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Schlicht

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[54] **HOMOGENIZING METHOD AND APPARATUS**

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[51] **Int. Cl.** **B01f 5/08**

[58] **Field of Search** ..... 259/4, DIG. 30; 138/42, 43; 251/127

[56] **References Cited**

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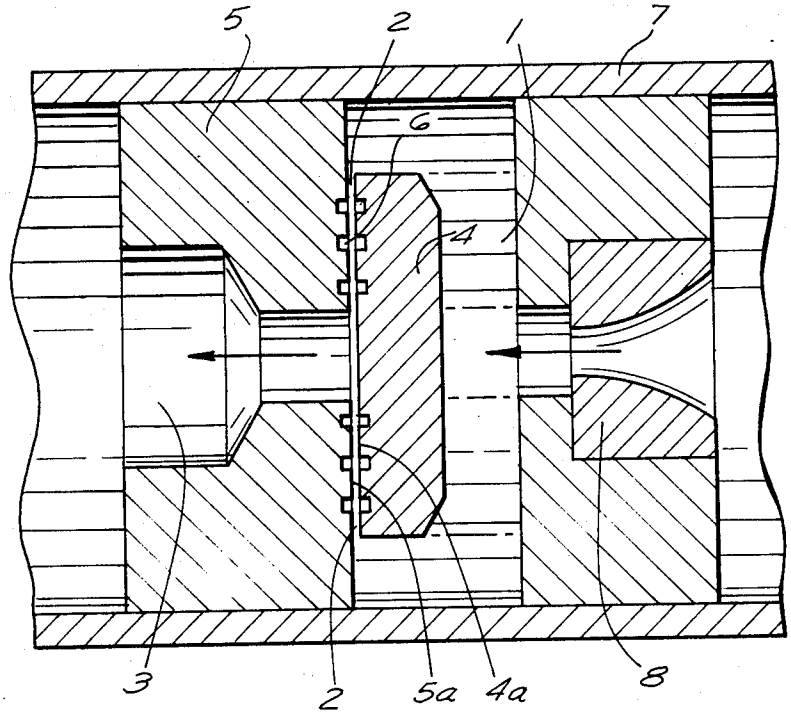
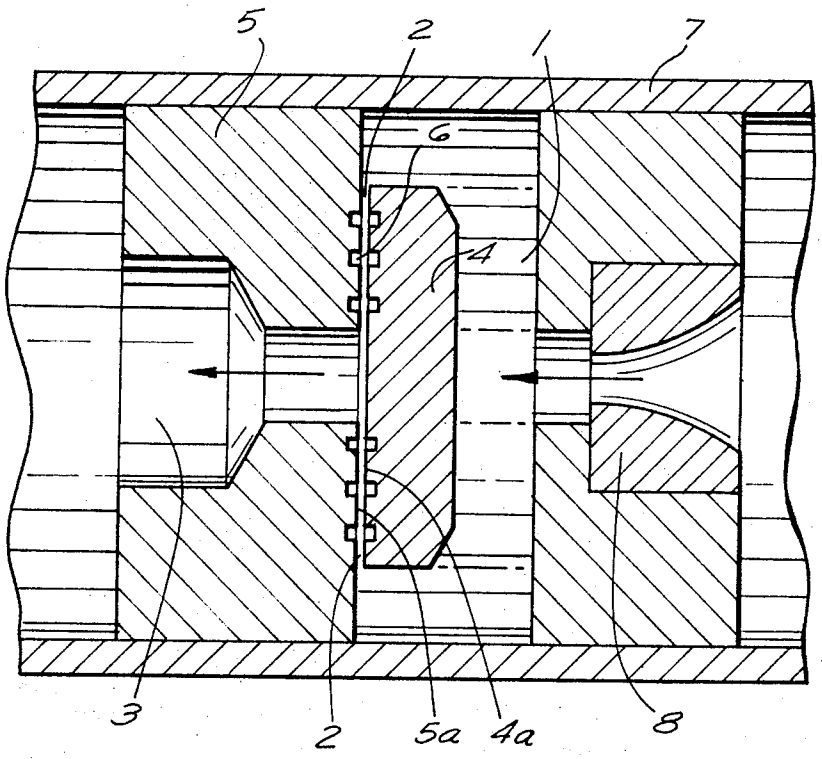
[57] **ABSTRACT**

A method and apparatus for homogenizing liquids containing a plurality of non-admixable phases. The liquid is forced under pressure and at high speed from the radially outward to the radially inward periphery of an annular gap, and during the passage it is made to undergo cavitation once or repetitively.

7 Claims, 1 Drawing Figure




5
2
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HOMOGENIZING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates generally to the homogenization of liquids, and more particularly to the homogenization of liquids containing several non-admixable phases. Still more particularly the invention relates to a method and an apparatus for effecting such homogenization.

The art already knows homogenizing apparatus in which liquids containing several non-admixable phases —which liquids are usually supplied in form of emulsions—are forced under high pressure from the radially inner to the radially outer periphery of an annular gap. In so doing the droplets of the dispersed phase are subdivided as a result of the shear tension which is caused during the passing of the liquid through this gap. After exiting at the radially outer periphery of the gap the liquid particles impinge at high speed on an abutment surface provided for this purpose, the intention being to obtain a subsequent further reduction in size of the particles by fragmentation.

These prior-art approaches to the problem at hand have been found suitable in a variety of instances. It has, however, been observed that in so far as the degree of homogenization which can be obtained with them, their effectiveness is definitely limited. Hence, there continues to exist a need for a method and an apparatus which will provide improved homogenization in a simple and effective manner.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to provide this improvement.

More particularly it is an object of the present invention to provide an improved method for homogenizing liquids containing several non-admixable phases.

A concomitant object of the invention is to provide an apparatus for carrying out the novel method.

In pursuance of these objects, and of others which will become apparent hereafter, one feature of the invention resides in a homogenizing method for liquids containing non-admixable phases, which method comprises, briefly stated, the step of establishing an annular gap having an outer and an inner periphery. Thereupon, a multi-phase liquid containing separate non-admixable phases is passed under pressure and at high speed through the annular gap from the outer towards the inner periphery thereof. During the passage through this gap the liquid is caused to undergo cavitation. This method provides the desired improvements.

An apparatus for carrying out the novel method comprises means defining an annular gap having a radially inner and a radially outer periphery and being bounded by a pair of juxtaposed surfaces. The supply channel for the liquid to be homogenized communicates with the radially outer periphery and the removal channel communicates with the radially inner periphery, and during passage between the juxtaposed surfaces bounding the radial gap the liquid is caused by suitable means to undergo cavitation.

According to a currently preferred embodiment of the apparatus at least one of the surfaces is provided with one or several concentric annular grooves which preferably are closer towards the radially inner periphery than the radially outer periphery of the annular gap. The dimensions of the grooves and the width of the annular gap are so coordinated with one another and with the pressure at which the liquid is supplied that in operation there will develop in the annular gap alternating regions in which the pressure of the liquid is respectively above and below the boiling pressure of the continuous phase of the liquid. It is further advantageous, in a sense improving the homogenizing effect, to provide upstream of the annular gap at least one shear nozzle known per se and through which the liquid is made to pass, in order to supply the liquid in adequately prehomogenized state to the annular gap.

The novel features which are considered as characteristic for the invention are set forth in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a somewhat diagrammatic axial section through an apparatus according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing the drawing now in detail, it will be seen that in the illustrated apparatus there is provided a hollow cylindrical jacket or casing **7** in which there are mounted—spaced from one another in the direction of fluid flow through the jacket, as indicated by the two arrows—a homogenizing plate **4** and the axially apertured homogenizing seat member **5.** The plate **4** has a supply channel **1** composed of the illustrated axial inlet bore, radial passages and an outer annular chamber portion. All of these portions of the channel **1** are clearly illustrated and none of them are believed to require a more detailed discussion. To effect pre-homogenization of the liquid a shear nozzle **8** known per se is installed in the axial bore of the channel **1** so that the liquid to be homo-genized must pass through the nozzle **8** before it can reach the annular gap still to be described.

An axial removal or outflow channel **3** communicates with the aperture in the homogenizing seat **5.**

According to the present invention the juxtaposed surfaces of the plate **4** and the seat **5** define with one another a radial annular gap **2** having a radially outer and a radially inner periphery. The liquid entering through the nozzle **8** will flow around the plate **4** and enter the gap **2** at the radially outer periphery thereof, passing at high speed and under pressure in the radially inward direction to the radially inner periphery of the gap **2** and from there into the channel **3.** In the illustrated embodiment both of the surfaces bounding the gap **2,** which are identified with reference numerals **4a** and **5a,** respectively, are each provided with three concentric annular grooves **6.** However, only one of these surfaces could be provided with only one of these grooves, or with two or more of them. The width of the gap **2** and the dimensions of the grooves **6** are so coordinated with one another that in the gap **2** there will develop in operation alternating regions in which the pressure to which the liquid is subjected will be below and above the boiling pressure of the continuous phase of the liquid.

Because the flow of the liquid is radially inward from the outer to the inner periphery through the gap **2**, the pressure will decrease in the gap because of the linear decrease in cross-section. This means that, if the dimensions and flow conditons are appropriately selected and coordinated, the pressure of the liquid passing through the gap **2** will drop below the boiling pressure of the continuous phase in the gap **2**, but not in the annular grooves **6**. In so far as the annular grooves **6** are concerned, it will be appreciated that the sudden cross-sectional increase experienced by the liquid on encountering the grooves **6** results in a shock-like increase of the pressure above the boiling pressure, so that the vapor bubbles which have formed in the annular gap prior to encountering of the respective grooves **6** because the pressure had been below the boiling pressure, will collapse and the droplets of the dispersed liquid phase will be very finely distributed.

Advantageously the grooves **6** will be closer to the inner periphery of the gap **2** than to the outer one, and by utilizing several of the grooves **6** which are encountered successively as the liquid passes through the gap **2**, alternating vaporization and cavitation zones are obtained. Because the cross-section of the annular gap **2** decreases in direction from the outer towards the inner periphery the pressure in each successive annular vaporizing zone is lower than in the preceding one, so that renewed vaporization will result in each cavitation zone.

It is pointed out that the configuration and the dimensioning of the plate **4** and of the seat **5**, as well as the width and radial length of the annular gap **2** and the arrangement and dimensioning of the grooves **6**, as well as the speed at which liquid is supplied into the gap **2**, can be determined and coordinated with reference to one another by persons with ordinary skill in the art given the above information and in dependence upon the liquid to be homogenized and the degree of homogenization which it is desired to obtain. It is not absolutely necessary that the liquid be pre-homogenized, as by passing it through the nozzle **8**, before entering into the gap **2**, but if it is desired to obtain homogenization conditions, then it is important that such pre-homogenization be provided.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in the homogenization of liquids, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge, readily adapt it for various applications without omitting features that from the standpoint of prior art fairly constitute essen-tial characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are adapted to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. A homogenizing method for liquids containing non-admixable phases, comprising the first step of establishing an annular gap having an outer and an inner periphery; the second step of passing a multi-phase liquid under pressure and at high speed through said annular gap from said outer towards said inner periphery thereof; and the third step of causing the development of cavitation in said liquid during passage thereof through said annular gap.

2. A method as defined in claim **1**, wherein said third step comprises causing the repeated development of cavitation during passage of said liquid through said annular gap.

3. A homogenizing apparatus, particularly for homogenizing liquids containing a plurality of non-admixable phases, comprising first means defining an annular gap having an outer and an inner periphery and being bounded by a pair of juxtaposed surfaces; and second means for effecting the development of cavitation in liquid passing at high speed and under pressure through said annular gap from said outer towards said inner periphery thereof.

4. An apparatus as defined in claim **3**, said second means comprising at least one annular groove provided in at least one of said surfaces, the dimensions of said annular groove and of said annular gap being so coordinated that the liquid pressure within said annular gap is below, and in the region of said annular groove is above the boiling pressure of the continuous phase of said liquid.

5. An apparatus as defined in claim **4**; and further comprising at least one additional annular groove provided in said one surface and concentric with said one annular groove.

6. An apparatus as defined in claim **5**, wherein said annular grooves are closer to said inner periphery than to said outer periphery.

7. An apparatus as defined in claim **3**; and further comprising at least one shear nozzle upstream of said annular gap and through which said liquid is compelled to pass.

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