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Blatter

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[54] **APPARATUS FOR RECONDITIONING LIQUIDS CONTAMINATED WITH MICROORGANISMS**

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[52] **U.S. Cl.** **210/199,** 210/63, 210/219, 210/221, 261/93, 261/122

[51] **Int. Cl.** **C02b 1/38**

[58] **Field of Search** 210/63, 220, 221, 199, 219; 261/93, 122, 124

[56] **References Cited**

UNITED STATES PATENTS

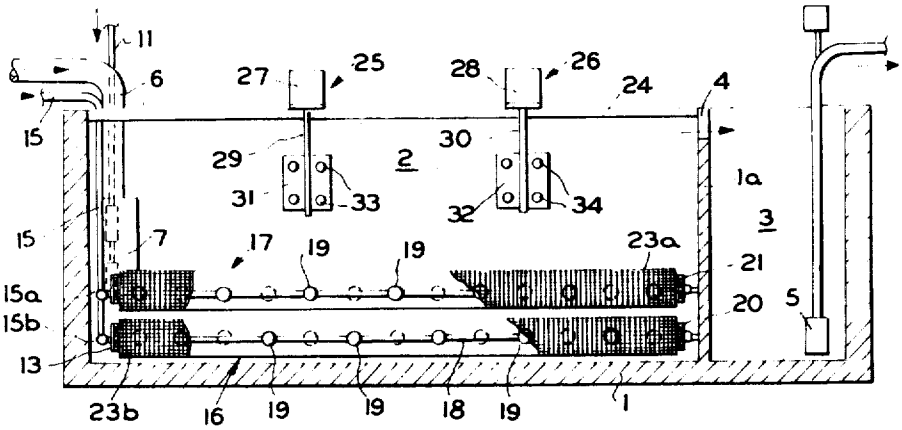
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[57] **ABSTRACT**

A method of reconditioning a liquid substance that has been contaminated with micro-organisms, in which the substance to be reconditioned is introduced into a container and ozone is conducted through the substance while this is being agitated. The liquid substance may be ozonized in two consecutive stages, the ozone in the first stage being at a gauge pressure, whereas in the following stage it is decompressed substantially to atmospheric pressure. Apparatus for performing the method is also described and claimed.

5 Claims, 3 Drawing Figures



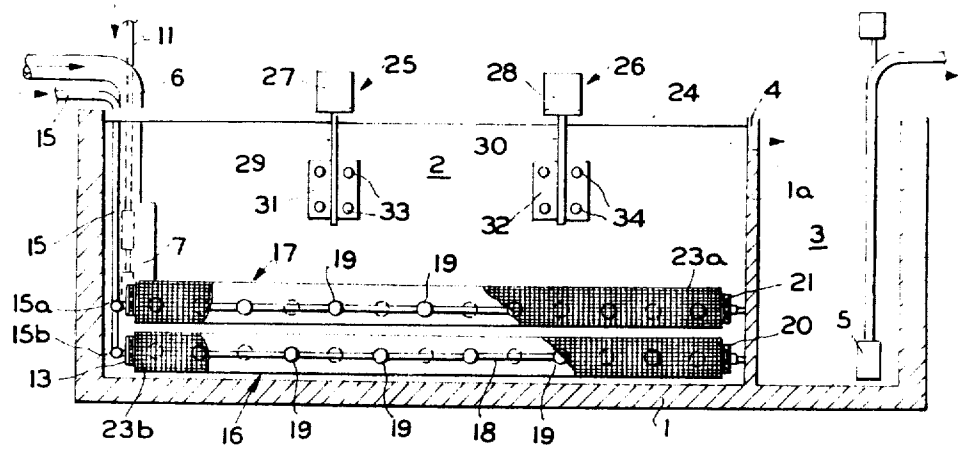


FIG. 1

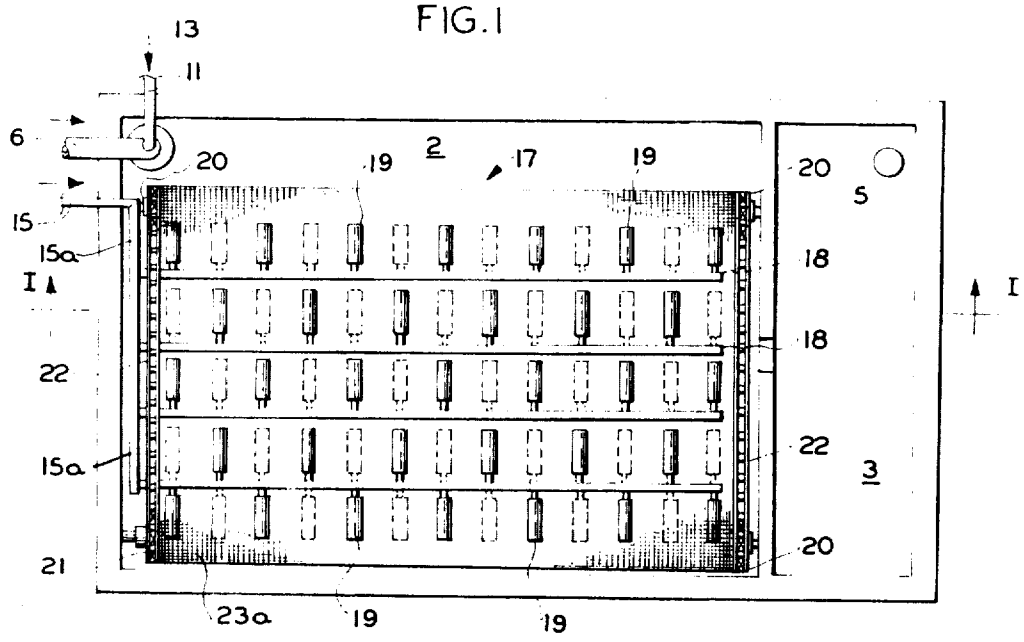


FIG. 2

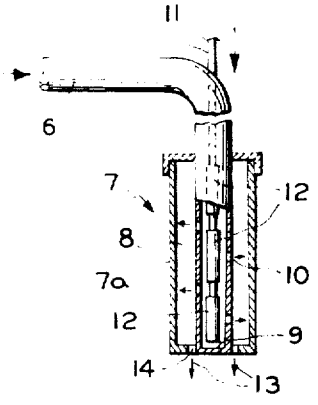


FIG. 3

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APPARATUS FOR RECONDITIONING LIQUIDS CONTAMINATED WITH MICROORGANISMS

This invention relates to a method of reconditioning liquids that have been contaminated with micro-organisms, particularly oils and oil emulsions, with a view to their re-use as lubricants. The invention also relates to apparatus for performing the method.

Numerous liquids used for lubrication, cooling and other purposes gradually accumulate a growing population of micro-organisms and they then not only become useless for their intended technical purpose but also constitute a hazard to personnel. For instance, in the oils or their emulsions that are conventionally used for lubrication in the metal working industries it has been found that after a time these liquid lubricants tend to ferment. This can be recognized by the penetrating stench which they emit, and personnel are exposed to diverse complaints such as eczema, eye and other infections.

The adverse consequences of lubricants becoming contaminated with micro-organisms have been known for some time, and for many years diverse means have been used for their control. One drastic, though relatively expensive method consists in completely draining the lubricating system from time to time, flushing it out with a detergent fluid, and then refilling it with fresh lubricant oil. In view of the steady rise in the price of all lubricants attempts have more recently been made to control the undesirable growth of micro-organisms by adding chemical substances. Suitable substances have in fact been discovered and they can be successfully used, but in view of the very large volumes of lubricants that are used in industrial plant the continuing cost of such chemical additions is unacceptably high.

The method proposed by the present invention solves the problem by tackling it in a different way, namely by filling the liquid into a container and then passing ozone through the liquid whilst simultaneously agitating the same. Preferably the liquid is ozonized in two consecutive stages, the ozone in the first stage being at a gauge pressure, whereas in the following stage it is decompressed substantially to atmospheric pressure.

Apparatus according to the invention for performing this method consists of a container provided with at least one entry and one exit for the substance that is to be reconditioned, at least one agitating device which projects into the liquid-filled container and, near the bottom of the container at least one device for the introduction into the liquid-filled container of ozone in finely divided bubbles.

In a preferred form of construction of this apparatus two devices for the distribution of ozone are provided, the one above the other, and each of these devices comprises several ozone distributors distributed over substantially the entire container cross-section, said distributors being disposed horizontally and substantially in a plane inside the space enclosed by an endless rotating metal mesh in such manner that the substance that is to be reconditioned flows through the two strands of mesh above and below and at the same time makes contact with the finely divided bubbles of ozone issuing from the ozone distributors.

Preferably at least one pressure ozonizer is provided inside the container and precedes the above-described devices to form the first ozonizing stage. The pressure

ozonizer may usefully comprise a cylindrical shell with an open bottom end, a liquid admission pipe, provided with lateral outlet openings, projecting into said shell, the end of said admission pipe being closed and the interior of the pipe containing a plurality of vertically aligning ozone distributors which are supplied with ozone through a pipe that is coaxial with said liquid admission pipe.

However, conveniently the liquid admission pipe extends to the bottom edge of the cylindrical shell, and the annular cross-section that remains for the discharge therethrough of the ozonized substance may be variable for the purpose of adjusting the pressure existing inside the pressure ozonizer.

With advantage the now distributors may be ceramic tubes from the outside of which the ozone that has been axially introduced into one end of the tube issues in the form of finely divided bubbles.

The invention will how be described in greater detail, by way of example, with reference to the accompanying drawing, in which

FIG. 1 is a schematic sectional elevation of apparatus for reconditioning a lubricant oil that is contaminated with micro-organisms.

FIG. 2 is a plan of the apparatus shown in FIG. 1, and

FIG. 3 is a detail of the apparatus.

In the drawing, a container generally indicated by the numeral 1 is divided by a vertical partition 1*a* into two compartments 2 and 3. Compartment 3 serves for the reconditioning of a lubricant oil contaminated with micro-organisms, the reconditioned oil via an overflow 4 entering the second compartment 3 whence it is pumped into a lubricating system (not shown) by a recirculating pump 5.

A pipe 6 projects from above into compartment 2 for the introduction of the contaminated oil that is to be reconditioned. The bottom part of the pipe 6, as will be understood from FIGS. 1 to 3, is surrounded by a pressure ozonizing device 7 comprising a shell 7*a*. The top of the cylindrical shell 7*a* closes tightly around the periphery of the oil pipe 6, so that the top of the annular chamber 8 formed between the shell 7*a* and the pipe 6 is tightly sealed. The end 9 of the oil inlet pipe 6 is likewise closed. However, the portion of the pipe 6 that is surrounded by the shell 7*a* contains a number of slots 10 through which the oil that is to be reconditioned can enter the annular chamber 8 from the inlet pipe 6. An ozone supply pipe 11 enters the oil inlet pipe 6 from above and extends coaxially with the pipe 6 into close proximity with its aforesaid end 9. Within the portion enclosed by the shell 7*a* the ozone pipe 11 has three serially connected ozone distributors 12. These ozone distributors 12 are hollow cylindrical ceramic bodies which by virtue of their fine porous structure permit the ozone to be dispersed in very fine bubbles. The ozone entering through pipe 11 at a slight gauge pressure of say 3 meters water column, therefore penetrates the ozone distributor 12 and mixes in pipe 6 with the lubricant oil that is to be reconditioned, entering the annular chamber 8 through the slots 10, together with the oil. The oil mixed with the ozone finally leaves the bottom end of the annular chamber 8 in the direction of the arrows 13, the oil and the ozone being continuously and vigorously mixed along its entire path from the ozone distributors 12 to the end of the annular chamber.

The bottom end **14** of the annular chamber **8** is preferably provided with an adjustable sliding gate (not shown) which permits the outlet cross-section of the annular chamber **8** to be changed as desired. Adjustment of the gate permits the pressure inside the shell **7***a* to be controlled.

Moreover, an ozone pipe **15** likewise enters the compartment **2** and supplies ozone to devices **16** and **17** disposed the one above the other in the lower part of the compartment. These devices likewise serve to distribute the ozone in the form of finely divided bubbles. As will be understood from the plan in FIG. **2**, the pipe **15** at the level of the device **17** has a horizontal portion **15***a* connected to a plurality of distributing pipes **18**. The distributing pipes **18** extend across the full length of the compartment **2** and each distributing pipe carries a plurality of ozone distributors **19**. These ozone distributors have the form of hollow cylindrical ceramic bodies and—in the same way as the ozone distributors **12** shown in FIG. **3**—they are adapted to produce a finely divided dispersion of ozone bubbles in the lubricant oil in which they are immersed.

Anchored to the walls of compartment **2** in respect of each device **16** and **17** are four chain wheel **20** respectively **21**. The device **17** shown in FIG. **2** in plan comprises two chains **22** which run over the chain wheels **21**, and which are kept in motion by a motor not shown. Attached to the chains **22** is an endless fine mesh wire fabric **23***a*/**23***b* which is thus kept in continuous circulatory motion.

The bottom device **16** which is supplied with ozone through a horizontal pipe portion **15***b* (FIG. **1**) is in principle of the same construction as the device **17** and thus requires no special description.

The compartment **2** is provided with a cover **24** which carries two agitators **25** and **26**. Whereas the motors **27** and **28** for driving these agitators are mounted on top of the cover **24**, the shafts **29** and **30** carrying the agitator blades **31** and **32** project into the interior of the container. In order to mix and agitate the oil thoroughly the blades **31** and **32**, which may naturally be of any desired shape, are provided with openings **33** and **34**. According to the size of the compartment any desired number of agitators may be provided.

The described equipment functions as follows: The contaminated oil from a lubricating system first enters the interior of the compartment **2** through the pipe **6**. Whilst passing through the pressure ozonizer illustrated in FIG. **3** the oil is very intimately though only briefly brought into contact with the slightly pressurized ozone. This has a shock effect on the micro-organisms contained in the oil, and a large proportion of these organisms is oxidatively destroyed in this first stage of the process.

The oil leaving the pressure ozonizer in the direction of the arrows **13** then flows through the two distributing devices **16** and **17** from the bottom upwards. Further ozonization takes place here and ensures that the reconditioned pure oil overflowing into the compartment **3** contains no living micro-organisms. Whereas the oil passes through the revolving metal mesh fabrics **23***a* respectively **23***b*, a major proportion of the impurities contained in the oil is intercepted.

The sequential performance of ozonization under pressure and then with decompressed ozone ensures that all the micro-organisms contained in the oil will be oxidatively destroyed, without impairment of the lubricity of the oil. The employment of the described apparatus permits considerable volumes of lubricant oils to be saved and workmen to be effectively protected from infection by micro-organisms contained in the oil. Moreover, lubricant oil used in a circulating system requires replacement at far more infrequent intervals and this also constitutes a major saving in labor and time.

In an experimental plant the annual saving in lubricant oil was found to work out as follows:

Emulsion required for one machine, per annum, without ozonization	25 168 liters
Emulsion required for one machine, per annum, using ozonization	24 128 liters
Saving due to ozonization	1 040 liters

The saving in labor follows from the following example:

Stoppages of machines, per annum in the absence of oil ozonization	55 hours
Stoppages of machines, per annum, with oil ozonization	8 hours
Emptying and cleaning machines, per annum, in the absence of oil ozonization (work for 2 men)	110 hours
Emptying and cleaning machines, per annum, with oil ozonization	16 hours

Since large workshops nowadays may contain hundreds of oil-lubricated machines the saving in lubricants and working time that can be effected is quite considerable.

Experience shows that the gauge pressure in the pressure ozonizer shown in FIG. **3** is preferably adjusted to about 3 meters water column. However, this is naturally merely a suggested optimal value. The apparatus will work satisfactorily also when operated at considerably different pressures.

The wire mesh **23***a* and **23***b* associated with the two ozonizing devices **16** and **17** is preferably a fine mesh fabric of stainless steel (micromesh).

The agitators **25** and **26** which are entirely conventional may naturally be considerably modified and structurally varied. Any known type of agitator, such as rotating bars, horseshoes, paddles, cross bars, propellers, turbines etc. could be used.

What is claimed is:

1. Apparatus for reconditioning a liquid contaminated with microorganisms comprising a container provided with at least one entry and one exit for the liquid to be reconditioned, at least one agitating means which projects into the container and at least one device near the bottom of the container for the introduction of finely divided bubbles of ozone into the container, each such device comprising ozone distributors distributed over substantially the entire cross-section of the container, said distributors being disposed horizontally and substantially in a plane inside the space enclosed by an endless rotating metal mesh in such manner that the liquid to be reconditioned flows through the two meshes and at the same time contacts the finely divided bubbles of ozone issuing from the ozone distributor.

2. Apparatus according to claim 1, comprising at least one pressure ozonizer inside the container, which

pressure ozonizer precedes the said devices and forms a first ozonization stage.

3. Apparatus according to claim 2, in which the pressure ozonizer comprises a cylindrical shell with an open bottom, into which a liquid inlet pipe provided with lateral outlet openings projects, the end of said inlet pipe being closed and the interior of the inlet pipe containing a plurality of vertically aligned ozone distributors supplied with ozone through a pipe that is coaxial with the liquid inlet pipe.

4. Apparatus according to claim 3, in which the liquid inlet pipe extends to the bottom edge of the cylindrical shell and the annular cross-section that remains for the discharge therethrough of the ozonized substance is variable for the purpose of controlling the pressure existing inside the pressure ozonizer

5. Apparatus according to claim 1, in which the said ozone distributors have the form of ceramic tubes from which the ozone that is axially introduced into one end thereof issues in the form of finely divided bubbles.

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