Aug. 13, 1935. W. J. BLANCHARD 2,011,032

HEAT EXCHANGER

Filed Jan. 23, 1935 2 Sheets-Sheet 1

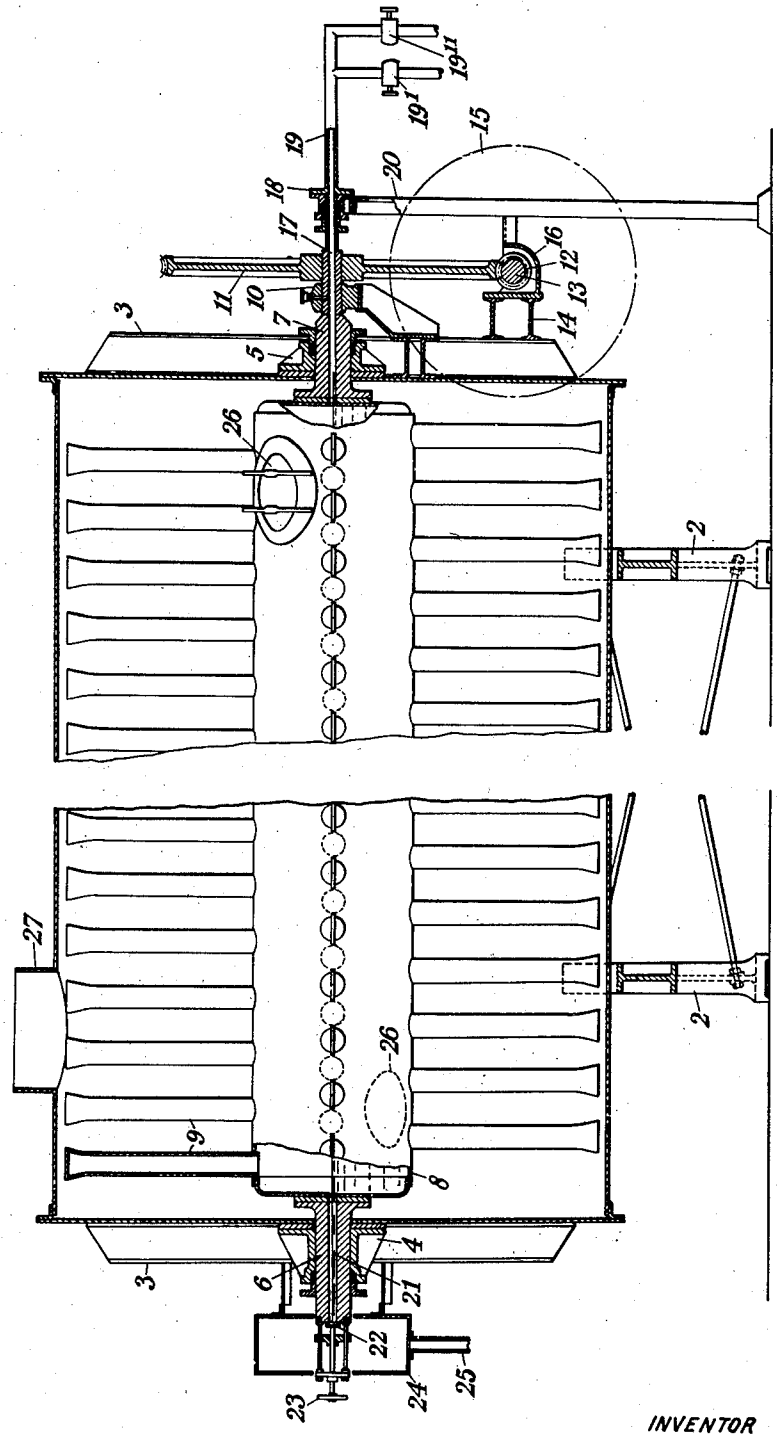


Fig. 1

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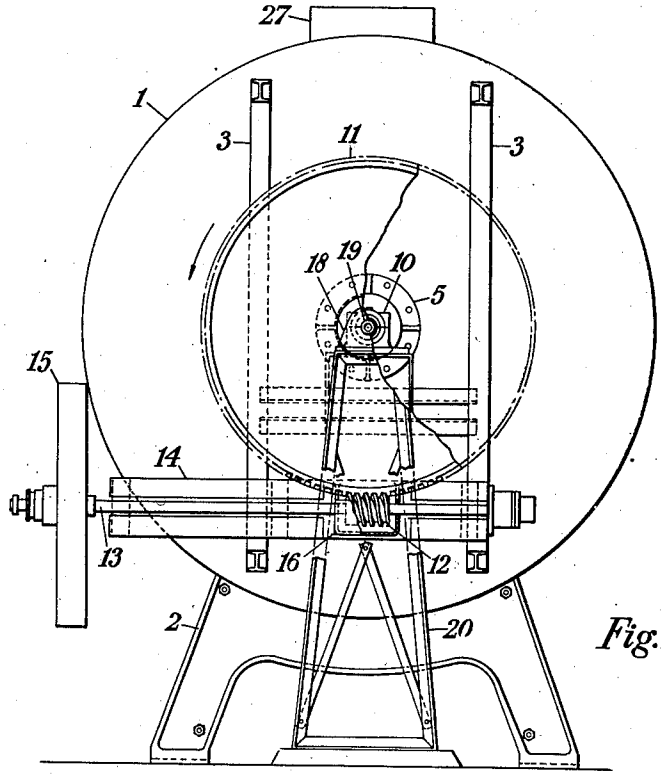


Fig.2

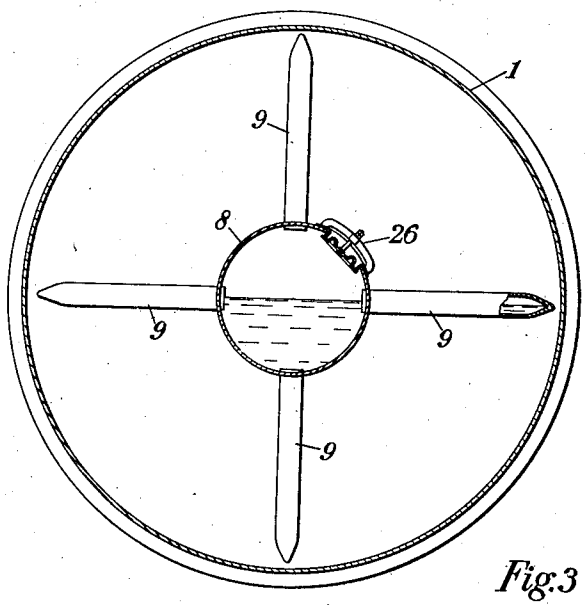


Fig.3

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2,011,032

HEAT EXCHANGER

Walter Joseph Blanchard, London, England

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12 Claims. (Cl. 257—79)

The present invention relates to heat exchangers and more particularly to devices of this character suitable for use as crystallizers in sugar manufacture. The invention however is not limited to this application and can be used for various other purposes, some of which are hereinafter specified.

An object of the present invention is to provide a heat exchanger with rugged construction and simple design which will be easy to maintain in good order and to keep clean.

Another object of the invention is to provide a heat exchanger in which a mass to be treated may be cooled or heated uniformly throughout its bulk.

A further object of the invention is to provide a heat exchanger in which both the treating material and the mass to be treated are agitated.

Still another object of the invention is to provide a heat exchanger in which the entire bulk of the mass to be treated will be traversed by the treating material.

Other objects of the invention will be apparent from the following description as it proceeds.

The heat exchanger comprises an outer container and a rotatable inner container in the form of a drum having a series of outwardly projecting tubes disposed along its length in such a manner that the paths swept out by successive tubes overlap.

More specifically the heat exchanger comprises two concentric drums, the outer one of which is fixed, the inner drum being rotatable and provided with a series of tubes communicating at their inner ends with the interior thereof and closed at their outer ends, said tubes projecting radially outward from said inner drum towards the outer drum and being so disposed that the paths swept out by successive tubes overlap.

The two drums are preferably cylindrical and concentric, the inner rotatable drum being mounted on journals supported at the axis of the outer drum, and these journals may comprise stuffing boxes providing fluid tight bearings.

According to a feature of the invention treating fluid is supplied to and led out from the inner rotating drum by way of axial conduits provided in the supporting trunnions. The flow of fluid therethrough may be controlled at one or both ends by suitable valves.

The inner drum may be rotated by any gearing such as a worm gearing.

Access is preferably provided to the interior of the inner drum by way of manholes normally closed by suitable covers, whereby cleaning of the interior thereof is made possible. Moreover means may be provided for automatically cleaning the interior and exterior surfaces of the inner drum and the tubes connected thereto.

The axes or the common axis of the containers may conveniently be arranged horizontally or nearly so whereby, if the inner container is partially filled with liquid, the projecting tubes along the whole length thereof will be emptied at each revolution of the container as they are raised above the horizontal axis.

According to a modification of the invention the two drums may be arranged to rotate together as a single unit.

In order that the invention may be more clearly understood an embodiment thereof will now be described with reference to the accompanying drawings in which:

Fig. 1 is a sectional longitudinal elevation,

Fig. 2 is an end view in part broken away, and

Fig. 3 is a transverse section of a heat exchanger constructed according to the invention.

Referring to the drawings, the heat exchanger comprises an outer drum 1 mounted on a supporting framework 2. The end walls of the drum are reinforced by the girders 3, and carry at their centres journals 4 and 5 through which pass respectively the trunnions 6 and 7. The journals 4 and 5 are shown as comprising a simple form of stuffing box, but of course, any suitable construction may be employed.

The trunnions 6 and 7 support between them an inner drum 8 from which project the tubes 9 which, as will be seen from Fig. 1, are arranged around the drum in a spiral formation and so that the paths they sweep out as they rotate overlap. In the arrangement shown, the paths overlap by one half the width of a tube, but it will be understood of course that the extent of overlap may be greater or less as may be found most suitable for the work contemplated.

The trunnion 7 at its outer end seats upon a thrust bearing 10 which is supported by a bracket from the drum 1. All expansion therefore takes place away from this bearing and is provided for at the other end of the machine. Keyed on the trunnion 7 is a worm wheel 11 which is engaged by a worm 12 located on the shaft 13 which latter is supported in saddle bearings fixed on the girders 14 mounted on the end of the drum 1. An electric motor or any other suitable form of drive applied to the pulley 15 is employed to rotate the worm. A clutch mechanism of any suitable type may be incorporated in the drive. The worm 12 is shown as encased in an oil bath 16 by means of

which the worm mechanism is kept suitably lubricated.

Passing through the trunnion 7 is a conduit 17 which is continued through a stuffing box 18 to a fixed supply pipe 19. This pipe may be branched as shown, one branch being employed for the supply, say, of cooling water, while the other serves for the supply of steam. These branches may be controlled by the respective valves or cocks 19', and 19''. The stuffing box 18 is shown supported on a framework 20, although of course any other supporting means which may be more convenient may be employed.

At the other end of the machine the trunnion 6 is provided with an outlet conduit 21 controlled by a screw-down control valve 22 which may be adjusted by the hand wheel 23 according to requirements. The outlet from the conduit 21 feeds into the splash box 24 with which is connected the outlet pipe 25.

Access to the interior of the inner drum is provided by means of the manholes 26 closed by suitable covers and preferably provided as shown one at each end of the drum. It is thus possible for a cleaner to enter the drum and clean the interior of the tubes 9 as well as the inner surface of the drum 8.

The tubes 9 may be fastened to the inner drum 8 in any desired way, suitably by welding. The ends of the tubes may be closed by caps or in any other suitable way but preferably by flattening and welding the flattened seam, the flat portion being arranged in the direction of the axis of the container. Alternatively, it may be arranged obliquely so as to cause a feed of the material in the outer container and for this same purpose, if desired, the tubes themselves may be of flattened cross section and be arranged obliquely with refreence to the axis of the container.

It will be understood of course that modification may be made in the construction of the machine without departing from the scope of the present invention, and according to one such modification, the inner and outer drums may be arranged to revolve together as a single unit. It will be readily understood that the operation of the machine in this way will be similar to the operation of the machine as above described, since the rotation of the outer drum will not substantially affect the mass to be cooled.

In the operation of the machine as a sugar crystallizer, the massecuite from the vacuum pans is delivered hot into the drum 1 by way of the chute 27, while cold or warm water for the cooling or heating thereof is fed through the pipe 19 into the inner cylinder. The valve 22 may be fully opened, in which case, since the outlet is arranged on the central axis, the inner container will be maintained approximately half full of water. The actual level of the water in the inner container can however be regulated by suitable adjustment of the valve 22 or by the arrangement of a suitable overflow or siphon at the outlet end, but it is important that the hollow interior of the inner container should not be completely filled with cooling water.

It will thus be seen that as the inner drum rotates the cooling water contained in the downwardly directed tubes 9 is emptied out as these tubes rise above the horizontal, cooling during the upper cycle being effected by the film of water left in the tubes and by the heat absorption of the material of the tubes themselves. By virtue of the spiral arrangement or overlap of the tubes it is apparent that the entire mass to be cooled within the drum 1 will be traversed by the cooling tubes. Furthermore, the cooling water in the inner drum is in a constant state of agitation. These two facts combine to produce an extremely uniform cooling of the mass.

The tubes 9 are preferably arranged sufficiently widely spaced to avoid revolving the mass as a whole and so that the crystals forming in the mass are treated gently and are not broken or ground. The tendency is therefore, to produce large crystals since no sudden chilling takes place and the existing crystals are caused to grow instead of batches of minute new crystals forming. This is particularly desirable in sugar manufacture in order that the operation of separating the crystals from the mother liquor in the centrifugal machines may be simplified. The larger the crystals which are obtained the easier and more efficient is the subsequent separation and consequently the better the yield of sugar.

After the desired temperature in the crystallizer has been attained it is usually found that the mother liquor is still supersaturated with sugar. Useful advantage of this fact can be taken by heating the mass by passing steam or hot water through the inner container so as to make the separation of the mother liquor from the sugar crystals more easy in the centrifugal separators. No sugar is dissolved by this heating because the mother liquor is still supersaturated.

Although the invention has been so far described particularly with reference to a crystallizer for sugar manufacture, it will be understood of course that many other uses may be found for the machine. It may, for instance, be employed for heating a liquid in the inner container by passing steam or flue gases through the outer container or vice versa. If the device is to be used for heating a liquid in the inner container it is preferable not to fill this container completely, so that circulation of the liquid through the tubes is effected in the manner above described.

Where the apparatus has to be used for heating by passing steam through the inner container, troughs may be arranged inside this container to collect the condensate for discharging and which would thereby avoid accumulation thereof.

As mentioned above, accumulated scale rust or other deposits in the heat transmitting surfaces either internally or externally can be removed by manual cleaning for which purpose the manholes 21 are provided. Scale may be removed from inside the tubes 9 in any suitable way, a convenient method being to pass a grinder down the interior of each tube. It may be desirable however, to effect the cleaning automatically. For example, the tubes could be kept clean on the outside by means of a ring placed loosely around each tube which slides up and down by its own weight during the rotation of the inner container. Such a ring would best be made pliable, such as a ring of chain, and loosely fit around the tubes. This arrangement could be used for cleaning soot off the external surfaces of the tubes if the contents of the inner container are being heated by flue gases passed through the container. For cleaning the tubes internally, a loosely fitting plunger which would move up and down inside the tube during rotation may be provided. Alternatively, some moderately abrasive material, such as pebbles or shot, could be placed in bulk inside the inner container to some point lower than the horizontal centre line. This material should be heavier than the fluid in the

inner container and would remain in the machine indefinitely, continuously moving in and out of the various tubes to clean the same.

I claim:

1. Heat exchanger comprising a fixed outer drum, an inner drum, trunnions on said inner drum, journals mounted in the ends of said outer drum supporting said trunnions, conduits formed in said trunnions, the conduit at one end affording communication between a liquid supply pipe and the interior of said drum, the conduit at the other end affording an outlet for liquid and tubes arranged on said inner drum radiating therefrom and disposed in spiral formation around said inner drum in such a manner that the paths swept out thereby as the inner drum rotates overlap.

2. Heat exchanger comprising a fixed outer drum, an inner drum, trunnions on said inner drum, journals mounted in the ends of said outer drum and tubes projecting from said inner drum, said tubes being arranged in straight longitudinal rows, the tubes in successive rows being displaced longitudinally by a distance equal to one half the width of a tube.

3. Heat exchanger comprising a fixed outer drum, an inner drum, trunnions on said inner drum, journals mounted in the end walls of said outer drum supporting said trunnions, conduits formed in said trunnions, one of said conduits connecting a supply pipe with the interior of said inner drum, the other of said conduits affording an outlet from said inner drum, a control valve regulating said outlet, said inner drum comprising tubes projecting radially outward therefrom and arranged in spiral formation thereon in such a manner that the paths swept out thereby as they rotate overlap.

4. Heat exchanger comprising a fixed outer drum, an inner drum, trunnions on said inner drum, journals mounted in the end walls of said outer drum supporting said trunnions, conduits formed in said trunnions, one of said conduits connecting a supply pipe with the interior of said inner drum, the other of said conduits affording an outlet from said inner drum, a control valve regulating said outlet, a splash box encasing said outlet and the control valve therefor, said inner drum comprising tubes projecting radially outward therefrom and arranged in spiral formation thereon in such a manner that the paths swept out thereby as they rotate, overlap.

5. Heat exchanger comprising a fixed outer drum an inner drum, trunnions on said inner drum, journals mounted in the ends of said outer drum supporting said trunnions, one of said trunnions engaging a thrust bearing by which longitudinal movement thereof is limited, clearance to accommodate expansion between the ends of said inner and outer drums at the other end of the machine, and tubes on said inner drum projecting radially outward therefrom, and so arranged thereon that the paths swept out by said tubes as they rotate overlap.

6. Heat exchanger comprising a fixed outer drum an inner drum, trunnions mounted on said inner drum, journals mounted in the ends of said outer drum supporting said trunnions, a thrust bearing limiting longitudinal movement of the of said trunnions, a clearance being provided for expansion at the other end of the machine, conduits formed in said trunnions, a coupling comprising a stuffing box connecting one of said conduits to a supply pipe, the other of said conduits constituting an outlet from said inner drum and tubes on said inner drum radiating outwardly therefrom, and arranged thereon so that the paths swept out by said tubes as they rotate, overlap.

7. Heat exchanger comprising a fixed outer drum an inner drum, trunnions mounted on said inner drum, journals mounted in the ends of said outer drum supporting said trunnions, a thrust bearing engaging one of said trunnions and limiting longitudinal movement thereof, driving means comprising a worm gear applied to one of said trunnions, and tubes arranged on said inner drum radiating outwardly therefrom and disposed so that the paths swept out by said tubes, as they rotate, overlap.

8. A heat exchanger comprising an outer container and an inner container in the form of a drum, trunnions on said inner drum, journals mounted in the ends of said outer container supporting said trunnions, conduits formed in said trunnions, the conduit at one end affording communication between a liquid supply pipe and the interior of said drum, the conduit at the other end affording an outlet for liquid, and tubes arranged on said inner drum radiating outwardly therefrom, successive tubes in the direction of rotation being spaced in the longitudinal direction by a distance that is less than the diameter of a tube.

9. Crystallizer comprising a fixed outer drum, an inlet for hot solution in said drum, an inner drum, trunnions mounted on said inner drum, journals mounted in the ends of said outer drum supporting said trunnions, an inlet conduit for cooling water passing through one of said trunnions through which water is supplied to the interior of said inner drum, tubes communicating with the interior of said inner drum and radiating outwardly therefrom, said tubes being closed at their outer ends and being arranged on said drum with successive tubes in the direction of rotation longitudinally displaced by a distance less than the diameter of a tube, an outlet conduit for said cooling water passing through the other said trunnion, and means for controlling the mean level of the cooling fluid in said inner drum.

10. Crystallizer comprising a fixed outer drum constituting a container for hot solution, an inner drum mounted on hollow trunnions journalled in the ends of said outer drum, means comprising said hollow trunnions for passing treating fluid through said inner rotatable drum, a series of tubes radiating from said inner rotatable drum outwardly towards said outer container, said tubes communicating at their inner ends with the interior of the inner drum, and being disposed on said inner drum with the axes of successive tubes longitudinally displaced along said inner drum by a distance less than the diameter of a tube, and means for rotating said inner drum, whereby said tubes are passed through the hot solution in said outer drum to traverse the whole volume thereof in a single revolution of said inner drum.

11. Crystallizer comprising a fixed outer drum constituting a container for hot solution, an inner drum mounted on trunnions journalled in the ends of said outer drum, conduits passing through said trunnions, the conduit at one end constituting an inlet for cooling water and the conduit at the other end constituting an outlet for said water, means for controlling the flow of water through said inner drum, and a series of tubes projecting radially outwards from said inner drum, said tubes being arranged on said

inner drum with successive tubes longitudinally spaced by a distance less than the diameter of a tube, said tubes communicating at their inner ends with the hollow interior of said inner drum and being closed at their outer ends, said tubes moreover extending from said inner drum substantially to the inner surface of said outer drum, and means for rotating said inner drum, whereby substantially the entire mass of solution to be cooled is traversed by said tubes in a single revolution of said inner drum.

12. Crystallizer comprising a fixed outer drum constituting a container for hot solution, an inner drum mounted on trunnions journalled in the ends of said outer drum, conduits passing through said trunnions, the conduit at one end constituting an inlet for cooling water and the conduit at the other end constituting an outlet for said water, a screw-down valve controlling said outlet conduit, and a series of tubes projecting radially outwards from said inner drum, said tubes being arranged on said inner drum with successive tubes longitudinally spaced by a distance less than the diameter of a tube, said tubes communicating at their inner ends with the hollow interior of said inner drum and being closed at their outer ends, said tubes moreover extending from said inner drum substantially to the inner surface of said outer drum, and means for rotating said inner drum, whereby substantially the entire mass of solution to be cooled is traversed by said tubes in a single revolution of said inner drum.

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