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APPARATUS FOR HOMOGENIZING

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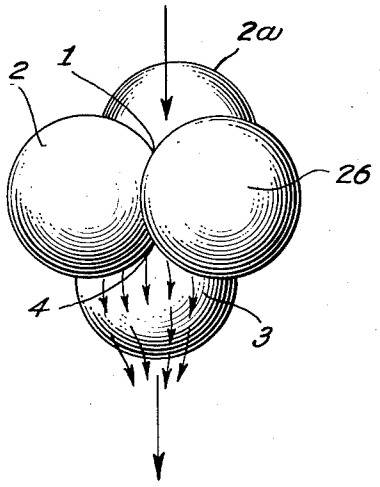


Fig. 1.

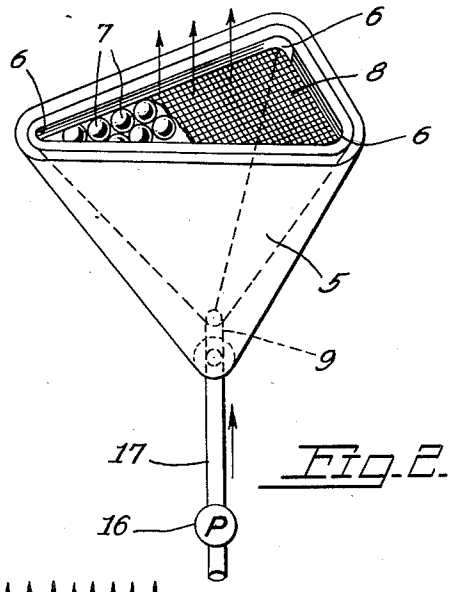


Fig. 2.

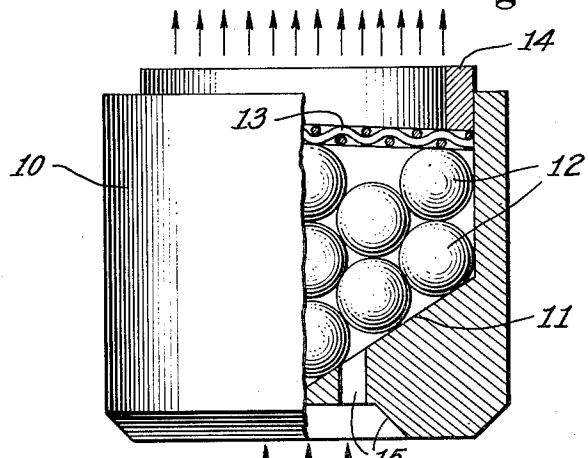


Fig. 3.

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APPARATUS FOR HOMOGENIZING

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This invention relates to the homogenizing of dispersions, such as milk, and has for its object the provision of an improved apparatus for this purpose.

Homogenization is mainly a division of particles or drops of a liquid, dispersed in another liquid, into a greater number of smaller units. The effect of the division is that the particles or drops are less readily separated by gravity or centrifugal force from the liquid in which they are dispersed. The concept of homogenization also comprises a mixing effect, that is, a uniform mixing of the particles or drops with the liquid. Thus, homogenized products are characterised by finely comminuted particles uniformly mixed with the liquid in which they are suspended or emulgated.

The homogenization is effected by forcing the liquid containing the suspended or emulgated material through an homogenizing member. In this way, the material dispersed in the liquid is finely comminuted, because, as stated, the particles or drops are atomized into a much larger number of smaller particles or drops, which become uniformly distributed in the liquid. Previously, it has been common practice to use an homogenizing member in the form of a spring-pressed valve and seat, the liquid being forced under high pressure through a narrow slit formed by displacement of the valve body from its seat under the liquid pressure. Thus, the particles or drops are split up and atomized into a large number of smaller units. Such homogenization of milk, for example, requires a very high pressure in the order of perhaps 200 kg./cm.^{2}. This high pressure in turn necessitates expensive pumps of special construction, and the power consumption in relation to the degree of homogenization is also very high.

According to the invention, the liquid to be homogenized is forced through a set of juxtaposed balls, between which are formed passageways of continuously varying throughflow area. In other words, the liquid is forced through an opening formed in a set of three balls arranged in the same plane, whereupon it enters an enlarged chamber, called the whirl chamber, formed by the three balls together with a fourth ball in the next plane. In the opening, the liquid assumes a velocity which depends upon the pressure of the pump which forces the liquid through the ball set. As the balls can be made with very high accuracy and with very smooth surfaces (ball bearing balls may be used), the frictional losses when the liquid passes through

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the opening are small, and the larger part of the energy applied can be utilized for conversion into liquid turbulence friction in the enlarged chamber, the whirl chamber. For this reason, a homogenizing member made of balls has a very good homogenizing effect. Experiments have shown that a certain degree of homogenization is achieved when using a much lower pressure than that which is necessary in conventional homogenizing members. To obtain the degree of atomization which requires 200 kg./cm.^{2} with known homogenizing members of the type referred to, it has been found sufficient to use about 15 kg./cm.^{2} when the product is forced through a set of balls of suitable size. Thus, by using a pump pressure of 15 kg., it is possible to homogenize normal whole milk, heated to 60° C., down to an average diameter of the fat globules of less than 1.4 μ, 90% of the fat contained in the milk being less than 2 μ in size and the largest fat particles being about 2.5 μ. This degree of atomization corresponds to the effect of ordinary type high pressure homogenizers operating at a pressure of 100 to 200 kg.

The set of balls may be arranged in different ways. They may, for example, be enclosed in a cylindrical casing, the two ends of which are covered by a grate or the like which keeps the balls in position. A short cylindrical container or a container of any other shape may also be used. The disposition of the balls which best satisfies the object of the invention (the balls should all be of exactly the same size) is that in which the balls occupy the minimum volume. The balls then contact at the largest possible number of points and the passageways formed between them will all be alike and will have the smallest possible throughflow area in relation to the ball diameter. The balls are therefore arranged tetrahedron-wise, that is, their centers form one or several contacting tetrahedrons. As mentioned above, the minimum number of balls is four, and their centers then form a tetrahedron. When the number of balls in the set is increased, and when the above condition is satisfied, the set will form a tetrahedron of increasing size. The surest and simplest way of obtaining this disposition of the balls is when the container in which the set is held is in the form of a tetrahedron. The latter need not, however, be a complete tetrahedron but tetrahedron-shaped parts of it may be omitted. For example, one or several or all of the corners of the tetrahedron may be cut away. It is preferable to round off the edges of the tetrahedron by a

radius approximately equal to that of the balls, since when sharp edges are used, passageways of a substantially larger area than between the balls are formed.

For a better understanding of the invention, reference may be had to the accompanying drawing, in which

Fig. 1 is a perspective view of a set of balls arranged according to the invention;

Fig. 2 is a perspective view of one form of the homogenizing device, and

Fig. 3 is a side elevational view, partly in section, of another form of the device.

Referring to Fig. 1, which illustrates the simplest arrangement of balls, the liquid flows from above through an opening 1 formed by three balls 2, 2^a and 2^b, positioned in an upper plane, into a chamber formed by the said three balls together with a fourth ball 3 in a lower plane. The balls are held in any suitable manner in the nested, intercontacting arrangement illustrated in Fig. 1, so that the liquid in flowing under the pump pressure through the ball set 2, 2^a, 2^b and 3 is confined to the paths indicated by the arrows in Fig. 1. It will be understood that the four balls of the set define an enlarged central space or whirl chamber to which the opening 1 forms an inlet passage. The liquid escapes from this whirl chamber through three outlet passages, each outlet passage 4 being formed by the lower ball 3 and two adjacent balls of the upper series 2, 2^a and 2^b. When the number of balls is increased, several parallel passageways of the same kind are formed and the flows merge and separate again in each plane or series of balls.

As shown in Fig. 2, a larger set of balls is arranged in a tetrahedron-shaped container 5, the interior of which has rounded corners 6. The radius of each rounded corner 6 is approximately equal to the radius of each ball 7, so that the balls fit closely into the corners. The balls 7 are held in position in the container by a perforated member or grating 8. The direction of flow is assumed to be as indicated by the arrows, that is, upward from the bottom. Thus, the inlet 9 is at the lower part and the outlet is through the grating 8 at the top.

As shown in Fig. 3, a cylindrical container 10 is provided with a conical bottom 11 and contains a set of balls 12 which are covered by a perforated member or netting 13 held against the balls by a ring 14 removably secured in the container. The liquid is assumed to flow upward from inlet 15 in the bottom of the container, the homogenized liquid finally discharging through the netting 13 and the interior of ring 14.

Depending upon the object of the homogenizing, a distinction must be made between the atomizing effect and the mixing effect. When it is desired principally to atomize the particles or drops, it is best to utilize the available amount of pressure energy in a single step. It has been found preferable in practice, however, particularly when homogenizing milk, to use a certain number of steps (at least two steps), the finely atomized dispersed particles from the first step being efficiently mixed with the continuous phase in the last step or steps, so as to avoid the formation of agglomerates of particles sticking to the membrane scales which are easily formed in homogenizing.

As mentioned with reference to Fig. 1, when the number of balls is increased, several parallel passageways are formed which run together and ramify again for each plane of balls. When an efficient mixing action is desired in the homogenizing, a tube-shaped container, in which the direction of flow is in the longitudinal direction of the tube, should preferably be used. The balls should then be arranged in planes at right angles to the longitudinal direction of the tube. The longer the tube and the greater the number of ball planes, the higher the mixing effect will be.

It will be apparent that according to the present invention the milk or other liquid is forced through a whirl chamber within a set of at least four intercontacting spheres (the balls 2, 2^a, 2^b and 3), the liquid being directed into the whirl chamber by way of an inlet passage (the passage 1) defined by three of the spheres (the balls 2, 2^a and 2^b) and being directed from the whirl chamber by way of a plurality of outlet passages (the passages 4) each defined by two of these three spheres and fourth sphere (the ball 3). The means for forcing the liquid through the interspaces of the ball set comprise the container (5, 10) for the balls, and a pump 16 in the pipe line 17 leading to the container inlet (9, 15).

We claim:

1. A device for homogenizing milk and other dispersions, which comprises a container having an inlet for the dispersion to be homogenized and an outlet for the homogenized dispersion, and a set of intercontacting balls in the container, the interspaces of the ball set forming flow paths between said inlet and outlet.

2. A device according to claim 1, in which the balls are of equal size.

3. A device according to claim 1, in which the ball set is in the form of a tetrahedron, whereby the set occupies the smallest possible volume in the container and the balls contact each other at the largest possible number of points.

4. A device according to claim 1, in which the container is in the general form of a tetrahedron.

5. A device according to claim 1, in which the container is in the general form of a tetrahedron, the interior of the container having corners rounded with a radius approximately equal to the radius of each ball.

6. A device according to claim 1, in which the container is cylindrical.

7. A device according to claim 1, in which the container is cylindrical and has a conical end wall in the interior thereof.

8. A device according to claim 1, in which the container is cylindrical and has a conical end wall in the interior thereof, said inlet being located in the conical end wall.

9. A device according to claim 1, comprising also a perforated member secured to the container for holding the balls in predetermined relative positions therein.

10. A device according to claim 1, comprising also a perforated member secured to the container for holding the balls in predetermined relative positions therein, said member as forming said outlet.

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