesh belt associated with the first conveyor extends beneath the surface of the liquid coolant, thereby subjecting the potatoes to uniform surface freezing which is essential to the success of the leaching process.

It will also be appreciated that by controlling the speed of the first continuous conveyor, the immersion time of the potatoes or other product may be accurately controlled. The success of the above described fry potato sugar leaching process is dependent upon the depth of freezing on the outer surfaces of the potato pieces. Although many liquid coolants can be used, best results are obtained with sliced potato tubers when they are submerged in a coolant of dichlorodifluoromethane at $-22^\circ$F. for a period of approximately 5-15 seconds. This provides freezing of the potato outer surfaces to a depth of less than 1 millimeter. By controlling the speed of the conveyor, the submergence time and the depth of freezing may be controlled within tolerable limits. Conventional methods of carrying out the leaching process have been performed by spraying the potatoes with a coolant or cold air. However, such cooling methods for the most part, have proven unsatisfactory since the time and degree of exposure is nonuniform and may not be accurately controlled.

After surface freezing in the liquid coolant, the products are advanced to the second conveyor 26 for movement through the reheat compartment. Preferably, heating units, such as conventional electrical resistance elements, are located immediately below the load-carrying section of the conveyor. It will be appreciated that the second conveyor is also of the wire mesh type, such that heating of the potatoes occurs rapidly due to the opening in the mesh conveyor belt. The second conveyor is driven by a second drive motor 48 at a speed the same as or greater than that of the first conveyor to prevent a build up of the products discharged by the first conveyor. The synchronization may be achieved by conventional means or, if desired, both conveyors may be driven through a single drive motor.

It should be noted that as the potatoes are removed from the reservoir and discharged to the second conveyor, the liquid coolant may adhere somewhat to the potato surfaces. As the potatoes are heated by the heating means 28, the residue liquid coolant is boiled off into the interior of the second compartment. Thus, the heating elements perform a dual function by both reheating the potato pieces and boiling off the residue liquid coolant from the potato surfaces.

In order to minimize the loss of liquid coolant and thereby reduce the costs of operating the apparatus, it is important that any coolant in the gaseous stage, such as the boiled-off coolant, be condensed, recovered and returned to the reservoir. This is achieved by providing each compartment with a pair of inclined, oppositely disposed condenser coil banks 50 generally extending above the first and second conveyors. In addition, in a preferred embodiment of the present invention liquid seals are provided to isolate the apparatus from ambient and uncondensed gases are removed from the first and second compartments by way of purger connections 52 and 54 connected to a vacuum pump 56 of a conventional type to provide approximately 1/2 inch Hg. negative vacuum in each compartment.

Each bank of coils is connected to a compressor 58 of a conventional type which pumps ammonia, or a similar coolant, through the coil banks for cooling thereof to approximately $-50^\circ$ Fahrenheit. When the coolant gases come in contact with the condenser coils, they form droplets which are re-deposited back into the coolant reservoir by way of drip troughs 60 and 62 in the coolant compartment and inclined floor panel 64 located in the reheat compartment.

However, a portion of the gaseous coolant in the compartments is not condensed by the coils. Recovery of this uncondensed gaseous coolant is accomplished by using a vacuum system including purge fittings 52 and 54 which are preferably centrally disposed in the top portions of each compartment. The uncondensed gases flow first through fittings 52 and 54, and then through vacuum pump 56 and desiccant filter 66 before being returned through an inlet pipe 68 to the coolant reservoir 24. Preferably, the end of return pipe 68 is located beneath the surface of the liquid coolant, such that any gases remaining in the return flow will be bubbled through the coolant for condensation of liquefaction therein.

Of course, a vacuum can only be established within apparatus 10 if the apparatus is totally isolated from ambient. According to a preferred embodiment of the present invention, isolation may be accomplished by establishing seals, preferably liquid-type vapor seals on the inlet and discharge ends of the apparatus.

The inlet end vapor seal 68 consists preferably of a receiving vessel 70 filled with a liquid 72 to a predetermined level. The liquid may be any which is suitable for human consumption and compatible with potatoes, or such other products as may be processed in the apparatus, and may include, for example, water, edible oils, and the like. As can be seen in FIG. 5, a feed conveyor 74 carries the potatoes from the immediately preceding processing apparatus, which may be a dicer, slicer, peeler, scaler, or the like, and drops them into liquid 72 in vessel 70. Vessel 70 may function as a pre-rinse
vat in addition to serving as the container for the liquid-type seal. An inclined inlet conveyor system 76, preferably constructed of stainless steel, carries the potatoes from vessel 70 and discharges them through entrance opening 20 of housing 12. Conveyor system 76 consists of conveyor 18 enclosed by conveyor housing 78. Conveyor housing 78 has one end extending below the surface of liquid 72 in vessel 70, and the other end joining with entrance opening 20 to form a continuous, enclosed conduit from the liquid seal to within housing 12. Conveyor 18 is closely received and operates within conveyor housing 78 and includes cleats or flights 80 mounted at spaced intervals to facilitate transporting the potatoes from vessel 70 to entrance opening 20. It is essential that conveyor 18 and conveyor housing 78 extend below the surface of liquid 72 and vessel 70 at a sufficient distance to insure formation of seal 82. In this connection it has been found that if the s sate seal is established if the conveyor system extends at least four inches below the liquid surface.

Discharge end liquid seal 82, as can be seen in FIG. 6, includes outlet chute 84 joined at one end to exit opening 30 and submerged at the other end below the level of liquid 86 in discharge vessel 88 to define an enclosed conduit from within housing 12 to the liquid seal. Vessel 88 may be, for example, a tempering vat wherein the potatoes are subjected to tap water at about 80°F. to raise their temperature before entering the blancher. Alternatively, vessel 88 may be a fry potato blancher. Liquid 86, as with liquid 72, may be any substance which is suitable for human consumption and compatible with potatoes or such other products as may be processed in the apparatus. It is important that vessel 88 contain a sufficient level of liquid 86 that chute 84 extends a distance below the surface of the liquid sufficient to insure formation of seal 82. It has been found that a satisfactory seal is established if chute 84 extends at least four inches below the surface of liquid 86.

It is particularly desirable that the liquid level in vessels 70 and 88 be a substantial distance vertically below entrance opening 20 and exit 30, respectively, to insure that the liquids 72 and 86 will not be carried into the housing by the pressure differential established when a vacuum is drawn within the housing. It is therefore preferred that the liquid levels be a minimum of two feet vertically below the respective openings 20 and 30. Vapor seals 68 and 82 enhance the capacity of condenser coils 50 by as much as 50 percent and virtually eliminate gaseous coolant loss. In addition, with the effectiveness of the gaseous coolant recovery system thus enhanced, the amount of heat generated by the heating means 28 can be substantially increased, such as by utilizing higher wattage heating units. The additional heat increases the amount of liquid coolant which is boiled from the product surfaces in the second compartment before discharging the products through exit opening 30, and thereby decreases liquid coolant losses.

It will be appreciated from the foregoing description that the 20 of housing of the present invention provides a versatile means of automatically carrying out the above described fry potato sugar leaching process, in addition to other processes requiring the movement of products through a liquid coolant. It should be noted that the apparatus housing is substantially closed, thereby minimizing the loss of gaseous coolant therefrom to further reduce the costs of operating the apparatus. Furthermore, it will be appreciated that by utilizing two separate continuous conveyors the temperature conditions of the coolant and re-heat compartments are more effectively isolated from each other. For example, as the first conveyor passes continuously through the liquid coolant at 12°F. and the second continuously through the liquid coolant vapor at about 12°F., the loss of coolant therein is substantially reduced and would have a chilling effect upon the re-heat compartment if it extended therein. Contrastingly, the second conveyor obtains a relatively high temperature coolant from the heater and would have a heating effect upon the cooling compartment if it extended substantially into the coolant compartment or through the liquid coolant reservoir. By providing separate conveyors for the coolant and re-heat steps, the overall efficiency of the apparatus is greatly increased.

It should be noted that minor changes in the materials of the conveyors or the exact location thereof, or in the shape, location or number of condenser coils are deemed to fall within the scope of the present invention. It should also be noted that while the apparatus of the present invention is intended primarily to carry out the above described fry potato sugar leaching process, it may also be utilized in carrying out other processes requiring similar steps involving a liquid coolant and product re-heat.

The foregoing is considered illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed is as new as follows:

1. An apparatus for handling food products and the like, said apparatus comprising a substantially closed housing having first and second portions and including an inlet for receiving the products and an outlet for discharging the products, conveyor means in said housing for advancing the products at a controlled rate between the first and second portions, reservoir means in said housing for containing a liquid coolant for cooling the products advanced by said conveyor means, a portion of said conveyor means extending through said liquid coolant reservoir for passage of the products through, heating means in said housing and remote from said liquid coolant reservoir for heating the products subsequent to cooling in said liquid coolant reservoir and boiling off the coolant adhering to the product, and condensing means in said housing extending generally above said reservoir and said conveyor means for condensing the boiled off coolant for return to said reservoir.

2. The structure set forth in claim 1 further including liquid-type seals communicating with said inlet and outlet to isolate the interior of said apparatus from the ambient.

3. The structure set forth in claim 2 wherein said liquid-type seals comprise a vessel containing a liquid through which said products pass upon entering said inlet and following discharge from said outlet.

4. The structure set forth in claim 3 wherein said liquid is water.

5. The structure set forth in claim 1 wherein said housing includes first and second substantially closed compartments, an inlet opening in said first compart-
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7. The structure set forth in claim 5 wherein said apparatus includes means for returning the recovered liquid coolant to said liquid coolant reservoir.

8. The structure set forth in claim 5 wherein said conveyor means includes a first continuous conveyor comprised of a plurality of product-carrying sections defined by partitions extending at an angle to the direction of travel of the first conveyor, each product-carrying section being at least momentarily completely submerged in the liquid coolant during advance of the first conveyor such that the products are completely submerged in the liquid coolant thereby completely exposing their outer surfaces to the liquid coolant.

9. The structure set forth in claim 8 wherein said conveyor extends past said entrance opening for receiving the products therethrough, said first conveyor being a substantially horizontal position when passing said entrance opening and being in a second substantially horizontal position when passing through said liquid coolant reservoir to force the products down into the liquid coolant.

10. The structure set forth in claim 9 wherein said conveyor means includes shield means extending parallel to the path of travel of said first conveyor as it passes through said liquid coolant reservoir for substantially closing each of said product-carrying sections to prevent displacement of the products therefrom.

11. The structure set forth in claim 8 wherein said conveyor means includes a second continuous conveyor extending through said second compartment to move the products from said communication passage to said exit opening, said first conveyor being oriented to discharge the products carried thereby to said second conveyor, a major portion of said second conveyor being in said second compartment such that it will not significantly heat up said first compartment, and a major portion of said first conveyor being in said first compartment such that it will not significantly cool said second compartment.

12. The structure set forth in claim 11 wherein said heating means is located adjacent said second conveyor to rapidly heat the products passing thereby.

13. The structure set forth in claim 12 wherein said apparatus includes liquid-type seals on said inlet and outlet for isolating the interior of said apparatus from the ambient and vacuum means for removing uncondensed coolant gases from said housing and returning said gases to said liquid coolant reservoir.

14. An apparatus for a potato sugar leaching process, said apparatus comprising a substantially closed housing including first and second compartments, said first compartment including a liquid coolant reservoir for surface freezing the potatoes, said second compartment including heating means for reheating the potatoes subsequent to the surface freezing and boiling off liquid coolant adhering to the potatoes, and conveyor means for advancing said potatoes at a preselected rate through said liquid coolant reservoir in said first compartment and past said heating means in said second compartment.

15. The structure set forth in claim 14 wherein said apparatus includes condenser means for condensing boiled off gaseous coolant in said first and second compartments for return to said liquid coolant reservoir.

16. The structure set forth in claim 15 wherein said condenser means includes inclined banks of condenser coils extending generally above said conveyor means in said first and second compartments.

17. The structure set forth in claim 14 wherein said apparatus includes means for isolating the interior of said compartments from ambient and further includes vacuum means for removing uncondensed coolant gases from said housing.

18. The structure set forth in claim 17 wherein said means for isolating the interior of said compartment comprises liquid-type seals.

19. The structure set forth in claim 14 wherein said conveyor means includes variable speed drive means for controlling the time the potatoes are submerged in said liquid coolant reservoir thereby controlling the depth of surface freezing.

20. The structure set forth in claim 19 wherein said conveyor means includes a first conveyor located substantially in said first compartment for advancing the potatoes through said liquid coolant reservoir, and a second conveyor located substantially in said second compartment for advancing the potatoes past said heating means.

21. The structure set forth in claim 20 wherein said first conveyor is comprised of a mesh-type belt and a plurality of spaced partitions extending at angles from said belt to define potato-carrying sections, said partitions extending downwardly from said belt where said first conveyor passes through said liquid coolant reservoir and being effective to advance the potatoes through the coolant reservoir toward said second conveyor.

22. The structure set forth in claim 21 wherein said heating means is located adjacent said second conveyor including a mesh-type belt to permit passage of the liquid coolant and heat energy therethrough.