July 23, 1968 S. E. JACKE ET AL 3,394,274

SONIC DISPERSING DEVICE

Original Filed July 13, 1964

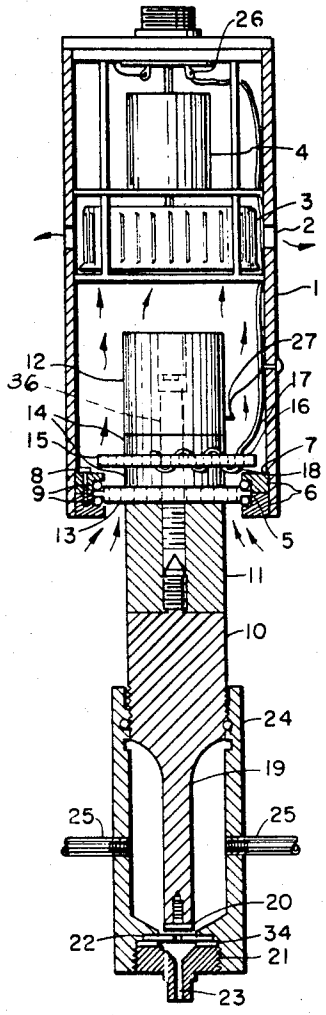


FIG. 1

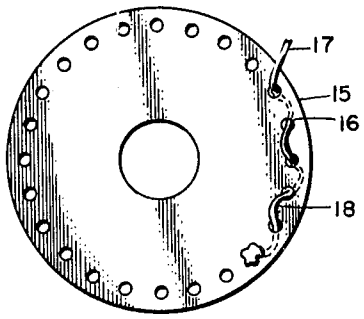


FIG. 2

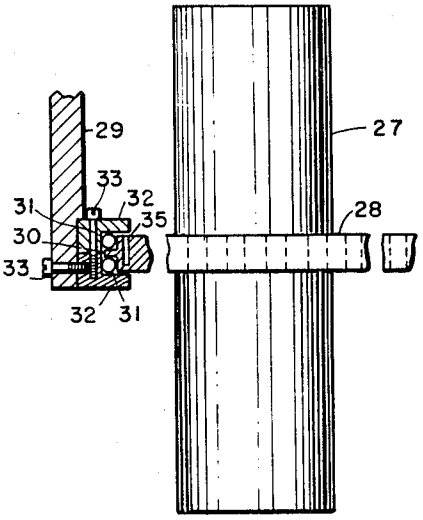


FIG. 3

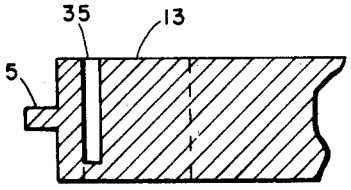


FIG. 4

INVENTORS
STANLEY E. JACKE
HENRY BIAGINI

BY

Blair Buckles & Cesari
ATTORNEY

United States Patent Office 3,394,274 Patented July 23, 1968

3,394,274

SONIC DISPERSING DEVICE

Stanley E. Jacke, Ridgefield, and Henry Biagini, Stamford, Conn., assignors, by mesne assignments, to Branson Instruments Incorporated, Stamford, Conn., a corporation of Delaware

Original application July 13, 1964, Ser. No. 384,025, now Patent No. 3,328,610, dated June 27, 1967. Divided and this application Apr. 12, 1967, Ser. No. 636,563
3 Claims. (Cl. 310—8.1)

ABSTRACT OF THE DISCLOSURE

The disclosed apparatus includes an ultrasonic transducer having a back member, a first piezoelectric disk, a disk-shaped electrode, a second piezoelectric disk, a vent plate, and a front member all clamped together by a single axial bolt. The exposed marginal portions of the electrode and the vent plate are perforated for cooling the piezoelectric disks. The transducer is supported in vibration insulating fashion in a case. A sonic energy concentrating horn is affixed to the front member. A casing adjustably threaded on the horn mounts a wear insert immediately below the tip of the horn. An inlet opening in the casing admits liquid and solid material which then flows into the zone between the horn tip and the insert. Energization of the transducer develops sonic vibrations in this zone to disperse the solid material into the liquid; the resulting dispersion exiting through an opening in the insert and an outlet in the casing.

Reference to related applications

This application is a divisional application of our copending application Ser. No. 384,025, filed July 13, 1964, entitled Sonics; which is in turn a continuation-in-part of our application Ser. No. 125,568, filed July 20, 1961, entiled, Sonic Disperser, now U.S. Patent No. 3,328,610 dated June 27, 1967.

Background and objects of the invention

Attempts have been made to disperse materials by the use of sonic vibrations, and especially by the use of ultrasonic vibration. A number of problems have arisen, especially with vertastile instruments and those which need to be portable or semi-portable. The problems will be brought out in connection with a generalized description of a sonic disperser which will be described as an ultrasonic disperser as this is the most important single field for the present invention, although vibrations in the audible range are included and are sometimes useful.

Essentially dispersers comprise a sonic transducer, which may be of the piezoelectric or magnetostrictive type, coupled with the provision for a zone in which the sonic vibrations are imparted to the liquids or liquids and solids which are to be dispersed. Preferably, in order to increase efficiency, the transducer is provided with a tapering end which acts as a sonic transformer, increasing the magnitude of the vibrations at its narrow end. Two different types of problems arise, both of which are solved by the transducer and disperser aspects of the present invention. The first type of problem deals with the transducer mechanism itself, and the second with the design and the elements of the actual dispersing zone. The first type of problem will first be discussed.

The disperser described generally above is usually portable or semi-portable and may for certain purposes be handheld. This means that it is undesirable to impart any considerable amount of sonic vibration, such as ultrasonic vibration, to the case. This can be effected, as will be described in greater detail below, by connecting an

axial nodal point of the vibrating mechanism through a thin ring, preferably perforated, as is the case with the perforated electrodes described above, and having a very thin metal edge at its periphery which is fastened to the case through resilient means such as, for example, elastic O rings. The perforated electrodes perform the functions of cooling, reducing lead breakage and presenting a relatively thin metal element at or near the nodal point of the sonic vibrating mechanism which can be connected to the outer casing through resilient means which effect practically complete sonic decoupling. Thus in the preferred disperser form both types of invention are involved. However, the sonically vibrating element need not be a transducer, it can be any sonically vibrating element so long as the connection to an outer casing is through a thin solid ring, at or near the nodal point of vibrations, resiliently connected to the outer casing. In such a case, the ring, which may be perforated metal, performs only the decoupling function and not the combined functions of decoupling, cooling and lead protection as in the preferred embodiment of the present invention.

The problems encountered in the zone where the actual dispersion takes place are quite different in their nature from those presented by cooling and lead breakage. In the actual zone of dispersion there are two severe problems and, as they present requirements which are mutually contradictory, compromises have been necessary. It is necessary that there be a very rapid flow of material through the zone where dispersion is taking place because while the first effect of the sonic vibrations is to bring about dispersion, continued exposure of the emulsions or suspensions produced to sonic vibrations proceeds to reverse the phenomenon and produce emulsions or dispersions in which the units of the dispersed phase rapidly increase in size. This is just what is not wanted because ordinarily the finer emulsion or suspension is the better its properties. The demulsification which occurs when there is too long an exposure to sonic vibration sometimes goes so far as actually to break emulsions.

The requirement for short dwell time in the sonic vibrating zone is at odds with the requirement that there be sufficient transfer of energy in the form of sonic vibrations. The shorter the dwell time, other things being equal, the smaller the amount of energy to which the medium is exposed. This has necessitated in the past an extremely-critical adjustment of zone size, because, of course, the thinner the layer of liquid medium passing across the end of the sonic transformer, the more rapidly the sonic energy is transmitted into the medium. This requirement for very accurately controlled and usually quite thin zones raises another very serious problem, and that is sonic erosion. If the zone is quite thin there will be very serious wear both on the tapered end of the sonic transformer and on the adjacent point on the housing. This has proven quite costly and has a further disadvantage that the relation of zone thickness changes. In the present invention this is solved by providing a very long wearing insert opposite the end of the sonic transformer together with the preferred embodiment of the invention including removable tips for the sonic transformer which may be of different shapes to suit the rheological properties of the media to be dispersed. Also the invention provides for adjusting means, preferably micrometric adjusting means, for changing the zone thickness without disassembly. In this way for a considerable period of time wear can be compensated for until finally the wear inserts have reached the point where they need to be replaced. In the present invention this is done simply, cheaply, and the inserts themselves are of a form which can be manufactured at almost negligible cost.

The present invention, therefore, permits a sonic disperser which can be adjusted to give optimum results over a wide range of materials, and maintain these optimum results, and at the same time presents no problem if the liquid load suddenly changes, as for example if the flow of liquid is interrupted. Even if there is no liquid at all, the instrument does not overheat to the point of damaging itself, and also interruption due to lead breakage is eliminated. The result is an extremely versatile instrument which can be designed to be portable or semi-portable, and which can be rapidly adjusted to meet varying conditions. At the same time this great versatility, protection against overheating, lead breakage, is achieved in a very simple and economical construction which can be manufactured at minimum cost.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

It will be apparent to those skilled in the sonic art that the hand-held transducer assembly, usually provided with a concentrating horn, may be used alone without the disperser attachment for sonically treating solids, liquids, and gases.

The invention will be described in detail in connection with the preferred type of disperser instrument employing a piezoelectric transducer operating in the ultrasonic range, for example from about 20 to 30 kc. The description will also deal with the most versatile modification of the present invention, it being understood that there where continuous operation with a uniform material is required, some modification of the completeness and rapidity of adjustment may be made.

The invention will also be described in conjunction with the drawing in which:

FIG. 1 is a vertical cross-section;

FIG. 2 is a plan view of one of the perforated electrodes;

FIG. 3 is a section through a casing and vibrating rod, and

FIG. 4 is a section, partly broken away, on an enlarged scale through part of a perforated electrode.

Similar reference characters refer to similar parts throughout the several views of the drawing.

The device shown in FIG. 1 is housed in a two part casing, the upper part of which is shown at **1** and may be of metal. It is provided at a point above the electrodes of the transducer with openings **2** through which cooling air may leave. A blower **3** driven by a motor **4** serves to produce a rapid draft of cooling air in through the bottom of the casing and up through holes in the electrodes as will be described. The bottom part of the casing is provided with a shoulder **7** in which are mounted two metal rings **6** with rubber O rings **9** clamped together with bolts **8**. This supports the transducer, as will be described below.

The transducer is formed of two piezoelectric wafers **14** separated by an aluminum disk electrode **15** provided with holes **16**. The other wafer is directly connected to a metallic resonating element or front member **11**, and a second perforated aluminum disk **13** constitutes the other electrode. Above the top piezoelectric wafer is another resonating block or back member **12** which may be of different metal than that of the block **11**, or which may be of the same material. The blocks and wafers are bolted together by a central bolt **36**. As a result, the two metallic resonating blocks and the usual outer silvered surfaces of the two wafers are at the same electrical potential, usually ground. The electrode vent plate **13** provides for additional cooling. The electrode **13**, which is situated near the axial nodal point of the transducer, is provided with a thin peripheral edge **5** which is clamped between the O rings and, therefore, supports the transducer on the casing. Thus as the amount of metal in the disk is very small, due to the perforations and to the thin peripheral fin, and primarily due to the poor sonic transmission quantities of the resilient O rings, there is negligible sonic coupling to the casing **1**. The coupling may be further reduced by cutting a groove, which is illustrated in FIG. 4, as groove **35**.

As has been stated above, cooling air is drawn in the bottom of the casing and passes up through the perforations in the electrodes effecting good cooling. Leads are fastened to one or more of the electrodes, the drawing showing attachment to electrode **15**. The lead **17** is rigidly attached, for example, by soldering to the electrode disk. The wire is then looped through several holes forming loose strain loops **18** and is led to one pin from an inlet socket **26**. The other pin is connected to the casing and then through a slack wire to a pin **27** on the upper resonating block. This second lead could be connected to the grounded electrode vent plate **13**, but the illustrated construction is somewhat simpler and more compact.

The bottom of the sonic transformer **10** tapers into a thin section **19** which increases the amplitude of oscillation of the transducer. The tapered end is preferably threaded and a removable wear element **20** is attached to the frontal surface of the transformer by screw means. A second casing **24** is screwed onto the large portion **10** of the sonic transformer with extremely fine threads and is provided with side openings **25**. The end of the casing carries fine internal threads and a plug **21** screws into it. This plug is provided with a discharge opening **23** leading into a recess in which is mounted a wear insert **22** which is also centrally perforated. The plug bears against a gasket **34** which maintains the casing **24** liquid tight.

In operation liquid or liquids flow in through the inlets **25** and pass in a thin layer between the vibrating tip **20** and the wear insert **22**. The spacing is micrometrically adjusted by screwing the casing **24** on the transformer to provide the optimum layer thickness. The dispersion passes out through the discharge hole **23** and as the materials have remained in the zone of violent sonic vibrations only for the time necessary to produce dispersion there is no degradation in the quality of the dispersion. The instrument operates continuously and the dimensions of the zone of dispersion can be maintained constant by an occasional adjustment of the casing **24**. Finally, after an extended period of operation which may vary from a number of hours to many days, the insert **22** wears thin, or also the tip **20** may wear to an excessive thinness. When this occurs, the plug **21** is unscrewed, a new insert is introduced, and if necessary a new tip **20**. The operation is very rapid, requires no special tools or equipment, and the device is ready to start operation again. Adjustment is then made until the appearance of the dispersion leaving the pipe **23** shows that it is of optimum quality.

The use of a chamber provided by a tubular casing **24** constitutes the most practical shape of instrument. However, it should be understood that all that is necessary is that the liquid medium to be dispersed must pass through the sonic zone. It is possible to introduce the medium or a component thereof directly into the sonic transformer employing a hollow tapering portion **19** and a hollow end piece **20**. Such a device operates readily and effectively but it is much more expensive and has a further disadvantage where the instrument is to be used with various materials. When the instrument is used first on one material and then on another it is necessary to clean it out. This presents much more of a problem when hollow sonic transformers are used, whereas the casing **24** of the preferred form shown in the drawing can easily be removed and all parts thoroughly and rapidly cleaned.

There must be some means for containing the liquids to be dispersed. However, the containing means does not necessarily have to be integral with the disperser as is the

casing **24**. The vibrating tip may be used in a separate container.

In FIG. 1 the disperser is shown with a blower to produce a positive draft of cooling air. Where the heat dissipation is considerable, this is desirable to prevent overheating of the piezoelectric wafers. However, for some instruments the blower may be omitted and the natural flow of air out of an open-top casing may be sufficient. The blower, therefore, is not an essential element of the disperser though a desirable one in the preferred modification.

FIG. 3 shows sonic decoupling only and is illustrated in connection with a sonically vibrating metal rod **27**, the sonic vibrations being imparted thereto by any suitable transducer means (not shown). Casing **29** which surrounds the rod **27** is connected thereto through a perforated disk **28** which is fastened to or near a nodal point on the rod **27**. This perforated disk is provided with a thin peripheral fin **30** which is held between two O rings **31** and two rings **32** connected to the casing **29** and bolted together by bolts **33**. It will be noted that the structure shown is substantially similar to the coupling of the casing **1** in FIGS. 1 and 2, but in FIG. 3 the disk does not perform the additional function of an electrode. Here the perforation is merely to reduce the amount of metal and, therefore, the sonic coupling. The effect is further carried out by the thin fin **30** which actually contacts the resilient O rings. The disk is provided with a groove **35** as in the case of the perforated electrode described in connection with FIG. 4. The groove still further reduces the sonic coupling.

As illustated the connection is through a perforated disk in which there are a number of holes. Of course, there may be only a few large holes which in the extreme would be represented by a spider connecting a thin peripheral ring. The main thing is to reduce the connecting mass of metal, and as there is no cooling function it is immaterial whether the disk has a large surface of metal to be exposed to cooling air. Only the decoupling effect is sought here and this is just as complete as in FIG. 1.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

For example, the transducing elements of the present invention may be comprised of any number of piezoelectric wafers desired in accordance with the teachings of the co-pending application of Stanley E. Jacke, Ser. No. 128,451, filed Aug. 1, 1961 entitled Transducer.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A dispersing device comprising:

a sonic energy transducer adapted to be energized with alternating current electrical energy and provide mechanical vibrations in response to said energy;

a mechanical transformer having a threaded portion along its side acoustically coupled with its input end to said transducer and providing increased amplitude of vibrations at its output end;

a tubular casing forming a treatment chamber for fluid surrounding the output end of said transformer and being threaded at one end for engaging said threaded transformed portion, whereby by means of said threaded engagement the spacing between the frontal surface at the output end of the transformer and the other end of said casing may be varied;

a removable plug closing said other end of said casing and having an aperture adapted to serve as an outlet for discharging fluid from said chamber after passage thereof in proximity to the frontal surface at the output end of said transformer;

said plug and casing having surfaces for clamping therebetween a removable flat annular disk disposed opposite and spaced from said frontal transformer surface, said disk acting as a replaceable wear surface;

annular gasket means for providing a seal disposed between said disk and said plug, and

fluid inlet means located on said casing at a point between its ends for admitting fluid which is treated by being passed from said inlet means through said chamber into the space between said frontal surface and disk, and then discharged through said disk and the aperture of said plug.

2. A dispersing device as set forth in claim **1**, the frontal surface of the output end of said transformer being provided with a replaceable wear element.

3. A dispersing device as set forth in claim **1**, said sonic transducer being adapted to operate in the ultrasonic frequency range.

References Cited

UNITED STATES PATENTS

2,512,743	6/1950	Hansell	310—8.2
2,680,333	6/1954	Calosi	310—26
2,774,193	12/1956	Thatcher	51—59
2,774,194	12/1956	Thatcher	310—26
2,804,724	9/1957	Thatcher	51—59
2,855,244	10/1958	Camp	310—26
2,939,251	6/1960	Greening	51—59
2,949,900	8/1960	Bodine	310—26
3,091,060	5/1963	Giegerich	51—59
3,103,310	9/1963	Lang	310—8.2
3,328,610	6/1967	Jacke	310—9.1
2,514,080	7/1950	Mason	159—1

J. D. MILLER, *Primary Examiner.*