

US 20100122488A1

(19) **United States**(12) **Patent Application Publication**  
**Fukai**(10) **Pub. No.: US 2010/0122488 A1**(43) **Pub. Date: May 20, 2010**(54) **OIL EMULSION**

Feb. 12, 2008 (JP) ..... 2008-029955

Mar. 28, 2008 (JP) ..... 2008-085317

(76) Inventor: **Toshiharu Fukai, Nagano (JP)**

Correspondence Address:

**WENDEROTH, LIND & PONACK, L.L.P.****1030 15th Street, N.W., Suite 400 East****Washington, DC 20005-1503 (US)****Publication Classification**(51) **Int. Cl.**  
**C10L 1/32** (2006.01)(52) **U.S. Cl.** ..... **44/302; 44/301**(57) **ABSTRACT**

[Object] To provide an oil emulsion which can be readily ignited using a conventional, commercially available burner without need of a specific type of device and which has a high ratio of water to an oil and is inexpensive.

[Solving Means] An oil emulsion is obtained by mixing under agitation an oil, an emulsifier and a specific type of water obtained by initially passing water through an ion exchange resin, passing either tourmaline or a silicon dioxide-rich rock selected among igneous rocks and further passing the other. The oil emulsion obtained by mixing the oil, the emulsifier and the water is inexpensive and is able to maintain a stable emulsified state.

(21) Appl. No.: **12/451,457**(22) PCT Filed: **Apr. 4, 2008**(86) PCT No.: **PCT/JP2008/056762**

§ 371 (c)(1),

(2), (4) Date: **Nov. 13, 2009**(30) **Foreign Application Priority Data**

May 15, 2007 (JP) ..... 2007-128752

Aug. 21, 2007 (JP) ..... 2007-214988

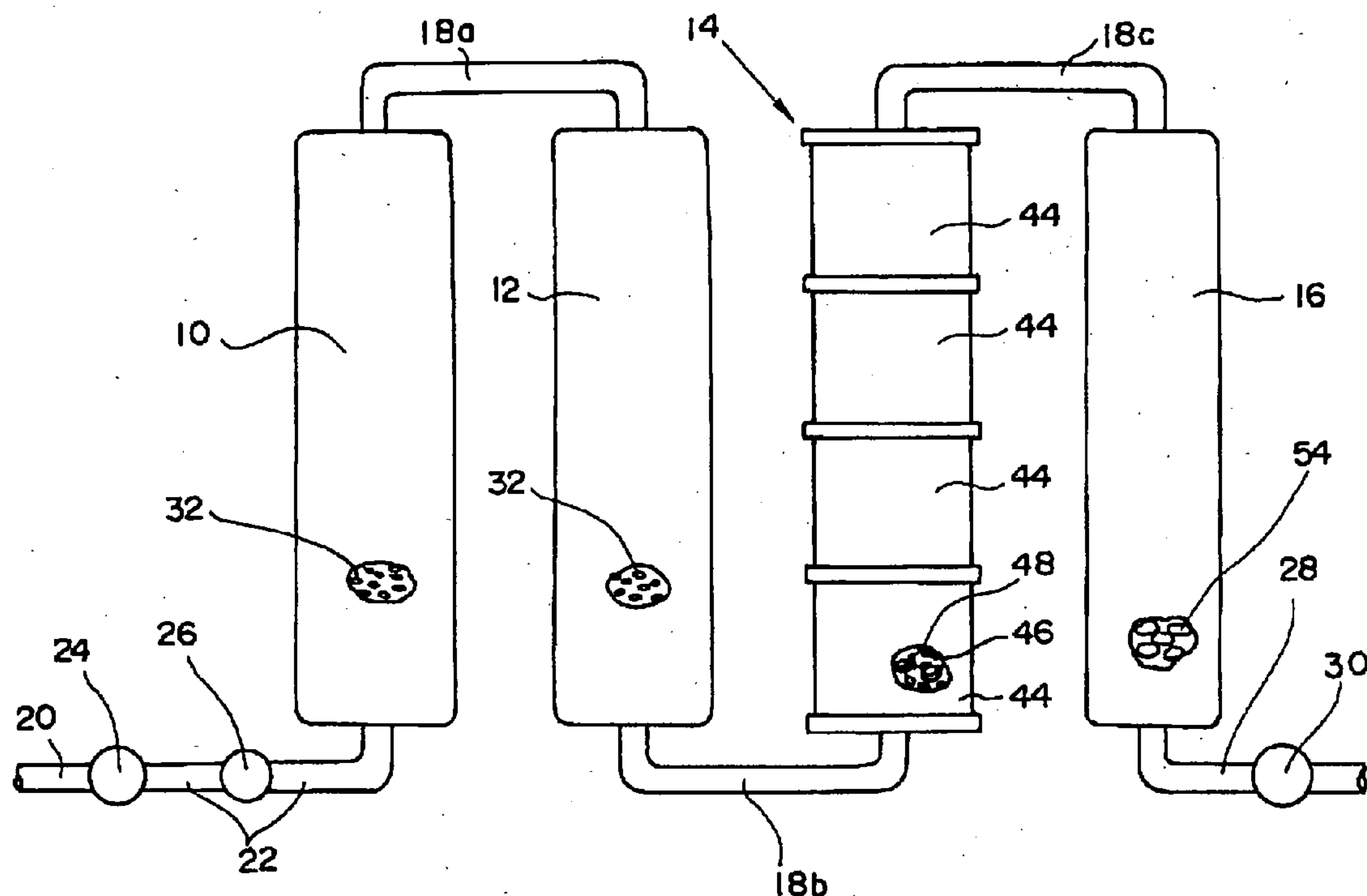


FIG. 1

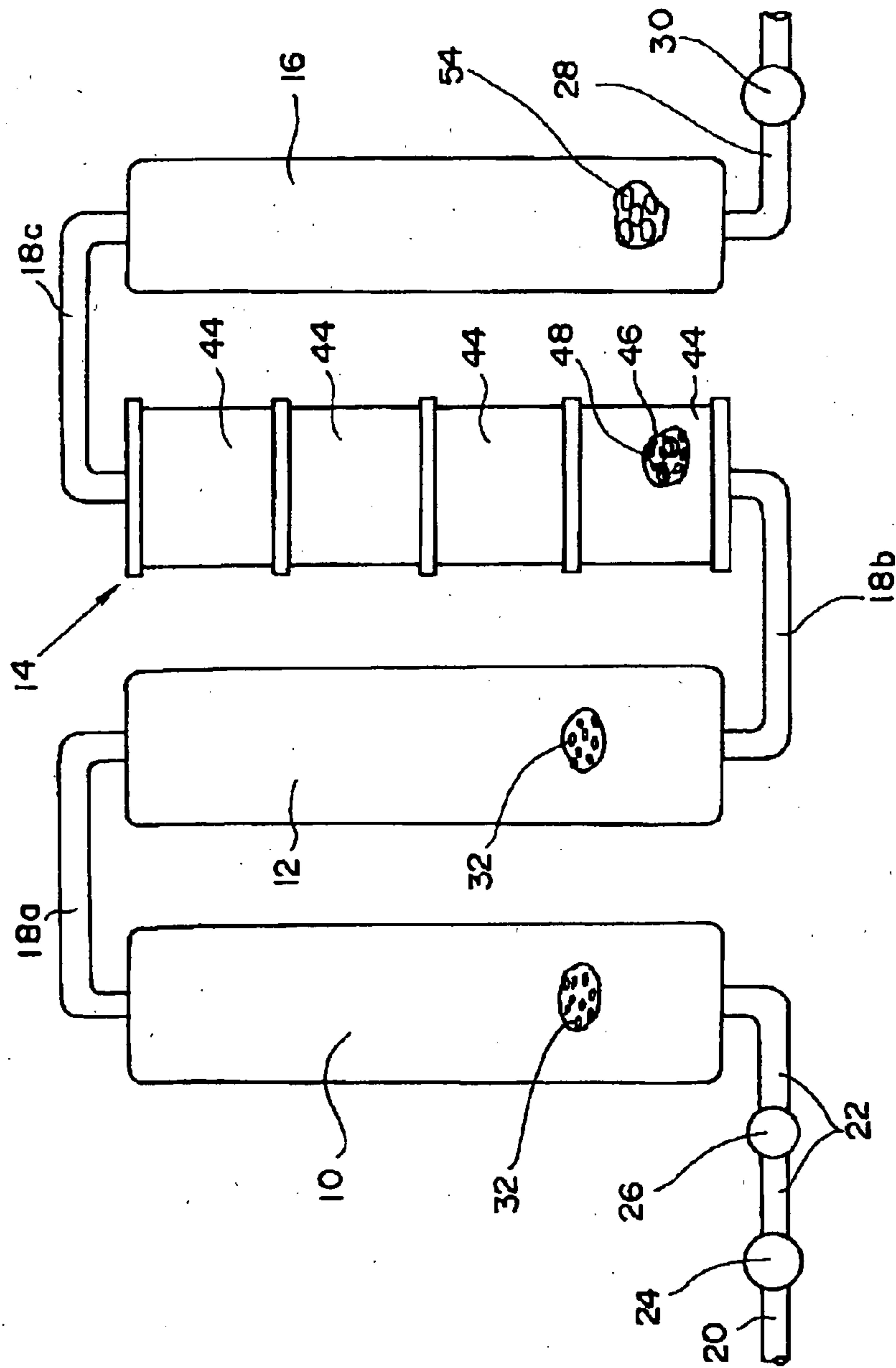
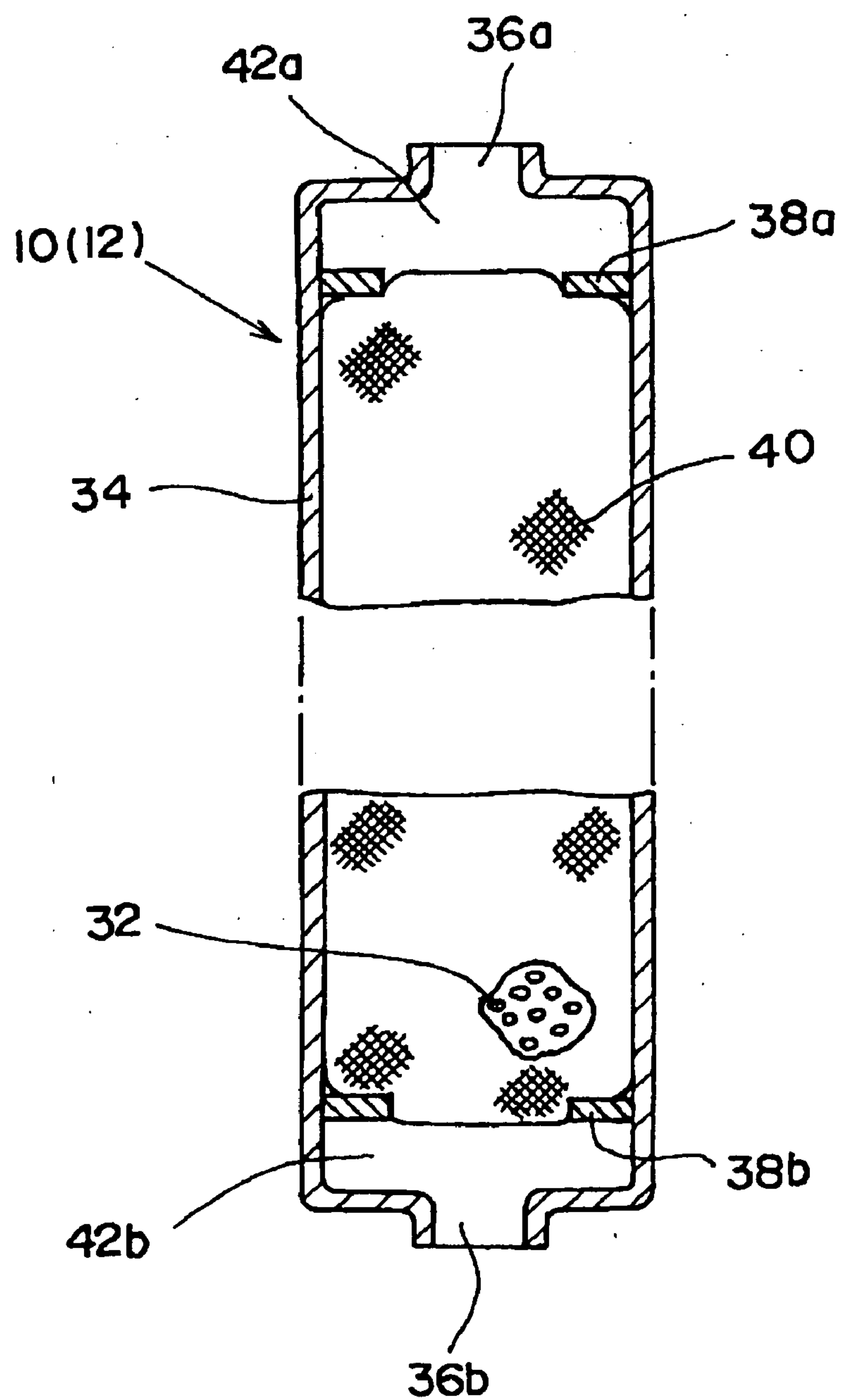


FIG. 2



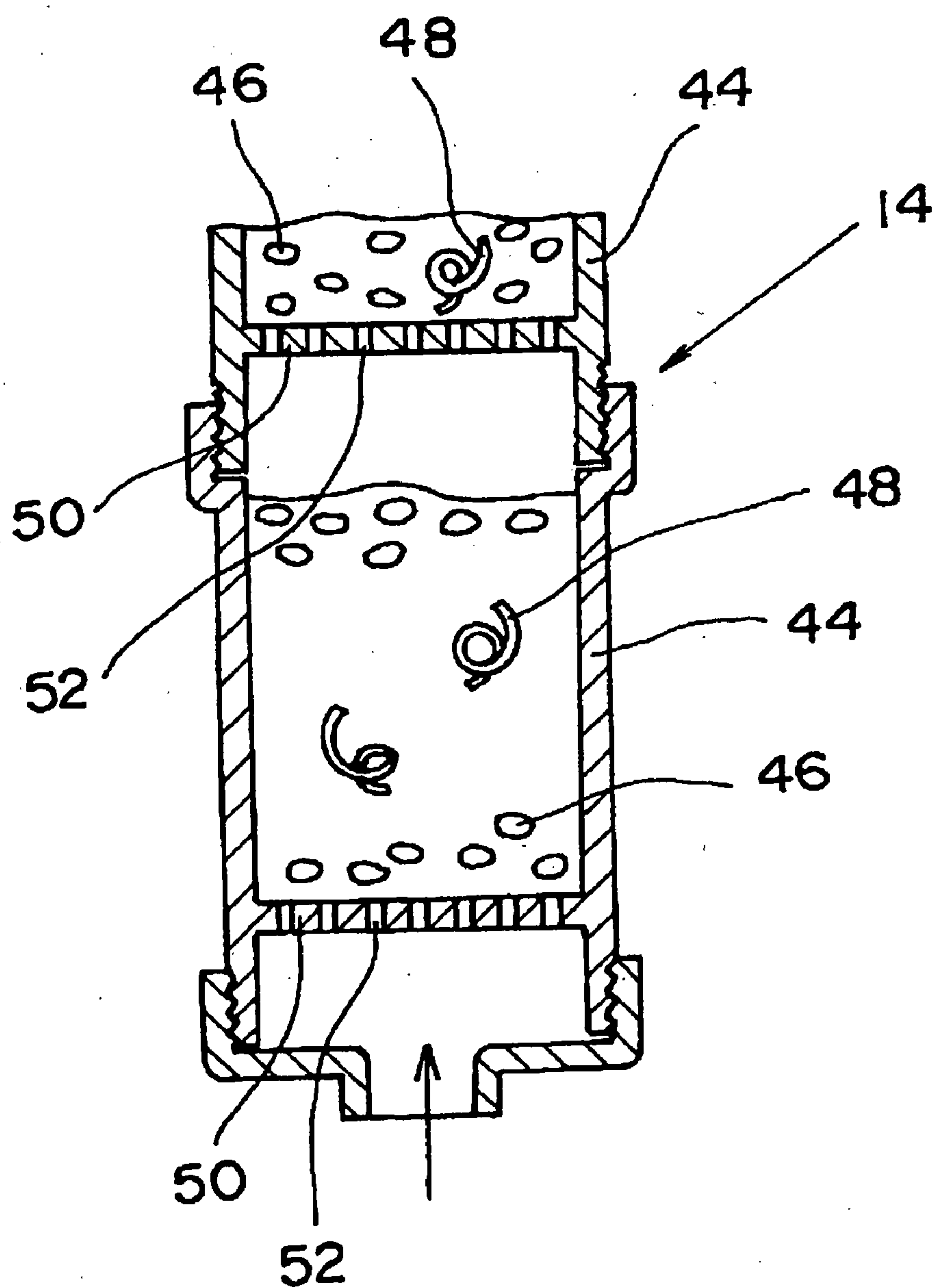


FIG.4

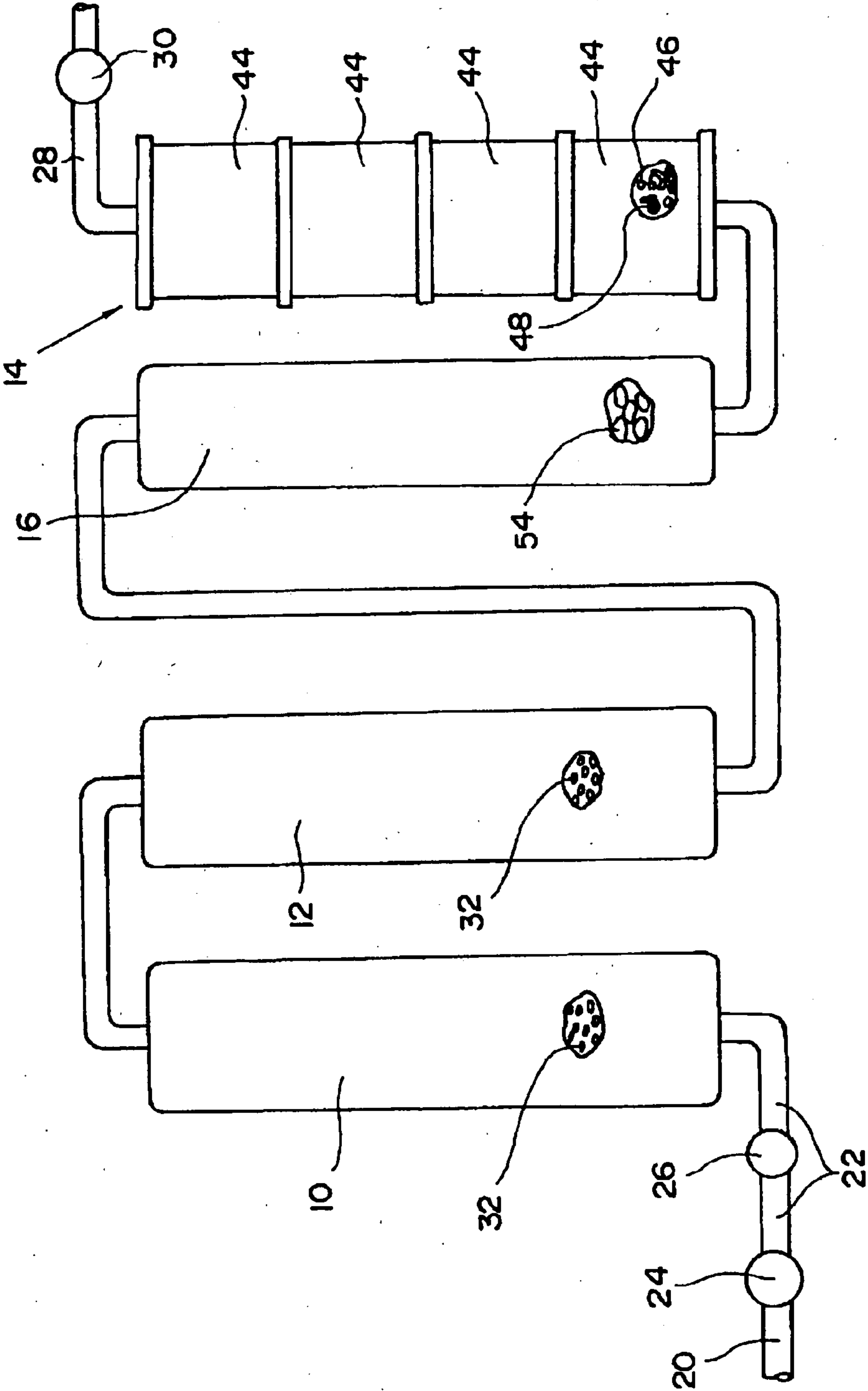


FIG.5

LIGHT OIL

Values indicated by wt%

Batch emulsification of 5% of castor oil (% by weight relative to oil)								
No.	1	2	3	4	5	6	7	8
Refreshed water	89.5	79	68.5	58	47.5	37	26.5	16
Castor oil	0.5	1	1.5	2	2.5	3	3.5	4
Light oil	10	20	30	40	50	60	70	80
Emulsification stability (1 day / room temperature)	○	○	○	○	○	○	○	×
Emulsification stability (7 days / room temperature)	○	○	○	○	○	○	○	×
Emulsification stability (15 days / room temperature)	○	○	○	○	○	△	△	×
Emulsification stability (30 days / room temperature)	○	○	○	○	○	△	△	×
Emulsified state	O/W type or O/W/O type							

○ no phase separation
△ separation due to a difference in specific gravity (coacervation)
× separation



FIG.6

A HEAVY OIL

Values indicated by wt%

Batch emulsification of 5% of castor oil (% by weight relative to oil)								
No.	1	2	3	4	5	6	7	8
Refreshed water	89.5	79	68.5	58	47.5	37	26.5	16
Castor oil	0.5	1	1.5	2	2.5	3	3.5	4
A Heavy oil	10	20	30	40	50	60	70	80
Emulsification stability (1 day / room temperature)	○	○	○	○	○	○	○	×
Emulsification stability (7 days / room temperature)	○	○	○	○	○	○	○	×
Emulsification stability (15 days / room temperature)	○	○	○	○	○	○	△	×
Emulsification stability (30 days / room temperature)	○	○	○	○	○	○	△	×
Emulsified state	O/W type or O/W/O type							

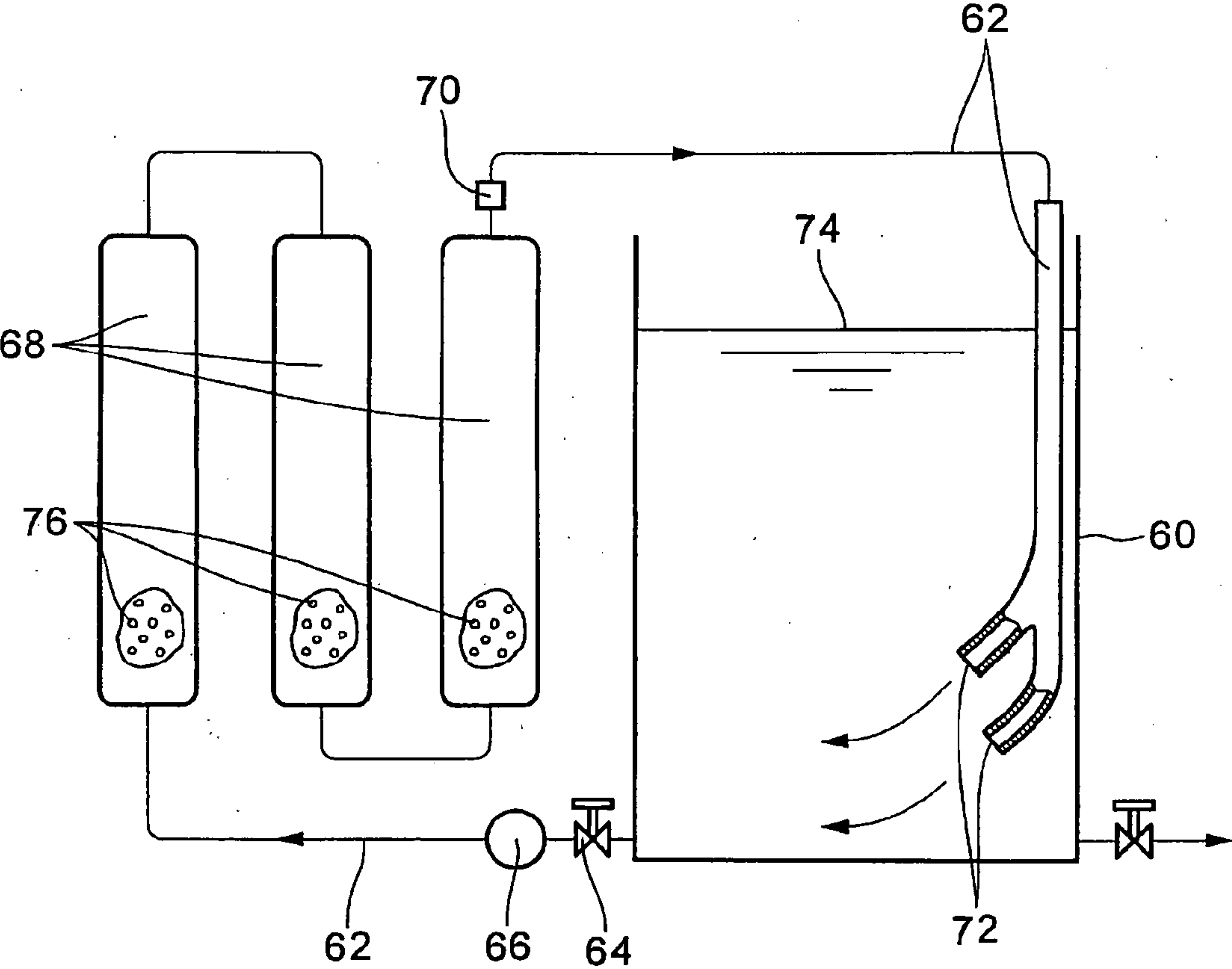
○ no phase separation

△ separation due to a difference in specific gravity (coacervation)

×

separation

FIG. 7





## OIL EMULSION

**[0001]** This application is a U.S. national stage of International Application No. PCT/JP2008/056762 filed Apr. 4, 2008.

**[0002]** This invention relates to an oil emulsion in which oils such as a waste oil, a waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline and a petroleum-based dry solvent, coal tar, asphalt (melt) and the like are emulsified with water.

### BACKGROUND OF THE INVENTION

**[0003]** Emulsion fuels obtained by emulsifying oils and water are conventionally known. A prior art technique of making an emulsion fuel is proposed in Patent Literature 1. In this technique, mixed matters are removed from a waste oil, and the resulting waste oil, water and a surface active agent are placed in an apparatus, followed by subjecting the waste oil, water and surface active agent to high-speed mixing under agitation in a magnetic field to provide an emulsion fuel.

**[0004]** For an instance of mixing ratios in the emulsion fuel, it has been widely known that limit on of the addition of water is such that oil:water:surface active agent=7:2:1. It has also been known that a more increasing amount of water results in the facilitated separation of emulsion and the increasing latent heat of evaporation, thus being unsuited for practical application. In practice, an emulsion fuel having a ratio of water ranging 10~15% (i.e. an emulsion fuel having a low ratio of water) has been unlikely to ignite with a burner in air at normal temperatures. More particularly, with an emulsion fuel prepared by mixing an oil, water and a surface active agent, there has arisen a disadvantage that ignition is unlikely to occur at normal temperatures.

**[0005]** In order to ensure good ignition of an emulsion fuel, improvements in burner and combustion method have been studied. For an improvement of a burner design, a burner provided with two fluid nozzles has been proposed. The two fluid nozzles mean those having two nozzles including a fuel-jetting nozzle for ignition and an emulsion fuel jetting nozzle. The fuel nozzle for ignition is pilot-lit and the emulsion fuel is ignited based on the pilot light. However, if a burner having such two fluid nozzles is used, the drawback that an emulsion fuel is unlikely to ignite could not be overcome completely. On the other hand, with respect to an improvement in combustion method, there have been considered a method in which a combustion unit is preliminarily set at 800° C., and an emulsion fuel is jetted into the combustion unit, and a method in which the temperature of a combustion environment is set at about 1600° C. and an emulsion fuel is jetted into the combustion environment. However, these methods are disadvantageous in that a high temperature combustion unit or a facility for the combustion environment becomes necessary, so that plant costs run up.

[Patent Literature 1] Japanese Patent No. 3513662

**[0006]** In the technique of Patent Literature 1, a disadvantage is involved in that expensive facilities of several tens of millions of yen are necessary for forming a magnetic field and carrying out high-speed agitation so as to emulsify a waste oil and water using the waste oil, the water and a surface active agent. In conventional emulsion fuels, a mixing ratio of water

is as low as about 20%, for which if an emulsion fuel is produced, substantial cost reduction cannot be achieved over 100% fuel. In addition, emulsion fuels have a drawback in that combustion calorie is lower than 100% fuel because water is contained. Because of the lower calorie of the emulsion fuel than that of 100% fuel, a prolonged combustion time over 100% fuel is necessary, with an attendant poor combustion efficiency.

**[0007]** With conventional emulsion fuels, they cannot be easily ignited by means of commercially available burners, or cannot be completely combusted, and a fuel odor is smelled in a combustion gas after combustion. To avoid this, where conventional emulsion fuels are combusted, a specific type of expensive burner or a specific combustion method has to be used, with the attendant disadvantage that combustion costs become high or CO<sub>2</sub> cannot be reduced. Where city water containing a chlorine ion is used for the preparation of an emulsion fuel, an oil containing chlorine generates dioxine and NO<sub>x</sub>, with concern that environmental pollution is facilitated.

**[0008]** Expensive surface active agents have been conventionally employed as an emulsifier for the preparation of emulsion fuels, so that cost reduction cannot be attained with emulsion fuels using such surface active agents. Where an emulsion fuel using a surface active agent as a chemical product is combusted, dioxine generates thereby causing environmental pollution. Accordingly, there is a demand for those other than surface active agents for use as an emulsifier.

**[0009]** A first object of the invention is to provide an inexpensive oil emulsion which can be readily ignited by using a conventional, commercially available burner as it is without need of any specific type of apparatus and in which a ratio of water to oil is high. A second object of the invention is to provide an oil emulsion which has a calorific value substantially equal to or higher than 100% fuel when used as an emulsion fuel. A third object of the invention is to provide an oil emulsion which is inexpensive without use of an expensive surface active agent as an emulsifier and is able to reduce CO<sub>2</sub> or NO<sub>x</sub> over conventional counterparts. A fourth object of the invention is to provide an oil emulsion which is able to prevent freezing thereof and can maintain an emulsified state over a long time.

### SUMMARY OF THE INVENTION

**[0010]** An oil emulsion according to the invention is characterized by being obtained by mixing under agitation an oil, an emulsifier and a specific type of water obtained by initially passing water through an ion exchange resin, further passing through one of rocks including tourmaline and a silicon dioxide-rich rock selected among igneous rocks, and passing the other rock. The invention is characterized in that when the total of the oil, the emulsifier and the specific type of water is at 100% by weight, a weight ratio of the oil ranges 10%~75%, a weight ratio of the emulsifier is not larger than 20% of the weight of the oil, and the balance is a weight ratio of the specific type of water. The invention is characterized in that the silicon dioxide-rich rock selected among the igneous rocks is at least one of obsidian, pearlstone and pitchstone. The invention is characterized in that the tourmaline is mixed with at least one metal of aluminium, a stainless steel and silver. The invention is characterized in that the oil is any one of a waste oil, a waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline, a petroleum-based dry solvent, coal tar



and asphalt (melt), and the emulsifier is a plant oil consisting of any of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more of the oils, in which the weight ratio of the plant oil ranges 0.3%~15% of the weight of the oil. The invention is characterized in that the weight ratio of the plant oil ranges 0.8%~15% of the weight of the oil. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the specific type of water is circulated through and moved in a circulation path provided with a silicon oxide-rich rock selected among the igneous rocks therein in an air contact-free condition so that the specific type of water circulated through and moved in the circulation path is mixed with the oil and the plant oil. The invention is characterized in that the silicon dioxide-rich rock selected among the igneous rocks and provided in the circulation path is at least one rock of obsidian, pearlstone and pitchstone. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the oil consists of light oil, heavy oil or a dry solvent, and the emulsifier consists of a plant oil made of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more thereof, in which the weight ratio of the plant oil is smaller than 0.3% by weight of the oil. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and the specific type of water circulated through and moved in the circulation path is mixed with the oil and the plant oil. The invention is characterized in that the silicon dioxide-rich rock selected among the igneous rocks and provided in the circulation path consists of at least one of obsidian, pearlstone and pitchstone. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the oil consists of kerosene or gasoline, the emulsifier consists of a plant oil made of one of castor oil or rapeseed oil to which the other of castor oil or rapeseed oil or at least one of sunflower oil and rice oil is added, and the weight ratio of the plant oil ranges 0.3%~15% of the weight of said oil. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and the specific type of water circulated through and moved in the circulation path is mixed with the oil and the plant oil. The invention is characterized in that the silicon dioxide-rich rock selected among the igneous rocks and provided in the circulation path consists of at least one of obsidian, pearlstone and pitchstone. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to

and mixed with 100% by weight, in total, of the oil, the plant oil and the specific type of water. The invention is characterized in that the specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and the specific type of water circulated through and moved in the circulation path is mixed with the oil and the emulsifier. The invention is characterized in that the silicon dioxide-rich rock selected among the igneous rocks and provided in the circulation path consists of at least one of obsidian, pearlstone and pitchstone. The invention is characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of the oil, the emulsifier and the specific type of water.

#### BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. 1 is a schematic view showing an instance of an apparatus for making a specific type of water used in an oil emulsion according to the invention.

[0012] FIG. 2 is a schematic sectional view of a soft water generator used in the apparatus shown in FIG. 1.

[0013] FIG. 3 is a schematic sectional view of an essential part of an ion generator used in the apparatus shown in FIG. 1.

[0014] FIG. 4 is a schematic view showing other instance of an apparatus for making a specific type of water used in an oil emulsion according to the invention.

[0015] FIG. 5 is a table showing whether emulsification is possible or not at eight weight ratios of light oil, castor oil and a specific type of water in case where castor oil is mixed with light oil in an amount of 5% by weight of the light oil.

[0016] FIG. 6 is a table showing whether emulsification is possible or not at eight weight ratios of heavy oil, castor oil and a specific type of water in case where castor oil is mixed with heavy oil in an amount of 5% by weight of the heavy oil.

[0017] FIG. 7 is a schematic view of an apparatus for adding dissolved oxygen to water used in an oil emulsion according to the invention.

#### ILLUSTRATION OF REFERENCE NUMERALS

- [0018] 10 first soft water generator
- [0019] 12 second soft water generator
- [0020] 14 ion generator
- [0021] 16 rock accommodating container
- [0022] 32 ion exchange resin
- [0023] 46 tourmaline mixture
- [0024] 48 metal for mixing
- [0025] 54 rock
- [0026] 62 circulation connecting pipe
- [0027] 76 rock

#### DETAILED DESCRIPTION OF THE INVENTION

[0028] The specific type of water used in the invention has a minus oxidation-reduction potential and contains a hydrogen ion ( $H^+$ ), hydrogen ( $H_2$ ), a hydroxyl group ( $OH^-$ ), active hydrogen and dissolved oxygen. The emulsion fuel using this specific type of water facilitates combustion by the action of the hydrogen ion ( $H^+$ ), hydrogen ( $H_2$ ), hydroxyl group ( $OH^-$ ), active hydrogen, dissolved oxygen and the like, and is able to ignite by means of a commercially available burner. Accordingly, it is not necessary to use a specific type of expensive burner or a specific combustion method as conven-



tionally employed, thus being very economical. The oil emulsion of the invention can readily ignite by means of a commercially available burner, so that combustion close to complete combustion becomes possible, and emissions of  $\text{CO}_2$  and  $\text{NO}_x$  generated by incomplete combustion of a conventional emulsion fuel that is unlikely to ignite can be significantly reduced. In the practice of the invention, the oil emulsion can be obtained by merely mixing under agitation an oil, an emulsifier and a specific type of water. It is not necessary to form a magnetic field for emulsification or provide a specific type of expensive device such as a high-speed agitator or the like. Thus, the oil emulsion can be produced inexpensively. Moreover, with the oil emulsion of the invention, water (specific type of water) occupies a large proportion on a total weight basis. When such an oil emulsion is used as an emulsion fuel, fuel costs can be remarkably reduced over the case where there is used 100% fuel or a conventional emulsion fuel having a low ratio of water.

**[0029]** Since the specific type of water contains a hydrogen ion ( $\text{H}^+$ ), hydrogen ( $\text{H}_2$ ), a hydroxyl group ( $\text{OH}^-$ ), dissolved oxygen and active hydrogen in large amounts, combustion as an emulsion fuel allows a calorific value substantially equal to 100% fuel to be produced by the action of the hydrogen ion ( $\text{H}^+$ ), hydrogen ( $\text{H}_2$ ), hydroxyl group ( $\text{OH}^-$ ), dissolved oxygen and active hydrogen, thus enabling a combustion efficiency to be improved. This specific type of water is introduced into a circulation path provided with a silicon dioxide-rich rock selected among igneous rocks therein and is repeatedly circulated in the circulation path without contact with air during the circulation. This permits dissolved oxygen to be contained at a high concentration (DO ranges 10.7~11.3 mg/l) exceeding a saturated dissolved oxygen concentration (DO is generally at 8~8.45 mg/l although changed depending on the temperature) and, at the same time, active hydrogen can be contained in large amounts. When this water having a high concentration of dissolved oxygen and a large amount of active hydrogen is used as water for forming an oil emulsion, there can be prepared an emulsion fuel having a higher calorific value. Depending on the type of oil (e.g. light oil or heavy oil), a calorific value higher than that of 100% fuel can be obtained.

**[0030]** The specific type of water contains a hydronium ion ( $\text{H}_3\text{O}^+$ ) and a hydroxyl ion ( $\text{H}_3\text{O}_2^-$ ), both having a surface active effect. Accordingly, it is not always necessary to use a surface active agent as an emulsifier for producing the oil emulsion of the invention, and an emulsifier and a plant oil (i.e. a plant oil made of any of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more thereof) can be used. If such a plant oil is used, an emulsification stability state can be maintained at room temperature over a long time (from 1 week to 1 month or over), thereby enabling such an emulsion fuel to be sold through marketing channels. If a plant oil is used as an emulsifier for an emulsion fuel in place of a surface active agent, the resulting fuel can be used as an emulsion fuel that does not generate dioxine by combustion and does not pollute an environment.

**[0031]** Where a plant oil is used as an emulsifier and kerosene or gasoline is used as an oil, the plant oil used is made of a mixture that is obtained by adding one of castor oil or rapeseed oil to the other of castor oil or rapeseed oil or at least one of sunflower oil and rice oil. In doing so, an emulsification stabilizing period can be remarkably prolonged to about one month when compared with the case where castor oil, rapeseed oil, sunflower oil or rice oil is used singly as a plant

oil (an emulsification stabilizing period of several hours to several days). Moreover, where a plant oil is used as an emulsifier and where light oil, heavy oil or a dry solvent is used as an oil, a stable emulsification state of several tens of minutes to several hours can be maintained even if the weight ratio of the plant oil relative to the oil is smaller than 0.3%.

**[0032]** An oil emulsion using a dry solvent as an oil contains mainly water and the dry solvent. Accordingly, the oil emulsion using a dry solvent as an oil can be applied to both of the cases where dirt of laundry is soluble in water and is also soluble in oil. Thus, such an emulsion can be used for any sort of cleaning.

**[0033]** The oil emulsion of the invention is prepared by mixing under agitation an oil such as a waste oil, a waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline (including naphtha), a petroleum-based dry solvent, coal tar, asphalt (melt) and the like, a specific type of water, and an emulsifier (including a plant oil made of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more thereof). In the practice of the invention, "waste oil, waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline, petroleum-based dry solvent, coal tar, asphalt (melt) and the like" are generically called "oil".

**[0034]** Prior to illustration of the oil emulsion of the invention, "specific type of water (hereinafter referred to as refreshed water)" used for producing an oil emulsion of the invention is described with reference to FIGS. 1 to 3. FIG. 1 is an illustrative view showing an example of an apparatus for making refreshed water. A first soft water generator **10**, a second soft water generator **12**, an ion generator **14**, and a rock accommodating container **16** are successively connected in series through connection pipes **18a**, **18b** and **18c**. Pressurized water such as, for example, city water, is supplied from a water supply pipe **20** via a connecting pipe **22** to the first soft water generator **10**. An inlet on-off valve **24** such as a bibcock is provided between the water supply pipe **20** and the connecting pipe **22**, and a check valve **26** is provided on the way of the connecting pipe **22**. A delivery pipe **28** is provided at the outlet side of the rock accommodating container **16** and has an outlet on-off valve **30** at the tip of or on the way of the delivery pipe **28**.

**[0035]** With city water, water fed from the water supply pipe **20** is passed to the first soft water generator **10**, the second soft water generator **12**, the ion generator **14** and the rock accommodating container **16** in this order and is taken out from the delivery pipe **28** by opening the outlet on-off valve **30**. With the case other than city water, water stored in water reservoir, not shown, is introduced through the supply pipe **20** into the first soft water generator **10** by means of a pump. In the case, a check valve **26** is provided between the pump and the first soft water generator **10**.

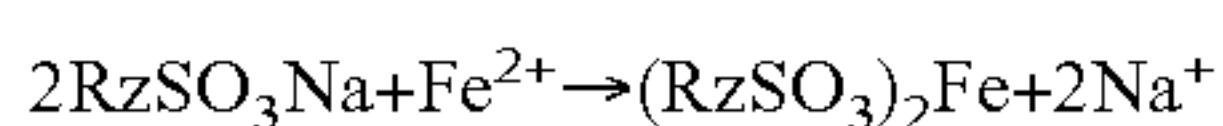
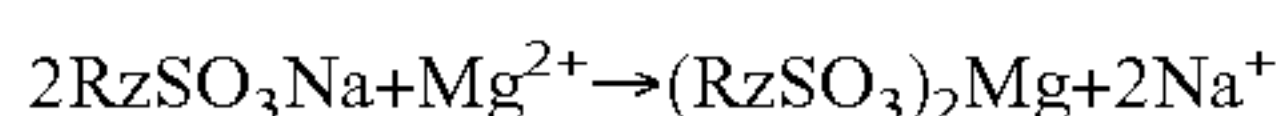
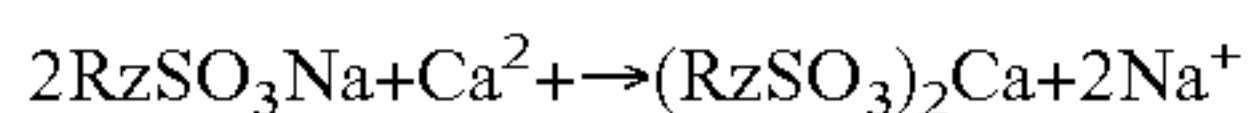
**[0036]** The first soft water generator **10** and the second soft water generator **12**, respectively, contain a large quantity of a particulate ion exchange resin **32** therein, with its section being shown in FIG. 2. The soft water generators **10**, **12**, respectively, have a body **34** which is cylindrical in shape and has water outlet and inlet ports **36a**, **36b** at upper and lower ends thereof, respectively. The cylindrical body **34** is provided with shield members **38a**, **38b** at inner surfaces kept slightly away from the upper and lower ends thereof as, respectively, having an opening at the center thereof. The ion exchange resin **32** contained in a fine net **40** is accommodated



between the paired shield members **38a**, **38b**. The reason why the shield members **38**, each having the opening at the center thereof, are provided at the inner walls positioned slightly away from the outlet and inlet ports **36a**, **36b** is that the fine net **40** having ion exchange resin **32** is placed between the paired shield members **38** to establish spaces **42a**, **42b** in the vicinity of the outlet and inlet ports **36a**, **36b**, respectively. The passage of water through the central openings of the shield members **38a**, **38b** permits invariable contact of the water with the ion exchange resin **32**. The reason why the ion exchange resin **32** is placed in the net **40** is that the particulate ion exchange resin **32** can be wholly removed along with the net **40**.

[0037] The first and second soft water generators **10** and **12**, respectively have a height set, for example, at 80 cm and an inner diameter set at 10 cm herein. The accommodating height of the ion exchange resin **32** is set, for example, at 70 cm (permitting the upper and lower spaces **42a** and **42b** to be established). The accommodating height of the ion exchange resin **32** should be sufficient to satisfactorily effect ion exchange. On the other hand, when the height of the accommodated ion exchange resin **32** is too high (e.g. over about 200 cm in the height of the accommodated the ion exchange resin **32**), the ion exchange resin **32** becomes resistant to the passage of water, resulting in a reduced flow rate of water passing through the inside of the soft water generator. Accordingly, the height of the accommodated the ion exchange resin **32** should be so set as not reducing the flow rate. The container accommodating the ion exchange resin **32** is divided into two. The reason for this is that the first and second soft water generators **10** and **12** are suppressed in height to substantially such a level as the ion generator **14** and the rock accommodating container **16** and that it is avoided to reduce the flow rate owing to the pressure loss of water passing therethrough. Of course, the two soft water generators **10**, **12** may be combined together to provide one soft water generator.

[0038] The ion exchange resin **32** serves to eliminate metal ions, such as  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and the like from water to provide soft water and especially to lower water hardness to a level close to zero. The ion exchange resin **32** used includes, for example, a strongly acidic cation exchange resin ( $\text{RzSO}_3\text{Na}$ ) obtained by uniformly sulfonating a sphere-shaped styrene-divinylbenzene copolymer. This ion exchange resin **32** undergoes the following ion exchange resin with metal ions such as  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and the like.



[0039] More particularly,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and the like can be eliminated from water by passage through the ion exchange resin **32**. The use of the strongly acidic cationic exchange resin as the ion exchange resin **32** results in formation of sodium ions ( $\text{Na}^+$ ). The ion exchange resin **32** may be one which is able to generate ions other than  $\text{Na}^+$  and should preferably be one which generates  $\text{Na}^+$ . If city water is used, chlorine is contained in aside from the metal ions such as  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and the like. The chlorine undergoes no change when city water is passed through the ion exchange resin **32**.

[0040] On the other hand, when water ( $\text{H}_2\text{O}$ ) is passed through the ion exchange resin **32**, the following changes take place.



[0041] As shown in (1) and (2) above, hydroxide ions ( $\text{OH}^-$ ) and hydronium ions ( $\text{H}_3\text{O}^+$ ) generate from water after passage through the ion exchange resin **32**.

[0042] If hard water is used and passed through the ion exchange resin **32**, metal ions such as  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and the like are eliminated from the water to provide soft water. The passage through the ion exchange resin **32** permits  $\text{Na}^+$ ,  $\text{OH}^-$  and a hydronium ion ( $\text{H}_3\text{O}^+$ ) to be generated in the water. However, chlorine ( $\text{Cl}$ ) present in city water passes as it is without undergoing ionization. It will be noted that no  $\text{Na}^+$  may be produced depending on the type of ion exchange resin **32**.

[0043] Next, a partial sectional view of the ion generator **14** is shown in FIG. 3. The ion generator **14** has a plurality of cartridges **44** arranged in a similar manner and continuously connected in series vertically. Individual cartridges **44** have particulate tourmaline **46** alone or a mixture of the particulate tourmaline **46** and a plate-shaped metal **48** accommodated therein. The tourmaline has plus and minus electrodes, with which an electromagnetic wave having 4~14 micrometers is applied to water, so that clusters of water are cleaved off thereby generating hydronium ions ( $\text{H}_3\text{O}^+$ ). The electromagnetic wave having a wavelength of 4~14 micrometers has an energy of 0.004 watts/cm<sup>2</sup>. The tourmaline **46** used herein may consist of fine pieces of tourmaline. Alternatively, the tourmaline **46** may be a tourmaline mixture called tourmaline pellets, which are commercially available as containing tourmaline, a ceramic and aluminium oxide (which may contain silver therein) at mixing ratios by weight of about 10:80:10. The ceramic contained in the tourmaline pellets acts to keep the plus and minus electrodes separated from each other. The tourmaline **46** may be made by mixing not less than 10 wt % of tourmaline **46** with the ceramic and heating the resulting mixture at 800° C. or over, by which the tourmaline **46** that disappears within a given period of time (e.g. within about 3 months for a pellet diameter of 4 mm) under agitation in water can be made. The tourmaline **46** increases in strength when heated, thus ensuring a prolonged time of the disappearance. After passage through the ion exchange resin **32**, water is converted to soft water having a hardness close to zero, and the tourmaline particles **46** are mutually collided with one another in the soft water. When using the soft water having a hardness close to zero, magnesium and calcium are prevented from being attached to the minus electrode of the tourmaline **46**, thereby preventing the function as the plus and minus electrodes of the tourmaline **46** from lowering.

[0044] The metal **48** used is at least one of aluminium, a stainless steel and silver. The metal **48** should preferably be one which is not corroded in water and is not soluble in water. Of these metals **48**, aluminium has the bactericidal or antifungal action and the bleaching function, and stainless steel has the bactericidal or antifungal action and the detergency-improving action and silver has the bactericidal or antifungal action. Copper or lead cannot be used as the metal **48** because of its toxicity. Expensive materials such as gold cannot be adopted in view of costs. The tourmaline **46** and the metal **48** are mixed at a weight ratio of 10:1 to 1:10. Over the range, one



of the materials becomes excessive, so that the effects of both materials cannot be shown simultaneously.

[0045] The cartridge **44** is in the form of a hollow cylinder opened at one end thereof and has a multitude of holes **52** at a bottom face **50** thereof. The size of the hole **52** is so set that where the tourmaline **46** and the metal **48** are placed in the cartridge **44**, the tourmaline **46** and the metal **48** do not pass through the holes **52** at the bottom **50**. As shown in FIG. 3, the respective cartridges **44** have a multitude of holes **52** at the bottom **50** thereof, on which the tourmaline **46** and the metal **48** are placed. The respective cartridges **44** are so set that water is run from the bottom toward the top of the cartridge **44**. More particularly, in the respective cartridges **44**, water passing through the multitude of holes **52** at the bottom **50** upwardly jets toward the tourmaline **46** and the metal **48**. It will be noted that the size and number of the holes **52** are so set: city water has a high hydraulic pressure, such pressurized water is caused to vigorously collide with the tourmaline **46** and the metal **48** in the cartridge **44**; and in this condition, the tourmaline **46** and the metal **48** are agitated by the force of the pressurized water in the cartridge **44**. The agitation of the tourmaline by jetting water toward the tourmaline is that the tourmaline and water are frictionally contacted under the agitation, with the result that the electrodes are dissolved out in water to cleave the clusters of water, thereby generating a large quantity of hydronium ions ( $\text{H}_3\text{O}^+$ ).

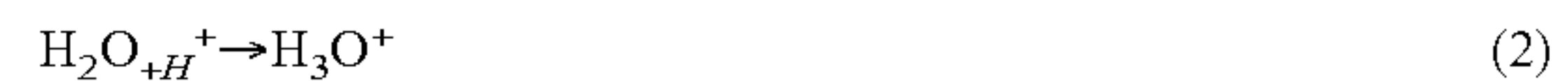
[0046] In an instance of practical installment, four cartridges **4**, each having an accommodation capacity with an inner diameter of 5 cm and a depth of 7 cm, are put one on another. The tourmaline **46** and the metal **48** are charged in the respective cartridges **44** in such an amount that the tourmaline **44** and the metal **48** can be freely moved within the cartridge **44**. Although the number of the cartridges **44** may be increased or decreased, only one cartridge **44** having a great accommodation capacity may be used. The tourmaline **46** and the metal **48** are, respectively, placed in a plurality of cartridges **44** having a reduced capacity. The plural cartridges **44** are connected, in which the agitation efficiency of the tourmaline **46** and the metal **48** can be enhanced by the force of water. The tourmaline **46** contained in the cartridges **44** is disappears in several months by dissolution in water. The cartridges **44** are arranged as to be readily detached such as by screwing, permitting easy supplement of the tourmaline **46** in the respective cartridges **44**. It will be noted that it is not necessary to supplement the metal **48** which is not dissolved in water but all cartridges **44** containing the tourmaline **46** and the metal **48** may be replaced by a used ones. The capacity of the cartridge **44** may vary depending on the flow rate.

[0047] It is to be noted that the accommodation of the tourmaline **46** alone or a mixture of the tourmaline **46** and the metal **48** in the cartridges **44** has been illustrated above. In order to increase an amount of a minus ion that is added to water passing through the cartridge **44**, it is necessary to increase the number of mutual contacts of particles of the tourmaline **46**. To this end, the tourmaline **46** alone may be accommodated in the cartridges **46**. In this connection, however, the mixing of the metal **48** with the tourmaline **46** results in a more increase in number of minus ions from the tourmaline **46**.

[0048] The tourmaline **46** has plus and minus electrodes. When tourmaline is agitated in water, water ( $\text{H}_2\text{O}$ ) dissociates into hydrogen ion ( $\text{H}^+$ ) and hydroxide ion ( $\text{OH}^-$ )



[0049] Further, hydronium ions ( $\text{H}_3\text{O}^+$ ) having the surface activity are formed from the hydrogen ion ( $\text{H}^+$ ) and water ( $\text{H}_2\text{O}$ ). The amount of the thus formed hydronium ions ( $\text{H}_3\text{O}^+$ ) is far much larger than that generated by means of the ion exchange resin **32**.



[0050] Part of the hydronium ions ( $\text{H}_3\text{O}^+$ ) combines with water ( $\text{H}_2\text{O}$ ) to form a hydroxyl ion ( $\text{H}_3\text{O}_2^-$ ) and hydrogen ions ( $\text{H}^+$ )



[0051] The water passed through the ion exchange resin **32** is further passed through the ion generator **14**. Eventually, hydronium ions ( $\text{H}_3\text{O}^+$ ), hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ),  $\text{H}^+$  and  $\text{OH}^-$  are generated in water. The chlorine ( $\text{Cl}$ ) passed through the ion exchange resin **32** and the  $\text{Na}^+$  generated at the ion exchange resin **32** pass through the ion generator **14** as they are without undergoing any reaction.

[0052] The water passed through the ion generator **14** is further passed through the rock accommodating container **16** in which a silicon dioxide-rich rock (i.e. a rock containing about 65-75% of silicon dioxide) selected among igneous rocks is accommodated. The silicon dioxide-rich rock **54** selected among igneous rocks (classified into volcanic rocks and plutonic rocks) includes rhyolite such as obsidian, perlite, pitchstone and the like for volcanic rock, and granitoid for plutonic rock. At least one of these rocks is accommodated in the rock accommodating container **16**. Rhyolites such as obsidian, perlite, pitchstone, etc., or granitoid bears minus electron.

[0053] The silicon dioxide-rich rock selected among igneous rocks (e.g. rhyolite such as obsidian, perlite, pitchstone or the like, or granitoid) has an oxidation-reduction potential of  $-20 \sim -240$  mV as a raw stone. It should be noted that those rocks soluble in water are not used as the rock **54**. The rock accommodating container **16** is, for example, in the form of a cylinder having an inner diameter of 10 cm and a height of 80 cm, and the silicon dioxide-rich rock **54** selected among igneous rocks having a particle size, for example, of 5~50 mm is accommodated in an amount sufficient not to lower a flow rate of the water being passed.

[0054] When the water passed through the ion generator **14** is run through the rock accommodating container **15**,  $e^-$  (minus electron) is added to the water. As a consequence, the chlorine ( $\text{Cl}$ ) contained in city water is converted to a chlorine ion by the action of the minus electron.



[0055] This  $\text{Cl}^-$  and the aforementioned  $\text{Na}^+$  are, respectively, kept in stable ionic condition. The stable condition means that these ions are kept over a long time without evaporation. The hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ) are also in stable ionic condition. By the passage of the water through the rock **54**, hydronium ions ( $\text{H}_3\text{O}^+$ ) are more generated on comparison with the case of water being passed through the ion generator **14**, along with hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ) and hydrogen ions ( $\text{H}^+$ ) being further generated.





The passage of water through the rock **54** brings about the following reactions other than those indicated above.



**[0056]** Moreover, when water is passed through the rock accommodating container **16**, the oxidation-reduction potential of the water is changed from +340 mV to -20~-240 mV by means of the minus electrons of the rock **54**. Using hot water in place of water, the minus oxidation-reduction potential becomes more stabilized. The water passed through the rock **54** contains large amounts of dissolved oxygen and active hydrogen.

**[0057]** As shown in FIG. 1, a specific type of water (refreshed water) is one obtained by passing initially through an ion exchange resin, then through the tourmaline **46** (or a mixture of the tourmaline **46** and the metal **48**) and finally through the rock accommodating container **16**. The refreshed water contains  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{H}^+$ ,  $\text{OH}^-$ ,  $\text{H}_2$ , hydronium ions ( $\text{H}_3\text{O}^+$ ), hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ), active hydrogen and dissolved oxygen in large amounts. The water has an electromagnetic wave of a wavelength of 4~14 micrometers having an energy of 0.004 watts/cm<sup>2</sup> and has an oxidation-reduction potential of -20~-240 mV.

**[0058]** As water used to produce the oil emulsion of the invention, there is used refreshed water obtained by passing water through the ion exchange resin **32**, the tourmaline **46** (or a mixture of the tourmaline **46** and the metal **48**) and the rock **54** in this order. Although water has been passed through the ion exchange resin **32**, the tourmaline **46** (or a mixture of the tourmaline **46** and the metal **48**) and the rock **54** in this order in FIG. 1, water may be passed through the ion exchange resin **32**, the rock **54** and the tourmaline **46** (or a mixture of the tourmaline **46** and the metal **48**) in this order. More particularly, as shown in FIG. 4, water may be passed through the first soft water generator **10**, the second soft water generator **12**, the rock accommodating container **16** and the ion generator **14** in this order.

**[0059]** In FIG. 4, water passed through the ion exchange resin **32** passes through the rock **54**.  $\text{e}^-$  (minus electron) generates in the water by the action of the rock **54**. As a consequence, the chlorine contained in city water is converted to a chlorine ion by means of the minus electrons.



The  $\text{Cl}^-$  and  $\text{Na}^+$  generated by means of the ion exchange resin **32**, respectively, become ionically stabilized. It will be noted that the water passed through the ion exchange resin **32** may not contain  $\text{Na}^+$  in some case.

**[0060]** The water passed through the ion exchange resin **32** has  $\text{H}^+$ ,  $\text{OH}^-$  and hydronium ions ( $\text{H}_3\text{O}^+$ ) as shown in the formulas (1) and (2). When the water passed through the ion exchange resin **32** is further passed through the rock **54**, the following reactions take place.



**[0061]** In these reactions, the hydronium ions ( $\text{H}_3\text{O}^+$ ) generate in amounts larger than those generated by means of the ion exchange resin **32**.

**[0062]** As stated above, the passage of water through the rock **54** after the ion exchange resin **32** permits not only  $\text{Na}^+$  and  $\text{OH}^-$  originally existing in water, but also freshly generated  $\text{Cl}^-$  and hydronium ions ( $\text{H}_3\text{O}^+$ ) to exist in water. The water passed through the rock **54** has an oxidation-reduction potential of -20~-240 mV. Using hot water in place of water, the minus oxidation-reduction potential becomes more stabilized. Moreover, the water passed through the rock **54** contains large amounts of dissolved oxygen and active hydrogen.

**[0063]** The water passed through the rock **54** is further passed through the ion generator **14** having the tourmaline **46** and the metal **48** therein. By this, the following reactions take place.



**[0064]** The hydronium ions ( $\text{H}_3\text{O}^+$ ) generate in large amounts. Part of the hydronium ions ( $\text{H}_3\text{O}^+$ ) is converted to hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ).



**[0065]** As a consequence, the water passed through the tourmaline **46** and the metal **48** contains increased amounts of hydronium ions ( $\text{H}_3\text{O}^+$ ), hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ),  $\text{OH}^-$ , and  $\text{H}^+$ .

**[0066]** As shown in FIG. 4, the water passed through the ion exchange resin **32**, the rock **54** and the tourmaline **46** (or a mixture of the tourmaline **46** and the metal **48**) in this order contains  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{OH}^-$ , hydronium ions ( $\text{H}_3\text{O}^+$ ), hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ),  $\text{H}^+$ , dissolved oxygen and active hydrogen and thus contains the same components as the refreshed water obtained in FIG. 1. Moreover, the water has an electromagnetic wave of 4~14 micrometers having an energy of 0.004 watts/cm<sup>2</sup> and an oxidation-reduction potential of -20~-240 mV. As a result, the water created with reference to FIG. 4 and the refreshed water created in FIG. 1 have the same effects. The water produced by use of the apparatus of FIG. 4 and the refreshed water produced in FIG. 1 eventually have the same components therein. Thus, the water produced by use of the apparatus of FIG. 4 is also called refreshed water.

**[0067]** The results of quality inspection of the refreshed water are as follows. The values for city water are indicated in parentheses for comparison with the refreshed water provided that the values of city water same as those of the refreshed water are indicated as "same". The nitrous acid-derived nitrogen and nitric acid-derived nitrogen; 1.8 mg/l (same), chlorine ion: 6.8 mg/l (9.0 mg/l), general bacteria: 0/ml (same), cyan ion: less than 0.01 mg/l (same), mercury: less than 0.0005 mg/l (same), organic phosphorus: less than 0.1 mg/l (same), copper: less than 0.01 mg/l (same), iron: less than 0.05 mg/l (less than 0.08 mg/l), manganese: less than 0.01 mg/l (same), zinc: less than 0.005 mg/l (less than 0.054 mg/l), lead: less than 0.01 mg/l (same), hexavalent chromium: less than 0.02 mg/l (same), cadmium: less than 0.005 mg/l (same), arsenic: less than 0.005 mg/l (same), fluorine: less than 0.15 mg/l (same), calcium, magnesium, etc. (hardness): 1.2 mg/l (49.0 mg/l), phenols: less than 0.005 mg/l (same), anionic surface active agent: less than 0.2 mg/l (same), pH value: 6.9 (same), odor: no offensive odor (same), taste: no abnormal taste (same), chromaticity: 2 degrees (same), and turbidity: 0 degree (one degree)



**[0068]** The refreshed water has many effects indicated below.

(a) Having surface activity

**[0069]** The refreshed water contains hydronium ions ( $\text{H}_3\text{O}^+$ ) and hydroxyl ions ( $\text{H}_3\text{O}_2^-$ ), which have surface activity (O/W type emulsion emulsifying action).

(b) Having a very weak energy (rearing light ray)

**[0070]** Tourmaline emits a very weak energy (an electromagnetic wave with a wavelength of 4~14 micrometers). This weak energy cleaves clusters of water, permitting toxic gases or heavy metals included in the clusters to emit to outside.

(c) Containing hydrogen ion ( $\text{H}^+$ ), hydrogen gas and hydroxyl group ( $\text{OH}^-$ )

(d) Having an oxidation-reduction potential of -20~-240 mV.

(e) Containing dissolved oxygen and active hydrogen.

**[0071]** Next, the oil emulsion of the invention is described. The oil emulsion of the invention is an O/W emulsion or O/W/O emulsion which is obtained by mixing under agitation an oil such as a waste oil, a waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline, a petroleum-based dry solvent, coal tar, asphalt (melt) and the like, refreshed water and an emulsifier. The term "emulsifier" used herein may be any one provided that it is able to emulsify an oil and water, and may be, for example, a surface active agent. As an emulsifier other than surface active agents, it is preferred to use "a plant oil consisting of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more thereof". The plant oil may be any one of castor oil, rapeseed oil, sunflower oil and rice oil, or may be a mixture of two to four of castor oil, rapeseed oil, sunflower oil and rice oil. Where a plurality of plant oils are mixed, it is preferred to contain at least castor oil and rapeseed oil because an emulsified condition is kept over a long time. Where an oil emulsion using the plant oil as an emulsifier is employed as an emulsion fuel, no dioxine is generated and thus, environmental pollution can be prevented.

**[0072]** For the mixing of an oil, refreshed water and an emulsifier, it is preferred to add the refreshed water and the emulsifier to the oil in no particular order and mix the three components under agitation so as to maintain the emulsified state over a long time. If one of refreshed water and an emulsifier is added to an oil and mixed under agitation, followed by further mixing the other under agitation, the mixture is once emulsified, but is separated within a short time. Moreover, when refreshed water and an emulsifier are initially agitated, to which an oil is mixed under agitation, the mixture is once emulsified, but is separated within a short time. The use of a plant oil as an emulsifier is now described.

**[0073]** The experimental results using "light oil" as an oil, castor oil as a plant oil and refreshed water as water are shown in FIG. 5. In the experimental results shown in FIG. 5, the weight of the castor oil is set at 5% of the weight of the light oil, and the total weight of the light oil, the castor oil and the refreshed water is at 100%. FIG. 5 shows the experimental results using eight different weight ratios (Nos. 1 to 8) of light oil, castor oil and refreshed water. The experimental results are illustrated based on FIG. 5. In No. 1 of FIG. 5, when the weight ratio of the light oil is set at 10% of the total weight, the weight ratio of the castor oil is at 0.5% (i.e. 5% of the weight ratio of the light oil) and the weight ratio of the refreshed water is at 89.5% (=100%-10%-0.5%). In No. 5, when the weight ratio of the light oil is at 50%, the weight ratio of the castor oil is at 2.5% (i.e. 5% of the weight ratio of the light oil)

and the weight ratio of the refreshed water is at 47.5% (=100%-50%-2.5%). In No. 7, when the weight ratio of the light oil is at 70%, the weight ratio of the castor oil is at 3.5% (i.e. 5% of the weight ratio of the light oil) and the weight ratio of the refreshed water is at 26.5% (=100%-70%-3.5%). The weight ratio of the light oil is gradually increased from No. 1 to No. 8 and the weight ratio of the refreshed water is gradually decreased correspondingly.

**[0074]** The experimental results are shown while classifying the period into four groups (1 day, 7 days, 15 days and 30 days). In No. 1~No. 5, all of emulsification stability (1 day/room temperature), emulsification stability (7 days/room temperature), emulsification stability (15 days/room temperature) and emulsification stability (30 days/room temperature) are marked as "o" in which the mark "o" indicates that an emulsified state is stable over the indicated period of time. Although no experiment over 30 days is carried out, the emulsified state is stable up to 30 days and thus, it is considered that the emulsified state (no separation between the light oil and the water) over 30 days continues. From the above, it will be seen that the oil emulsion of the invention has satisfactory usefulness as an emulsion fuel to be sold through distribution channels. On the other hand, in No. 8, all of emulsification stability (1 day/room temperature), emulsification stability (7 days/room temperature), emulsification stability (15 days/room temperature) and emulsification stability (30 days/room temperature) are marked as x, which indicates no emulsification (separation).

**[0075]** In No. 6 (60% by weight of light oil, 3% by weight of castor oil and 37% by weight of refreshed water) and No. 7 (70% by weight of light oil, 3.5% by weight of castor oil and 26.5% by weight of refreshed water), while "o" is marked on emulsification stability (1 day/room temperature) and emulsification stability (7 days/room temperature), "Δ" is marked on emulsion stability (15 days/room temperature) and emulsion stability (30 days/room temperature). The mark "Δ" indicates the occurrence of separation due to a difference in specific gravity. More particularly, the mark "Δ" indicates a state where although an emulsified state is substantially maintained, part of the oil separates and part of the separated oil remains at an upper portion. In the oil emulsion of the invention, the mixture in the separated state due to the difference in specific gravity can be again emulsified, by agitation, stably over 7 days or more. Nos. 6 and 7 demonstrate that the emulsified state remains stable for 7 days and the separation caused due to the difference in specific gravity occurs over 15 days or more. As will be appreciated from the experimental results, emulsification becomes stabilized for at least 7 days (up to 5 days). If the emulsion is stable for 7 days, it may be sold, for example, as an emulsion fuel through distribution channels and is thus considered suitable for practical application. It will be noted that if the emulsion becomes separated due to the difference in specific gravity as indicated by "Δ", an emulsified state can be secured at least for 7 days by agitation, thus being well suited for practical application.

**[0076]** Based on FIG. 5, when the weight ratio of the light oil ranges from 10% to 70% and the weight ratio of the refreshed water ranges from 89.5% to 26.5% in case where castor oil is mixed with 5% by weight relative to the weight of light oil, the resulting oil emulsions obtained by mixing the light oil, refreshed water and castor oil under agitation ensure an emulsification stabilizing period of at least 7 days. Thereafter, even if the emulsion becomes separated due to the difference in specific gravity marked as "Δ", a stable emulsi-



fied state can be maintained by agitation for at least 7 days. The reason why the emulsification stabilizing period of 7 days is taken as one of measures is that a practical period prior to use and after purchase is assumed in part for one who purchases the oil emulsion as an emulsion fuel.

**[0077]** In FIG. 5, experiments using 5% by weight of castor oil relative to the light oil are shown. Thereafter, many experiments were conducted while changing the weight ratio of castor oil relative to the light oil. If the weight ratio of castor oil relative to light oil ranges 0.8%~15% (inclusive), results similar to FIG. 5 are obtained. If the weight ratio of castor oil relative to light oil is not smaller than 0.3% and smaller than 0.8%, a separated state due to the difference in specific gravity marked as “Δ” was observed in some cases for 15 days and 30 days of Nos. 1~5 marked as “○” of FIG. 5. More particularly, it is considered that when the weight ratio of castor oil relative to light oil is not smaller than 0.3% and smaller than 0.8%, an emulsification stabilizing period of from 1 day to about 7 days can be obtained, during which it is possible to sell the emulsion through distribution channels. It will be noted that if a separated state due to the difference in specific gravity marked as “Δ” is observed, an emulsified state can be maintained by agitation for further about 7 days. The weight ratio of castor oil relative to light oil of 15% or over is omitted. If the ratio exceeds 15%, the viscosity of an oil emulsion became high and the oil emulsion was not sucked into a burner and thus, no ignition with the burner was possible. With respect to light oil, it has been found that even if a weight ratio of castor oil relative to the light oil is smaller than 0.3%, an emulsified state can be maintained over about several hours. Accordingly, in order to prepare an oil emulsion using light oil and employ it immediately, the use of castor oil at a weight ratio of smaller than 0.3% relative to the light oil is effective.

**[0078]** In No. 1 of FIG. 5, the weight ratio of the light oil is at 10%. Although emulsification proceeds if using a weight ratio of light oil of not smaller than 10%, a desired calorific value cannot be obtained when using the light oil at 10% or below. Accordingly, the lower limit of the weight ratio of the light oil is at 10%. In No. 7 of FIG. 5, the weight ratio of the light oil is 70% and the weight ratio of the light oil in No. 8 of FIG. 5 is 80%. Although emulsified state is maintained for about 7 days when using the light oil at a weight ratio of 70%, no emulsification is realized using the light oil at a weight ratio of 80%. An experiment is carried out in order to determine what weight ratio of light oil is effective for maintaining an emulsified state. As a result, it has been found that an emulsified state can be obtained for several tens of minutes to several hours when using 75% by weight of the light oil. Accordingly, the upper limit for the weight ratio of the light oil is set at 75%.

**[0079]** Next, experimental results using heavy oil as an oil, castor oil as a plant oil and refreshed water as water are shown in FIG. 6. In the experimental results on the heavy oil shown in FIG. 6, the weight of castor oil is set at 5% of the weight of the heavy oil and the total of the heavy oil, castor oil and refreshed water is at 100% by weight. FIG. 6 shows experimental results using eight different ratios by weight (Nos. 1~8) of the heavy oil, castor oil and refreshed oil. The ratios by weight of the oil, castor oil and refreshed water of Nos. 1~8 in FIG. 6 are the same as the ratios by weight of the oil, castor oil and refreshed water of Nos. 1~8 in FIG. 5. The difference between the experimental results of FIG. 6 and the experimental results of FIG. 5 resides only in No. 6. In No. 6 using

the light oil in FIG. 5, although emulsification stability (1 day/room temperature) and emulsification stability (7 days/room temperature) are marked with “○”, “Δ” is marked on emulsification stability (15 days/room temperature) and emulsion stability (30 days/room temperature). In contrast, in No. 6 of FIG. 6 using heavy oil (60% by weight of heavy oil, 3% by weight of castor oil, and 37% by weight of refreshed water), all of emulsification stability (1 day/room temperature), emulsification stability (7 days/room temperature), emulsification stability (15 days/room temperature) and (30 days/room temperature) are marked with “○”. In No. 6 of FIG. 6 (60% by weight of heavy oil, 3% by weight of castor oil, and 37% by weight of refreshed water), the emulsified state can be maintained for 30 days.

**[0080]** No. 7 of FIG. 6 and No. 7 of FIG. 5 are the same with respect to the emulsified state and the partially separated state, and No. 8 of FIG. 6 and No. 8 of FIG. 5 are also the same. In No. 7 of FIG. 6, while emulsification stability (1 day/room temperature) and emulsification stability (7 days/room temperature) are marked with “○”, emulsification stability (15 days/room temperature) and emulsification stability (30 days/room temperature) are marked with “A”. In No. 8, all of emulsification stability (1 day/room temperature), emulsification stability (7 days/room temperature), emulsification stability (15 days/room temperature) and (30 days/room temperature) are marked with “x”. In No. 7 using the heavy oil (70% by weight of heavy oil, 3.5% by weight of castor oil and 26.5% by weight of refreshed water), the emulsion is stabilized at least for 7 days and separation takes place in 15 days due to the difference in specific gravity. More particularly, separation may take place between 8 days and 14 days due to the difference in specific gravity. Thus, with the heavy oil as in No. 7, an emulsification stabilizing period of at least 7 days is ensured like the light oil. After the period, a separated state is caused due to the difference in specific gravity. Nevertheless, agitation enables a stable emulsified state to be maintained at least for 7 days, thus the emulsion being well suited for practical application.

**[0081]** In FIG. 6, experiments using 5% by weight of castor oil relative to the heavy oil are shown. Next, many experiments were carried out in which ratios by weight of castor oil to the heavy oil were changed. When the weight ratio of castor oil to the heavy oil ranged 0.8%~15% (inclusive), results similar to those of FIG. 6 were obtained. When the weight ratio of castor oil to the heavy oil is not smaller than 0.3% and smaller than 0.8%, some compositions of No. 1~No. 6 of FIG. 6 marked with “○” for 15 days and 30 days may suffer separation due to the difference in specific gravity as marked with “Δ”. More, particularly, if the weight ratio of castor oil to the heavy oil ranges from not smaller than 0.3% to smaller than 0.8%, an emulsification stabilizing period of from 1 to about 7 days can be obtained, during which it is considered possible to sell the emulsion through distribution channels. The weight ratio of castor to the heavy oil of 15% or over is omitted. This is because when the ratio exceeds 15%, the viscosity of the resulting oil emulsion becomes high and the emulsion cannot be sucked into a burner. In addition, since castor oil is expensive, the weight ratio of up to about 15% is determined as an upper limit. It has been found that if a weight ratio of castor oil to the heavy oil is smaller than 0.3%, an emulsified state can be maintained over about several hours. Accordingly, where an oil emulsion using the heavy oil is used immediately after



preparation, an oil emulsion having a weight ratio of castor oil to the heavy oil of even smaller than 0.3% can be effectively used.

[0082] In No. 1 of FIG. 6, the weight ratio of the heavy oil is at 10%. Although emulsification is possible at a weight ratio of the heavy oil of not larger than 10%, a desired calorific value cannot be obtained when the ratio of the light oil is not larger than 10%. Accordingly, the lower limit of the weight ratio of the heavy oil is at 10%. The weight ratio of the heavy oil in No. 7 of FIG. 6 is 70%, and the weight ratio of the heavy oil in No. 8 of FIG. 6 is 80%. An emulsified state of about 7 days is maintained when the weight ratio of the heavy oil is 70%. No emulsification proceeds when the weight ratio of the heavy oil is at 80%. An experiment has been made to confirm at what weight ratio of the heavy oil an emulsified state is maintained, revealing that an emulsified state of several tens of minutes to several hours can be obtained at a weight ratio of the heavy oil of 75%. Accordingly, the upper limit of the weight ratio of the heavy oil is at 75%.

[0083] FIG. 5 refers to an experiment in which a plant oil and castor oil are mixed with light oil, and FIG. 6 refers to an experiment in which a plant oil and castor oil are mixed with heavy oil. Using, in place of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more of castor oil, rapeseed oil, sunflower oil and rice oil, experiments were carried out relative to the light oil and heavy oil. As a result, the same results as in FIGS. 5 and 6 using castor oil were obtained. More particularly, emulsions using any of plant oils such as rapeseed oil, sunflower oil, rice oil or a mixture of two or more of castor oil, rapeseed oil, sunflower oil and rice oil exhibit the same positions of “○” for emulsification stability, “Δ” for separation due to the difference in specific gravity and “x” for complete separation in FIGS. 5 and 6.

[0084] In FIG. 5, experimental examples using a light oil are shown along with mixtures of the light oil and kerosene. In practice, in view of the advantages of the ease in combustion and inexpensiveness, mixtures with kerosene are more frequently employed than light oil alone. The weight ratio of kerosene in a mixture of the light oil and kerosene generally ranges about 10%~50%. When a mixture of the light oil and kerosene is further mixed with a plant oil and refreshed water, there can be obtained a stable emulsified state. Using a mixture of the light oil and kerosene, positions of “○” for emulsification stability, “Δ” for separation due to the difference in specific gravity and “x” for complete separation in FIGS. 5 and 6 are same as the light oil in FIG. 5.

[0085] In FIG. 6, experimental examples using a heavy oil are shown, and experiments using mixtures of the heavy oil and kerosene are also conducted. In practice, since heavy oil is frozen in winter, heavy oil and kerosene are frequently mixed so as to prevent heavy oil from being frozen in winter. The weight ratio of kerosene in a mixture of the heavy oil and kerosene generally ranges about 20%~50%. When a mixture of the heavy oil and kerosene is mixed with a plant oil and refreshed water, there can be obtained a freeze-free, stable emulsified state. The mixture of the heavy oil and kerosene exhibits the same positions of “○” for emulsification stability, “Δ” for separation due to the difference in specific gravity and “x” for complete separation, as the heavy oil in FIG. 6.

[0086] It will be noted the experimental examples of the light oil and castor oil are shown in FIG. 5 and experimental examples of the heavy oil and castor are shown in FIG. 6. Where a waste oil, a waste edible oil, a petroleum-based dry solvent, coal tar and asphalt (melt) are used as an oil (mixed

with a plant oil and refreshed water), the same results as shown in FIGS. 5 and 6 are obtained. More particularly, the emulsions using a waste oil, a waste edible oil, a petroleum-based dry solvent, coal tar and asphalt (melt) as an oil exhibit the same positions of “○” for emulsification stability, “Δ” for separation due to the difference in specific gravity and “x” for complete separation as in FIGS. 5 and 6.

[0087] Where kerosene or gasoline is used as an oil, one of castor oil, rapeseed oil, sunflower oil or rice oil is used as a plant oil, and a weight ratio of kerosene or gasoline ranges, for example 10%~70%, the emulsification stabilizing period ranges from several hours to several days. In this connection, however, if one of castor oil or rapeseed oil to which the other of castor oil or rapeseed oil or at least one of sunflower oil and rice oil is added is used, the emulsification stabilizing period can be remarkably prolonged to about one month.

[0088] The oil emulsion whose emulsified state is stabilized has concern that it is frozen in cold districts. To avoid this, 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed under agitation with 100% by weight, in total, of an oil emulsion prepared from an oil, an emulsifier (including a plant oil) and refreshed water. By this, the emulsion can be prevented from being frozen in cold districts and an emulsified state can be prolonged by about 3 to 7 days.

[0089] When the ratio of water arrives at about 10%~15%, conventional emulsion fuels have been unlikely to ignite with known commercially available burners. The unlikelihood of ignition of known emulsion fuels is considered due to the use of water (oxidized water) whose oxidation-reduction potential is at a plus level of +600~+800 mV. In contrast, the oil emulsion of the invention contains refreshed water whose oxidation-reduction potential is at -20~-240 mV (i.e. a minus oxidation-reduction potential) and further containing a hydrogen ion ( $H^+$ ), hydrogen ( $H_2$ ), a hydroxyl group ( $OH^-$ ), dissolved oxygen and active hydrogen. If the weight ratio of the refreshed water is from about 25% to about a level exceeding 80%, the oil emulsion of the invention can readily ignite by use of a commercially available burner. More particularly, the oil emulsion of the invention can ignite without resorting to any specific type of burner conventionally employed. Since the refreshed water contains a hydrogen ion ( $H^+$ ), hydrogen ( $H_2$ ), a hydroxyl group ( $OH^-$ ), dissolved oxygen and active hydrogen, a large amount of hydrogen gas generates by means of the hydrogen ion ( $H^+$ ), hydrogen ( $H_2$ ) and the hydroxyl group ( $OH^-$ ) upon combustion of the oil emulsion of the invention. As a consequence, the hydrogen gas and active hydrogen and dissolved oxygen are subjected to explosive combustion, thereby obtaining a calorific value comparable to that of 100% fuel.

[0090] The oil emulsion of the invention is able to readily ignite by means of a commercially available burner, thus enabling complete combustion of the oil emulsion of the invention. Eventually,  $CO_2$  and  $NO_x$  produced upon combustion can be drastically reduced in amount by the complete combustion. The complete combustion of the oil emulsion of the invention is evidenced from the fact that there is no fuel odor such as of light oil, heavy oil and the like in an exhaust gas after the combustion.

[0091] The refreshed water employed in the preparation of the oil emulsion of the invention contains large amounts of a hydronium ion ( $H_3O^+$ ) and a hydroxyl ion ( $HO_2^-$ ) and thus, has the surface activity (emulsifying action for O/W emulsion). More particularly, the oil emulsion of the invention has



not only the surface activity of an emulsifier, but also the surface activity of the refreshed water. As will be seen from FIGS. 5 and 6, emulsification stabilizing period can be maintained over a long time, for example, of about 30 days and thus, the emulsion can be practically usable as a fuel sold through distribution channels. Since the refreshed water has the surface activity, it becomes possible to use no surface active agent as an emulsifier. In other words, it becomes possible to use a plant oil at a small weight ratio as an emulsifier. This makes the costs lower when compared with those costs of conventional emulsion fuels, and generation of dioxine can be prevented.

[0092] With the oil emulsion of the invention using a plant oil as an emulsifier, it is not necessary to use such a surface active agent conventionally employed, so that no dioxine is generated by combustion and environmental pollution can be prevented. In prior art, city water containing chlorine is ordinarily used, for which dioxine has been further generated in large amounts. In contrast, the refreshed water used in the invention contains neither a surface active agent nor chlorine and the resulting emulsion does not generate dioxine as in prior art can be used as a safe reliable fuel or the like.

[0093] The oil emulsion of the invention prepared by use of light oil (or a mixture of light oil and kerosene) as an oil can be used as a fuel for oil motors, agricultural machinery and air planes and as a fuel for diesel engines. The oil emulsion of the invention prepared by use of heavy oil (or a mixture of heavy oil and kerosene) can be used as a fuel for ships and also as a fuel for thermal power generation. The oil emulsion of the invention prepared by use of waste oil or waste edible oil as an oil can be used as a fuel for general combustion.

[0094] In conventional emulsion fuels, a mixing ratio of water is at most about 20%, for which limitation is placed on the cost reduction if the emulsion fuel is used. In contrast, the oil emulsion of the invention contains refreshed water whose ratio ranges about 20%~90% of the total weight. If the oil emulsion is used, for example, as an emulsion fuel, fuel costs can be remarkably reduced over 100% fuel or conventional emulsion fuels.

[0095] Where a petroleum-based dry solvent is used as an oil, there are shown the same results as those of light oil shown in FIG. 5. More particularly, with oil emulsions using a petroleum-based dry solvent as an oil, the position of “o” for emulsification stability, the position of “Δ” for separation due to the difference in specific gravity and “x” for complete separation are same as in FIG. 5. Where the dry solvent is used as an oil, the resulting oil emulsion of the invention using the dry solvent comprises water as one of components and the dry solvent as the other component. When using an oil emulsion using a dry solvent as an oil, the emulsion can be applicable to both a water-soluble soil and an oily soil. Accordingly, if clothes attached with a water-soluble soil and with an oily soil may be washed simultaneously in one washing tub.

[0096] In FIGS. 5 and 6, experimental results using plant oils as an emulsifier are shown. An experiment has been made using known emulsifiers other than plant oils (e.g. surface active agents and the like). Similar results as in FIGS. 5 and 6 are obtained even when the ratio by weight of an emulsifier is less than 20% by weight of an oil although depending on the type of emulsifier. It will be noted that where a plant oil is used as an emulsifier, emulsification can be achieved when the weight ratio of the plant oil is at 15% or below of the weight of the oil. On use as an emulsion fuel, dioxine is prevented from being generated upon combustion.

[0097] If an emulsifier other than plant oils is used in an amount of 0.3%~0.8% by weight relative to an oil, an emulsification stabilizing period of 1 day to about 7 days can be obtained like plant oils used at the same weight ratios as in Nos. 1 to 7 of FIG. 5 and Nos. 1 to 7 of FIG. 6. Moreover, if an emulsifier other than a plant oil is used and the weight ratio to an oil is smaller than 0.3% in case where “light oil alone” or “heavy oil alone” is mixed and emulsified, an emulsified state can be maintained over several tens of minutes and several hours. Accordingly, where an oil emulsion based on the light oil or heavy oil is used immediately after preparation thereof, the oil emulsion can be effectively used even if the weight ratio of an emulsifier other than a plant oil to the light oil or heavy oil is smaller than 0.3%.

[0098] Next, an apparatus of adding dissolved oxygen and active hydrogen to refreshed water so as to increase a caloric value is illustrated with reference to FIG. 7. Refreshed water is accommodated in a tank 60. The tank 60 is connected with one end of a circulation connecting pipe 62. The circulation connecting pipe 62 is communicated at one end thereof with a lower portion of the tank 60 and disposed at the other end below a water level of the tank 60, with an intermediate portion thereof passing outside of the tank 60. The circulation connecting pipe 62 has an on-off valve 64, a pump 66 for water feed, a rock accommodating container 68 and a filter 70 in this order from an upstream side (the tank 60 side) toward a downstream side. The circulation connecting pipe 62 has, at the other down stream side thereof, an opening 72 which is positioned well below a water level 74 in the tank 60.

[0099] The rock accommodating container 68 accommodates a silicon dioxide-rich rock 76 (i.e. a rock containing about 65%~76% of silicon dioxide) selected among igneous rocks. As the silicon dioxide-rich rock 76 of igneous rocks (classified into volcanic rocks and plutonic rocks), there are mentioned obsidian, perlite, pitchstone, etc., as rhyolite and granite and the like as plutonic rock. Of the igneous rocks, obsidian is preferably used in view of the inexpensiveness and the ease in availability. In order that a large amount of dissolved oxygen is contained in water, it is preferred to contact water with the rock 76 over a long time. To this end, it is necessary to elongate the rock accommodating container 68. The rock accommodating container 68 may be divided into several short-sized cylinders (e.g. in length of about 80 cm) and water is circulated and passed through the several cylinders of the rock accommodating container 68 to permit specific type of water or refreshed water to come into contact with the silicon dioxide-rich rock 76 for a long time.

[0100] The manner of circulating and contacting specific type of water or refreshed water with the silicon dioxide-rich rock 76 is described. Water is placed in the tank 60 and the height of the water level 74 is so set as to become well higher than the position of the opening 72 of the circulation connecting pipe 62. The water placed in the tank 60 is refreshed water. Thereafter, the on-off valve 14 is opened to operate the pump 66. By suction with the pump 66, the water in the tank 60 is introduced into the circulation connecting pipe 62 and comes into contact with the silicon dioxide-rich rock 76 in the rock accommodating container 68. Long contact of the water with the rock 76 enables the clusters of the water to be cleaved. The size of the silicon dioxide-rich rock 76 is set at 5~50 mm so as to cleave the clusters of the water. Water is made of bonding electron pairs of oxygen and hydrogen atoms and is a substance having a large amount of intermolecular gaps. More finely cleaved clusters of water result in a wider intermolecu-



lar gap. Large amounts of the dissolved oxygen and active hydrogen contained in the water by contact with the rock 76 can be entered into the gaps which become widened by cleavage of the clusters. Moreover, the cleavage of the clusters of water enables the gaps, into which other substances can enter, to be widened. That is, an emulsifier, an oil or the like may be entered into the gaps.

**[0101]** The water passed through the rock accommodating container 68 is introduced from the opening 72 of the circulation connecting pipe 62 to a portion lower than the water level 74 in the tank 60 and is mixed with the water in the tank 60. When the pump 66 is continuously operated, the water in the tank 60 is repeatedly re-circulated through the circulation connecting pipe 62 (provided with the rock accommodating container 68 therein) to the tank 60. The water passed through the rock accommodating container 68 contains large amounts of dissolved oxygen and active hydrogen and are mixed with water in the tank 60. More particularly, repetition of the circulation of water leads to a successively increasing concentration of dissolved oxygen, in particular, in water accommodated in the tank 60. At the position of connection with the tank 60 at an upstream side of the circulation connecting pipe 62, a sealed state relative to air is maintained. The sealed state relative to air is also maintained during the course of the circulation connecting pipe 62. At the position of the opening 72 at the downstream side of the circulation connecting pipe 62, the opening 72 is arranged below the water level 74, so that the water circulating through the circulation connecting pipe 62 is kept sealed relative to air. In this way, the circulation path of water shown in FIG. 1 permits the water to be circulated in sealed state, and air is not mixed in the water during the course of the circulation. More particularly, the water is not exposed to air during the course of the circulation. In FIG. 7, although the top of the water level 74 in the tank 60 is exposed to air, the water is not exposed to air by mixing of water with air during the course of the circulation. It will be noted that in FIG. 7, the tank 60 is provided in the circulation path, the circulation path may be formed of a completely closed pipe without providing the tank 60.

**[0102]** As stated above, since the water is circulated and brought into contact with the silicon dioxide-rich rock 76 without mixing of air with the water (without exposing the water to air), dissolved oxygen and active hydrogen can be contained in the refreshed water in large amounts. A greater number of cycles of circulation through the circulation connecting pipes 62 result in larger amounts of dissolved oxygen and active hydrogen (especially, dissolved oxygen) contained in the refreshed water. For instance, 5~10 cycles of circulation through the circulation connecting pipe 62 enable a dissolved oxygen concentration (DO) to be at about 11 mg/liter. A saturated dissolved oxygen concentration (DO) differs depending on the temperature and is generally in the range of about 8.0~8.4 mg/liter. When air is not contacted with the refreshed water during the circulation in a manner as set above, the dissolved oxygen concentration (DO) contained in the refreshed water can be remarkably increased (to a supersaturated concentration of dissolved oxygen). If the refreshed water whose dissolved oxygen concentration is supersaturated is used as water for producing an emulsion fuel, the combustion of the emulsion fuel is facilitated by the action of large amounts of dissolved oxygen concentration (DO) and active hydrogen upon combustion of the fuel. Although depending on the type of oil, this emulsion fuel can generate an energy (calorific value) greater than 100% fuel.

**1-24.** (canceled)

**25.** An oil emulsion, characterized by being obtained by mixing under agitation an oil, an emulsifier and a specific type of water obtained by initially passing water through an ion exchange resin, further passing through one of rocks including tourmaline and a silicon dioxide-rich rock selected among igneous rocks, and finally passing the other rock.

**26.** The oil emulsion according to claim 25, characterized in that a weight ratio of said oil ranges 10%~75%, a weight ratio of said emulsifier is not larger than 20% of the weight of said oil, and the balance is a weight ratio of said specific type of water when the total of said oil, said emulsifier and said specific type of water is 100% by weight.

**27.** The oil emulsion according to claim 26, characterized in that the silicon dioxide-rich rock selected among the igneous rocks is at least one of obsidian, pearlstone and pitchstone.

**28.** The oil emulsion according to claim 26, characterized in that said tourmaline is mixed with at least one metal of aluminium, a stainless steel and silver.

**29.** The oil emulsion according to claim 25, characterized in that said oil is any one of a waste oil, a waste edible oil, light oil, a mixture of light oil and kerosene, heavy oil, a mixture of heavy oil and kerosene, kerosene, gasoline, a petroleum-based dry solvent, coal tar and asphalt (melt), and said emulsifier is a plant oil consisting of any of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more of the oils, wherein the weight ratio of said plant oil ranges 0.3%~15% of the weight of said oil.

**30.** The oil emulsion according to claim 29, characterized in that the weight ratio of said plant oil ranges 0.8%~15% by weight of said oil.

**31.** The oil emulsion according to claim 29, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.

**32.** The oil emulsion according to claim 29, characterized in that said specific type of water is circulated through and moved in a circulation path provided with a silicon oxide-rich rock selected among the igneous rocks therein in an air contact-free condition so that said specific type of water circulated through and moved in the circulation path is mixed with said oil and said plant oil.

**33.** The oil emulsion according to claim 32, characterized in that the silicon dioxide-rich rock selected among said igneous rocks and provided in said circulation path is at least one rock of obsidian, pearlstone and pitchstone.

**34.** The oil emulsion according to claim 32, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.

**35.** The oil emulsion according to claim 25, characterized in that said oil consists of light oil, heavy oil or a dry solvent, and said emulsifier consists of a plant oil made of any of castor oil, rapeseed oil, sunflower oil, rice oil or a mixture of two or more thereof, wherein the weight ratio of said plant oil is smaller than 0.3% by weight of said oil.

**36.** The oil emulsion according to claim 35, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.



**37.** The oil emulsion according to claim **35**, characterized in that said specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and said specific type of water circulated through and moved in the circulation path is mixed with said oil and said plant oil.

**38.** The oil emulsion according to claim **37**, characterized in that the silicon dioxide-rich rock selected among said igneous rocks and provided in said circulation path consists of at least one of obsidian, pearlstone and pitchstone.

**39.** The oil emulsion according to claim **37**, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.

**40.** The oil emulsion according to claim **25**, characterized in that said oil consists of kerosene or gasoline, said emulsifier consists of a plant oil made of one of castor oil or rapeseed oil to which the other of castor oil or rapeseed oil or at least one of sunflower oil and rice oil is added, and the weight ratio of said plant oil ranges 0.3%~15% of the weight of said oil.

**41.** The oil emulsion according to claim **40**, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.

**42.** The oil emulsion according to claim **40**, characterized in that said specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and said specific type of water

circulated through and moved in the circulation path is mixed with said oil and said plant oil.

**43.** The oil emulsion according to claim **42**, characterized in that the silicon dioxide-rich rock selected among said igneous rocks and provided in said circulation path consists of at least one of obsidian, pearlstone and pitchstone.

**44.** The oil emulsion according to claim **42**, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said plant oil and said specific type of water.

**45.** The oil emulsion according to claim **25**, characterized in that said specific type of water is circulated through and moved in the circulation path provided with the silicon dioxide-rich rock selected among the igneous rocks therein in an air contact-free condition, and said specific type of water circulated through and moved in the circulation path is mixed with said oil and said emulsifier.

**46.** The oil emulsion according to claim **45**, characterized in that the silicon dioxide-rich rock selected among said igneous rocks and provided in said circulation path consists of at least one of obsidian, pearlstone and pitchstone.

**47.** The oil emulsion according to claim **45**, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said emulsifier and said specific type of water.

**48.** The oil emulsion according to claim **25**, characterized in that 0.01%~3% by weight of at least one of methanol, ethanol and oleyl alcohol is added to and mixed with 100% by weight, in total, of said oil, said emulsifier and said specific type of water.

\* \* \* \* \*