

[54] CRYSTALLIZER

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[22] Filed: Oct. 12, 1971

[21] Appl. No.: 188,422

[52] U.S. Cl. 127/15, 127/16, 162/92,
259/9

[51] Int. Cl. C13f 1/02, F28f 5/00

[58] Field of Search 127/16, 15; 165/92

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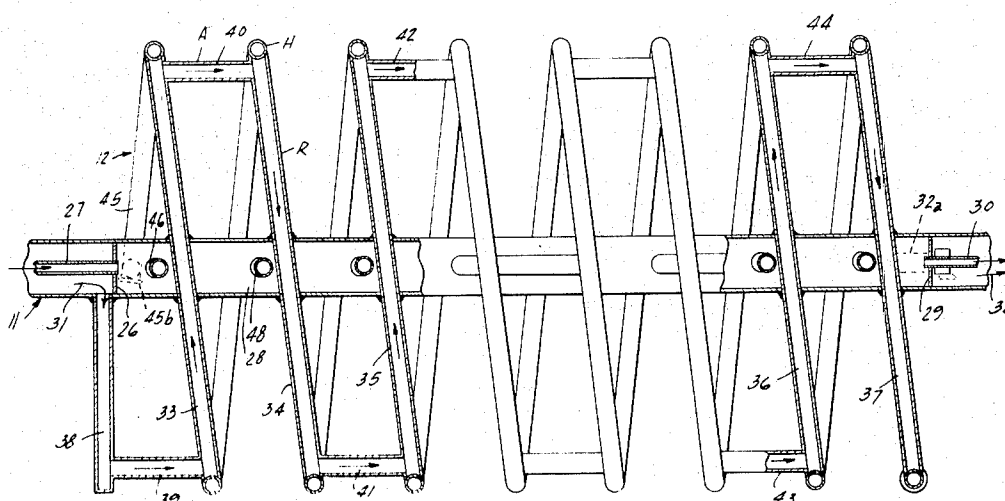
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[57] ABSTRACT

A crystallizer construction for sugar and the like having a cylindrical container with a rotatably driven axially extending hollow shaft therein and a helical tubular coil adjacent the periphery of the container supported on radially extending tubes spaced 90° apart with short, straight axially extending tubes across the end of the ends of the radial tubes with said tubes interconnected so that a heat transfer fluid flows from a first to the second end of the container, back to the first and back to the second by flowing first diametrically through the radial tubes and axially between the ends of the radial tubes in a zigzag path, next through the helical coil and then back through other radial tubes. The hollow shaft conducts a separate flow of heat exchange fluid.

9 Claims, 5 Drawing Figures



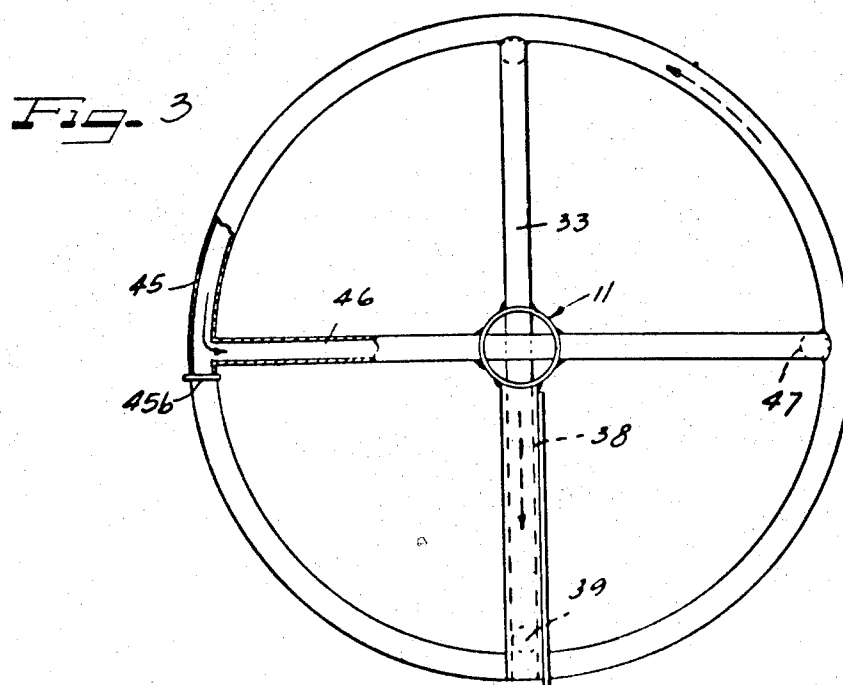
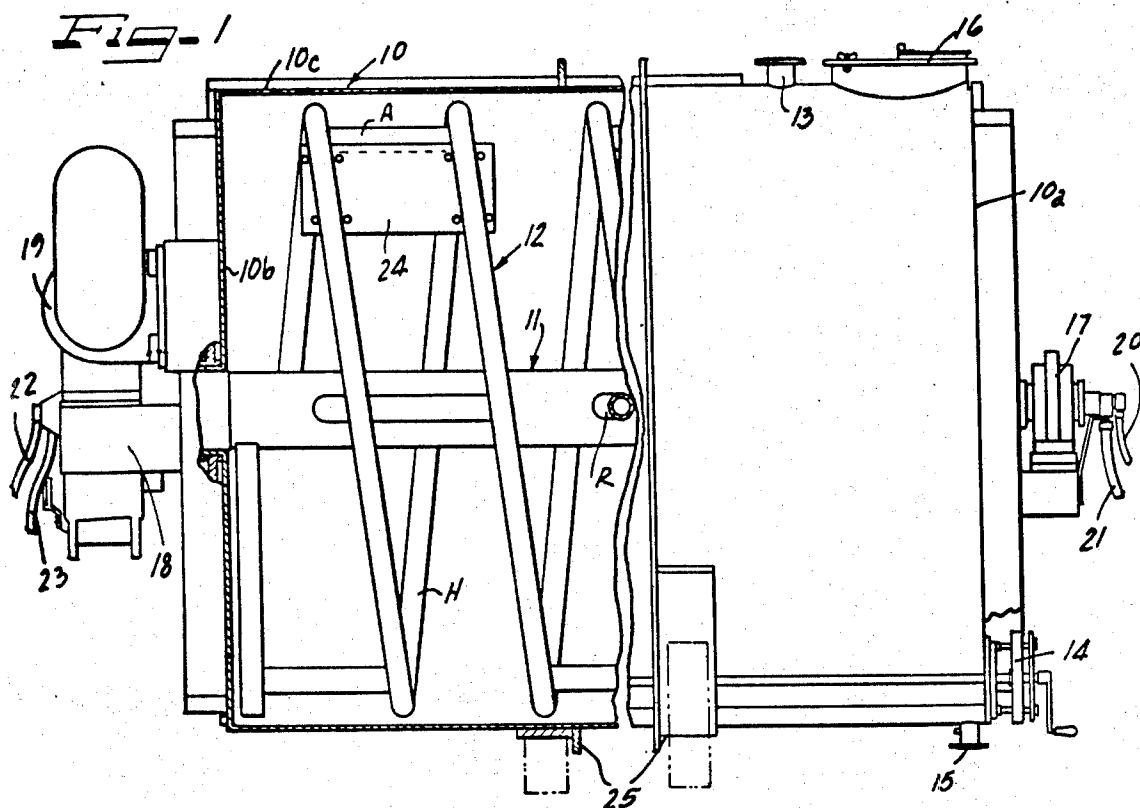


Fig. 2

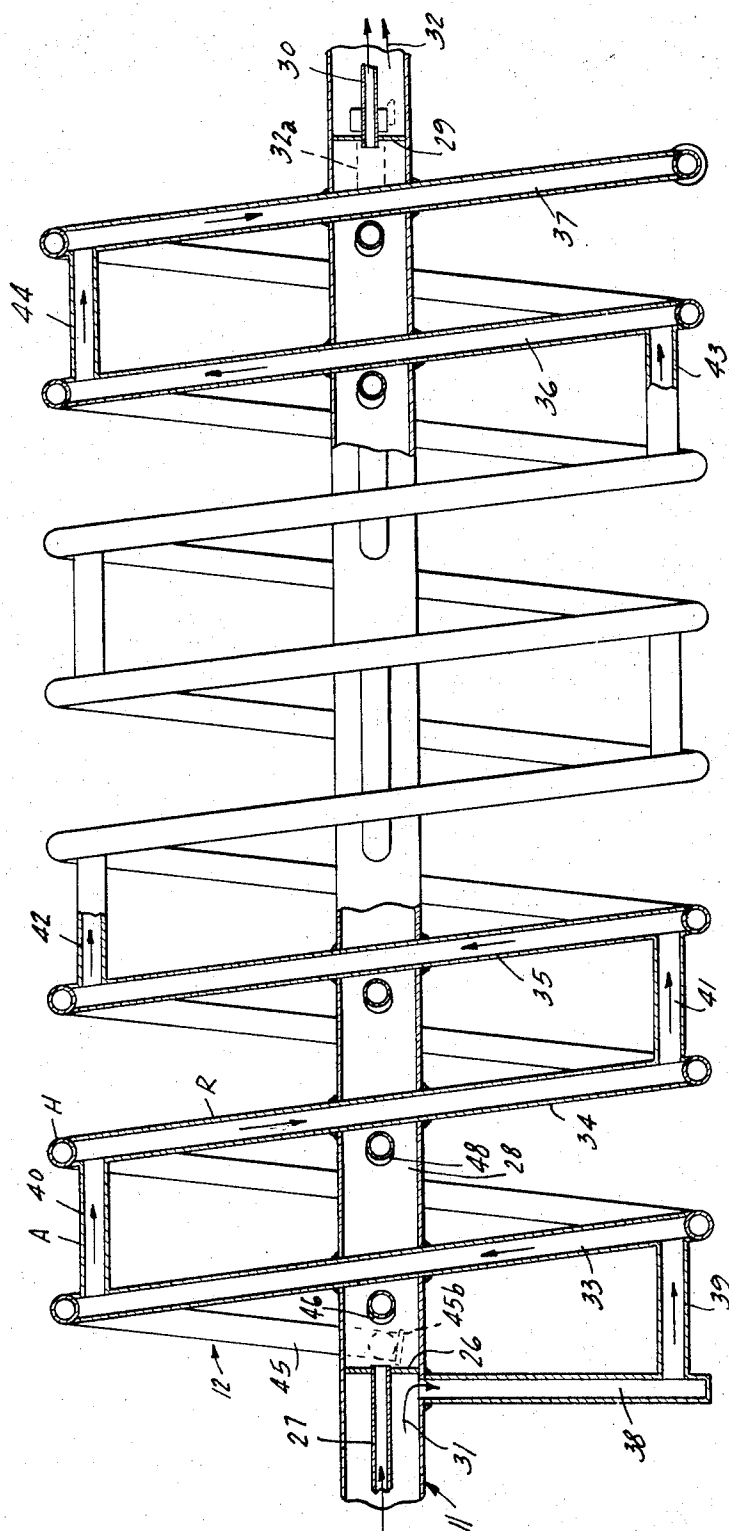


Fig. 4

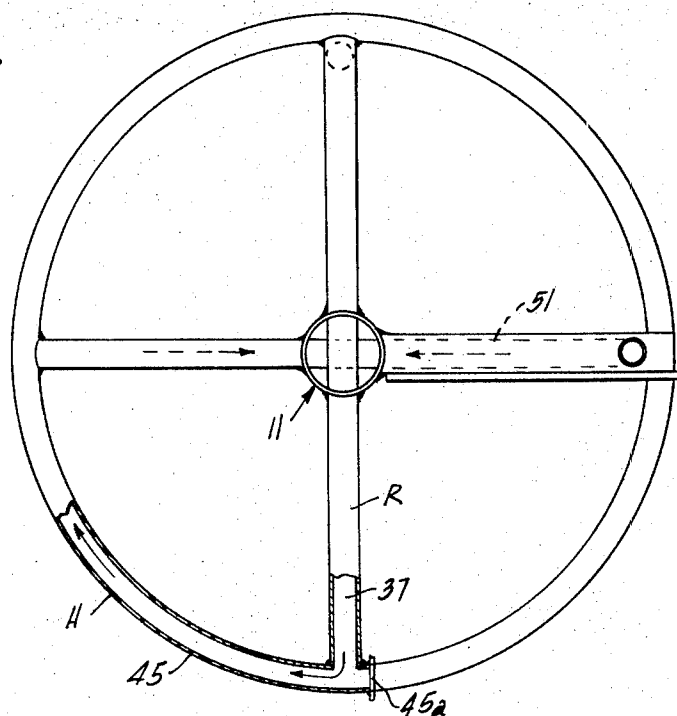
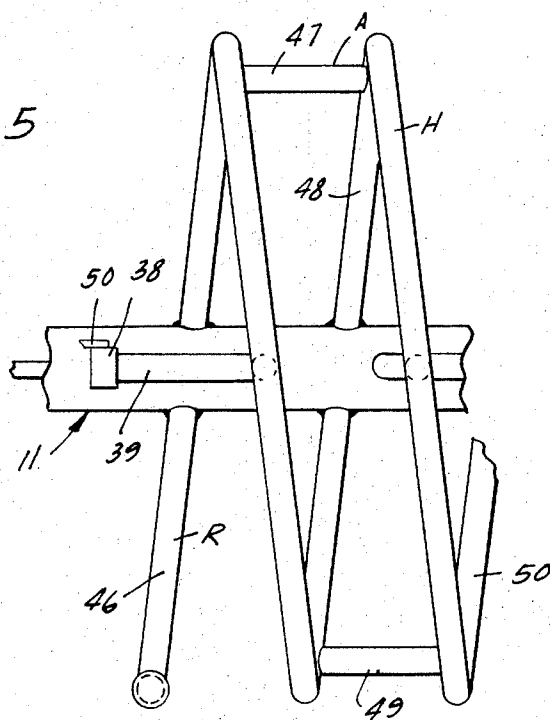


Fig. 5



CRYSTALLIZER

BACKGROUND OF THE INVENTION

The invention relates to an improved crystallizing apparatus such as employed in the manufacture of sugar or other crystalline substances from massecuite by subjecting the material to a heat transfer and agitating action.

In an effective commercial crystallizer, heat transfer must take place rapidly and uniformly and more effective heat transfer will increase the capacity of the crystallizer. It is important to not only have an effective and a substantial area of heat transfer surface but to effectively mix and agitate the materials so that the heat transfer surface is uniformly and constantly exposed to material being mixed. It is conventional to employ a mixer supported on a central shaft extending through the crystallizer with the shaft carrying heat transfer coils and agitating equipment. The arrangement, shape and distribution of these coils is an important factor in attaining a satisfactory high capacity heat transfer operation for crystallization.

It is also an important factor in a successful machine to be able to avoid slow-downs and plugging of the machine with the bridging over of the material between coils so that effective stirring can continue. In a typical crystallizing action heat transfer coolant is passed through the coils. When the material builds up undesirably and bridges melt across the coils and collects on the shaft, steam is passed through them to melt the material and break the bridging and remove the coating.

It is accordingly an object of the present invention to provide a crystallizer structure utilizing a container with a heat transfer rotor therein wherein the coils for the heat transfer fluid are advantageously and uniquely positioned so that they perform a more effective mixing operation coincident with the heat transfer operation for increased effectiveness and output.

A further object of the present invention is to provide a crystallizing mechanism of the type described wherein the heat transfer fluid is conducted through coils which are positioned so that their location corresponds more closely with the volume distribution of the massecuite to be cooled.

It is a further object of the invention to provide a crystallizer wherein the heat transfer fluid coils are designed to offer a means of discharging the massecuite instead of having extra members such as scrolls to do so.

A still further object of the invention is to provide a crystallizer which has an improved distribution of cooling area in proportion to distribution of the product volume and wherein a plurality of fluid circuits are provided so that an independent hot water or steam flow can be passed through cooling coils or center shaft for melting of buildup.

A still further object of the invention is to provide an improved crystallizer having a design which affords a multi-pass fluid flow circuit through the coils.

A feature of the invention is the provision of a hollow tubular shaft with coils mounted thereon wherein the shaft accommodates one fluid circuit and the coils accommodate a separate independent fluid circuit.

A further feature of the invention is the provision of a rotary shaft within a crystallizer container wherein a helical coil is mounted on tubular spokes with the spokes so arranged that they conduct heat transfer fluid

flow in separate zigzag passes through the container with coil arrangement providing three passes through the container.

Other objects, advantages and features, and equivalent constructions and operations will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiment in the specification, claims and drawings in which:

IN THE DRAWINGS

FIG. 1 is an elevational view, with a portion in section, of a crystallizer constructed and operating in accordance with the principles of the present invention;

FIG. 2 is a fragmentary elevational view, with portions broken away, of the heat transfer rotor of the crystallizer mechanism of FIG. 1;

FIG. 3 is an end elevational view, with portions broken away, taken from the left end of FIG. 2;

FIG. 4 is an end elevational view taken from the righthand end of FIG. 2, with parts broken away; and

FIG. 5 is a fragmentary elevational view of a portion of the structure of FIG. 2, but with the rotor rotated 90° from the position of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates the crystallizer having a hollow cylindrical container 10 with a shaft 11 rotatably mounted thereon being supported in bearings 17 and 18 on the ends walls 10a and 10b of the container. The container has an outer cylindrical wall 10c provided with a fitting for delivery of the material to be processed. An inlet fitting is shown at 13 and the processed contents can be removed through a discharge valve opening 14. A drain and steam cleanout is provided at 15 and an inspection manhole opening is provided at 16. The container is of stainless steel or similar non-corrosive material suited to the processing of food-stuffs. For crystallizing sugar and the like, it is continually stirred and treated by a heat transfer rotor 12 mounted on the shaft 11.

The rotor 12 which effects the stirring and which is formed of hollow tubes so as to conduct a coolant for the crystallization process basically comprises a helical shaped tube H which extends coaxially from one end of the container 10 to the other with its coils positioned adjacent the periphery of the container. The rotor also includes radial tubular elements R which extend continuously diametrically across the rotor and are positioned in two rows with the rows 180° apart so that there is a radial heat exchange and stirring member each 180° around the shaft. The rotor further contains axial tubes A which bridge across the ends of the radial tubes R and are connected so that flow is in a zigzag path from one side of the container to the other until a full axial pass is completed. All of the tubular elements are arranged so that the heat exchange coolant flows in a first axial pass from one end of the container to the other, in a return axial pass through the helical tubes H, and then in a third axial pass.

The flow arrangement is also constructed so that there are two separate circuits flowing through the heat exchange mechanism, one circuit being formed through the hollow shaft 11 and the other circuit being formed through the tubes 12.

The shaft is driven in rotation by a driving motor and gear reduction arrangement. With continued rotation, the contents of the container 10 are stirred and continued changed exposure between the contents and the heat exchange tubes is effected, and the tubes are so constructed and arranged so that they will have a concentration of area toward the periphery of the container where the greatest concentration of material is found. This provides an advantage over structures heretofore available which merely provided heat exchange surfaces and did not distribute them in accordance with the distribution of material being treated.

For flow through the hollow shaft 11 and the tubes 12 inlet lines 20 and 21 are provided. After the heat exchange fluids in the two circuits have passed through the container they are discharged through lines 22 and 23 at the other end.

Suitable supports 25 are provided for mounting the container on a framework or stand.

In certain cases for aiding in stirring, there are provided a number of paddles attached to the radial tubes such as shown by the paddle 24.

FIGS. 2 through 5 will better illustrate the intricacies of construction of the rotor. As illustrated in FIG. 2, the shaft 11 is a hollow cylinder. Barrier plates 26 and 29 are located at the ends so that the center portion of the tube will conduct the thermal transfer fluid, and the deliver line 27 and discharge line 30 are connected through holes in the plates 26 and 29. The lines 27 and 30 are connected to rotary pressure joints not shown. Either cold or hot fluid may be directed through the shaft.

Heat transfer fluid for the tubes is delivered at 31, and when it has completed its circulation through the tubes it is discharged as shown at 32 through line 32a. By arranging the flow of heat transfer fluid in two separate circuits, the stream, or heated water can be flowed through either of the circuits in the event of bridging or hardening of the crystallized material on the rotor. This material tends to collect on the shaft so that steam can be directed through the shaft during operation to remove this material without interfering with the flow of heat exchange fluid through the rotor tubes. Similarly, if bridging of material occurs between the rotor tubes, steam can be directed through the tubes without interfering with the flow of heat exchange fluid through the shaft. Thus, with sugar buildup between parts it can be easily cleared. Further, the arrangement of the tubes themselves is such that the requirement for separate structural supports is eliminated. This reduces the chance of sugar buildup between adjacent parts. Small scrapers such as shown at 50 in FIG. 5 may be provided but these are mounted on the tubular rotor and the heat exchange rotor itself provides the supports for these members.

The first pass of the heat exchange fluid through the rotor is through a combination of radial and axial tubes. As shown in FIGS. 2 and 3, the heat exchange fluid enters at 31 flowing first radially outwardly in a radial tube 38 and then into an axial tube 39. The fluid then flows into radial tube 33 diametrically across the container and then into axial tube 40, and then into radial tube 34, into axial tube 41, radial tube 35, and axial tube 42. The fluid is thus conducted in a zigzag path from one end of the container to the other and as shown on the righthand side of FIG. 2 after flowing through axial tube 43, flows through radial tube 36,

through axial tube 44, through radial tube 37 and then the fluid is directed into its second pass. In the second pass it flows into one end of the helical tube 45, as shown in FIG. 4. The helical tube 45 can be made of one piece with a wall 45a, FIG. 4, at the end. Flow through the second pass then proceeds helically until the heat exchange fluid reaches the left end of the container. At that point, as shown in FIG. 3, it passes into a radial tube 46 and the helical tube is provided with an end wall 45b. The helical tube 45 and the radial tube 46 are interconnected by merely cutting a generally circular hole in the wall of the tube 45 and welding the end of the tube 46 in place. A similar connection is made to connect the axial tubes to the radial tubes. As shown in FIG. 2, the radial tubes also perform the function of supports for the helical tubes and the helical tubes can be welded to the ends of the radial tubes to close the ends and flow at the end of the radial tubes passes to the axial tubes.

When the flow finishes its second pass, and flows into the radial tube 46, it then flows diametrically across the container to flow into an axial tube 47, FIG. 5 (FIG. 5 is rotated 90° from the view of FIG. 2). From the axial tube 47, it flows into another radial tube 48, then to axial tube 49 and again into radial tube 50 following the pattern of the radial and axial tubes in a zigzag path for the full length of the container until the fluid has completed its third pass.

At the end of the third pass the fluid flows into the radial line 51, FIG. 4, and out through the line 32a, FIG. 2.

Thus, with the multi-pass design an increase in cooling area has been effected without a concentration of tubes. The tubes can be made of stainless steel and commercial tubing can be used for a relatively less expensive construction.

The major cooling operation takes place at the area of maximum radius where the largest volume distribution of the material to be cooled is located. Further, the axial portions provide good stirring members and with their location and the location of the helical coil out at the inner periphery of the container, effective cooling takes place at that location. The tubes are positioned so that the contents flow over the tube surfaces for greatest change of exposure of heat transfer surface. The structure does not employ cooling through a stationary water jacket on the outside of the tank which has been done heretofore and which is inefficient and expensive and yet the present structure has attained a high capacity. The structure has avoided the use of structural steel for supports for the tubes and scrapers, thus eliminating unsanitary design features. The arrangement of the helical coil with the radial and axial members eliminates the need for a helical sweep conveyor. A spacing of radial members of at least 12 inches apart is possible because of the high cooling efficiency and this minimizes the bridging. The high concentration of cooling within the container without the use of water jackets eliminates the objectionable sweating due to condensation of cooling members with structures heretofore available.

We claim as our invention:

1. A crystallizer construction for sugar and the like comprising in combination:
 - a hollow container for containing a product for a heat exchange process;
 - a shaft within the container mounted for rotation;

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means for driving the shaft in rotation about an axis;
a plurality of axially extending relatively straight
short tubes supported to rotate with the shaft for
conducting a heat exchange medium and for agitat-
ing the product within the container;

support means for the axial tubes in the form of a plu-
rality of relatively straight radially extending tubes
supported on the shaft;

the ends of said radial tubes and the ends of said axial
tubes being interconnected so that the fluid flows
alternately radially outwardly and then axially and
then inwardly in an alternating direction back and
forth across the container.

2. A crystallizer construction for sugar and the like
constructed in accordance with claim 1:

wherein the shaft is hollow and a separate fluid cir-
cuit is provided for directing fluid through the shaft
independent of the fluid flowing through said
tubes.

3. A crystallizer construction for sugar and the like
constructed in accordance with claim 1:

wherein said interconnected radial and axial tubes
are arranged in a first and a second set wherein the
heat exchange fluid flows from one end of the con-
tainer to the other in the first set, and thereafter
flows from one end of the container to the other in
said second set.

4. A crystallizer construction for sugar and the like
constructed in accordance with claim 3:

wherein the radial tubes of said first and second sets
are positioned substantially 90° apart on the shaft.

5. A crystallizer construction for sugar and the like
constructed in accordance with claim 3:

including a helical axially extending tubular coil in-
terconnecting said first and second sets.

6. A crystallizer construction for sugar and the like

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comprising in combination,

a hollow container for containing a product for a heat
exchange process,

a hollow central shaft mounted within the container,
means for driving the shaft in rotation about an axis,
fluid conducting tubes supported on said shaft for ro-
tation therewith,

a first fluid circuit conducting a heat exchange fluid
through the shaft, and

a second fluid conducting circuit independent of the
first directing a heat exchange fluid through said
tubes so that separate flows may be directed
through said circuits.

7. A crystallizer construction for sugar and the like
constructed in accordance with claim 6 wherein said
tubes include a helical coil extending for the length of
the container, radial support tubes mounting the helical
coil on the shaft, and axially extending tubes connect-
ing between the ends of said radial tubes with flow
through each of the tubes.

8. A crystallizer construction for sugar and the like
constructed in accordance with claim 7 wherein said
tubes are connected so that fluid flow passes diametri-
cally from one side of the container to the other in a ra-
dial tube and then through an axial tube to another ra-
dial tube to flow diametrically to the other side of the
container for flow from one end of the container to the
other, and said fluid flows through the helical coil back
to the first end of the container and then through other
radial support tubes diametrically from one side of the
container to the other and back to said other end of the
container.

9. A crystallizer construction for sugar and the like
in accordance with claim 8 wherein said radial tubes
are spaced 90° apart on the shaft.

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