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R. A. CHADBURN ET AL
HEAT-EXCHANGERS

3,147,799

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2 Sheets-Sheet 1

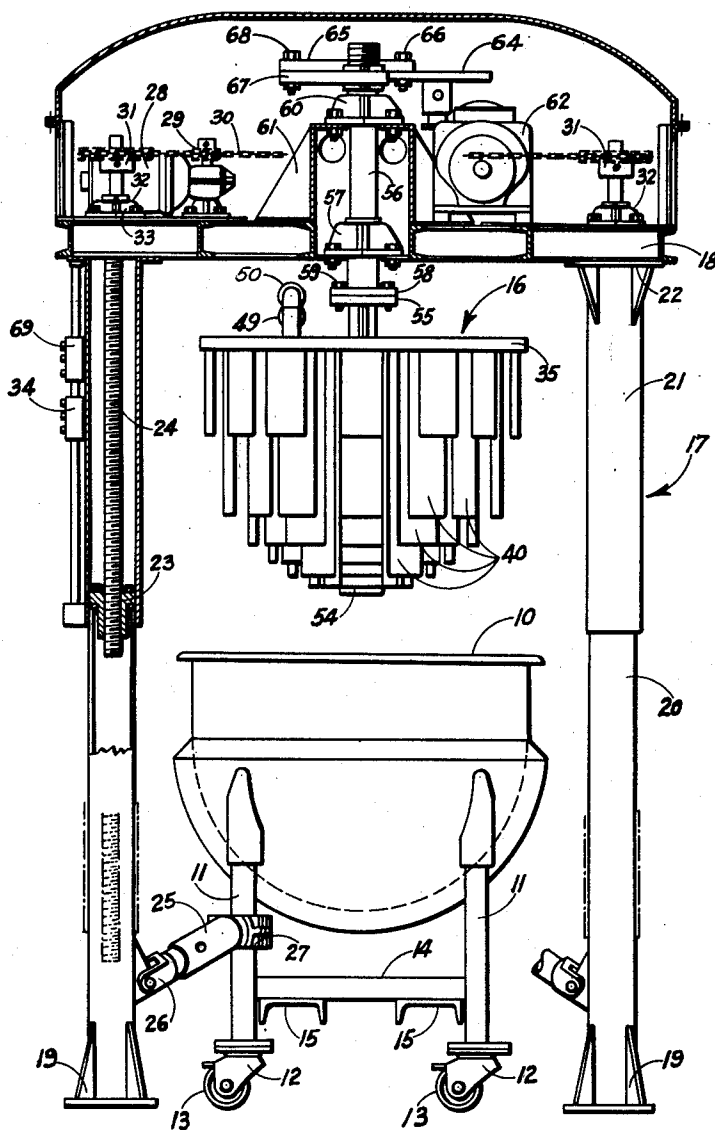


FIG. 1

INVENTORS
ROBERT A. CHADBURN,
WILLIAM H. DIVINE AND
WILLARD R. ZAHN
BY

Sidney N. Rosenfeld
ATTORNEY

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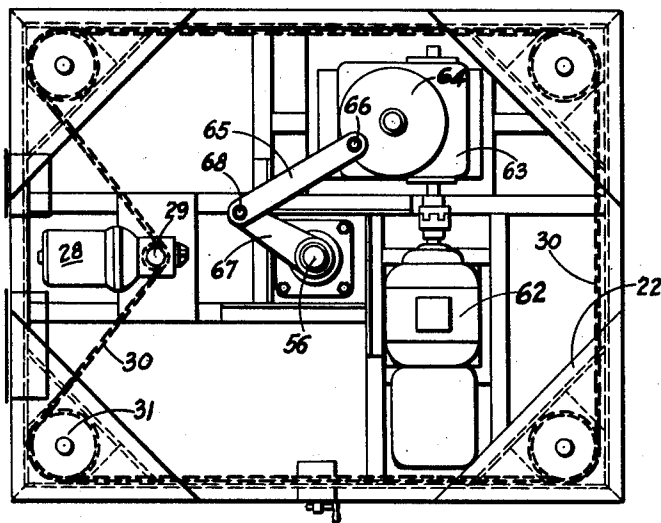


FIG. 2

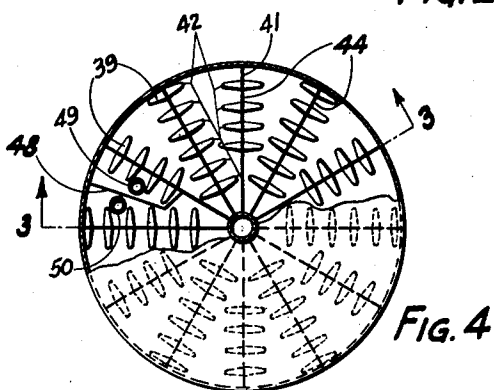


FIG. 4

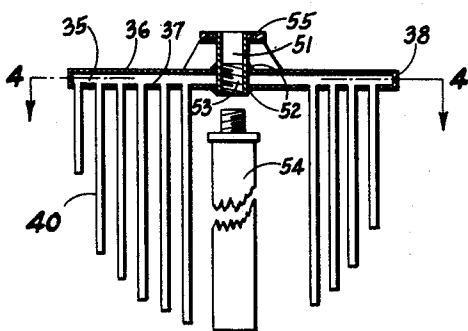


FIG. 3

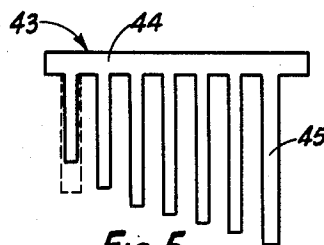


FIG. 5

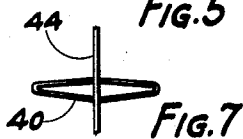


FIG. 7

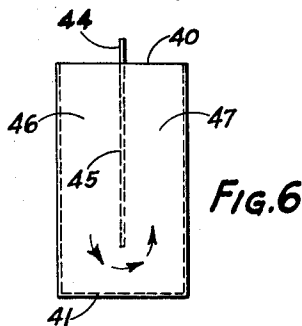


FIG. 6

INVENTORS
ROBERT A. CHADBURN,
WILLIAM H. DIVINE AND
WILLARD R. ZAHN

BY

Sidney N. Rosenfeld
ATTORNEY

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HEAT-EXCHANGERS

Robert A. Chadburn and William H. Divine, Spring Garden Township, York County, and Willard R. Zahn, West Manchester Township, York County, Pa., assignors to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

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3 Claims. (Cl. 165-86)

This invention relates to heat-exchangers and, more particularly, to heat-exchangers adapted for the batch cooling or heating of liquids.

It is an object of the invention to provide a liquid heat-exchanger, including a plurality of banks of heat-exchange tubes adapted for insertion into a liquid to be heated or cooled, and wherein a heat-exchange fluid is passed in series flow through the various banks. Yet another object of the invention is to provide a heat-exchanger of the type just above-mentioned, wherein means are provided for oscillating the heat-exchange tubes to increase heat transfer.

A further object is to provide an oscillatable heat-exchanger for batch cooling of liquid of minimum power requirements, easily cleaned, and wherein no stratification of the liquid to be heated or cooled may occur.

The invention consists of the novel constructions, arrangements and devices to be hereinafter described and claimed for carrying out the above-stated objects and such other objects as will appear from the following description of a preferred embodiment of the invention described with reference to the accompanying drawings, in which:

FIG. 1 is an elevation of a heat-exchanger assembly according to the invention, with parts broken away to better show details;

FIG. 2 is a top view thereof;

FIG. 3 is a sectional view in elevation of the heat-exchanger;

FIG. 4 is a top view of the heat-exchanger, with parts thereof broken away in order to better show details;

FIG. 5 is an elevation of a typical spacer web used in conjunction with the heat-exchanger;

FIG. 6 is an elevation of a typical heat-exchange tube for use with the heat-exchanger; and

FIG. 7 is a top view of of the heat-exchange tube of FIG. 6.

Like numerals refer to like parts throughout the several views.

Turning now to FIG. 1, a container 10 is provided for receiving the particular substance to be cooled or heated. In this particular instance, container 10 is of semi-spherical configuration, but it will be apparent that it may take any particular shape as desired. Container 10 is supported on four legs 11 (only two of which are shown). Legs 11 terminate in typical casters 12, receiving wheels 13 on which the container 10 may be rolled. A plurality of bracing members 14 and 15 may be provided between legs 11, as desired, in order to suitably strengthen the entire structure.

A heat-exchanger 16 is mounted above container 10. Heat-exchanger 16 is supported for vertical movement both into and out of container 10, and at the same time is adapted for being oscillated within the container 10. In order to mount heat-exchanger 16, four telescoping leg posts 17 receive a machinery platform 18 at their upper ends thereof. A gusset plate 19 is optionally attached to the bottom of each leg post 17 for the purpose of stabilizing the entire structure. Bracing members (not shown) may be attached between gusset plates 19 to add the necessary rigidity.

Leg posts 17 are formed of a first fixed leg portion 20 and a second movable portion 21. A gusset plate 22 is mounted on top of each leg portion 21 for the purpose of suitably securing machinery platform 18 thereto. A drive screw nut 23 is fixedly received on each fixed leg portion 20. Each drive screw nut 23 receives within it a drive screw 24. Machinery platform 18 is supported on drive screws 24, and is movable upwardly and downwardly therewith as the drive screws are rotated within drive screw nuts 23.

A locking arm 25 has one end 26 thereof attached to fixed leg portion 20, while the other end 27 thereof is attached to leg 11 of container 10 in order to suitably secure and center the same with respect to heat-exchanger 16.

Some means must be provided to rotate drive screws 24, and this takes the form of a drive screw motor 28, suitably mounted on machinery platform 18. Motor 28 rotates a roller chain sprocket drive 29. A sprocket chain 30 is trained over four roller chain sprockets 31 and also over sprocket drive 29. Roller chain sprockets 31 are each affixed atop a respective drive screw 24 by any suitable means. A flanged thrust and radial bearing 32 is suitably affixed to machinery platform 18 and journals drive screw 24 therein. Flanged bearing 32 additionally serves to support machinery platform 18 by way of a flange 33 on the drive screws 24. A suitable switch 34 is provided on one of the movable leg portions 21 in order to operate motor 28 for the purpose of driving sprocket chain 30 to rotate the drive screws 24. It will be appreciated that suitable electrical connections (not shown) will be provided between switch 34 and motor 28.

Heat-exchanger 16 comprises a liquid plenum 35 formed of a top wall 36 and a bottom wall 37, suitably joined together by a side wall 38. Bottom wall 37 has a plurality of apertures 39 therein, each aperture receiving a heat-exchange tube 40. Heat-exchange tubes 40 are closed at the bottom thereof by a suitable plug 41. It will be appreciated that the various heat-exchange tubes 40 will be of varying length, depending on the configuration of the container 10. If container 10 were of rectangular, boxlike form, then all heat-exchange tubes 40 could be of the same length. Heat-exchange tubes 40 are arranged into a plurality of banks 42 for fluid flow purposes, with the tubes of one bank being offset with respect to the tubes in the next adjacent bank (see FIG. 4) for purposes to be hereinafter explained. A plurality of spacer webs 43 are provided, each comprising a flow-directing member 44 seated between top wall 36 and bottom wall 37, and a plurality of spacer members 45, each received within a corresponding heat-exchange tube 40. The spacer members 45 divide each tube 40 into an inlet fluid flow passageway 46 and an outlet fluid flow passageway 47. A single flow-directing member 48 is also provided between top wall 36 and bottom wall 37, and serves to separate a liquid inlet 49 to liquid plenum 35 from a liquid outlet 50.

Heat-exchanger 16 receives a hollow shaft 51 centrally thereof, and is fastened thereto as by welds 52. Hollow shaft 51 is internally threaded as at 53 to receive any one of a plurality of optional items, such as a removable blade 54. It will be apparent that removable blade 54 may be replaced by a screw member (not shown), or a paddle member (not shown), as optionally desired. Hollow shaft 51 terminates at the upper end thereof in a flange 55 secured thereto by any suitable means.

Means are provided for oscillating heat-exchanger 16 and takes the form of a flanged oscillating drive shaft 56. Drive shaft 56 is journaled in a flanged thrust and radial bearing member 57, attached to machinery platform 18 by any suitable means. Bearing member 57 is similar

to bearing member 32, in that it not only journals shaft 56, but also receives a flange thereof (not shown) for supporting the same with respect to machinery platform 18. Shaft 56 terminates at the lower end thereof in a flange 58, attached thereto by any suitable means. Flanges 55 and 58 are bolted together by way of a plurality of bolts 59. A second bearing 60 is provided for journaling the extreme uppermost oscillating portion of drive shaft 56, and is supported on a bearing support structure 61, attached to machinery platform 18.

The means for oscillating drive shaft 56 take the form of a variable speed drive motor 62, driving a speed reducer 63. Speed reducer 63 drives an adjustable, oscillating drive 64. A first crank 65 has one end thereof connected to oscillating drive 64 by way of a bolt 66 for rotation therewith. The second end thereof is attached to a second crank 67 by way of a bolt 68. Crank 67 has its other end suitably attached to oscillating drive shaft 56. A suitable switch 69 is provided on one of the movable leg portions 21 in order to operate motor 62. Suitable electrical connections (not shown) are provided between switch 69 and motor 62.

In operation, the material to be cooled or heated is placed within container 10. Motor 28 is operated to rotate drive screws 24 in a direction to lower heat-exchanger 16 into container 10. Any suitable source of chilled or heated heat-exchange fluid may be provided (not shown), and the fluid flows through inlet 49 into liquid plenum 35 and thence into a first bank of heat-exchange tubes 40. It will be appreciated from an inspection of FIG. 4 taken in conjunction with FIG. 6 that the fluid flow will be into the inlet fluid passageway 46 of the heat-exchange tubes 40, thence under the spacer members 45, and up the outlet fluid passageway 47 of the heat-exchange tubes 40, back into the plenum 35, and thence to the next bank of heat-exchange tubes. It will be apparent that the above set out series flow will continue until finally the fluid will exit the plenum 35 by way of outlet 50. This series flow of the heat-exchange fluid gives excellent velocities and, in addition, represents a cost saving with respect to material flow, pumping, power expended, etc. The alternative to series flow would be, of course, to provide for simultaneous flow through all the heat-exchange tubes.

Heat-exchanger 16 is preferably oscillated within container 10 to increase the heat transfer between the tubes and the material to be cooled or heated. It will be noted that the heat-exchange tubes 40 of one bank 42 are offset with respect to the next adjacent bank, so that no stratification of the substance being cooled or heated within container 10 may occur. This problem would, of course, only arise with respect to fairly viscous substances. In order to oscillate the heat-exchanger 16, variable speed motor 62 is placed into operation, driving speed reducer 63 and oscillating drive 64. It will be appreciated from an inspection of FIG. 2, that rotation of oscillating drive 64 will have the effect of oscillating crank 67, attached drive shaft 56, and hollow shaft 51, which will then oscillate heat-exchanger 16.

The minimum oscillation preferred is the distance between the various banks 42 of heat-exchange tubes 40 to overlap the banks. Again, this relates to the problem of stratification when the substance being cooled or heated is a particularly viscous substance. The oval or elliptical shape of the heat-exchange tubes 40, as shown, is preferred over a round shape to give a larger surface area for the same volume whereby the heat transfer is

increased. In addition, less power is needed to oscillate the heat-exchanger 16 because of the greater slip flow across the major part of the tube surface. This greater slip flow also has the effect of further increasing the heat transfer rate.

Vertical tubes 40 with smooth (rather than finned or otherwise irregular) surfaces are desirable to produce low "drag-out" losses, even though the heat transfer may be somewhat less. In addition, cleaning of the tubes 40 by dipping or inverted spray is facilitated. Irregular or finned tubes would produce "ledges" or blind spots to hinder these processes.

We wish it to be understood that our invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

We claim:

1. A heat-exchanger comprising a heat-exchange fluid plenum, said plenum defining a continuous cavity, a plurality of radially arranged banks of spaced heat exchange tubes depending from and communicating with said plenum, each bank including a plurality of tubes, the said tubes being closed at their ends remote from said plenum, spacer means within said tubes of each bank dividing said tubes into inlet and outlet fluid flow passageways, a plurality of fluid flow directing means in said plenum segregating the outlet passageways of one bank of tubes and the inlet passageways of the next adjacent bank of tubes, said spacer means and said fluid flow directing means of each bank being integral, whereby series fluid flow through said banks of tubes and parallel flow through the tubes in each of said banks is effected, and an external fluid inlet communicating with the inlet passageways of one bank of tubes, an external fluid outlet communicating with the outlet passageways of the next preceding bank of tubes and a baffle member within said plenum encompassing the inlet passageways of one of said banks of tubes and separating said external fluid inlet and outlet.

2. The heat-exchanger of claim 1 including means for oscillating said heat-exchange tubes, whereby the tubes will effect a greater heat exchange between themselves and a fluid in a vat in which the tubes are adapted to be positioned.

3. The heat-exchanger of claim 1 including means for vertically moving said heat-exchange tubes, whereby said tubes may be moved into and out of a fluid in a vat in which the tubes are adapted to be positioned.

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