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MIXING APPARATUS

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Fig. 1.

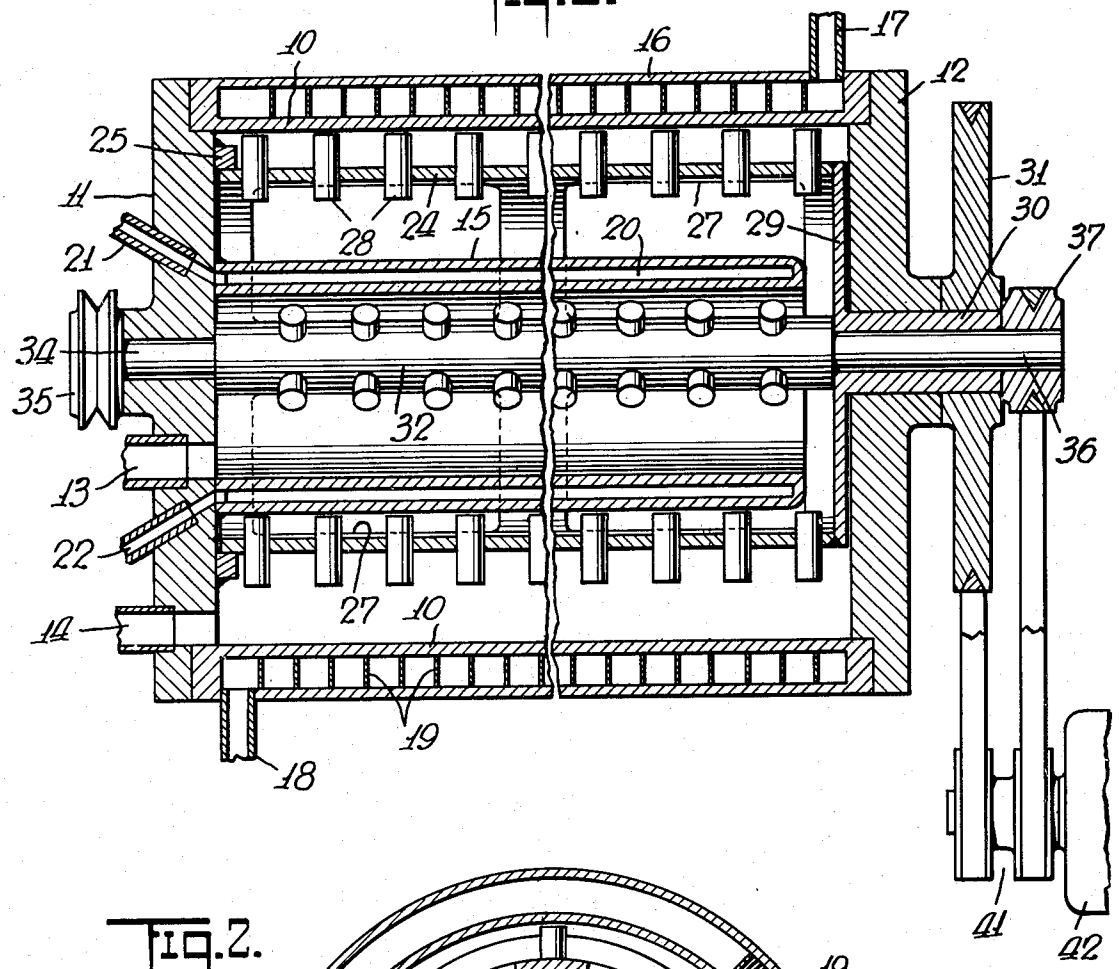
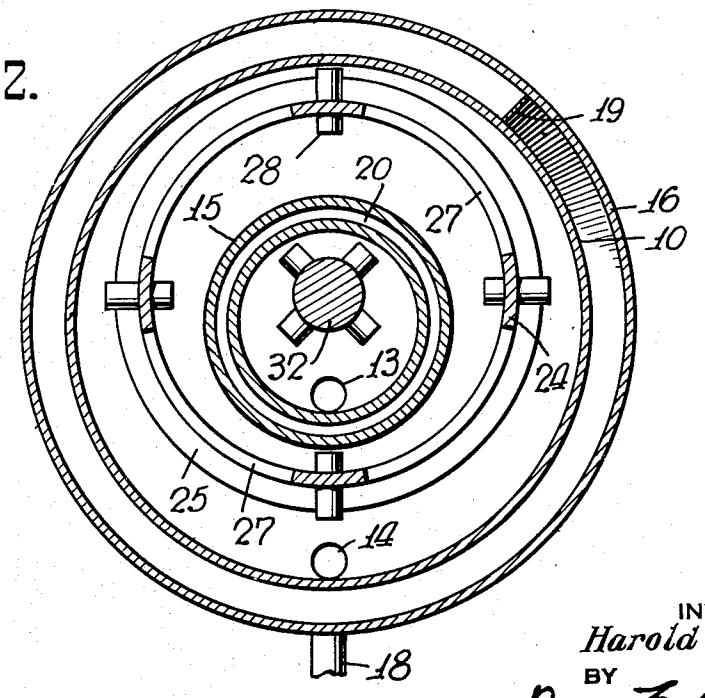


Fig. 2.



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MIXING APPARATUS

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13 Claims. (Cl. 259—6)

This invention relates to the treatment of fluid, plastic, or other flowable material composed of two or more ingredients which are not miscible, or at least not readily miscible, or in one of which it is desired to secure a rapid, uniform and thorough dispersion of one or more other ingredients, as in making an emulsion, or where chemical reaction between different ingredients is desired, or where physical change in one or more fluids is desired.

This invention is an improvement in mixing apparatus of the type in which the material being processed may be continuously passed through a chamber and simultaneously mixed, agitated, emulsified, or otherwise treated. The agitating mechanism is of the rotary type and the processing may be merely that resulting from the action of the agitator or may also include temperature change or maintenance.

As an important feature of the invention the apparatus is made compact by providing a plurality of processing chambers, one inside of another, and in communication in series with each other.

As another feature of the invention the chambers are concentric and communicate only at one end, so that the material flows lengthwise of one chamber, and then in the reverse direction in another, the chambers having separate agitators.

As a further feature the chamber walls are concentric in respect to each other, and the agitators in both chambers are eccentric in respect to said chambers.

As a further feature the agitators are concentric in respect to each other, and may be driven at different speeds.

As a further feature means are provided for effecting temperature control of the inner chambers as well as of the outer chambers.

Various other novel features will be apparent from, or will be pointed out in connection with, the following description and the accompanying drawing, in which:

Fig. 1 is a central longitudinal section through an apparatus embodying my invention, and

Fig. 2 is a transverse section.

In the construction illustrated there is provided a cylindrical peripheral wall 10 and end walls 11 and 12, the end wall 11 having two ports or pipe connections 13 and 14, one of which serves as an inlet for the material to be processed, and the other as an outlet for the processed material.

The end wall 11 has connected thereto an annular wall or partition 15 which is concentric with the wall 10 and spaced from the end wall 12 so as to form two chambers communicating with each other near the end wall 12. The ports 13 and 14 are disposed one inside of and the other outside of the partition wall 15, so that the material while being agitated as hereinafter described as a substantially uniform rate of continuous bodily flow longitudinally through one processing chamber and then back through the other one, so that successive portions of the material will all remain in the chamber and be processed for substantially the same length of time.

The inlet may be connected to a supply pump drawing the material from a premixing tank or in controlled ratio from separate supply pipes for the different ingredients, or in some cases the end wall may be provided with a plurality of inlets for the different ingredients and through which such ingredients are delivered at controlled rates and in controlled relative proportions by pumps or other forcing means. The outlet or a conduit connected thereto may be provided with throttling or flow controlling means whereby any desired superatmospheric pressure may be maintained in the processing chamber. Suction may be applied for treatment under partial vacuum, or the outlet may be open if operation at atmospheric pressure is desired. Obviously the port 13 may serve as the inlet and the port 14 serves as the outlet, or the flow may be in the reverse direction.

If it is desired to change the temperature of the material as a part of the processing, or to maintain a given temperature if the processing involves an exothermic or endothermic reaction, there may be provided a jacket 16 for a heat transfer medium. The annular space between the jacket and the wall 10 may be provided with an inlet 17 at one end and an outlet 18 at the opposite end. The space between the walls 10 and 16 and between the inlet and the outlet may be provided with a baffle 19 of helical or other form. Other suitable means may be used to prevent short circuiting of the heat transfer medium from the inlet to the outlet and cause it to flow in a helical or other path around the processing chamber or back and forth along the latter.

If temperature control is desired, the wall or partition 15 is made of two spaced sheets with a space 20 therebetween and having an inlet 21 and an outlet 22 for the circulation of a temperature changing medium. In this space or jacket 20 any suitable means may be employed to insure flow of the refrigerant or other temperature changing medium lengthwise of the jacket and preventing short circuiting from the inlet to the outlet.

As an important feature means are provided for effecting a turbulent flow in each of the processing chambers.

In the outer chamber encircling the wall 15 there is provided an agitator which has a rotatable cylindrical wall 24 carrying longitudinally disposed rows of impact members 28. It is shown as having ports 27 alternately arranged with the impact members, but in some forms such ports are not essential. This hollow agitator has an end wall 29 provided with a shaft 30 extending through the end wall 12 and provided with suitable means for rotating it, such as a pulley 31. The agitator and its shaft are eccentrically disposed in respect to the concentric walls 10 and 15, and as the shaft 30 is at only one end, suitable means such as a supporting flange 25 is provided at the other end.

The impact members may be of various kinds, shapes or dimensions. They are shown as rows of pins 28 extending both outwardly and inwardly from the wall 24. The pins are of such length in respect to the eccentricity of the agitator that the inner ends of the pins will just clear the wall 15 at one side of the axis and the outer ends of the pins will just clear the wall 10 at the other side of the axis.

A separate agitator 32 is provided in the inner chamber and this has its body portion solid rather than hollow. It is eccentrically disposed within and in respect to the wall 15, and preferably is concentric with the outer agitator. It is provided with impact members or pins similar to those on the outer agitator, but extending only outwardly. They are of such length in respect to the eccentricity that they just clear the wall 15 at one side of the axis.

It will be noted that with the apparatus in the position shown in the drawing, the zone of minimum clearance between the outer agitator and the chamber wall 10 is at the upper side and that the zone of minimum clearance between the inner agitator and the partition 15 is likewise at the upper side. It will also be noted that the space of maximum clearance between the outer agitator and the partition is at the upper side of said partition and the zone of maximum clearance between the inner agitator and said partition is at the lower side of the latter.

The agitator 32 is provided with an extension or stub shaft 34 provided with suitable means for rotating it, such for instance as a pulley 35. This is shown at the opposite end of the apparatus from the shaft 30, but the shaft 30 may be hollow and the agitator 32 may have a shaft extension 36 extending therethrough and connected to a driving element such as a pulley 37. In some constructions all of the agitators may be driven at the same angular velocity and form a single shaft.

Thus, material entering through the inlet 13 is thoroughly agitated by the inner agitator as the material moves lengthwise of the apparatus, and it then flows into the outer chamber and there is agitated not only by the impact members projecting outwardly from the wall 24, and by the impact members extending inwardly from said wall, but also by the flow back and forth through the ports in said wall.

The angular velocity of the impact members of the inner and outer agitators may be substantially the same or may be different, depending upon the character of agitation desired. By making the relative diameters of the pulleys 31 and 37 substantially the same as the relative diameters of the inner and outer agitators, the two pulleys may be driven from equal sized pulleys 41 of an electric motor 42, and the peripheral velocity of the outer ends of the impact members 28 of the outer agitator will be substantially the same as the peripheral velocity of the outer ends of the impact members of the inner agitator.

The driving of the two agitators at different or variable velocities may be obtained by variable speed gearing, or by connecting separate prime movers or sources of power to the shafts 30 and 34 or 36.

It will be noted that the outer chamber is directly subjected to the action of a temperature changing or temperature maintaining medium on both its outer and inner walls, and that the medium in the space 20 acts on the material in both the inner and the outer chambers. If it is desired, the agitator 32 may be made hollow, and temperature changing or maintaining medium circulated therethrough in a manner well known in the art.

An additional ingredient may be delivered through a passage in the agitator 32 and into the chamber through ports distributed along the length thereof.

In one respect it may be considered that there are three chambers, one inside the wall 15, one between this wall and the ported wall 24, and the third outside of the wall 24. Two of these chambers, namely those on opposite sides of the wall 24, have the material surging back and forth through the ports of the wall 24, so that the turbulent agitation is increased and it contacts both the wall 10 and the wall 15, which may be heated or cooled. The wall 15 corresponds in function to the outer surface wall of a core, and thus may be considered as a hollow stationary core.

Obviously the type of impact members shown, or various other types of impact members, may be employed.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A processing apparatus including a chamber having a substantially cylindrical peripheral wall, a rotatable agitator having a substantially cylindrical peripheral wall within said chamber and eccentrically disposed in respect to said first mentioned wall, said agitator wall having outwardly and inwardly extending beater elements, and a core encircled by said agitator, said core comprising a cylindrical wall rigid with said chamber wall and having a chamber therein communicating with said first mentioned chamber at one end thereof.

2. A processing apparatus including a chamber having a substantially cylindrical peripheral wall, a rotatable agitator having a substantially cylindrical peripheral wall within said chamber and eccentrically disposed in respect to said first mentioned wall, said agitator wall having outwardly and inwardly extending beater elements, a core encircled by said agitator, said core comprising a cylindrical wall rigid with said chamber and having a chamber therein communicating with said first mentioned chamber at one end thereof, and a rotatable agitator encircled by said core wall.

3. A processing apparatus including a chamber having a substantially cylindrical peripheral wall, a rotatable agitator having a substantially cylindrical peripheral wall within said chamber and eccentrically disposed in respect to said first mentioned wall, said agitator wall having outwardly and inwardly extending beater elements,

a core encircled by said agitator, said core comprising a cylindrical wall rigid with said chamber and having a chamber therein communicating with said first mentioned chamber at one end thereof, and a rotatable agitator encircled by said core wall, said chamber wall and said core wall being coaxial, and said agitators being coaxial.

4. A processing apparatus including a chamber having a substantially cylindrical peripheral wall, a rotatable agitator having a substantially cylindrical peripheral wall within said chamber and eccentrically disposed in respect to said first mentioned wall, said agitator wall having outwardly and inwardly extending beater elements, a core encircled by said agitator, and having a cylindrical wall rigid and concentric with said chamber wall and having a chamber therein communicating with said first mentioned chamber at one end thereof, a rotatable agitator encircled by said core wall, and coaxial with said first mentioned agitator, and means for controlling the temperature of said chamber and core cylindrical walls.

5. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls.

6. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls, the outer agitator having beater members extending inwardly and outwardly therefrom, and the inner agitator having beater members extending outwardly therefrom.

7. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls, said apparatus having an inlet and an outlet at one end, one being inside of and the other outside of the inner of said walls, and a passage at the other end of said apparatus connecting said chambers, whereby material being processed may flow through said chambers in series and lengthwise of the apparatus.

8. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls, said inner wall having a passage therein for the circulation of a temperature changing medium.

9. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls, said inner wall and said outer wall each having means for the circulation of a heat exchange medium in heat exchange relationship with the adjacent chambers.

10. A processing apparatus having a pair of generally cylindrical concentric spaced walls, a pair of concentric rotatable agitators having their axis eccentrically disposed in respect to said walls, one of said agitators being in the chamber encircled by the inner of said walls, and the other agitator being in the chamber between said walls, and means for rotating said agitators at different speeds.

11. In an apparatus for continuously processing flowable material, an outer generally cylindrical casing, partition means dividing the interior of said casing into a plurality of generally concentric processing chambers, an inlet and an outlet communicating respectively with different ones of said chambers and means affording communication between the chambers in a manner to cause material to flow through the chambers in series, and an annular agitator encircling the partition means forming the inner wall of one of said chambers and rotatable in said one chamber about an axis which is eccentric with respect to the axis of the chamber.

12. In an apparatus for continuously processing flowable material, an outer generally cylindrical casing, partition means dividing the interior of said casing into a plurality of generally concentric processing chambers, an inlet and an outlet communicating respectively with different ones of said chambers and means affording communication between the chambers in a manner to cause flow of material through the chambers in series, and a plurality of agitators rotatable respectively in different ones of said chambers and eccentric with respect to the walls of the chambers at least one of said agitators being generally cylindrical and encircling the partition means forming the inner wall of the chamber in which said one agitator is disposed.

13. In an apparatus for continuously processing flowable material, an outer generally cylindrical casing, partition means dividing the interior of said casing into a plurality of generally concentric processing chambers, an inlet and an outlet communicating respectively with the innermost and outermost ones of said chambers and means affording communication between the chambers so as to cause material to flow through the chambers in series, a rotatable cylindrical agitator eccentrically disposed in an outer one of said chambers and encircling the partition means forming the inner wall of the last mentioned chamber, and a second agitator eccentrically disposed and rotatable in the innermost one of said chambers.

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