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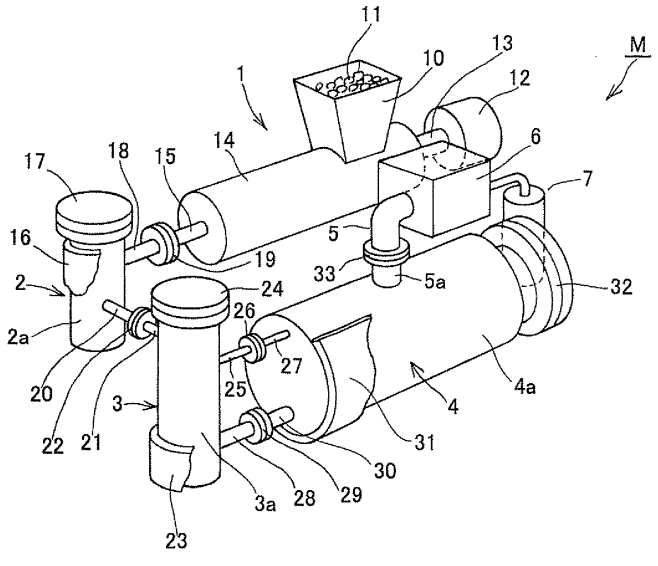
(54) PETROCHEMICAL APPARATUS

(57) A conversion-to-oil apparatus is not provided with rotary members in a heating unit and in a decomposing unit in the process of changing plastic into oil, a residue tank and catalyst, wherein plastic gel is fed into a first buffer tank 2 comprising a cylinder disposed vertically, a second buffer tank 3 comprising a cylinder disposed vertically and finally a vaporizing vessel 4 comprising a cylinder 4a disposed laterally, a liquid surface L • S in the vaporizing vessel 4 being adjusted at a diagonal center position in the vertical direction of the cylinder by controlling both the feeding amount of plastic gel and the temperature of the liquid surface so as to be a temperature of 400°C to 410°C, so that the rotary members, the residue tank and the catalyst become unnecessary to make the structure of the apparatus compact.

FIG.1



EP 2 770 039 A1

Description

Technical Field

[0001] The present invention relates to a liquefying apparatus for converting plastic material into oil by means of thermal decomposition.

Technical Background

[0002] In general, there is known a small-sized conversion-to-oil apparatus for converting continuously waste plastic into oil. In the apparatus, crushed pieces of waste plastic are melted into plastic gel in a heating unit in the shape of cylinder with a heater and a lead screw is provided therein to gradually feed the plastic gel into a decomposing unit in the shape of an inclined cylinder disposed adjacent to the heating unit. The decomposing unit has a lead screw therein for feeding the plastic gel slantingly upwardly while it is heated at a temperature above 400°C to produce plastic gas which is then decomposed by means of catalyst. Further, the decomposed gas is cooled in a condenser to be liquefied while residue is discharged continuously from a portion close to the upper end of the decomposing unit.

Prior Art Document

Patent Document

[0003] Patent document 1: Japanese Laid Open Publication No.2006-152175

Summary of the Invention

Problem to be Solved by the Invention

[0004] However, in the above liquefying apparatus, each of the heating unit and the decomposing unit has a lead screw rotated by a motor to feed molten plastic, and, therefore, the number of mechanical parts increases. Further, control for rotation is needed, and the spaces between the lead screws and the cylinder cases are clogged, respectively, to cause troubles. In addition, the residue of the decomposing unit is discharged by a residue discharging mechanism, and , however, a small amount of residue is thinly remained on the inner surface of the cylinder case to be carbonized to cause a trouble. Accordingly, a periodical maintenance operation is needed. And it is necessary to provide a catalyst cylinder accommodating catalyst therein to decompose plastic gas. The catalyst must be renewed periodically to cause an increase of cost.

Means for Solving the Problem

[0005] An apparatus for converting plastic into oil in such a way that the plastic is heated to be melted to produce vaporized plastic gas by thermal decomposition, which is cooled to be liquefied wherein the apparatus comprises an extruder for melting plastic to form plastic gel to be extruded, a buffer tank for storing the plastic gel extruded from the extruder at a predetermined temperature for a predetermined time, a vaporizing vessel which stores melted plastic from the buffer tank to vaporize it from its liquid surface to form plastic gas and which has a large-size of vaporizing surface area, temperature of which is controlled.

[0006] It is preferable that the temperature of the liquid surface is controlled at a temperature of 400°C to 410°C. Further, it is preferable that the buffer tank comprises two vertical-type of cylinders which are disposed at different height positions, respectively, the vaporizing vessel comprises a lateral-type of cylinder, and the buffer tank and the vaporizing vessel are heated by plate-like heaters at their outer circumferential surfaces, respectively. And it is preferable that maintenance lids are provided in an openable and closeable manner at their one ends, respectively. It is further preferable that a feeding amount of plastic is so controlled that the liquid surface of melted plastic in the vaporizing vessel is maintained at a diagonal center position in the vertical direction of the vessel in the shape of a cylinder. In addition, when the liquid surface of the melted plastic rises at a position higher than that of the diagonal center position, the watt density of the plate-like heater covering the outer circumferential wall of the vaporizing vessel is increased and when the liquid surface is lowered from the diagonal center position, the watt density of the plate-like heater is decreased. And it is preferable that its watt density is controlled in a range of 0.6w/cm^2 to 1.4w/ cm^2. It is further preferable that the liquefying apparatus has a condenser for liquefying the plastic gas produced in the vaporizing vessel, and the condenser can store a predetermined hydrocarbon oil. The above liquefying apparatus preferably has a condenser for liquefying the plastic gas produced in the vaporizing vessel, and the condenser stores neutralizer for neutralizing chlorine generated after

vinyl chloride is treated.

Effect of the Invention

[0007] In this invention, the extruder can melt a lot of plastic into plastic gel for a short time, and the temperature of the buffer tank is so controlled as to produce molten plastic without carbonizing the plastic gel by maintaining it in the buffer tank for a predetermined time while it is heated. In addition, the vaporizing vessel with a large vaporizing surface area can vaporize efficiently molten plastic to be thermally decomposed. Further, if the liquid surface of the molten plastic is maintained at a temperature of 400 °C to 410 °C, hydrocarbon oil corresponding to A-heavy oil and kerosene can be efficiently produced from PP and PE without carbonizing them.

[0008] Two vertical-type of buffer tanks are disposed at different height positions, respectively, so that the plastic gel can be automatically fed from one buffer tank into the other buffer tank, and the plastic gel can be melt by the plate-like heater without carbonizing it. Furthermore, the vaporizing vessel is formed in the shape of a cylinder which is laterally disposed. Accordingly, a large vaporizing area is ensured, and if the circumferential wall of the vaporizing vessel is heated by the plate-like heater at an optimum temperature, the natural convection of the molten plastic is produced, so that a special stirring means is unneeded.

[0009] Further, the buffer tank and the vaporizing vessel are respectively provided with maintenance lids, and, accordingly, it is not necessary to provide a residue tank. The liquid surface of molten plastic is maintained at the diagonal center position of the cylindrical vessel, and, accordingly, a large vaporizing surface area can be ensured. And the power of the heater is controlled at a watt density of 0.6w/ cm^2 to 1.4w/cm^2 while synchronizing with the change of the liquid surface of the molten plastic, so that the liquid surface of the molten plastic can be maintained at a temperature of 400°C to 410°C at a constant height position. If a predetermined amount of light oil, heavy oil or mixed hydrocarbon oil produced by the apparatus is stored in the condenser, terephthalic acid produced after PET is treated can be condensed to be eliminated from there. In case that neutralizer such as caustic soda aqueous solution is stored therein, chlorine can be eliminated produced after vinyl chloride is treated.

Brief Description of the Drawings

[0010]

Fig. 1 is a perspective view showing a liquefying apparatus for plastic according to the present invention.
Fig.2 is a schematic view of the liquefying apparatus for plastic according to the present invention.
Fig.3 is a schematic view of a condenser for treating PET.
Fig.4 is a schematic view of a condenser for treating vinyl chloride.
Fig.5 is a schematic view of a condenser for treating both of PET and vinyl chloride.

Embodiments for Carrying out the Invention

[0011] Hereafter, embodiments of the present invention will now be described with reference to the drawings.

[0012] In Figs.1 and 2, a liquefying apparatus for converting plastic into oil according to the present invention has an extruder 1 for melting waste plastic pieces by frictional heating into plastic gel. A normal extruder provided with a lead screw therein can be used as a substitute for the extruder 1. The extruder 1 is connected with a first buffer tank 2 and a second buffer tank 3, each of which is for melting the plastic gel to feed it automatically into a vaporizing vessel 4 and is disposed at a different height position. The buffer tank 3 is disposed on the downstream side of the buffer tank 2. Molten plastic in the second buffer tank 3 is fed into the vaporizing vessel 4 which is disposed parallel to the extruder 1 to vaporize the molten plastic while thermally decomposing it. Over the vaporizing vessel 4 is disposed a condenser 6 which cools plastic gas to produce liquefied oil which is then stored in an oil tank 7.

[0013] The extruder 1 and the vaporizing vessel 4 are disposed parallel to each other. The disposition-direction of the first and second buffer tanks 2 and 3 is perpendicular to the disposition-direction of the extruding unit 1 and the vaporizing vessel 4, and, accordingly, the liquefying apparatus M is formed compactly in the shape of a letter ⊐.

[0014] The extruder 1 is provided with a hopper 10 from which small waste plastic pieces 11 are fed into a space between a lead screw 13 rotated by a motor 12 and a casing 14 in the shape of a cylinder, and the plastic pieces 11 are melted into plastic gel by frictional heating and the heat applied by a heater (not shown). The plastic gel is discharged from a discharging pipe 15. The first buffer tank 2 comprises a cylinder 2a disposed vertically. The circumferential wall of the cylinder 2a is heated by a plate-like heater16(Fig.1) to melt the plastic gel at a temperature of 390°C to 405°C. The cylinder 2a is, at its upper end, provided with closable/openable lid for maintenance and an inlet pipe 18 is extended toward the extruder 1 from the upper circumferential wall of the cylinder 2a. The discharging pipe 15 of the extruder 1

and the inlet pipe 18 are connected with each other at a joint19. Further, an outlet pipe 20 is extended toward the second buffer tank 3 in the direction perpendicular to the inlet pipe 18 from a position close to the lower end of the circumferential wall.

[0015] The second buffer tank 3 comprises a cylinder 3a which is disposed at a lower position than that of the first buffer tank 2 and an inlet pipe 21 extended from the upper circumferential wall of the cylinder 3a is connected with the outlet pipe 20 of the first buffer tank 2 via a joint 22. The cylinder 3a has a slightly larger length than that of the first buffer tank 2 and its circumferential wall is covered with a plate-like heater 23 to heat molten plastic therein at a temperature of 400°C to 415 °C. The cylinder 3a has a closable and openable lid 24 for maintenance at its upper end. The cylinder 3a has a gas discharging pipe 25 at its upper circumferential wall opposed to the vaporizing vessel 4 to supply plastic gas staying at the upper position of the cylinder 3a into a vaporizing space S(Fig.2) in the vaporizing vessel 4 and the gas discharging pipe 25 is, at a joint 26, connected with a gas inlet pipe 27 extended from a position, opposed to the vaporizing space S, on the end face 4a of the vaporizing vessel 4. That is, the above plastic gel is gradually heated through the first buffer tank 2 and the second buffer tank 3, and vaporized plastic gas in the second buffer tank 3 is fed into the vaporizing vessel 4. Thus, the second buffer tank 3 has also a supplementary function with respect to the vaporizing vessel 4. In this manner, if melted plastic is heated gradually through the two buffer tanks 2 and 3 to be fed finally into the vaporizing vessel 4, the change of the temperature in the molten plastic fed into the vaporizing vessel 4 is decreased to ensure an accurate temperature-control for the vaporizing vessel 4. A plastic pipe 28 is extended from the lower position of the circumferential wall of the cylinder 3a to feed the molten plastic into the vaporizing vessel 4 and connected with a plastic inlet pipe 30 extended from the lower position of an end wall 4a of the vaporizing vessel 4.

[0016] The vaporizing vessel 4 comprises a cylinder 4a disposed laterally and the circumferential wall of the cylinder 4a is covered with a plate-like heater 31 such as a ceramic heater. At the left end wall of the cylinder 4a is provided a maintenance lid 32 which is disposed closably and openably. A guide pipe 5a for an evaporating pipe 5 is extended upwardly and connected with the evaporating pipe 5 via a joint 33. Further, at a predetermined position of the cylinder 4a is disposed a level sensor 34 for detecting the liquid surface L • S of the molten plastic in the cylinder 4a (FIG. 2).

[0017] When an operation for the apparatus is finished, almost all amount of the molten plastic in the vaporizing vessel 4 is evaporated, and, therefore, a level sensor 35 is equipped at a low position for controlling the low level liquid surface.

[0018] The first and second buffer tanks 2 and 3 have a first and a second thermometers t_1 and t_2 on the respective inner walls of the cylinders 2a and 3a at respective lower height positions than those positions where each molten plastic is stored in the cylinders 2a and 3a. Two thermometers t_3 and t_4 are disposed at two predetermined positions on the bottom wall of the vaporizing vessel 4. The level sensors 34 and 35, the respective thermometers t_1, t_2, t_3 and t_4, the respective heaters 16, 23 and 31 and the motor 12 of the extruder 1 are connected with a controller C (Fig. 2).

[0019] The operation for the liquefying apparatus will now be explained. Especially, it is rather difficult to liquefy polyethylene (PE) in plastic normally used, and, accordingly, the operation for liquefying PE will now be explained as an example. However, it can be adapted for the case of polypropylene (PP). In the process for thermally decomposing the molten plastic, uniform heating and correct temperature-control are important. Especially, the first and second buffer tanks 2 and 3 and the vaporizing vessel 4 of the present apparatus are not provided with stirring means, and, therefore, a plate-like heater is used to heat those members uniformly at their circumferential walls. Further, the amount of plastic to be heated is limited in relation to heat transfer, and, especially, if those members are heated at a temperature above a range of 430°C to 440°C, the molten plastic in contact with the inner walls of the buffer tanks and the vaporizing vessel 4 is carbonized to stick to the respective inner walls. As a result, the heat transfer gets worse, and the molten plastic is sometimes blown up to cause a trouble. Therefore, the correct temperature control is important.

[0020] It is preferable that the liquid surface (L • S) of the vaporizing vessel 4 is set at a diagonal center position (height position) of the cylinder 4a in the vertical direction to obtain the largest vaporization-area.

[0021] The relationship between the liquid surface temperature and the conversion-to-gas is as follows. Percent (%) mentioned below shows the speed of conversion-to-gas for a predetermined time (e.g. one hour) and a rate of the speed in case that the speed of the conversion-to-gas at 423°C is supposed to be 100%.

The Relationship between the Liquid Surface Temperature and the Speed of Conversion-to-Gas (PE • PP)

Liquid Surface Temperature	Speed of Conversion-to-Gas
380°C	no conversion-to-gas
385°C	20%
390°C	40%
395°C	45%
400°C	50%
	(Light property oil C_{10} to C_{20} is much detected)
405°C	60%
	(Medium property oil C_{15} to C_{25} is much detected)

(continued)

Liquid Surface Temperature	Speed of Conversion-to-Gas
410°C	80% (Medium property oil C_{15} to C_{35} is much detected)
415°C	90% (Medium property oil C_{40} to C_{50} is much detected)
420°C	97% (Heavy property oil C_{40} to C_{50} is much detected)
425°C	A part of the molten plastic is converted into gas and most of it is carbonized.
430°C	Most of the molten plastic is carbonized.
440°C	The molten plastic is perfectly carbonized.

That is, if the speed of the conversion-to-gas is between 50% and 80%, time for treating the molten plastic is not so long and its carbonization is effectively prevented. Accordingly, it is preferable that the liquid surface is maintained at a temperature of 400°C to 410°C. If its temperature is below 400 °C, light property oil corresponding to gasoline is much produced not to be suitable for fuel. If its temperature is above 410°C, heavy property oil is much produced not to be suitable for fuel. If its temperature is between 400°C and 410°C, hydrocarbon oil corresponding to kerosene and A-heavy oil is much produced to have a high utility value. The temperature of the molten plastic close to the inner wall of the cylinder 4a is adjusted at a temperature of 415°C to 430°C and the plate-like heater 31 wounded around its outer circumferential wall is adjusted at a temperature of 420°C to 435°C.

[0022] The inside of the vaporizing vessel 4 is so heated that its outer circumferential wall is heated. And thus heating manner makes the structure of the vessel 4 simpler in comparison with a heating manner in which a heater is disposed inside of the vaporizing vessel 4 and maintenance for the inside of the vaporizing vessel 4 is easy. However, the largeness of the diameter of the cylinder 4a is limited to heat the cylinder 4a uniformly, and the diameter must be 35cm to 40 cm in view of heating efficiency. Especially, approximately 40 cm is preferable.

[0023] The plastic gel of 380°C produced in the extruder 1 drops into the first buffer tank 2 through the discharging pipe 15 and the inlet pipe 18. If the liquid surface of the molten plastic rises above the outlet pipe 20 disposed at a predetermined height position from its bottom, the amount of the molten plastic above the outlet pipe 20 drops into the second buffer tank 3 through the outlet pipe 20 and the inlet pipe 21 disposed at the upper portion of the second buffer tank 3. Then, the molten plastic flows into the outlet pipe 28 and the inlet pipe 30 so that the liquid surface of the second buffer tank 3 is equal to the liquid surface L • S of the vaporizing vessel 4 in their height positions. Further, in the second buffer tank 3, a part of the molten plastic is vaporized, and the vaporized gas is fed into a vaporizing space S in the vaporizing vessel 4 through the gas outlet pipe 25 and the gas inlet pipe 27 disposed at the upper portions of the tanks 3 and 4. The controller C adjusts both of the amount of extrusion by the extruder 1 by controlling the rotation of the motor 12 and the watt density of the plate-like heater 31 so that the liquid surface L • S in the vaporizing vessel 4 coincides with the center axis of the vessel 4 (the diagonal center height position in the vertical direction).

[0024] Each of the buffer tanks 2 and 3 and the vaporizing vessel 4 need not stirring means, and there is no valves for adjusting the flowing amount of molten plastic. The height position of the liquid surface L • S in the vaporizing vessel 4 is adjusted by controlling conditions such as the extruding amount by the extruder 1, the heating temperatures of the first and second buffer tanks 2 and 3 and the vaporizing vessel 4, and their respective diameters and lengths. In case that the liquid surface goes up above a predetermined position, the watt density is automatically increased by adjusting the voltage of the heater by thyristor to speed up the vaporization. On the contrary, in case that the liquid surface goes down, the watt density is decreased to make the vaporization speed slow so that the liquid surface is returned to the predetermined position for a short time.

[0025] In order to adjust the liquid surface of the molten plastic at a temperature of 400°C to 410°C, the watt density of the plate-like heater 31 must be between 0.6w/ cm^2 and 1.4w/ cm^2 in case that the vaporizing vessel 4 is set at a diameter of 40 cm to 50 cm.

[0026] Next, the structure of the condenser 6 for liquefying the plastic gas produced in the vaporizing vessel 4 into hydrocarbon oil will now be explained.

[0027] When PP and PE are liquefied, there is a case that PET and vinyl chloride are slightly mixed in them. In case that PET is mixed under 20%, as shown in Fig. 3, a main body 50 in the condenser 6 accommodates therein a predetermined amount of light oil, kerosene or produced hydrocarbon oil as the mixed oil, and the evaporating pipe 5 is dipped into the oil. That is, telephthalic acid produced by decomposing PET when it is treated, condenses in the hydrocarbon oil to settle it as residue Pa at the bottom of the main body 50. The hydrocarbon oil produced therein is collected through an overflow pipe 52, and the residue Pa is taken out of a drain pipe 53. The main body 50 is cooled by coolant such as

cooling water.

[0028] Fig. 4 shows a condenser 60 for neutralizing/eliminating chlorine (Cl) produced when vinyl chloride is treated. A main body 61 cooled by coolant accommodates counteractive (neutralizer) 62 therein such as sodium hydroxide (NaOH) or potassium hydroxide (KOH) and mixed oil produced therein is positioned on the liquid surface of the counteractive. When the amount of the mixed oil is stored in excess of a predetermined amount, the mixed oil is discharged outside through an overflow pipe 63. A evaporating pipe 5 is extended obliquely into the counteractive from the vaporizing vessel 4 to supply vaporized and decomposed gas thereinto. Chlorine in the supplied gas is neutralized to be changed into hydrochloric acid (HCL) in the counteractive. Further, since the evaporating pipe 5 is slanted downwardly, water drops can be effectively prevented from staying in the evaporating pipe 5a. A drain opening 64 is formed at the lower portion of the main body 61.

[0029] Fig. 5 shows a condenser 70 for treating waste plastic including both PE and vinyl chloride. The condenser 70 has a main body 71 which accommodates the counteractive 73 at its lower portion and hydrocarbon oil 72 on the counteractive 73 for condensing/eliminating the residue of telephthal acid, and chlorine (CL) in vinyl chloride is sunk to be neutralized with the neutralizer. In addition, the produced mixed oil is taken out of the upper end of an overflow pipe 74. The lower end of the evaporating pipe 5 is opened into the hydrocarbon oil and a drain opening 75 is formed at the lower end of the main body.

[0030] The optimum size of the apparatus for liquefying 10Kg of polyethylene (PE) for an hour is as follows.

1. Cylinder of extruder

$$1000\text{L (1000 mm)} \times 250\Phi \text{ (250 mm in diameter)}$$

2. Inlet pipe 15 and outlet pipe 18 25A (outer diameter 34 mm, thickness 3.2 mm)
3. First buffer tank

$$150\text{A (outer diameter 165.2 mm, thickness 5 mm)} \times 300\text{L}$$

4. Outlet pipe 20 and inlet pipe 21 32A (outer diameter 42.7 mm, thickness 3.5 mm)
5. Second buffer tank

$$150\text{A} \times 400\text{L}$$

6. Gas outlet pipe 25 and gas inlet pipe 27
10A (outer diameter 17.3 mm, thickness 2.3 mm)
7. Outlet pipe 28 and inlet pipe 30
40A (outer diameter 48.6 mm, thickness 3.5 mm)
8. Vaporizing vessel 4

$$1000\text{L} \times 400\Phi$$

[0031] The present apparatus is not provided with a residue tank for storing residue of molten plastic, and, accordingly, the maintenance lids 17, 24 and 32 formed at respective members is opened to eliminate the residue after the apparatus is operated for a predetermined time.

INDUSTRIAL APPLICABILITY

[0032] Mixed oil including hydrocarbon oil corresponding to A-heavy oil as main ingredient can be effectively produced from PP and PE among various waste plastic and this technology can be widely adapted for the industrial field of waste plastic.

EXPLANATION OF REFERENCE NUMERALS

[0033]

1 extruder

2 first buffer tank

3 second buffer tank

4 vaporizing vessel

5 evaporating pipe

6 condenser

7 oil tank

Claims

1. An apparatus for converting plastic into oil in which the plastic is heated to be melted so as to vaporize molten plastic in a process of thermal decomposition, which comprises:

an extruder for extruding plastic gel produced by melting the plastic;
a buffer tank for staying the plastic gel therein extruded from the extruder at a predetermined temperature for a predetermined time; and
a vaporizing vessel for storing molten plastic fed from the buffer tank to vaporize the molten plastic so as to produce plastic gas from a liquid surface of the molten plastic, the vaporizing vessel having a large vaporizing area therein, the temperature of which is adjusted.

2. An apparatus for converting plastic into oil according to claim 1, wherein the liquid surface is adjusted at a temperature of 400°C to 410°C.

3. An apparatus for converting plastic into oil according to claim 1, wherein the buffer tank comprises two cylinders which are disposed at different height positions, respectively, the vaporizing vessel comprises a lateral-type of cylinder, and the buffer tank and the vaporizing vessel are heated by a plate-like heater for covering the outer circumferential walls thereof.

4. An apparatus for converting plastic into oil according to claim 1 or 2,
wherein each of the buffer tank and vaporizing vessel has a closable/openable maintenance lid at its one end, respectively.

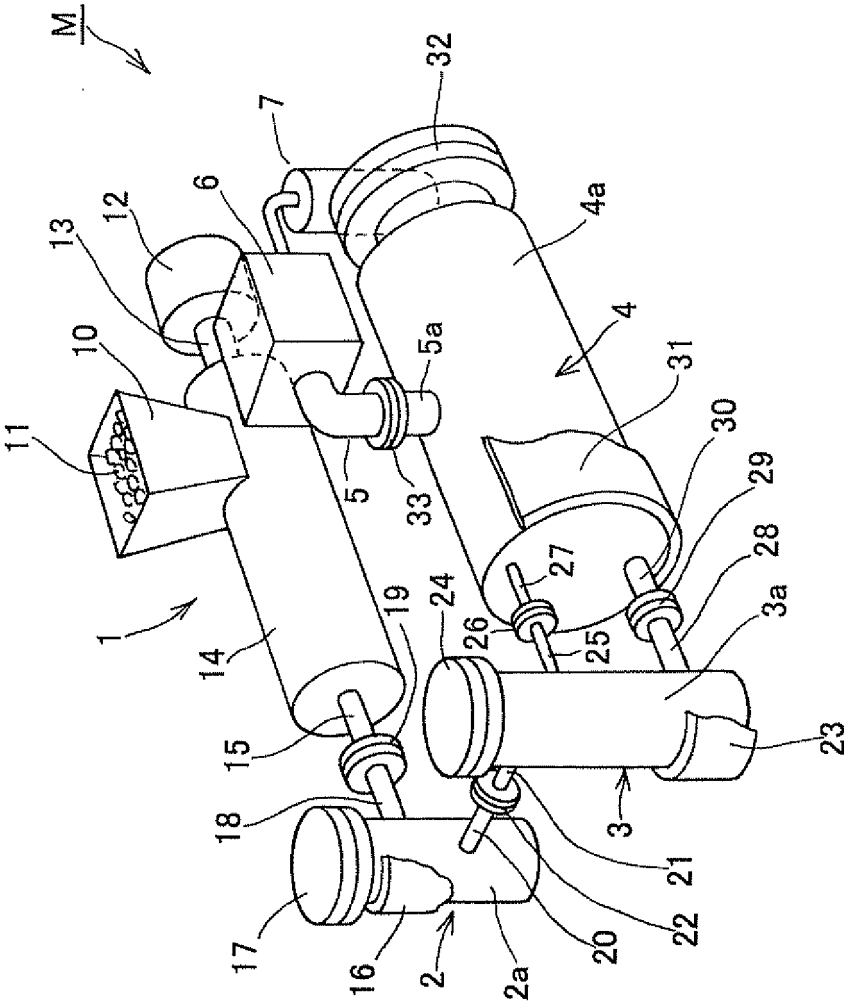
5. An apparatus for converting plastic into oil according to claims 1 to 3,
wherein a feeding amount of molten plastic is so adjusted that the liquid surface of the molten plastic coincides with a diagonal center position of the cylinder in the vertical position.

6. An apparatus for converting plastic into oil according to claim 5, wherein in case that the liquid surface of the molten plastic goes up above the diagonal center position of the cylinder in the vertical direction, a watt density of the plate-like heater for covering a circumferential wall of the vaporising vessel is increased, while in case that the liquid surface thereof goes down under the position, the watt density of the plate-like heater is decreased.

7. An apparatus for converting plastic into oil according to claim 6, wherein the watt density thereof is adjusted in a range of 0.6 w/cm^2 to 1.4 w/cm^2.

8. An apparatus for converting plastic into oil according to claim 1, wherein the apparatus has a condenser for liquefying the plastic gas produced in the vaporizing vessel, the condenser storing a predetermined amount of hydrocarbon oil.

9. An apparatus for converting plastic into oil according to claim 1, wherein the apparatus has a condenser for liquefying the plastic gas in the vaporising vessel, the condenser storing neutralizer for neutralizing chlorine produced after vinyl chloride is treated.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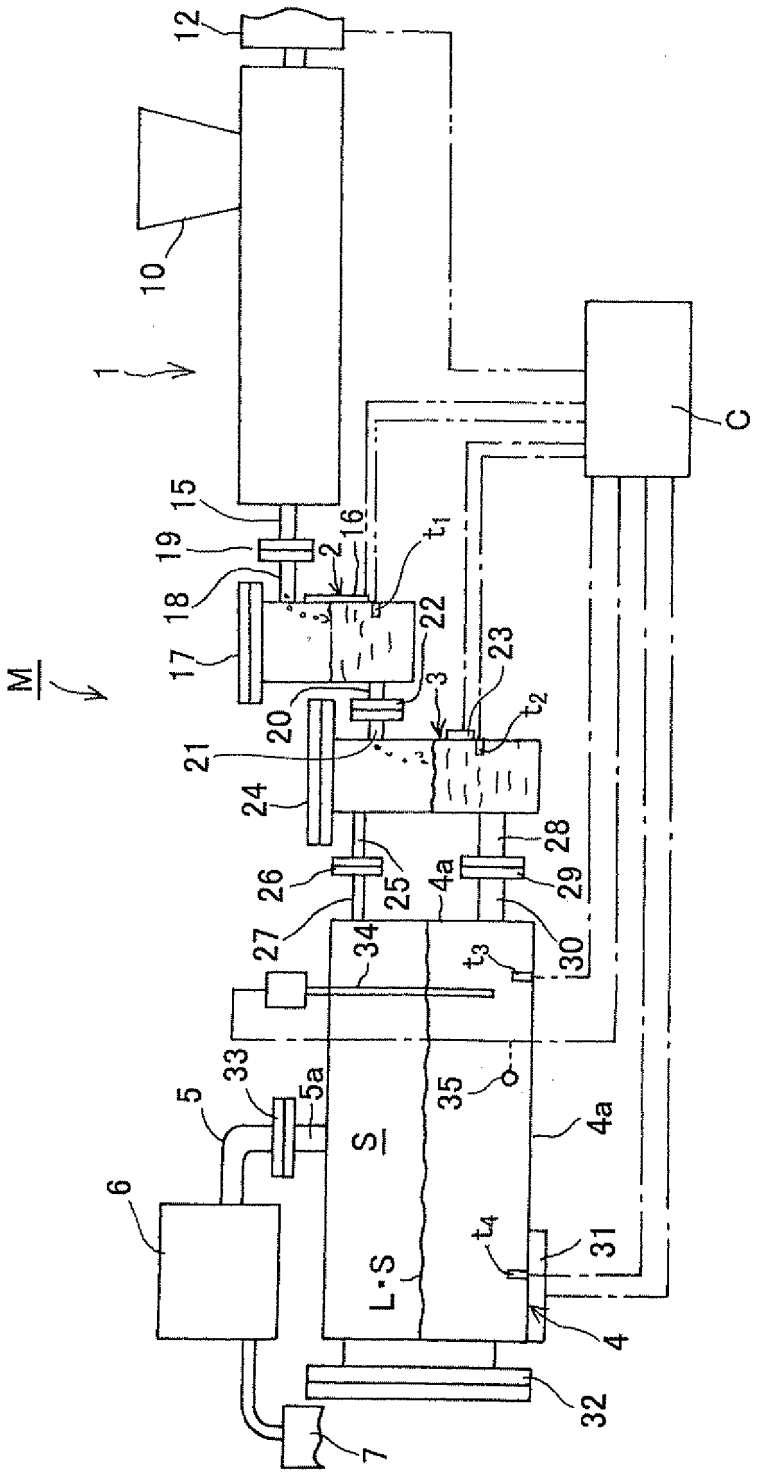
20
22

FIG.1

FIG.2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26
25
4a
29
27
34
t_3
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t_4
31
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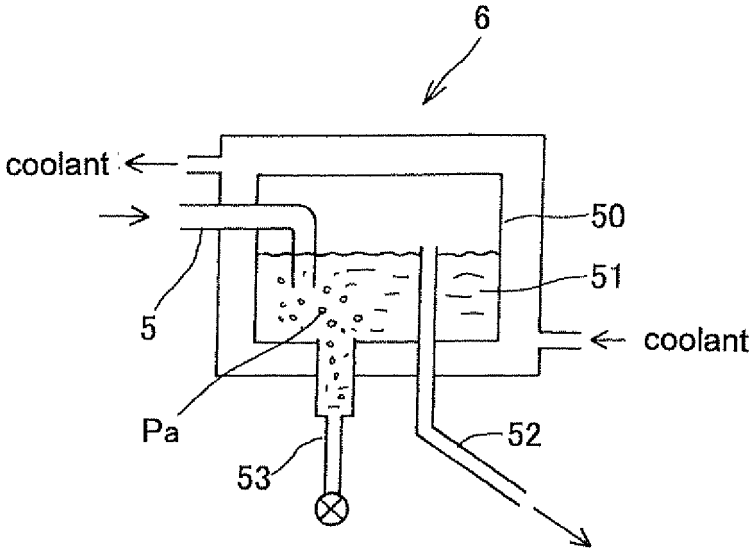
M

FIG.3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51
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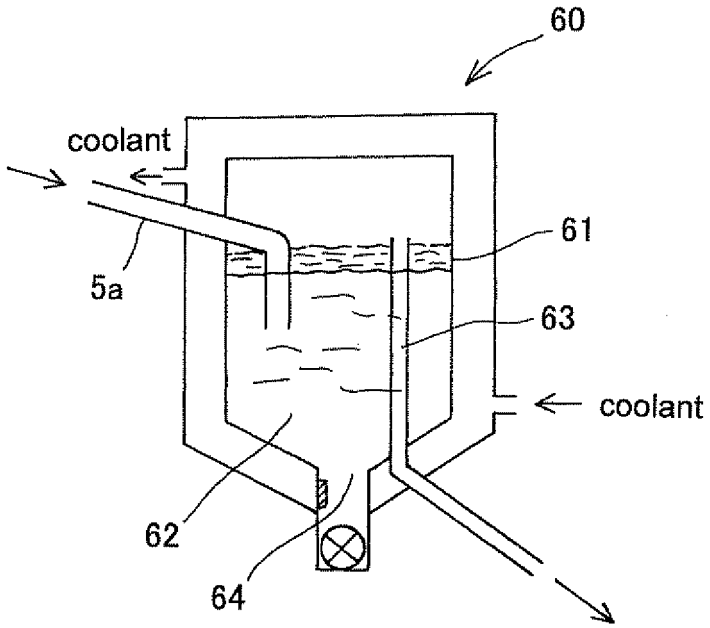
coolant
Pa
52
53

FIG.4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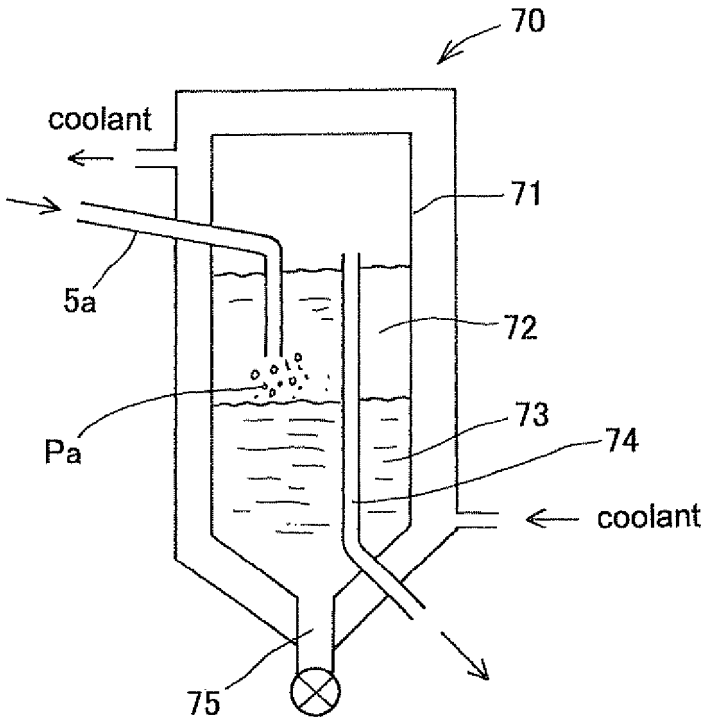
5a
63
coolant
62
64

FIG.5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/077118

A. CLASSIFICATION OF SUBJECT MATTER
C10G1/10(2006.01)i, *B09B3/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C10G1/10, B09B3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,Y Y A	JP 2010-284565 A (Kabushiki Kaisha Buresuto), 24 December 2010 (24.12.2010), claims 3, 5; paragraphs [0020], [0041], [0043], [0051] (Family: none)	1,2,4,5,8 3,9 6,7
Y	JP 2003-034794 A (Japan Science and Technology Corp.), 07 February 2003 (07.02.2003), claim 10; paragraphs [0003], [0008] (Family: none)	9
Y	JP 53-118402 A (Fujikura Electric Wire Corp.), 16 October 1978 (16.10.1978), claims; fig. 1 (Family: none)	1-5,8,9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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- JP 2006152175 A **[0003]**