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3,405,916

ULTRASONIC TREATMENT APPARATUS

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FIG. 1

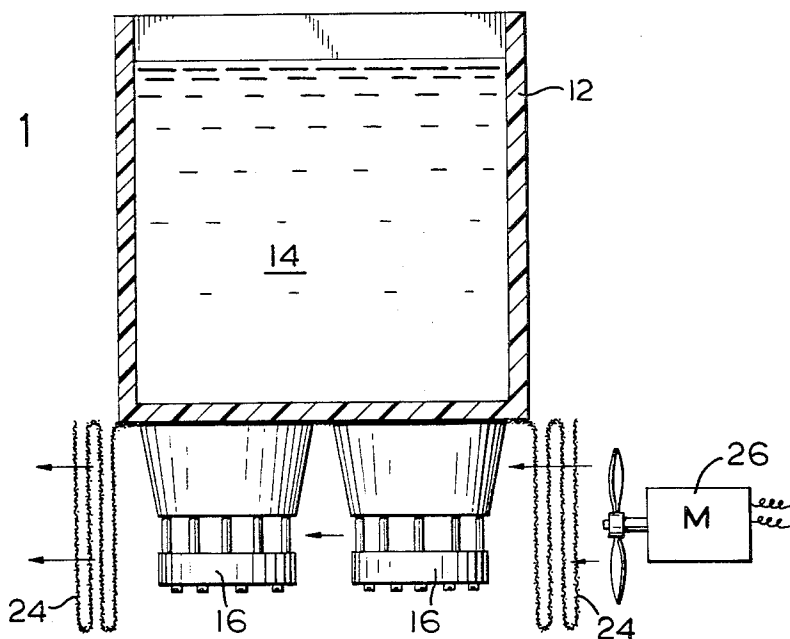


FIG. 2

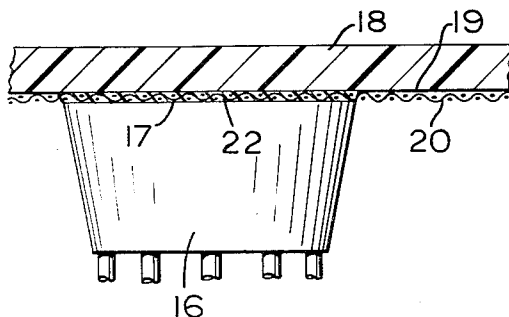
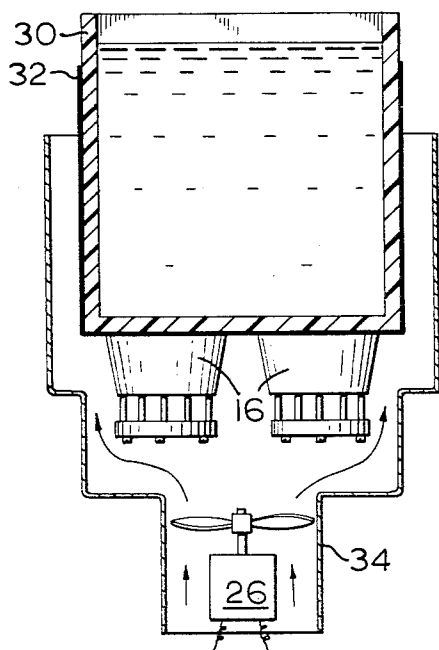


FIG. 3



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1

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ULTRASONIC TREATMENT APPARATUS

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ABSTRACT OF THE DISCLOSURE

In an ultrasonic cleaning or etching tank made of material having a relatively low thermal heat conductivity, such as plastics, a material having a higher heat conductivity is interposed between the transducer frontal surface and the tank surface and is extending beyond such frontal surface in order to provide for the removal of the dissipated heat from the interface between the tank and transducer.

This invention refers to an apparatus for treating articles, particularly cleaning or etching, by immersion in a solution which is agitated by sonic or ultrasonic energy. More particularly, this invention refers to a simplified arrangement for providing a sonically or ultrasonically agitated etchant, or other highly corrosive or chemically active solution.

When it is desired to subject articles to a highly corrosive solution which is agitated by sonic or ultrasonic energy, it has been necessary in the past to use a so-called "double boiler" arrangement. A smaller vessel of chemically inert material containing the etchant solution is disposed in a liquid bath, for instance water, contained in a larger vessel to which sonic or ultrasonic energy is applied. The sonic energy applied to the larger vessel and the liquid contained therein is then transmitted via the outer bath through the walls of the chemically inert vessel to the etchant solution. This double vessel arrangement is shown typically in U.S. Patent No. 2,861,932 to R. G. Pohl dated Nov. 25, 1958. It will be apparent that an arrangement of this type is cumbersome in that it occupies a greater amount of space than ordinarily would be necessary and, moreover, the sonic energy produced is not used in a most efficient manner since it has to travel through a plurality of liquids and vessel walls.

The arrangement described hereinafter overcomes the disadvantages noted hereinabove by using a single tank made of a material adapted to withstand the attacks of many etchant solutions. Since tank material of this type is very frequently a rather poor heat conductor, special provisions are made to remove the heat from the area at which the ultrasonic energy is applied to the tank.

A principal object of this invention is, therefore, the provision of a rather simple and inexpensive arrangement for providing a chemically active solution agitated by sonic energy, using a single tank to which ultrasonic transducers are attached.

Another important object of this invention is the provision of a tank made of material having a relatively low heat conductivity and including means for conducting heat away from the area at which sonic energy transducers are attached.

A further object of this invention is the provision of a tank made of material having a low thermal conductivity to which ultrasonic energy transducers are attached and including thermally conductive means disposed between the transducers and the tank and extending beyond the area of transducer attachment for conducting heat away from the area of transducer attachment.

Other and still further objects of this invention will be more clearly apparent from the following description when

2

taken in conjunction with the accompanying drawings in which:

FIGURE 1 is an elevational view, partly in cross section, of the invention;

FIGURE 2 is an enlarged view, illustrating the technique of transducer attachment; and

FIGURE 3 is an elevational view, partly in cross section, of an alternative embodiment.

Referring now to the figures and FIGURE 1 in particular, there is shown a tank 12 containing a solution 14, typically an etchant for treating, for instance, small semiconductor parts. The tank 12, in a typical case, is four inches by six inches by six inches high, made of one-quarter inch thick polyvinyl chloride or polypropylene material. The bottom of the tank is fitted with one or more ultrasonic transducers 16 which are adapted to receive electrical energy and provide sonic energy through the bottom of the tank to the solution 14.

Typically, each transducer is constructed of the clamped sandwich construction including a disk of piezoelectric material as shown in U.S. Patent No. 3,066,232, N. G. Branson, dated Nov. 27, 1962, entitled, "Ultrasonic Transducer."

The transducers are attached to the underside of the tank bottom in such a way as to assure removal of the heat created by the dissipation of sonic energy at the interface between the transducer 16 and the tank 12. This feature is particularly important since plastics material of the type described above and other chemically inert material, such as ceramic or glass, have a relatively low thermal conductivity. With special reference to FIGURE 2, the underside 19 of the tank is fitted with a layer of metal screening 20, for instance copper screening as used for screen windows, and then a suitable adhesive 22, for instance epoxy resin, is used to bond the frontal surface 17 of the transducer 16 and the screening to the underside of the tank bottom 18, the screening material 20 being interposed between the frontal surface 17 of the transducer and the underside of the tank. The purpose of the screen material is to conduct the dissipated energy away from the interface between the transducer and the tank, as such energy would tend to soften the epoxy resin and the tank material.

In a typical example, as shown in FIGURE 1, the screening was extended beyond the tank bottom and excess screening was shaped in the form of four loops or fins 24, each three inches high, as seen in FIGURE 1. A cooling fan 26 was mounted to one side to direct a stream of air through the loops of the screening and past the transducers. This arrangement was sufficient to assure reliable operation without softening of the bonding material interposed between the transducer and the tank, or softening of the tank material. In a typical case, two transducers were attached to the tank as described hereinabove and driven with a total power of 150 watts at 25 kHz.

A further advantage discerned was the substantial absence of erosion on the tank inside. It is believed that this phenomenon is caused by the relatively good impedance match between the plastics material and the liquid solution, their specific acoustic impedances being much closer in value than those of a liquid and the more commonly used stainless steel material.

An alternative arrangement is shown in FIGURE 3. The tank 30 is coated on its underside and along its sidewalls with an epoxy resin 32 to which has been added a material having a relatively high heat conductivity, for instance aluminum powder or flakes. The transducers 16 are bonded to the underside of the tank bottom whereby the epoxy resin provides the bonding strength while the metallic admixture provides the heat conductivity required to remove the dissipated heat from the interface between the trans-

ducer frontal surface and the tank. The epoxy resin with its admixture is extended beyond the area of transducer attachment and over a sufficient tank surface to provide an ample heat sink area. A blower 26 and an enclosure 34 are disposed to direct a stream of air toward the transducers 16 and along the outside of the tank 30, specifically from the underside of the tank along its sidewalls, in order to dissipate the heat conducted away from the interface between the transducers and the tank.

It will be apparent that the design described hereinabove is characterized by extreme simplicity and overcomes the problem of softening either of the bonding material or of the tank material itself, or both, caused by the dissipation of sonic energy at the interface and the lack of thermal conductivity of the tank material itself. To this end, material having a relatively good thermal conductivity is interposed between the transducer frontal surface and the tank and is extended beyond the area of transducer attachment so that the heat conducted away from this interface surface can safely be dissipated by regular cooling means.

While there have been described and illustrated certain specific and preferred embodiments of this invention, it will be apparent to those skilled in the art that various further changes and modifications may be made therein without deviating from the broad principle and intent of this invention.

What is claimed is:

1. An apparatus of the type described comprising:
a tank made of material having a relatively low thermal conductivity adapted to hold a liquid to be agitated by sonic energy;
- at least one transducer adapted to receive electrical energy and transmit sonic energy via a frontal surface thereof to said tank and liquid therein;
- a resinous bonding material disposed for bonding the frontal surface of said transducer to an outside surface of said tank, and
- a material having a heat conductivity greater than that of said tank material disposed between said frontal surface and said tank surface and extending beyond said frontal surface, for conducting heat away from the bonded interface between said transducer and tank.
2. An apparatus as set forth in claim 1 wherein said tank is made of non-metallic material.
3. An apparatus as set forth in claim 1 wherein said tank is made of plastics material.
4. An apparatus as set forth in claim 1 wherein said material having a heat conductivity which is greater than that of said tank material comprises metallic screening.
5. An apparatus as set forth in claim 1 wherein said material having a heat conductivity which is greater than

that of said tank material comprises metallic flakes dispersed in the bonding material.

6. An apparatus as set forth in claim 1 wherein said material having a heat conductivity which is greater than that of said tank comprises metallic powder dispersed in the bonding material.

7. An apparatus as set forth in claim 1 wherein a stream of cooling gas is directed toward said material portion which extends beyond said frontal surface.

8. An apparatus as set forth in claim 1 wherein said tank is plastics material, said bonding material is an epoxy resin, and said material having a heat conductivity greater than that of said tank material is metallic screening.

9. An apparatus as set forth in claim 8 wherein said screening is extended to form a cooling fin which is adapted to be cooled by forced air.

10. An apparatus of the type described comprising:
a tank made of material having a relatively low thermal conductivity adapted to hold a liquid to be agitated by sonic energy;
an ultrasonic transducer for receiving electrical energy and transmitting sonic energy via a frontal surface thereof to said tank and a liquid contained therein;
a resinous bonding material bonding the frontal surface of said transducer to said tank, and
means in contact with said bonding material for improving the thermal conductivity thereof at the area of transducer attachment to said tank.

11. An apparatus of the type described comprising:
a non-metallic tank adapted to hold a liquid to be agitated by sonic energy;
an ultrasonic transducer adapted to receive electrical energy and provide ultrasonic energy via a frontal surface thereof bonded by a resinous bonding material to said tank, and
metallic heat conducting means interposed between said transducer and tank, said heat conducting material being in contact with said resinous material and extending beyond the area of transducer attachment for conducting heat away from the bonding material and tank material at the location of transducer attachment to said tank.

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