

[54] EMULSIFYING AND DISPERSING APPARATUS WITH CONCENTRIC RINGS OF TOOLS

[75] Inventors: Manfred Zipperer; Reinhard Prochnau, both of Staufen, Germany

[73] Assignee: Internationale Laboratoriums-Apparate GmbH, Ballrechten-Dottingen, Germany

[22] Filed: Feb. 28, 1974

[21] Appl. No.: 447,049

[30] Foreign Application Priority Data
Mar. 1, 1973 Germany..... 2310321

[52] U.S. Cl. 259/24; 259/95; 259/DIG. 30; 415/83

[51] Int. Cl.² B01F 7/26

[58] Field of Search 259/DIG. 30, 95, 96, 5, 259/6, 7, 8, 9, 10, 22-26, 45, 46, 105, 106, 107, 108; 415/80, 81, 82, 83, 84

[56] References Cited
UNITED STATES PATENTS

1,711,154	4/1929	Michal	259/DIG. 30
2,619,330	11/1952	Willems	259/DIG. 30
2,688,470	9/1954	Marco	259/DIG. 30

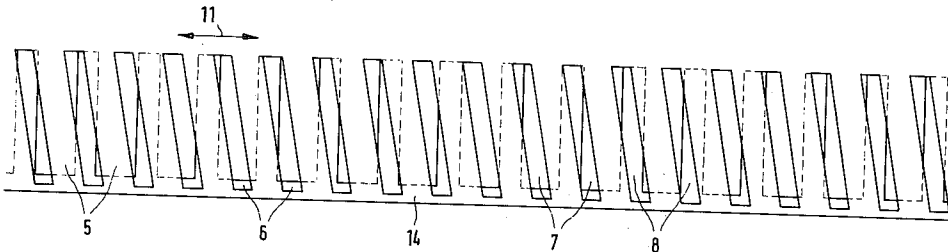
2,985,389	5/1961	Willems	259/96
3,195,867	7/1965	Mould	259/96
3,724,765	4/1973	Rohrbaugh	259/96

Primary Examiner—Robert W. Jenkins
Attorney, Agent, or Firm—Waters, Schwartz & Nissen

[57] **ABSTRACT**

Emulsifying and dispersing apparatus having at least one working stage formed of at least two concentric tool rings rotating relative to one another, such as a rotor and a stator, the tool rings including toothed elements separated by groove spaces which cooperate at least partly with a shearing action, are arranged about a suction chamber serving as a central supply chamber. At least one of the tool rings preferably runs at a frequency which may be as high as high ultrasonic values. Parallel surfaces of adjacent toothed elements, which bound the groove spaces in the peripheral direction of one of the tool rings have portions that are disposed in the axial direction at an acute angle relative to the surfaces or planes of the toothed elements of the other tool ring. In accordance with this arrangement, adjacent toothed elements constitute with their respective groove space cooperating impacting and shearing flanks tween the two rings, while the groove spaces in the outer tool ring constitute discharge openings about the entire periphery of the apparatus.

9 Claims, 5 Drawing Figures



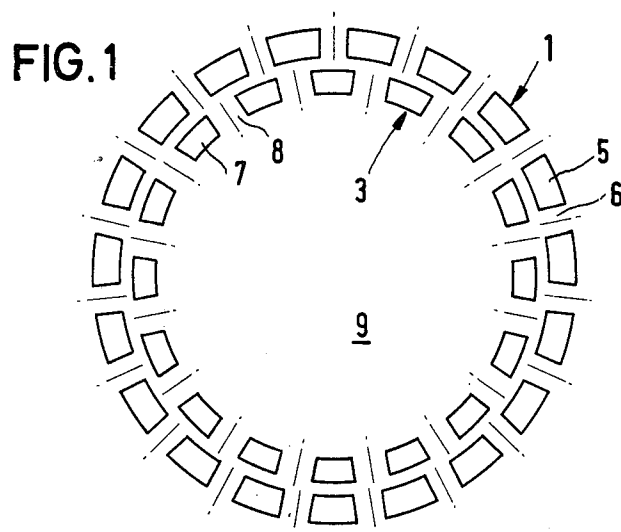


FIG. 3
PRIOR ART

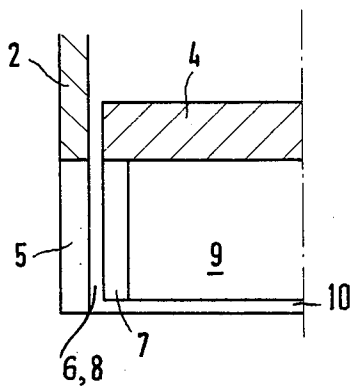


FIG. 5

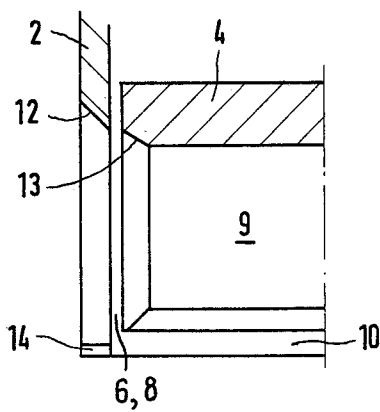


FIG. 2
PRIOR ART

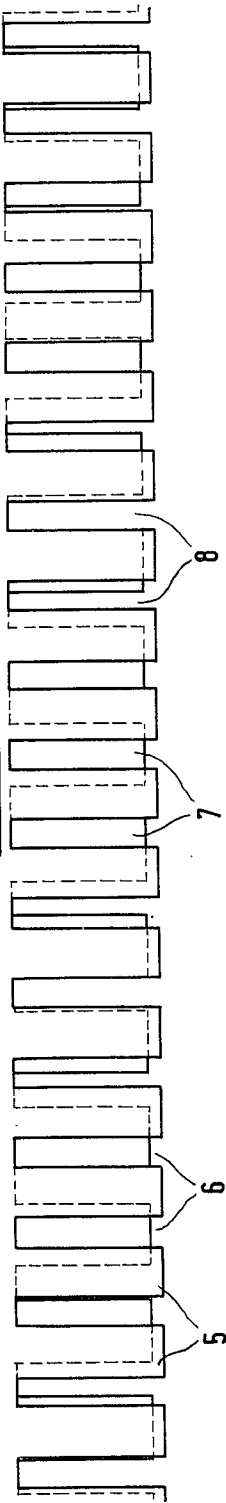
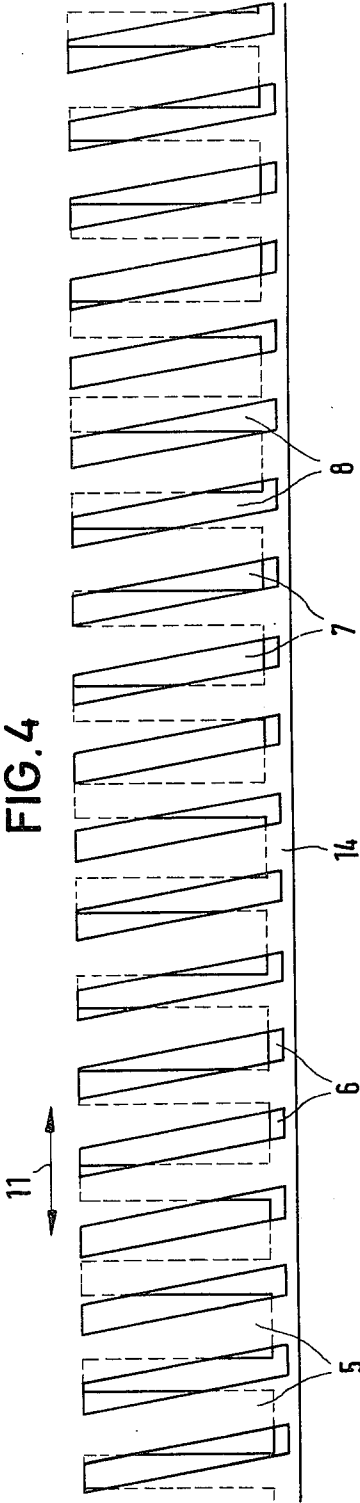


FIG. 4



EMULSIFYING AND DISPERSING APPARATUS WITH CONCENTRIC RINGS OF TOOLS

The invention relates to an emulsifying and dispersing apparatus for the treatment of a medium.

Apparatus for producing emulsions and dispersions for laboratory work and general production are already known which are based on the principle of a processing head rotating in the medium, e.g. a liquid mixture or liquid-solid mixture. Preferred apparatus of this kind comprise a rotor adapted to rotate relatively to a stator, and in one known constructional form a slotted rotor tube rotates in a likewise slotted stator tube.

Operating on the same principle are known mixing and dispersing apparatus wherein the rotor and stator are provided with rings of tools which cooperate with a shearing action and are arranged about a suction chamber used as a central supply chamber.

In these known apparatus, the groove spaces provided between the toothed elements of the stator and rotor, or the surfaces bounding said spaces, are arranged parallel to one another in the axial direction, that is to say the direction of the axis of rotation. Thus for example in the case of a processing head with an internal rotor and an external stator, the medium under pressure which is to be emulsified or dispersed is suddenly transferred over the full groove space cross-section out of the rotor groove spaces which extend in the axial direction into the likewise axially arranged outlet groove spaces of the stator.

It is disadvantageous that it is relatively easy for a rotation of the medium to occur since the outlet plane of the groove space streams is parallel to the axis of rotation. Small irregularities then cause rotation and the formation of funnels in the medium and therefore undesirable inspiration of air. Fiber materials, macromolecular cross-linked structures (polymerization products) and bio-structures are not cut with "knife action" but are smashed, mainly at the edges of the toothed elements.

As a result there is considerable wear on these edges, and fiber particles or the like easily become stuck in the radial gap between the rings of tools, cause jamming and in some cases blocking of the rotor. The result of the shredding operation, that is to say dispersion, is not the best that could be expected.

Finally, in the known apparatus with axially disposed groove spaces between the tools it is a disadvantage that, in the case of an arrangement immediately below the surface of the medium to be processed the detaching of the circulation flow is promoted in an undesirable manner. It is also problematic that the vortex flow of the medium issuing from the groove space zone of the usually internal rotor is not deflected upstream of the ducts in the stator but is transferred with a short lateral displacement directly and in a completely parallel manner into the stator groove spaces. This results in shearing stress losses and thus defects in the dispersion produced.

Furthermore, in the case of the known arrangement of the groove spaces in the stator, the superimposition effect of the turbulent flow outside the stator and within the medium is not sufficiently developed, so that there is insufficient development of the effect of pre-dispersion by the turbulent flow surrounding the processing head.

The present invention has as its object to obviate the aforesaid disadvantages, and to provide an apparatus of the type initially specified in such a manner that the risk of the formation of funnels in the medium, and therefore of drawing in air, is reduced. At the same time the circulating effect and therefore the dispersing effect are improved to a significant extent.

To solve this problem, it is proposed according to major features of the invention that parallel surfaces of adjoining toothed elements, bounding the groove spaces in the peripheral direction of at least one tool ring have portions that are inclined in the axial direction at an acute angle relative to the surfaces of the toothed elements of the other tool ring.

In this way it is made more difficult for the medium to rotate and form funnel cavities, since the vortex flow of medium, issuing from the working stage or the groove spaces of the external ring, is no longer parallel to the direction of the axis of rotation of the rotor or the concentrically rotating rings if both are made to spin.

Fiber and structure substances are no longer crushed at the toothed element edges but are severed or sheared at a cutting angle or flank. There is a reduction in the wear which occurs on the tooth edges and there is less jamming since the amount of force expended is substantially smaller when cutting is used.

The apparatus can now be arranged a short distance below the surface of the medium (upper ends of the groove spaces of the stator just below the medium surface), since the construction according to the invention makes a detachment of the circulating flow much more difficult.

As a result of the inclined positioning relative to one another the groove spaces of the rotor and the stator overlap during their relative rotation, in a relatively constant large dynamic cross-section (in the case of parallel overlapping groove spaces there is only a sudden opening and closing of the shearing cross-section). Consequently the turbulent flow of the medium passing from the groove spaces of one tool ring of a working stage into the groove spaces of the other ring of this stage is subjected to a deflecting effect, corresponding to the angle of the groove spaces relative to one another and a permanent high-frequency variation in its geometric form and volume.

In addition to an increased shearing stress within the medium flow this results in a further whirling of the medium in several planes. This latter whirling, when the medium is discharged from the working stage, causes an intensive mixing of the surrounding medium and thus an improvement in the pre-dispersion effect.

In a convenient further development of the invention the acute angle and thus the inclination of one set of groove spaces relative to the other set amounts to about 6 to 10°.

According to a further preferred feature of the invention the groove spaces of one tool ring are bound by axially parallel or axially disposed ones of the inclined portions of the toothed elements, and the groove spaces of the other ring of the same working stage are bound by other inclined toothed element portions, the inclination being always relative to the axis of the concentric tool rings.

It is also possible within the framework of the invention for the groove spaces of the tool rings of a working stage to be arranged at an inclination in opposite direc-

tions to one another by a certain angle relative to the axial direction.

A preferred, exemplary embodiment of the invention will be explained hereinafter with reference to the accompanying drawings, wherein

FIG. 1 shows a somewhat schematic view from below of a working stage formed of a rotor and a stator in an emulsifying and dispersing apparatus;

FIG. 2 shows in development rings of tools of the conventional type, cooperating in a working stage;

FIG. 3 shows a schematic section through the tool rings of the conventional type;

FIG. 4 shows a development (similar to FIG. 2) of tool rings of the type provided by the present invention, cooperating in a working stage; and

FIG. 5 shows schematically, in a sectional view (similar to FIG. 3) tool rings according to the invention.

According to FIG. 1, a working stage of an emulsifying and dispersing apparatus comprises an outer tool ring 1 of a stator 2 (see FIGS. 3, 5) and an inner, rotating tool ring 3 of a rotor 4 arranged concentrically thereto. The ring 1 is formed of toothed elements 5 which are usually separated from one another by substantially axially parallel prismatic groove spaces 6. Correspondingly toothed elements 7 of the rotor ring 3 are separated by groove spaces 8. It is possible to have both rings rotate.

In the illustrated constructional form the rotor ring 3 encloses a suction chamber 9 serving as a central supply chamber. In principle it is advantageous if the number of elements 5 is larger in the stator than that 7 in the rotor.

The medium to be dispersed or emulsified is aspirated through the suction chamber 9 and delivered to the exterior through the groove spaces 6, 8 between the toothed elements 5, 7 which cooperate at frequencies which can go up to high ultrasonic or supersonic values.

The schematic views of FIGS. 2, 4 show the overlapping of the toothed elements 5, 7 and groove spaces 6, 8 of the tool rings 1, 3 of the stator 2 and the rotor 4 in a chance rotation position relatively to one another.

FIG. 2, the conventional or prior-art arrangement, shows that about half of all the groove spaces of the rotor or stator respectively are masked by toothed elements of the other tool ring, that is to say the stator or rotor.

FIG. 3 shows that the conventional prismatic form of the groove spaces 6, 8 between the toothed elements 5, 7 provides a considerable obstacle to the flow of the medium.

In contrast, with the arrangement provided by the invention as shown in FIG. 4, it will be seen that, owing to the inclined arrangement of the groove spaces 6 in the stator, the sum of the passage cross-sections resulting from the overlapping of the groove spaces 6 of the stator and those 8 of the rotor is substantially greater. In addition, this inclination gives the advantages mentioned initially as regards the cooperation of the groove spaces 6, 8.

The direction of the rotation of the rotor is indicated in FIG. 4 by an arrow 11. Taking this direction of rotation into account, the inclination of the groove spaces 6 of the stator is such that the free cross-sections of passage at this particular time, formed by the overlapping groove spaces 6, 8, move apparently from below, relative to a suction aperture 10 as shown in FIG. 5, up-

wards into the suction chamber 9 with a shearing action.

To improve the flow conditions, according to FIG. 5 base surfaces or portions 12, 13 of the groove spaces 6, 8 are sloped at an angle of preferably 45°.

It is of secondary importance that, as shown in FIGS. 4, 5, the toothed elements 5 of at least the rotor may be connected at their free ends by a web 14 so that the groove spaces 6 are not open below but are actually inclined slots.

The present arrangement according to the invention can be used both in the case of conventional apparatus wherein the tool rings on the rotor and the stator extend substantially in a cylindrical arrangement and wherein the spacing between the rotor element relative to those of the stator cannot be varied, and also in the case of apparatus wherein the spacing gap between the toothed elements of both the rotor and the stator is capable of being varied in a manner as described in a U.S. Pat. application of one of the present joint inventors, M. Zipperer, Ser. No. 278,431, titled "Emulsifying and Dispersing Apparatus," now abandoned.

Tests have shown that apparatus with the construction according to the present invention provide about 4 times the circulating power so that the pre-dispersing effect is very marked. This means that a relatively small apparatus can be used for relatively large containers. It has been found that the degree of emulsification or dispersion even then is not any lower than with conventional apparatus. The inventive apparatus can be used both with processing heads which penetrate discontinuously into the medium to be treated, and also with continuously operating through-flow apparatus.

It will be understood that only an exemplary, preferred embodiment of the inventive emulsifying and dispersing apparatus has been shown with its most important features, and that many modifications and changes can be made therein without departing from the spirit and scope of the invention.

What we claim is:

1. An emulsifying and dispersing apparatus for the treatment of a medium, comprising at least one working stage formed of at least two relatively rotatable tool rings having concentric axes, such as a rotor and a stator, including first and second tool rings, formed by respective first and second toothed elements in respective planes, separated by first and second, substantially parallel groove spaces, said rings being arranged about a suction chamber that serves as a central supply chamber, wherein substantially parallel portions of adjacent ones of said toothed elements, which bound said groove spaces in the peripheral direction of at least one of said tool rings and cooperate in one of said working stages, are inclined in the axial direction at an acute angle relative to the respective planes of said toothed elements of the other one of said tool rings, thereby constituting a high proportion of overlapping between said first and said second groove spaces during the rotation of at least one of said tool rings, wherein said adjacent toothed elements constitute cooperating impacting and shearing flanks between said tool rings, and said groove spaces in the outer one of said tool rings constitute discharge openings about the entire periphery of the apparatus.

2. The apparatus as defined in claim 1, wherein the acute angle between said inclined parallel portions of the adjacent toothed elements, and thus the inclination

of one set of said groove spaces relative to the other set of said spaces, amounts to about 5° to 10°.

3. The apparatus as defined in claim 1, wherein said groove spaces of one of said tool rings are bound by axially disposed ones of said inclined parallel portions of the toothed elements, and said groove spaces of the other one of said tool rings of the same working stage are bound by other ones of said inclined parallel portions of the toothed elements.

4. The apparatus as defined in claim 3, wherein said first and said second tool rings are respectively associated with an external stator and an internal rotor, and wherein said groove spaces of the stator tool ring are bound in the peripheral direction by said inclined parallel portions of the toothed elements.

5. The apparatus as defined in claim 4, wherein said inclined parallel portions of the toothed elements are directed with their free ends at an inclination to the di-

rection of rotation.

6. The apparatus as defined in claim 5, wherein said toothed elements of the stator tool ring are longer in axial direction than those of the rotor tool ring.

7. The apparatus as defined in claim 1, wherein base surfaces of said groove spaces slope outwardly at an angle of about 45° in the direction of flow of the medium.

8. The apparatus as defined in claim 1, further comprising web portions between the free ends of at least one of said toothed elements, namely in the rotor, thereby limiting the respective ones of said groove spaces to inclined slots.

9. The apparatus as defined in claim 1, wherein the inclination of said parallel portions of the toothed elements is in opposite directions between said first and said second tool rings.

* * * * *

20

25

30

35

40

45

50

55

60

65