Nov. 16, 1948. J. E. MASON ET AL 2,453,718

HEAT EXCHANGE APPARATUS

Filed July 20, 1942 2 Sheets-Sheet 1

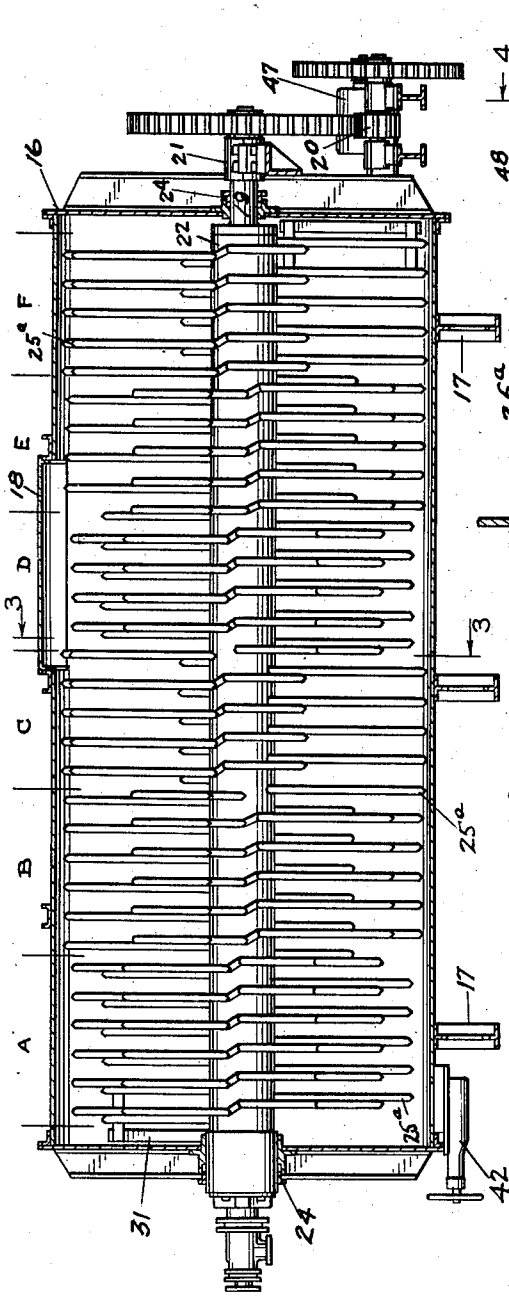


FIG. 1.

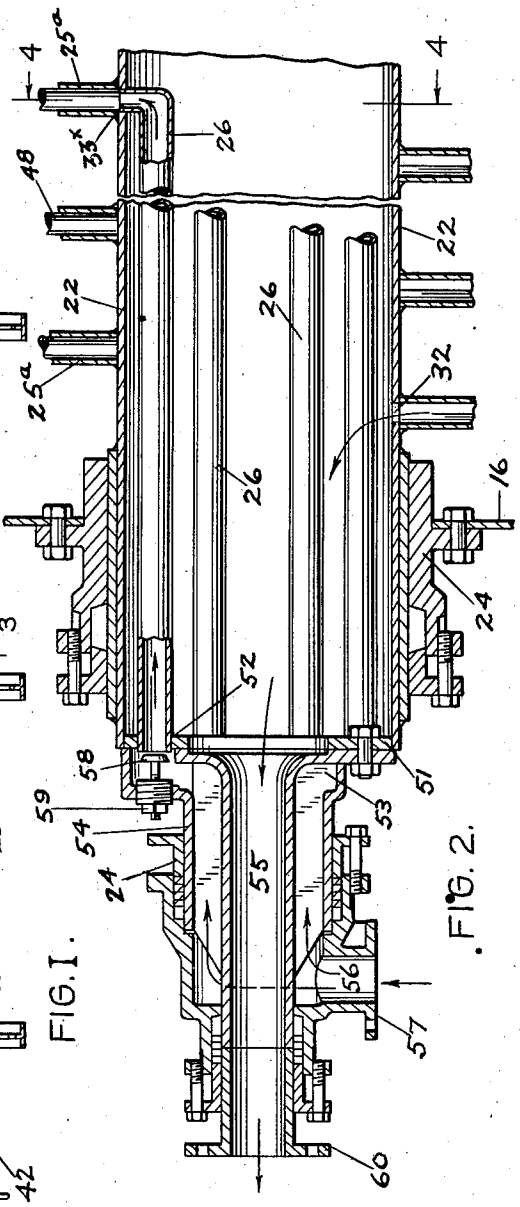


FIG. 2.

JOHN E. MASON AND CLARENCE WHITE
INVENTORS

BY H. A. McGraw
ATTORNEY

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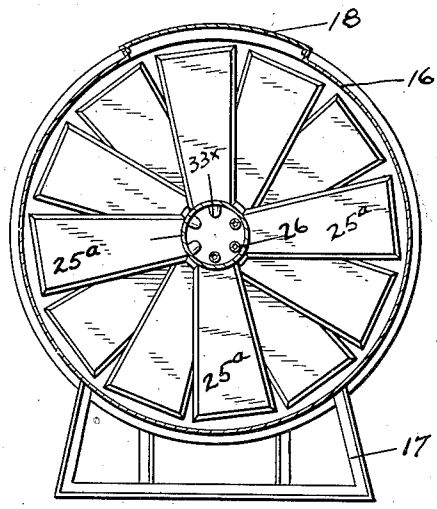


FIG. 3.

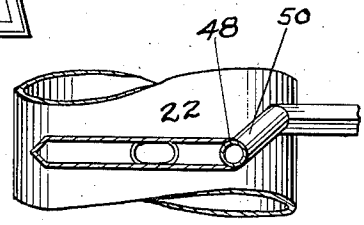


FIG. 5.

FIG. 4.

JOHN E. MASON AND CLARENCE WHITE
INVENTORS

BY

ATTORNEY

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UNITED STATES PATENT OFFICE

2,453,718

HEAT EXCHANGE APPARATUS

John E. Mason, Denver, Colo., and Clarence White, Capay, Calif.; Virginia A. White, executrix of Clarence White, deceased, and said Mason assignors to The Stearns-Roger Manufacturing Company, Denver, Colo., a corporation of Colorado

Application July 20, 1942, Serial No. 451,530

3 Claims. (Cl. 257—79)

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This invention relates to heat exchangers and more particularly relates to rapid crystallizers of the type employed in the manufacture of sugar.

Apparatus of this type depends on the movement, usually rotation, of heat-conductive bodies through a mass of material under treatment, with a heat exchange medium, usually a liquid, continuously circulated through the conductive bodies to promote the heat exchange action.

Many varieties of apparatus have been devised to promote crystallization in massecuite and similar solutions. For the most part, these machines have been subject to the objection that they employ a relatively large surface area tending to rotate the mass of material under treatment in comparison to the total space in which the treatment is performed.

Another objection has resided in the relatively long period of retention of the circulating heat-exchange medium in such apparatus, due primarily to the medium being fed in at one end of the apparatus and then caused to assume a slow circuitous passage through the same before it discharges at the opposite end.

The present invention represents a departure from prior practice by providing a relatively short retention interval for the heat exchange medium within the apparatus in addition to utilizing a relatively small surface area tending to rotate the mass of material under treatment.

It is an object of the present invention to provide a simple, durable and efficient apparatus for rapid crystallization treatments having a relatively large cooling surface in comparison with the treatment space and which employs only a small surface area tending to rotate the mass of material being treated.

Another object of the invention is to provide a simple and efficient system of circulating the liquid employed as the heat-exchange medium of such system.

A further object of the invention is to provide a selective control for close regulation of the temperature and volume of liquid circulated through such apparatus as the heat-exchange medium.

Other objects reside in novel details of construction and novel combinations and arrangements of parts all of which will appear more fully in the course of the following description.

To afford a better understanding of the practice of the invention, reference will be made to the accompanying drawings illustrating several different embodiments of the invention. In the

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drawings, in the several views of which like parts have been designated similarly,

Figure 1 is a vertical central section through our heat-exchange apparatus embodying features of the invention;

Figure 2 is an enlarged fragmentary section illustrating details of the heat-exchange medium circulation of the apparatus of Figure 1;

Figure 3 is a section taken along the line 3—3 of Figure 1;

Figure 4 is an enlarged fragmentary section taken along the line 4—4 of Figure 2; and

Figure 5 is a section through the structure of Figure 4 looking in the direction of the arrows 5—5 of Figure 4.

As illustrated in Figure 1, the tank 16 is cylindrical in shape and has a drum 22 driven through connection with a shaft 19 and suitable gearing 20 by a prime mover 47, such as an electric motor.

Filling of the tank is permitted through provision of a covered manhole 18 and draining can be regulated selectively through valve-controlled outlet 42. However, if desired, the tank may be the open-top type in which case it will be filled through the top opening. Packing glands 24 are provided to prevent leakage through the ends of tank 16 along shaft 19 or drum 22.

As illustrated in Figures 3, 4, and 5, the heat-exchange arm members 25a are mounted on drum 22.

These arms 25a have a conduit section 48 formed integrally with the arm member and located at its forward edge with the outer end of the conduit cut on a bevel as shown at 49 (Figure 4) to provide an intake opening for the circulating heat exchange fluid.

The conduits 48 terminate in fluid-conducting connection with a connecting conduit 50 of U-shaped section which is fixed on drum 22 in any suitable manner, as by welding for example. These conduits 50 discharge into the hollow interior of the next preceding arm member 25a with respect to the direction of rotation, and preferably the members 25a are mounted on drum 22 in offset relation to give a spiral arrangement to the group of members 25a functioning as a unit. The last of said members in the series discharges the substantially spent heat-exchange fluid through an opening 32 (see Fig. 2) into drum 22.

Another feature of the design of heat-exchange members 25a contributing to the general efficiency of the apparatus is the position of the cutting edge which comprises the exposed sur-

face of the conduit sections 48. This edge is at a slight angle to the radius bisecting member 25a, as clearly shown in Figure 4, and by being so disposed reduces the radial component of force tending to rotate the mass against which it moves.

The groups of members 25a may be any selected number within limits determined by the size of the apparatus and as shown in Figure 1 are six in number, designated A, B, C, D, E and F respectively. A series of pipes serving as supply conduits 26 are mounted inside drum 22 for conjoint rotation therewith and are six in number corresponding to the unit of the members groups.

Each conduit 26 terminates in a discharge outlet 33^x in communication with the first member 25a of a given group. Thus, each pipe 26 supplies only a given group of members 25a in the assembly, in a continuous action, the details of which will be described hereinafter.

At the end of drum 22 remote from shaft 19, an annular ring member 51 is fixed on the inside surface of drum 22 by welding and this ring is provided with suitable openings 52 acting as sockets for the pipes 26, the ends of which preferably are disposed slightly beyond the outer face of ring 51.

An annular distributing chamber 53 formed by a housing 54 and a central hollow discharge tube 55 extends outwardly from ring 51 and is supplied with heat-exchange medium through a stationary coupling member 56 having means 57 for its attachment to a supply conduit (not shown). The housing 54 and tube 55 are held on ring member 51 for conjoint rotation with drum 22 as illustrated in Figure 2 and a suitable packing gland 24 may be provided to prevent leakage between the rotary and stationary parts of this assembly.

Plug valves 58 are disposed adjacent the ends of conduits 26, and are adjustable relative thereto from outside housing 54 as indicated at 59 in Figure 2. By this arrangement, the volume of heat-exchange fluid delivered to any of the groups A, B, C, etc., can be selectively controlled.

Rotary tube 55 has means 60 at its exposed end for attachment to a suitable coupling member (not shown) through which its discharge may be conducted to waste or any desired receptacle (not shown).

In the operation of this apparatus, the fresh and spent heat-exchange liquids are not permitted to intermingle, and substantially spent liquid is discharged promptly from the apparatus.

The tank 16 is filled in the usual way with material to be treated, such as hot massecuite, and the motor 47 is started to rotate drum 22. The heat-exchange medium, in this case water, is delivered from its source of supply through inlet 56 to chamber 53.

Plug valves 58 are set initially for delivery of a predetermined quantity of heat-exchange medium from chamber 53 into each tube 26 and the water so delivered in turn passes through the outlet 33^x of the conduit and into the initial member 25a of a given group A or B or the like. When this liquid has filled the interior of this member 25a, it enters the associated conduit section 48, and thence through connecting conduit 50 into the next member 25a in the spiral series.

This action is repeated through the succession of members 25a of the series until the liquid reaches the last such member and discharges therefrom through opening 32 into the interior of drum 22. The accumulating liquid in drum 22 delivered through the several openings 32 overflows into rotary tube 55 from which it passes out of the apparatus.

While the flow of heat-exchange medium through each of the groups A, B, etc., is positive and continuous, it will be apparent that any given quantity of heat-exchange medium has only a relatively short period of retention in contact with the heat exchange surfaces prior to discharge from the apparatus.

Further the forward edges of members 26a have a relatively large heat-exchange surface contacting the massecuite, but a relatively thin edge moving directly against the massecuite and tending to rotate the same.

Consequently, this apparatus also has a substantially uniform heat exchange action throughout its length, and by regulation of the volume and temperature of the circulating medium, a close control on the crystallizing action can be exercised at all times.

While a relatively large number of members 25a are included in a single group, the effective temperature of the heat-exchange medium passing through the last member of the group is not substantially different than the temperature of such medium on entering the first member of the group, after operation is under way.

This is due to the fact that the rate of flow of the medium and the continuous action eliminate the development of any substantial temperature differentials in the surfaces against which the liquid moves in its passage through the group. Also the continuous change in direction induced by direction of the passages as well as rotation of members serves to keep the temperature of the components of the stream uniform.

Consequently, the liquid flowing through a given group is not substantially spent prior to discharge and performs its useful work with equal effectiveness throughout its entire course.

From the preceding description, it will be observed that in our invention, the heat-exchange action is induced by rotation of substantially rectangular heat-conductive members having a relatively thin edge engaging the tank solution and having a relatively large trailing surface contacting the solution in such rotation.

Likewise, it should be noted that the heat exchange members are arranged and function in groups, which may be units in the lengthwise extent of the series, or members of corresponding radial position throughout the entire range of the drum.

Provision is made for delivering heat-exchange medium differentially into the respective groups and preferably this differential action will be performed in conjunction with a selective regulation of the volume and temperature of the heat-exchange medium so delivered to the members.

In all the forms, the heat-exchange medium is delivered into and discharged from the same end of the apparatus and its interval of retention in the apparatus is of relatively short duration.

Where a continuous supply of heat-exchange medium is provided, the surface contact area and retention interval are predetermined so that the liquid immediately prior to discharge is still capable of performing useful work although for convenience in description it may be designated as "substantially spent medium."

While the apparatus has been described with particular reference to its application as a rapid crystallizer in the sugar refining process, it will be understood that it is adapted for a variety of

treatments, such as crystallization of chemical salts, for example.

Similarly, while its action in the sugar refining treatment will usually involve the circulation of a cool liquid, such as water, through the heat-exchange members to cool hot solution in the tank, it will be appreciated that under some conditions a reverse action will be employed in which hot water, steam or the like will be used to heat a cool solution in the tank.

Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

What we claim and desire to secure by Letters Patent is:

1. Heat exchange apparatus comprising a stationary cylindrical tank closed at its ends and supported in a horizontal position, a hollow rotary drum journaled in the ends of said tank, means exteriorly of the tank for rotating said drum, a series of hollow heat-exchange members held on the drum for conjoint rotation in groups and in fluid-tight connection therewith, adjoining members in said series having their lengthwise axes joining the drum at intervals lengthwise of the drum, valve-controlled means in said drum for continuously delivering separate streams of fresh heat-exchange medium separately under individual regulation to each group in the series, and means exteriorly of the tank for delivering heat-exchange medium to the medium-delivery means.

2. Heat exchange apparatus comprising a stationary cylindrical tank closed at its ends and supported in a horizontal position, a hollow rotary drum journaled in the ends of said tank, means exteriorly of the tank for rotating said drum, a series of hollow heat-exchange members held on the drum for conjoint rotation in groups and in fluid-tight connection therewith, adjoining members in said series having their lengthwise axes joining the drum at intervals lengthwise of the drum, conduits connecting the adjoining members of each group for the progressive circulation of heat-exchange medium through the respective members of a group, means in said drum for continuously delivering fresh heat-exchange medium to each group in the series, and means exteriorly of the tank for delivering heat-exchange medium to the medium-delivery means.

3. Heat exchange apparatus comprising a stationary cylindrical tank closed at its ends and supported in a horizontal position, a hollow rotary drum journaled in the ends of said tank, means exteriorly of the tank for rotating said drum, a series of hollow heat-exchange members held on the drum for conjoint rotation in groups and in fluid-tight connection therewith, adjoining members in said series having their lengthwise axes joining the drum at intervals lengthwise of the drum, rotary, valve-controlled means in said drum for continuously delivering fresh heat-exchange medium to each group in the series, and stationary supply means exteriorly of the drum for delivering heat-exchange medium to said rotary means.

JOHN E. MASON.
CLARENCE WHITE.

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