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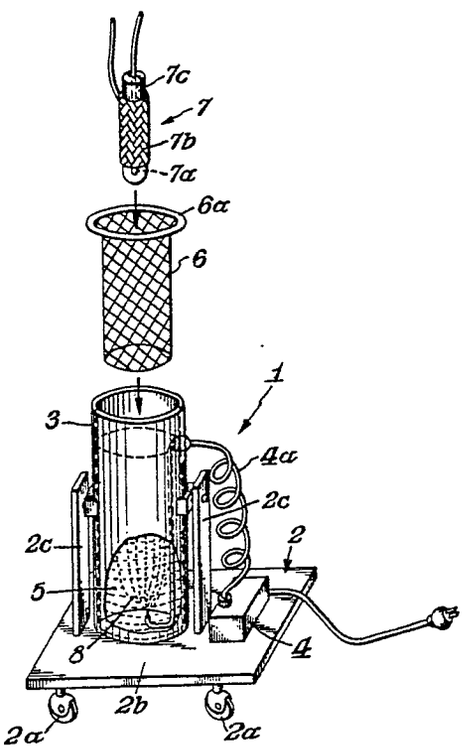
(54) Cleaning apparatus and methods.

(57) Cleaning apparatus is provided comprising a cleaning tank (3) which accomodates a cleaning solution (5) and an object (7) to be cleaned, and fluid supply means (4,4a) for supplying a fluid comprising air which is injected as bubbles into the cleaning solution (5), the fluid striking the object (7) to be cleaned. The fluid supply means (4,4a) supplies the fluid at a high velocity and with sufficient force that the air bubbles burst upon striking the object (7), thereby producing shock waves, including ultrasonic waves, which provide thorough cleaning of the object (7). The fluid may be air or a cleaning solution. The cleaning solution is preferably xylene or methyl ehtyl ketone.



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CLEANING APPARATUS AND METHODS

The invention relates to cleaning apparatus and methods.

Where objects are to be cleaned, various types of cleaning apparatus have been used depending upon the type of object that is to be cleaned and the degree of cleaning that is desired. For example, ultrasonic cleaning apparatus has conventionally been used in cases where a fluid detecting element of the type disclosed in Japanese Patent Publication (Kokoku) No. 59-47256 is to be cleaned. In that publication, the fluid detecting element comprises a pair of conductors which are separated by continuously porous, expanded polytetrafluoroethylene (EPTFE) containing a conducting substance which is sandwiched between the conductors. This fluid detecting element is utilized, for example, as an oil leakage sensor. Specifically, the abovementioned substance exhibits an increase in insulation resistance when it is permeated by an oil, such as heavy oil or gasoline. This electrical change is detected by a detector which is connected to the abovementioned conductors, so that the presence or absence of oil leakage is determined electronically. Such an oil leakage sensor must be regenerated by cleaning after it has detected oil leakage, or periodically when the sensor has been used over a long period of time even if no oil leakage is detected. In the past, an ultrasonic cleaning apparatus of the type mentioned above has been used for such cleaning.

However, oil leakage sensors of the type mentioned are of various shapes and sizes. Accordingly, in cases where, for example, a long oil leakage sensor is to be ultrasonically cleaned, a large ultrasonic cleaning apparatus capable of accommodating this sensor is required. However, a conventional large ultrasonic cleaning apparatus is extremely expensive.

Accordingly, there exists a demand for inexpensive cleaning apparatus which has cleaning thoroughness comparable to that of ultrasonic cleaning apparatus.

According to the invention, there is provided cleaning apparatus, comprising a cleaning tank for receiving a cleaning solution and an object to be cleaned, and fluid supply means for supplying a fluid comprising air which is injected as bubbles into said cleaning solution, said fluid striking the object to be cleaned, said fluid supply means supplying said fluid at a high velocity and with such force that said air bubbles burst upon striking said object, thereby producing shock waves, including ultrasonic waves, which provides thorough cleaning of said object.

According to the invention, there is also provided a method of cleaning an object comprising the steps of placing the object in a cleaning solution, and injecting air as bubbles into the cleaning solution such that the velocity at which the bubbles strike the object causes them to burst thereby producing shock waves including ultrasonic waves which provide thorough cleaning of the object.

Cleaning apparatus embodying the invention, and cleaning methods according to the invention, will now be described, by way of example only, with reference to the accompanying drawing which is an exploded perspective view, partly broken away, of the apparatus.

The cleaning apparatus to be described comprises a cleaning tank which accomodates a cleaning solution and an object to be cleaned, and fluid supply means for supplying a fluid containing air which is injected as bubbles into the cleaning solution, the fluid striking the object to be cleaned. The fluid supply means supplies the fluid at a high velocity and with sufficient force that the air bubbles burst upon striking the object, thereby producing shock waves, including ultrasonic waves, which provides thorough cleaning of the object. The fluid may be air or a cleaning solution. The cleaning solution preferably is xylene or methyl ethyl ketone.

More specifically, the cleaning apparatus to be described is characterized by the fact that it is equipped with (a) a cleaning tank which accomodates a cleaning solution and the object to be cleaned, and (b) a fluid supply means which supplies a fluid containing air that is released into the cleaning solution so that it strikes the object that is to be cleaned in the cleaning tank.

The air that is released into the cleaning solution forms air bubbles, which strike the object that is to be cleaned in the cleaning solution with sufficient force that they burst. When these air bubbles burst, shock waves, including ultrasonic waves, are generated, and these waves excite a vibration in the object that is to be cleaned. The cleaning solution is thus agitated by the fluid containing air that is released into the cleaning solution, so that the cleaning solution is constantly in fluid motion. As a result, these two effects act in combination so that the object that is to be cleaned can be cleaned with extreme thoroughness.

The principal constituent elements of the cleaning apparatus 1 are a supporting cart 2, a cleaning tank 3 and a compressor including fluid supply means 4.

The supporting cart 2 consists of a base 2b which is equipped with wheels 2a so that it is free to move. A pair of supports 2c are installed upright

facing each other on the top surface of the base 2b in order to support the cleaning tank 3.

The cylindrical cleaning tank 3 is preferably made of stainless steel, is open at the top and is supported by the supports 2c so that the tank 3 is free to rotate about a diameter of the tank as the axis of rotation. The axis of rotation is positioned at a point above the midpoint on the axial line of the cleaning tank 3, so that when the cleaning tank 3 is in a state of natural rest, the open end of the tank is positioned at the top as shown in the figure. Xylene is a preferred cleaning solution 5 and is accomodated in the cleaning tank 3 as an oil solvent.

The compressor 4 is installed on the base 2b of the supporting cart 2. Tube 4a, which preferably is made of Teflon (trade mark) fluorocarbon resin and which is connected to the compressor 4, is inserted into the cleaning tank 3, and the tip of this tube 4a is fastened to the bottom of the interior of the cleaning tank 3 so that the tip points upwardly.

In the Figure, basket 6, preferably a mesh made of stainless steel, is used when an oil leakage sensor or other object 7 to be cleaned is inserted into the cleaning tank 3. Specifically, the oil leakage sensor 7 is accomodated inside the mesh basket 6, and is inserted into the cleaning tank 3 along with the mesh basket 6. A flange 6a at the upper end of the mesh basket 6 catches on the upper edge of the cleaning tank 3, so that the oil leakage sensor 7 is suspended inside the cleaning tank 3, and so that the sensor 7 is submerged in the xylene cleaning solution 5.

As described above, the oil leakage sensor 7 may comprise a pair of conductors 7a,7b and a continuously porous EPTFE separator 7c containing a conductive substance interposed between the conductors.

In operation of the cleaning apparatus 1, the oil leakage sensor 7 is accomodated inside the cleaning tank 3 and submerged in xylene cleaning solution 5 as described above, and the compressor 4 is started. Compressed air or other fluid containing air fed from the compressor 4 passes through the tube 4a and is continuously released into the xylene cleaning solution 5 as air bubbles from the tip of the tube inside the cleaning tank 3. Because compressed air is thus continuously released into the xylene cleaning solution 5, the xylene cleaning solution 5 inside the cleaning tank 3 is constantly in a state of highly agitated fluid motion. The air bubbles released into the xylene cleaning solution 5 rise and strike the oil leakage sensor 7 with sufficient force that they burst. Shock waves, including ultrasonic waves, are generated at this point, and these waves excite a vibration in the oil leakage sensor 7.

As a result of a synergistic effect of the fluid motion of the xylene cleaning solution 5 and the excitation of vibration in the oil leakage sensor 7, the oil permeating the oil leakage sensor 7 is dissolved in the xylene cleaning solution 5, so that the oil leakage sensor 7 is cleaned and regenerated to approximately the same degree as when a similar cleaning is performed using a conventional ultrasonic cleaning apparatus.

Thus, although the cleaning apparatus 1 described has an extremely simple structure, it has a cleaning efficiency and thoroughness which is appoximately the same as that of an ultrasonic cleaning apparatus. Compared to an ultrasonic cleaning apparatus, the cleaning apparatus 1 is extremely inexpensive, and this reduced expense becomes more pronounced as the size of the apparatus required increases.

The invention is not limited to the above example. Various configurations may be employed. For example, in the apparatus as described above, the fluid containing air consisted only of air. However, this fluid could also be a cleaning solution containing air bubbles. In such case, the fluid supply means used would be a pump. The cleaning apparatus could also be applied to various other objects besides oil leakage sensors, and the cleaning solution used could be a cleaning agent other than xylene, such as, for example, methyl ehtyl ketone.

As described above, the apparatus makes it possible to obtain a very inexpensive cleaning apparatus which has a simple structure, but which has a cleaning effect comparable to that of conventional ultrasonic cleaning apparatus.

While the invention has been disclosed herein in connection with certain embodiments and detailed descriptions, it will be clear to one skilled in the art that modifications or variations of such details can be made without deviating from the gist of this invention, and such modifications or variations are considered to be within the scope of the claims hereinbelow.

Claims

1. Cleaning apparatus, comprising a cleaning tank (3) for receiving a cleaning solution (5) and an object (7) to be cleaned, and characterised by fluid supply means (4,4a) for supplying a fluid comprising air which is injected as bubbles into said cleaning solution (5), said fluid striking the object (7) to be cleaned, said fluid supply means (4,4a) supplying said fluid at a high velocity and with such force that said air bubbles burst upon striking said object (7), thereby producing shock waves, including ultrasonic waves, which provides thorough cleaning of said object.

2. Apparatus according to claim 1 characterised in that said fluid consists of air.

3. Apparatus according to claim 1, characterised in that said fluid is a cleaning solution containing air.

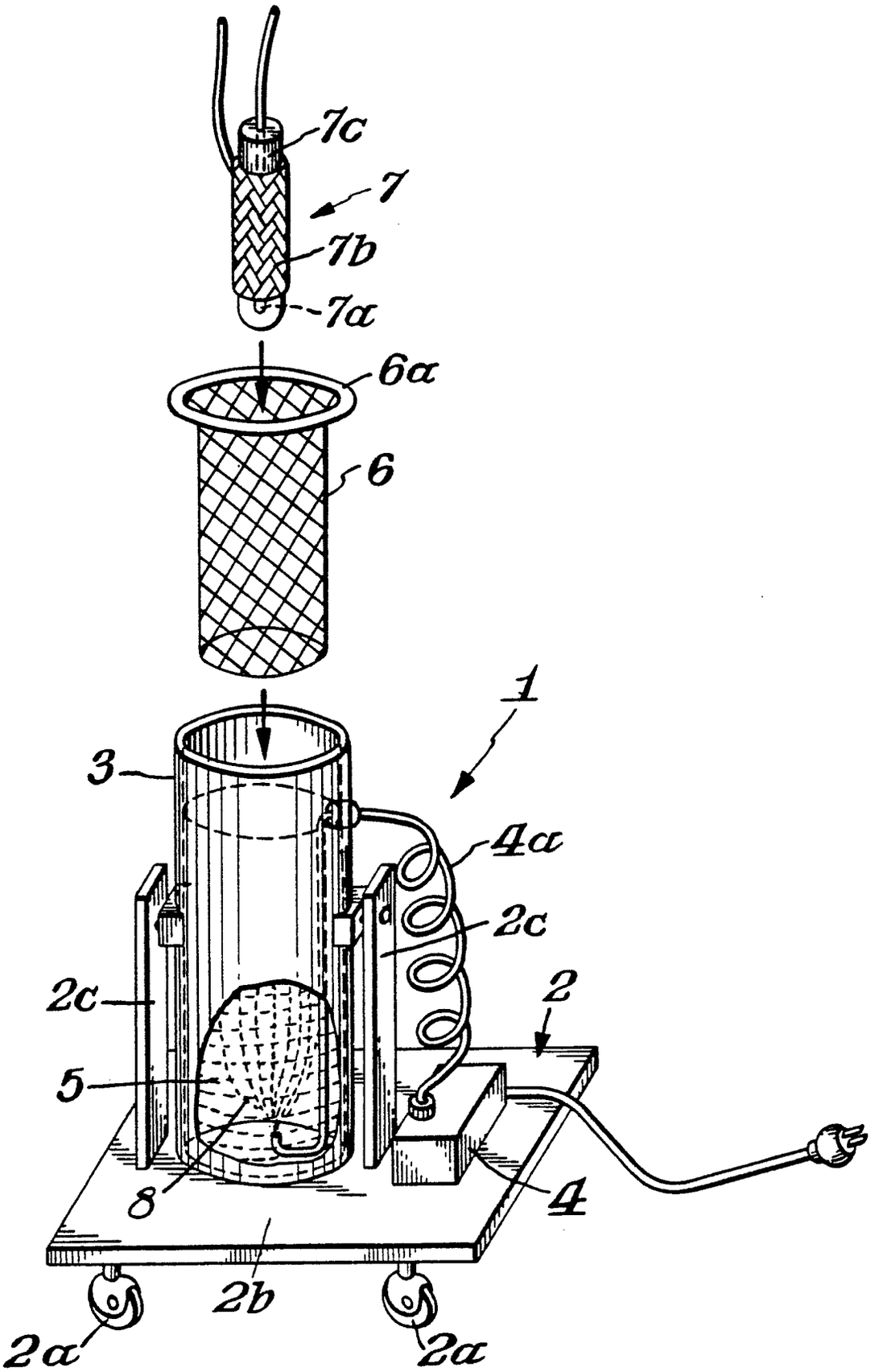
4. Apparatus according to any preceding claim, in that the or each said cleaning solution is xylene.

5. Apparatus according to any one of claims 1 to 3, characterised in that the or each said cleaning solution is methyl ethyl ketone.

6. A method of cleaning an object, comprising the step of placing the object (7) in a cleaning solution (5) and characterised by the step of injecting air as bubbles into the cleaning solution (5) such that the velocity at which the bubbles strike the object (7) causes them to burst thereby producing shock waves including ultrasonic waves which provide thorough cleaning of the object (7).

7. A method according to claim 6, characterised in that the air is injected contained in a fluid.

8. A method according to claim 7, characterised in that the fluid is a cleaning solution.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EUROPEAN SEARCH REPORT

Application Number

EP 89 30 3548

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	JP-A-5 262 964 (S. DENKI) * Whole document *	1,3,6-8	B 08 B 3/10 B 08 B 3/12
Y		2	
Y	GB-A-2 042 208 (ESSILOR INTERNATIONAL) * Columns 2,3; figure 1 *	2	
A		1,6-8	
A	CH-A- 311 228 (BERGER) * Page 1; figures 1-3 *	1,2,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 08 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-09-1989	VOLLERING J.P.G.

CATEGORY OF CITED DOCUMENTS

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