(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 371 756 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.12.2003 Bulletin 2003/51

(51) Int Cl.[7]: **C23C 22/73**, C23C 22/18

(21) Application number: **03012556.1**

(22) Date of filing: **02.06.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **12.06.2002 JP 2002171075**
12.06.2002 JP 2002171080
12.06.2002 JP 2002171081

(71) Applicant: **NISSAN MOTOR CO., LTD.**
Yokohama-shi Kanagawa-ken (JP)

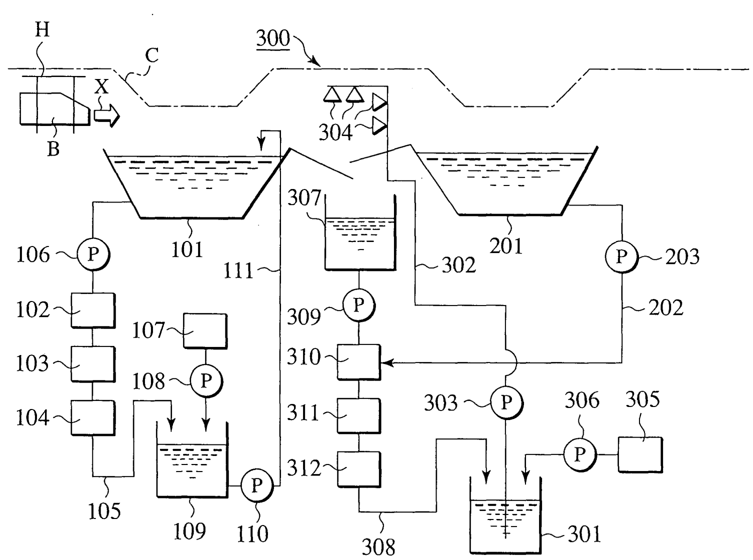
(72) Inventors:
- **Kishi, Hiroyuki**
Atsugi-shi, Kanagawa-ken (JP)
- **Miyamoto, Seiji**
Ebina-shi, Kanagawa-ken (JP)
- **Tanaka, Osamu**
Hadano-shi, Kanagawa-ken (JP)
- **Yaegashi, Hideaki**
Atsugi-shi, Kanagawa-ken (JP)
- **Obika, Masahiro**
Oume-shi, Tokyo (JP)

(74) Representative: **Schaeberle, Steffen**
Hoefer & Partner,
Patentanwälte,
Gabriel-Max-Strasse 29
81545 München (DE)

(54) Equipment and method of pretreatment before painting

(57) Equipment of pretreatment before painting for a composite vehicle body comprises a treatment tank, an aluminum chemical conversion unit, and a rinse unit. The treatment tank is filled with a degreasing and chemical conversion solution containing a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion. The mixed solution has a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2. The aluminum chemical conversion unit treats the composite vehicle body with a chemical conversion solution for aluminum. The rinse unit washes the composite vehicle body with a washing solution.

FIG. 1



EP 1 371 756 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to equipment and a method of pretreatment before painting, and specifically relates to equipment and a method of pretreatment before painting preferably used in a line of a pretreatment before painting, for example where a composite body of iron and aluminum flows.

2. Description of the Related Art

[0002] In the light of reduction in weight, an increase in rigidity, or improvement in recyclability, it has been examined to employ aluminum parts for a hood, a trunk lid, a door inner, and the like in a vehicle body.

[0003] As a pretreatment method of such a composite body of iron and aluminum, the Japanese Patent Translation Publication No. 2001-515959 (PCT International Publication No. WO99/12661) has proposed that only iron parts are subjected to chemical conversion in a first step and then aluminum parts are subjected to chemical conversion in a second step.

[0004] In order to etch aluminum and precipitate or mask dissolved aluminum, free or complex-bound fluoride ion are added to a chemical conversion solution used in the pretreatment method. The concentration of free fluoride ion is limited to less than 8/T (g/L, T: treatment temperature (°C)) so that excessive chemical conversion coating is not produced on an aluminum surface, that is, a large amount of sludge is not accumulated at a time.

SUMMARY OF THE INVENTION

[0005] However, in the method of pretreatment described in the above Japanese Patent Translation Publication No. 2001-515959, the chemical conversion solution contains fluoride ion. Accordingly, sludge of aluminum is accumulated in a tank, and it is necessary to remove and discarded the sludge. Moreover, as described above, excessive aluminum conversion coating is formed on the aluminum surface if the concentration of free fluoride is not controlled to less than a predetermined value. Accordingly, an operation and a system for control and management of the concentration of free fluoride and for control and management of a replenishment solution are required.

[0006] Furthermore, since the chemical conversion process for aluminum is provided after the chemical conversion process for steel, the total length of the pretreatment process is increased. Accordingly, the method is disadvantageous in a space, a treatment time, and an equipment cost.

[0007] An object of the present invention is to provide equipment and a method of pretreatment before painting capable of achieving less installation space, improvement in productivity, and significant reduction in an equipment cost, a chemical cost, management manhours, and an expense for wastewater treatment for a composite body of iron and aluminum.

[0008] The first aspect of the present invention provides equipment of pretreatment before painting, comprising: a treatment tank filled with a degreasing and chemical conversion solution containing a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion, the mixed solution having a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2, works being dipped in the treatment tank; an aluminum chemical conversion unit which treats the works with a chemical conversion solution for aluminum, the aluminum chemical conversion unit being provided at a subsequent stage of the treatment tank; and a rinse unit which washes the works with a washing solution, the rinse unit being provided at a subsequent stage of the aluminum chemical conversion unit.

[0009] The second aspect of the present invention provides a method of pretreatment before painting, comprising: dipping a composite vehicle body, which has any of an aluminum and aluminum alloy part for at least part of outer panel portions, into a degreasing and chemical conversion solution containing at least a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion, the mixed solution having a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2; treating the vehicle body in a chemical conversion solution for aluminum; and washing the vehicle body with a washing solution.

[0010] The third aspect of the present invention provides equipment of pretreatment before painting, comprising: a treatment tank filled with a degreasing and chemical conversion solution containing a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion, the mixed solution having a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2, works being dipped in the treatment tank; aluminum chemical conversion means for treating the works with a chemical conversion solution for aluminum, the aluminum chemical conversion means being provided at a subsequent stage of the treatment tank; and rinse means for washing the works with a washing solution, the rinse means being provided at a subsequent stage of the aluminum chemical conversion means.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The invention will now be described with reference to the accompanying drawings wherein;

FIG. 1 is a system view showing a first embodiment of equipment of pretreatment before painting of the present invention;
FIG. 2A is a perspective view showing an embodiment of a dust eliminator of the present invention;
FIG. 2B is a cross-sectional view showing an embodiment of a dust eliminator of the present invention;
FIG. 3 is a perspective view showing the other embodiment of a dust eliminator of the present invention;
FIG. 4 is a cross-sectional view showing the other embodiment of a dust eliminator of the present invention;
FIG. 5 is a system view showing a second embodiment of equipment of pretreatment before painting of the present invention;
FIG. 6 is a view for explaining a full dipping treatment and a half dipping treatment according to equipment of pretreatment before painting shown in FIG. 5;
FIG. 7 is a system view showing a third embodiment of equipment of pretreatment before painting of the present invention;
FIG. 8 is a conceptual diagram showing an embodiment of a water-polar organic solvent separator of the present invention;
FIG. 9 is a conceptual diagram showing an embodiment of an ion eliminator of the present invention;
FIG. 10 is a system view showing a fourth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 11 is a conceptual diagram showing an embodiment of a vacuum distillation unit of the present invention;
FIG. 12 is a system view showing a fifth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 13 is a system view showing a sixth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 14 is a system view showing a seventh embodiment of equipment of pretreatment before painting of the present invention;
FIG. 15 is a system view showing an eighth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 16 is a flowchart showing an example of a control flow of a controller shown in FIG. 15;
FIG. 17 is a plan view showing a ninth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 18 is a system view showing the ninth embodiment of equipment of pretreatment before painting of the present invention;
FIG. 19 is a flowchart showing a control flow of a controller shown in FIG. 17;
FIG. 20 is a table showing the results of the examples of the present invention; and
FIG. 21 is a table showing the results of the comparative examples.

DETAILED DESCRIPTION OF THE PREFERED EMBODIMENTS

[0012] Hereinafter, description will be made of embodiments of the present invention with reference to the drawings.

First Embodiment

[0013] FIG. 1 is a system view showing a first embodiment of equipment of pretreatment before painting of the present invention. The drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body.

[0014] Especially, a vehicle body B flowing through a painting line of this embodiment has a composite body made of iron and aluminum in which outer panel portions of a hood, a trunk lid, doors, and the like employ aluminum parts and the other parts are made of steel. However, in the equipment of pretreatment before painting of the present invention, all works are not necessarily limited to such an iron-aluminum composite bodies, and the iron-aluminum composite bodies and steel bodies may mixedly flow. Moreover, vehicle types with the iron-aluminum composite bodies different in portions employing aluminum parts may mixedly flow. Furthermore, vehicle bodies with all components including aluminum or an aluminum alloy may flow.

[0015] Hereinafter, for convenience, a vehicle body entirely made of iron components is referred to as an iron vehicle body. A vehicle body entirely made of aluminum or aluminum alloy components is referred to as an aluminum vehicle body. A vehicle body partially made of aluminum or aluminum alloy components and the other components made of iron is referred to as a composite vehicle body.

[0016] As shown in FIG. 1, the vehicle body B is conveyed by a painting conveyer C while being mounted on a hanger H. In this embodiment, two dipping tanks are provided along a line of the painting conveyer C. The dipping tank on the upstream side in a conveying direction indicated by an arrow X in the drawing is a treatment tank 101 (hereinafter, also referred to as a degreasing and chemical conversion tank 101) for degreasing treatment and chemical conversion. The dipping tank on the downstream side is a rinse tank 201 for washing the body B after degreasing treatment and chemical conversion. The treatment tank 101 is filled with a degreasing and chemical conversion solution, and the rinse tank 201 is filled with deionized water.

[0017] The degreasing and chemical conversion solution used in this embodiment can perform three kinds of treatments such as degreasing treatment, surface conditioning, and chemical conversion at the same process. As such a degreasing and chemical conversion solution, a treatment solution can be used, which contains at least a polar organic solvent, water, sodium ion and/or lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and nitrate ion and/or nitrite ion. Using this treatment solution, a degreasing process, a surface conditioning process, and a chemical conversion process can be simultaneously performed in one process, thus allowing significant reduction in treatment processes, simplification of treatment equipment, reduction in floor space, improvement in productivity, reduction in chemicals costs, and simplification of management of chemicals.

[0018] The degreasing and chemical conversion solution of this embodiment will be further described in detail. In a mixed solvent of the polar organic solvent and water, the weight ratio of the polar organic solvent to water is from 2.8:7.2 to 3.8:6.2, preferably 3.0:7.0 to 3.8:6.2, more preferably 3.3:6.7 to 3.8:6.2, still more preferably 3.3:6.7 to 3.5:6.5, and most preferably 3.5:6.5.

[0019] As an example of the polar organic solvent in this embodiment, lower alkyl ethers or lower alkyl esters of ethylene glycol or the like expressed by $(-CH_2-CH_2-O-)_n$ (n = 1, 2, 3, 4), lower alkyl ethers or lower alkyl esters of propylene glycol, dipropylene glycol, and the like, lower alkylene glycols such as diethylene glycol, triethylene glycol, tetraethylene glycol, lower alcohols, or esters of the same are listed.

[0020] As an example of ethylene glycol type lower alkyl ethers or lower alkyl esters, ethylene glycol ethers such as ethylene glycol monoethyl ether and ethylene glycol mono-n-butyl ether, diethylene glycol ether such as diethylene glycol monoethyl ether and diethylene glycol mono-n-butyl ether, triethylene glycol mono-n-butyl ether, tetraethylene glycol mono-n-butyl ether, ethylene glycol monoethyl ether acetate, diethylene glycol monoethyl ether acetate or the like are listed.

[0021] As an example of lower alkyl ethers or lower alkyl esters of propylene glycol or dipropylene glycol, propylene glycol butyl ether, dipropylene glycol monomethyl ether, polypropylene glycol monoethyl ether or the like are listed.

[0022] As an example of lower alcohols, alcohols with 1 to 8 carbon atoms, preferably 1 to 5 carbon atoms, and more preferably 1 to 4 carbon atoms. As the specific example, alcohols such as ethyl alcohol, isopropyl alcohol, tert-butyl alcohol, methoxydimethylpentanol, diacetone alcohol, 2-methoxyethanol, and 2-ethoxymethanol or the like are listed.

[0023] As an example of esters, ethyl lactate, methoxybutyl acetate, butyl lactate, or the like are listed.

[0024] Among the above-described polar organic solvents, it is most preferable to employ at least one glycol compound selected from a group consisting of diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, ethylene glycol monoalkyl ether, and from diethylene glycol monoalkyl ether, diethylene glycol dialkyl ether, and propylene glycol monoalkyl ether, or a mixed solvent of the glycol compound and the lower alcohol.

[0025] Preferably, the alkyl group in the glycol compound is an alkyl group with 1 to 5 carbon atoms. Preferably, the lower alcohol is alcohol with 1 to 8 carbon atoms, more preferably alcohol with 1 to 5 carbon atoms, and most preferably alcohol with 1 to 4 carbon atoms.

[0026] In the degreasing and chemical conversion solution of this embodiment, the above-described mixed solvent of the polar organic solvent and water contains at least sodium ion and/or lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and nitrate ion and/or nitrite ion.

[0027] Preferably, the content of phosphate ion is in a range from 0.2 to 0.5 parts inclusive by weight per 100 parts by weight of the mixed solvent. If the content is out of the range, an amount of oil to be mixed into the treatment solution is increased, thus resulting in insufficient stirring. Therefore, good zinc phosphate coating, which is a target, cannot be formed. A source of phosphate ion is not particularly limited, and as an example thereof, orthophosphoric acid, pyrophosphoric acid, polyphosphoric acid, trimetaphosphoric acid, tetrametaphosphoric acid, phosphorus pentoxide or the like is listed. The phosphate ion can be supplied as anions for metal ion (sodium ion and/or lithium ion, zinc ion, nickel ion, manganese ion) contained in the degreasing and chemical conversion solution.

[0028] The zinc ion has a function to form the zinc phosphate conversion coating with phosphate ion. Preferably, the content of zinc ion is in a range from 0.5 to 0.7 parts inclusive by weight per 100 parts by weight of the mixed solvent. If the content is out of the range, the amount of oil to be mixed into the treatment solution is increased, thus resulting in insufficient stirring. Therefore, a good zinc phosphate coating, which is a target, cannot be formed. As an example of a source of the zinc ion, mineral salts such as zinc oxide, zinc carbonate, zinc nitrate, zinc chloride, zinc sulfate, zinc phosphate or the like are listed.

[0029] The nickel ion has a function to improve corrosion resistance of the unpainted work. Preferably, the content of nickel ion is in a range from 0.09 to 0.23 parts inclusive by weight per 100 parts by weight of the mixed solvent. If the content is out of the range, the amount of oil to be mixed into the treatment solution is increased, thus resulting in insufficient stirring. Therefore, a good zinc phosphate coating, which is a target, cannot be formed. As an example of a source of the nickel ion, mineral salts such as nickel nitrate and nickel phosphate or the like are listed.

[0030] The manganese ion has a function to improve wet paint adhesion of the work containing metallic zinc.

Preferably, the content of manganese ion is in a range from 0.03 to 0.16 parts inclusive by weight per 100 parts by weight of the mixed solvent. If the content is out of the range, the amount of oil to be mixed into the treatment solution is increased, thus resulting in insufficient stirring. Therefore, a good zinc phosphate coating, which is a target, cannot be formed. As an example of a source of the manganese ion, mineral salts such as manganese nitrate and manganese phosphate or the like are listed.

[0031] Preferably, the content of nitrate ion and/or nitrite ion is in a range from 3.5 to 10.8 parts inclusive by weight per 100 parts by weight of the mixed solvent. If the content is out of the range, the amount of oil to be mixed into the treatment solution is increased, thus resulting in insufficient stirring. Therefore, a good zinc phosphate coating, which is a target, cannot be formed.

[0032] Preferably, the content of sodium ion and/or lithium ion is in a range from 0.8 to 3.3 parts inclusive by weight per 100 parts by weight of the mixed solvent. The sodium ion and/or lithium ion have a function to densify the crystal of the zinc phosphate coating formed on a surface of the work in combination with water of the degreasing and chemical conversion solution. As an example of a source of the sodium ion, sodium nitrate, sodium phosphate, sodium nitrite, or sodium hydroxide are listed. Part or all of sodium nitrate may be substituted with sodium nitrite. By action of nitrite ion, etching power of acid is further increased, and acceleration of the chemical conversion reaction can be expected.

[0033] Sodium ion can be substituted with lithium ion as monovalent alkali metal ion. Specifically, 50 % to 98 %, preferably 60 % to 90 %, and more preferably 70 % to 80 % of the amount of sodium ion is substituted with lithium ion. In other words, sodium ion are substituted with lithium ion so that the mol ratio of sodium ion to lithium ion is from 50:50 to 2:98, preferably from 40:60 to 10:90, and more preferably from 30:70 to 20:80. Since the degreasing and chemical conversion solution contains lithium ion, the crystal of the zinc phosphate coating is further densified, and the painting adhesion is further improved. As an example of a source of lithium ion, mineral salts such as lithium nitrate, lithium phosphate, and lithium nitrite are listed.

[0034] Preferably, the degreasing and chemical conversion solution is treated under a condition of a temperature of 40 to 60°C for 3 to 10 minutes.

[0035] By use of the degreasing and chemical conversion solution of the above-described composition, even if a large amount of oil is mixed into the degreasing and chemical conversion solution, or even if stirring of the degreasing and chemical conversion solution is insufficient, a zinc phosphate conversion coating having excellent corrosion resistance and paint film adhesion can be formed.

[0036] Returning to FIG. 1, the degreasing and chemical conversion solution in the treatment tank 101 is sucked by a pipe 105 and a pump 106 and returned to the treatment tank 101 by a pipe 111 and a pump 110 via a treatment solution replenishment tank 109. Along the pipe 105, a dust eliminator 102, a chemical conversion sludge eliminator 103, and an oil eliminator 104 are provided. The treatment solution containing the polar organic solvent and water passes the dust eliminator 102, the chemical conversion sludge eliminator 103, and the oil eliminator 104, and dust such as iron powder, chemical conversion sludge, and oil are removed from the treatment solution. The treatment solution is then temporarily stored in the treatment solution replenishment tank 109. A new degreasing and chemical conversion solution is replenished to the treatment solution replenishment tank 109 by a pump 108 from a treatment solution tank 107 which accommodates the new degreasing and chemical conversion solution and then adjusted. The adjusted degreasing and chemical conversion solution is returned to the degreasing and chemical conversion tank 101 by the above-described pipe 111 and pump 110.

[0037] The dust eliminator 102 removes foreign material such as iron powder contained in the treatment tank 101. The removed foreign material is discarded, and the treatment solution from which dusts are removed is fed to the next chemical conversion sludge eliminator 103. As a specific apparatus available for the dust eliminator 102 of this embodiment, a settling tank, a centrifugal separator, or a magnetic separator is listed.

[0038] As shown in FIGs. 2A and 2B, a settling tank 102A as an example of the dust eliminator 102 is provided with partitions 102A3 for meandering a flow path 102A2 in tanks 102A1. The treatment solution entered from an inlet 102A4 is meandered within the tank by the partitions 102A3 to reach an outlet 102A5. At this time, the flow rate at which the treatment solution flows upward is suppressed to be lower than the settling rate of the foreign material such as iron powder. Accordingly, the foreign material such as iron powder is deposited on the bottom of the tanks 102A1, and the treatment solution is cleaned. The settling tank 102A is as cheap as simple apparatus and effective for relatively heavy foreign material other than light foreign material floating in the treatment solution.

[0039] As shown in FIG. 3, in a centrifugal separator 102B as the other example of the dust eliminator 102, the treatment solution entered from an inlet 102B1 and the foreign material such as iron powder are accelerated by passing through a slit-shaped rotary mechanism 102B2 provided in a tangential direction. Accordingly, solid material (foreign material), heavier than the solution, is separated by a centrifugal force into a collection chamber 102B3 along an inner wall and discarded from a solid outlet 102B4. The treatment solution is caused to flow upward through an inner tube 102B5 and discarded from a treatment solution outlet 102B6. Therefore, the treatment solution is cleaned.

[0040] As shown in FIG. 4, in a magnetic separator 102C as another example of the dust eliminator 102, the treatment solution is introduced from an inlet 102C2 while a drum 102C1 containing a magnet therein is rotated in an arrow Y direction in the drawing. Accordingly, when the treatment solution passes a flow path 102C3 in contact with the drum 102C1, magnetic foreign material like iron is removed. The foreign material adhered to the drum 102C1 by a magnetic force is scraped by a scraper 102C4, and the treatment solution from which the foreign material is removed is discarded from an outlet 102C5.

[0041] These settling tank 102A, centrifugal separator 102B, and magnetic separator 102C can be used independently or in combination. Especially, the dust eliminator 102 combining the settling tank 102A with the magnetic separator 102C has a high removal rate of foreign material and is most preferable.

[0042] The dust eliminator 102 according to this embodiment is not intended to be limited to the above-described three forms and includes other forms. The dust eliminator 102 of the embodiment is provided for the pipe 105, but may be provided inside or outside of the treatment tank 101 itself.

[0043] The chemical conversion sludge eliminator 103 removes chemical conversion sludge contained in the treatment solution that has passed the above-described dust eliminator 102. The removed chemical conversion sludge is discarded, and the treatment solution from which the chemical conversion sludge has been removed is fed to the next oil eliminator 104. For the chemical conversion sludge eliminator 103, filters, which suppress the concentration of sludge of the treatment solution in the treatment tank 101 to 150 ppm such that the treatment solution is not contaminated, can be used without any limitations.

[0044] The oil eliminator 104 removes oil contained in the treatment solution that has passed the above-described chemical conversion sludge eliminator 103. The removed oil is discarded, and the treatment solution from which the oil has been removed is fed to the treatment solution replenishment tank 109. As an example of the oil eliminator 104 available in this embodiment, a warming type oil eliminator, a coalescer type oil eliminator, and an ultrafiltration type oil eliminator are listed.

[0045] The warming type oil eliminator is preferably applied to an aqueous solution containing a nonionic surfactant as a degreasing component. The warming type oil eliminator utilizes a characteristic that, when the aqueous solution is heated to more than a specified temperature, the nonionic surfactant becomes insoluble in water and the aqueous solution is separated into two phases of an oil phase composed of nonionic surfactant and a water phase.

[0046] In the coalescer type oil eliminator, oil droplets having a size of several micrometers dispersed in the aqueous solution are passed through a filter. Water/oil emulsions are thereby broken, and the oil droplets are grown and expanded. Accordingly, the oil droplets can float and be collected.

[0047] The ultrafiltration type oil eliminator uses ultrafiltration, that is, filtration using a filter composed of a mesh having a mesh size of about 0.01 to 0.001 μm and separating colloidal particles from a solvent by pressure filtration with a low pressure of about 0.5×10^{-5} to 5×10^{-5} Pa or suction filtration.

[0048] The warming type oil eliminator, the coalescer type oil eliminator, and the ultrafiltration type oil eliminator are selected depending on a required degree of oil/water separation and can be used independently or in combination.

[0049] Between the treatment tank 101 and the rinse tank 201 shown in FIG. 1, an aluminum chemical conversion zone 300 for spraying a chemical conversion solution for aluminum onto the vehicle body B is provided. In the aluminum chemical conversion zone 300, a floor surface of a booth is sloped so as to be lowest at the center thereof so that the sprayed chemical conversion solution does not flow into the treatment tank 101 of the preceding stage and the rinse tank 201 of the subsequent stage as much as possible.

[0050] Nozzles 304 for spraying the chemical conversion solution for aluminum onto a vehicle body B passing the aluminum chemical conversion zone 300 are attached to a pipe 302. The nozzles 304 are supplied by a pump 303 with the chemical conversion solution for aluminum from a chemical conversion solution replenishment tank 301 accommodating the chemical conversion solution for aluminum. In the example shown in FIG. 1, a plurality of nozzles 304 are provided on a ceiling surface and a side surface of the booth and spray the chemical conversion solution for aluminum onto a hood, a trunk lid, and doors of the vehicle body B which are aluminum parts.

[0051] The chemical conversion solution for aluminum collected on the floor surface of the booth is recovered to a recovery tank 307 and returned to the chemical conversion solution replenishment tank 301 by a pipe 308 and a pump 309. Meanwhile, a dust eliminator 310, a chemical conversion sludge eliminator 311, and an oil eliminator 312 are provided along a pipe 308 coupled to the recovery tank 307. The dust eliminator 310 removes dust contained in the recovered chemical conversion solution for aluminum. The chemical conversion sludge eliminator 311 removes chemical conversion sludge of aluminum and iron (produced during the treatment in the treatment tank 101 of the preceding stage). The oil eliminator 312 removes oil. These dust eliminator 310, chemical conversion sludge eliminator 311, and oil eliminator 312 can employ the specific examples shown in the above-described dust eliminator 102, chemical conversion sludge eliminator 103, and oil eliminator 104, respectively.

[0052] The chemical conversion solution for aluminum used in this embodiment is not particularly limited, and, for example, includes hexafluorotitanate and hexafluorozirconate. This new chemical conversion solution for aluminum is accommodated in a tank 305 of a chemical conversion solution for aluminum and supplied to the chemical conversion solution replenishment tank 301 by a pump 306. The chemical conversion solution for aluminum sprayed onto the vehicle body B from the nozzles 304 is thus adjusted.

[0053] Preferably, the chemical conversion solution for aluminum is treated under conditions of a pH from 2.5 to 10 and a temperature from 20 to 70 °C for periods from 20 to 100 seconds.

[0054] The rinse tank 201 is provided at a subsequent stage of the aluminum chemical conversion zone 300. The rinse tank 201 washes, with deionized water, the vehicle body B having a chemical conversion coating formed in the treatment tank 101 and the aluminum chemical conversion zone 300. In this embodiment, the vehicle body B is dipped in the rinse tank 201 to wash inner and outer panels of the vehicle body B. However, the washing treatment can be also performed by a spray treatment other than the dipping treatment.

[0055] In the deionized water in the rinse tank 201, dust, chemical conversion sludge, and oil adhered to the vehicle body B are mixed. The deionized water is sucked by a pipe 202 and a pump 203 and supplied to the dust eliminator 310 in the aluminum chemical conversion zone 300 of the preceding stage. These dust, chemical conversion sludge, and oil are removed, and the deionized water is then reused as deionized water for the chemical conversion solution for aluminum. The washing water in the rinse tank 201 sucked by the pipe 202 and the pump 203 may be supplied to the recovery tank 307 of the aluminum chemical conversion zone 30. Now that new deionized water is supplied from a deionized water supply apparatus (not shown) to the rinse tank 201.

[0056] Next, the operations will be described.

[0057] The vehicle body B that has been assembled by welding in a body assembling process is conveyed by the painting conveyor C while being mounted on the painting hanger H and first dipped in the treatment tank 101. Since the vehicle body B is dipped in the treatment tank 101, foreign material such as iron powder and oil adhered to the vehicle body B are removed into the treatment tank 101 by washing and degreasing effects of the degreasing and chemical conversion solution. Furthermore, in steel parts of the vehicle body B from which oil has been removed, the degreasing and chemical conversion solution reacts with iron to form a chemical conversion coating of zinc phosphate.

[0058] As for the aluminum parts of the vehicle body B, only dust removal and degreasing are performed. The aluminum parts do not react with the degreasing and chemical conversion solution, and the chemical conversion coating is not formed. In other words, since the degreasing and chemical conversion solution in this embodiment does not contain fluoride that etches aluminum, chemical conversion sludge of aluminum is not accumulated in the treatment tank 101. Compared to the conventional method of pretreatment disclosed in the Japanese Patent Translation Publication No. 2001-515959 previously described, operation man-hours, system costs, or the like required for removal and discharge of aluminum sludge can be reduced. Moreover, since aluminum sludge itself is not produced, operation man-hours or system costs for control of the concentration of fluoride can be reduced compared to the conventional method of treatment.

[0059] The degreasing and chemical conversion solution in the treatment tank 101 is sucked into the pipe 105 by the pump 106. The degreasing and chemical conversion solution is passed through the dust eliminator 102 so that foreign material such as iron powder contained in the degreasing and chemical conversion solution is removed. The degreasing and chemical conversion solution is passed through the chemical conversion eliminator 103 so that chemical conversion sludge of iron contained in the degreasing and chemical conversion solution is removed. The degreasing and chemical conversion solution is passed through the oil eliminator 104 so that oil such as press oil contained in the degreasing and chemical conversion solution is removed.

[0060] The degreasing and chemical conversion solution from which dust, chemical conversion sludge, and oil have been removed is fed to the treatment solution replenishment tank 109, where the degreasing and chemical conversion solution is replenished with a fresh degreasing and chemical conversion solution from the treatment solution tank 107 by the pump 108 and properly adjusted. The degreasing and chemical conversion solution is then returned to the treatment tank 101 by the pipe 111 and the pump 110. In this manner, the degreasing and chemical conversion solution in the treatment tank flows through a loop formed by the pipes 105 and 111. Accordingly, costs can be reduced by reduction in material costs, and the expense for the wastewater treatment can be reduced. Moreover, use of the degreasing and chemical conversion solution allows reduction in man-hours for management of pretreatment conditions. Furthermore, use of the degreasing and chemical conversion solution significantly reduces the numbers of washing processes. Accordingly, the expense for the wastewater treatment process is reduced because of reduction in an amount of the washing solution used.

[0061] The vehicle body B that has passed the treatment tank 101 is fed to the aluminum chemical conversion zone 300 and sprayed with the chemical conversion solution for aluminum from the nozzles 304. Specifically, the chemical conversion solution in the chemical conversion solution replenishment tank 301 is sucked by the pump 303 and sprayed from the nozzles 304 via the pipe 302 onto mainly the aluminum parts of the vehicle body B. The chemical conversion solution for aluminum sprayed onto the vehicle body B is collected on the floor surface of the booth and recovered to the recovery tank 307, from which the recovered solution is sucked by the pump 309. The chemical conversion solution for aluminum is passed through the dust eliminator 310, the chemical conversion sludge eliminator 311, and the oil eliminator 312, so that dust, chemical conversion sludge of aluminum or iron, and oil thereof are removed. The chemical conversion solution for aluminum is then returned to the chemical conversion solution replenishment tank 301 via the pipe 308.

[0062] By the treatment in the aluminum chemical conversion zone 300, the aluminum parts employed as the outer panel parts such as the hood, the trunk lid, and the doors can be treated with the chemical conversion coating. Especially, when these aluminum parts are used as the outer panel parts of the vehicle body B, a sufficient chemical conversion coating can be formed by only the spray treatment like this embodiment. Consequently, the length of the chemical conversion process for aluminum can be minimized.

[0063] At last, the vehicle body B that has passed the aluminum chemical conversion zone 300 is dipped in the rinse tank 201, and the chemical conversion solution adhered to the vehicle body B is washed off. The vehicle body B is conveyed to a drying oven, dried and then fed to an electrocoating process as undercoating. At this time, the washing solution in the rinse tank 201 is introduced to the upstream side of the dust eliminator 310 of the pipe 308 by the pipe 202 and the pump 203. After passing the dust eliminator 310, the chemical conversion sludge eliminator 311, and the oil eliminator 312, the washing solution is supplied to the chemical conversion solution replenishment tank 301. Accordingly, deionized water in the rinse tank 201 can be effectively used.

Second Embodiment

[0064] FIG. 5 is a system view showing a second embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body. This embodiment basically differs from the above-described first embodiment in that a dipping tank 313 is employed in the aluminum chemical conversion zone 300. The other components are similar to those of the above-described embodiment, and same components are given the same reference numerals.

[0065] The aluminum chemical conversion zone 300 of this embodiment is provided with the aluminum chemical conversion tank 313 (dipping tank 313) filled with the chemical conversion solution for aluminum. The vehicle body B conveyed by the painting conveyor C is fully dipped or half dipped in the aluminum chemical conversion tank 313 in accordance with a trajectory of the painting conveyor C.

[0066] Here, the full dipping is a treatment of dipping all of the vehicle body B in the chemical conversion solution for aluminum. The half dipping is a treatment of dipping only lower part of the vehicle body B under an upper line of a door panel (see B1 in FIG. 6) in the chemical conversion solution for aluminum. Levels of the solution, when the respective dipping treatments are performed, are shown in FIG. 6. When the vehicle body B does not have any parts made of an aluminum material above the upper line B1 of the door panel, for example, when a roof panel or a pillar is made of iron, the vehicle body B does not need to be fully dipped, and it is sufficient that the parts made of aluminum are dipped. Accordingly, the half dipping treatment can be employed. Even if a roof panel and the like are composed of an aluminum material, the vehicle body B may be treated with half dipping for chemical conversion of the aluminum parts in the lower part under the upper line B1 of the door panel, while the roof and the like, which are not dipped, may be sprayed with the chemical conversion solution for aluminum by the spray.

[0067] When half dipping is employed, the capacity of the treatment tank or the rinse tank can be set smaller than that in full dipping. Accordingly, initial costs for the chemical conversion solution for aluminum can be reduced, and energy required for warming the chemical conversion solution for aluminum can be also reduced.

[0068] The chemical conversion solution for aluminum in the dipping tank 313 is returned to the chemical conversion solution replenishment tank 301 by the pipe 308 and the pump 309. The pipe 308 coupled to the dipping tank 313 is provided with the dust eliminator 310, the chemical conversion sludge eliminator 311, and the oil eliminator 312. The dust eliminator 310 removes dust contained in the chemical conversion solution for aluminum. The chemical conversion sludge eliminator 311 removes chemical conversion sludge of aluminum and iron (produced during the treatment in the treatment tank 101 of the preceding stage). The oil eliminator 312 removes oil. These dust eliminator 310, chemical conversion sludge eliminator 311, and oil eliminator 312 can employ the specific examples shown in the above-described dust eliminator 102, chemical conversion sludge eliminator 103, and oil eliminator 104, respectively.

[0069] The chemical conversion solution for aluminum used in this embodiment is not particularly limited, and, for example, includes hexafluorotitanate and hexafluorozirconate. This new chemical conversion solution for aluminum is accommodated in a tank 305 of a chemical conversion solution for aluminum and supplied to the chemical conversion solution replenishment tank 301 by the pump 306. The chemical conversion solution for aluminum is properly adjusted, and then supplied to the dipping tank 313 by the pipe 302 and the pump 303.

[0070] Since the equipment of pretreatment before painting according to this embodiment employs the dipping tank 313 for full dipping or half dipping as means for aluminum chemical conversion, the equipment of pretreatment before painting is excellent in treatment especially when aluminum materials are employed for the inner panel portions.

Third Embodiment

[0071] FIG. 7 is a system view showing a third embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body. This embodiment basically differs from the above-described first embodiment in that a rinse tank 120, a water-polar organic solvent separator 112 and an ion eliminator are employed. The other components are similar to those of the above-described embodiment, and the same components are given the same reference numerals.

[0072] As shown in FIG. 7, the vehicle body B is conveyed by the painting conveyer C while being mounted on the hanger H. In this embodiment, the three dipping tanks 101, 120, and 201 are provided along the painting conveyer line. The dipping tank on the upstream side in the conveying direction indicated by an arrow X in the drawing is the treatment tank 101 for degreasing treatment and chemical conversion. The dipping tank on the downstream side of the treatment tank 101 is the rinse tank 120 for washing the vehicle body B after degreasing and chemical conversion. The most downstream dipping tank is the rinse tank 201 for washing the vehicle body B after aluminum chemical conversion. The treatment tank 101 is filled with the degreasing and chemical conversion solution, and the rinse tanks 120 and 201 are filled with deionized water.

[0073] The treatment solution replenishment tank 109 temporarily stores part of the degreasing and chemical conversion solution, which has passed the dust eliminator 102, the chemical conversion sludge eliminator 103, and the oil eliminator 104 for removal of foreign material, chemical conversion sludge, and oil. In addition to the degreasing and chemical conversion solution, the treatment solution replenishment tank 109 is supplied with the polar organic solvent from which water has been removed by the water-polar organic solvent separator 112 (described later) and water from which ion components have been removed by the ion eliminator 113. A new degreasing and chemical conversion solution is replenished to the treatment solution replenishment tank 109 from the treatment solution tank 107 by the pump 108 and then adjusted. The treatment solution tank 107 accommodates the new degreasing and chemical conversion solution. The degreasing and chemical conversion solution is returned to the degreasing and chemical conversion tank 101.

[0074] The water-polar organic solvent separator 112 separates water and the polar organic solvent from part of the treatment solution that has passed the oil eliminator 104. The separated water is supplied to the ion eliminator 113 via the pipe 114, and the separated polar organic solvent is supplied to the treatment solution replenishment tank 109 via the pipe 115.

[0075] The polar organic solvent contained in the degreasing and chemical conversion solution used in this embodiment is the alcohol, the glycol ether, or the diethylene glycol ether as described above. It is desirable that the water-polar organic solvent separator 112 of this embodiment employs a method of efficiently separating the polar organic solvent and water at low costs. For such a separation method, a separation method called pervaporation can be used. In pervaporation, as shown in FIG. 8, the mixed solution of the polar organic solvent and water to be separated is supplied to one side (supply side) 1122 of a separation membrane 1121 (non-porous membrane: membrane with holes with sizes of less than 1 nm) with selective permeability. The other side (permeation side) 1123 of the membrane 1121 is vacuated or depressurized. The mixed solution is moved from the high pressure side (supply side) 1122 to the low pressure side (permeation side) 1123 using the pressure difference between the supply side 1122 and the permeation side 1123 as a driving force. At this time, the separation membrane 1121 with the selective permeability significantly different in diffusion speed for each type of materials is interposed between the high pressure side 1122 and the low pressure side 1123 to separate the polar organic solvent and water.

[0076] As examples of the above-described separation membrane 1121, "Composite membrane with a maleic acid-cross-linked PVA film on a support membrane (Japanese Patent Laid Open No. 59-109204)", "Potassium-salt treated composite membrane of carboxyl methyl cellulose of 80% and polyacrylate of 20% *(J. Memb. Sci.,* 32, 207 (1987))", "Composite membrane with cross-linked PVA film on a PNA support membrane (*J. Memb. Sci.,* 36, 463 (1988)", "Hollow fiber membrane of a chitosan derivative (National Meeting of The Chemical Society of Japan (1989))", "Cobalt alginate membrane (Japanese Patent Application Laid-Open No. 61-404)", "Chitosan sulfate membrane (International Congress on Membranes (1987))", and "Polyion complex composite membrane of polyacrylic acid by hydrolysis of a PNA base membrane surface and ionene type polycation (Japanese Patent Application Laid-Open No. 1-224003)" are listed.

[0077] The ion eliminator 113 removes ion components from the water supplied from the water-polar organic solvent separator 112 via the pipe 114. The removed ion components are discarded, and the residual water is supplied to the treatment solution replenishment tank 109 via the pipe 116 and supplied to the rinse tank 120 via the pipe 114.

[0078] The ion eliminator 113 used in this embodiment is not special. As shown in FIG. 9, the ion eliminator 113 is a deionized water generator provided with an ion eliminator including ion exchange towers 1131 to 1133, a decarbonator tower 1134, and an anion exchange tower 1135. The ion exchange tower 1131 is filled with chelate resin type cation exchange resin capable of removing cation components contained in the degreasing and chemical conversion solution, for example, zinc ion, nickel ion, and manganese ion. The ion exchange tower 1132 is filled with styrene type strong base anion exchange resin capable of removing anion components contained in the degreasing and chemical conversion solution, for example, phosphate ion, nitrate ion, and the like. The ion exchange tower 1133 is filled with strong acid cation exchange resin in H form, which is a deionized water generator generally used for increasing water purity. The anion exchange tower 1135 is filled with styrene type strong base anion exchange resin in OH form.

[0079] The equipment of pretreatment before painting of the embodiment is provided with the following three circulating systems. As shown in FIG. 7, in the first circulating system, the treatment solution in the degreasing and chemical conversion tank 101 is circulated through the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the treatment solution replenishment tank 109, and the degreasing and chemical conversion tank 101.

[0080] In the second circulating system, the treatment solution in the degreasing and chemical conversion tank 101 is circulated through the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the water-polar organic solvent separator 112, the ion eliminator 113, and the rinse tank 120.

[0081] In the third circulating system, the solution in the rinse tank 120 is introduced to the dust eliminator 102 by the pipe 121 and the pump 122 and then circulated through the dust eliminator 102, the chemical conversion sludge eliminator 103, and the oil eliminator 104.

[0082] In addition to the above three circulating systems, the following circulating systems are constituted.

[0083] The fourth circulating system is formed by adding the water-polar organic solvent separator 112 to the above-described first circulating system, that is, the loop of the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the treatment solution replenishment tank 109, and the degreasing and chemical conversion tank 101. The polar organic solvent separated by the water-polar organic solvent separator 112 is thus supplied to the treatment solution replenishment tank 109.

[0084] The fifth circulating system is formed by adding the treatment solution replenishment tank 109 to the above-described second circulating system, that is, the loop of the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the water-polar organic solvent separator 112, the ion eliminator 113, and the rinse tank 120. Part of deionized water from which ions are removed by the ion eliminator 113 is thus supplied to the treatment solution replenishment tank 109.

[0085] The sixth circulating system is formed by adding the water-polar organic solvent separator 112 to the above-described third circulating system, that is, the loop of the rinse tank 120 and the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the treatment solution replenishment tank 109, and the degreasing and chemical conversion tank 101. The polar organic solvent separated by the water-polar organic solvent separator 112 is thus supplied to the treatment solution replenishment tank 109.

[0086] The seventh circulating system is formed by adding the ion eliminator 113 to the above-described sixth circulating system, that is, the loop of the rinse tank 120 and the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the water-polar organic solvent separator 112, the treatment solution replenishment tank 109, and the degreasing and chemical conversion tank 101. Ions are removed from the water separated by the water-polar organic solvent separator 112, and the water from which ions have been removed is supplied to the rinse tank 120.

[0087] The eighth circulating system is formed by adding the ion eliminator 113 to the above-described sixth circulating system, that is, the loop of the rinse tank 120 and the degreasing and chemical conversion tank 101, the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the water-polar organic solvent separator 112, the treatment solution replenishment tank 109, and the degreasing and chemical conversion tank 101. Ion are removed from the water separated by the water-polar organic solvent separator 112, and the water from which ion have been removed is supplied to the treatment solution replenishment tank 109.

[0088] As described above, the equipment of pretreatment before painting of this embodiment includes the three circulating systems of the first to the third circulating systems by broad classification, and the eight circulating systems by detailed classification. Accordingly, the composition of the treatment solution in the degreasing and chemical conversion tank 101 is stabilized, and excellent chemical conversion coatings with no variation in quality can be formed in a continuous treatment.

[0089] Since the equipment of pretreatment before painting of this embodiment includes the third circulating system, the electric conductivity of the washing solution in the rinse tank 120 can be maintained at less than 20 μS/cm, and oil, the treatment solution, or foreign material such as iron powder can be prevented from adhering to the surface of the work. Moreover, oil, the treatment solution, and foreign material such as iron powder brought to the subsequent process can be reduced as much as possible.

[0090] Next, the operations will be described.

[0091] Similar to the first embodiment, the vehicle body B that has been assembled by welding is conveyed by the painting conveyer C, and first washing and degreasing are performed in the treatment tank 101. At this time, the zinc phosphate chemical conversion coating is formed on the steel parts.

[0092] The vehicle body B that has passed the treatment tank 101 is washed with deionized water by being dipped in the rinse tank 120. The degreasing and chemical conversion solution, dust, chemical conversion sludge, and oil that are brought out by adhering to the vehicle body B are thus removed before the aluminum chemical conversion zone 300 of the subsequent stage. Accordingly, in addition to improvement in quality of the chemical conversion coating by the degreasing and chemical conversion solution, it can be prevented that the chemical conversion solution for aluminum is contaminated by foreign material bought therein. Consequently, load for recycling of the chemical conversion solution for aluminum is reduced, and recycling efficiency is improved.

[0093] The vehicle body B that has passed the rinse tank 120 is fed to the aluminum chemical conversion zone 300 and sprayed with the chemical conversion solution for aluminum from the nozzle 304. In such a manner, the aluminum parts can be treated with the chemical conversion coating.

[0094] At last, the vehicle body B that has passed the aluminum chemical conversion zone 300 is dipped into the rinse tank 201 to wash the treatment solution adhered to the vehicle body B. The vehicle body B is then conveyed to the drying oven and dried. The dried vehicle body is fed to the electrocoating process as undercoating.

Fourth embodiment

[0095] FIG. 10 is a system view showing a fourth embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body.

[0096] This embodiment is provided with a vacuum distillation unit 130 in place of the dust eliminator 102, the chemical conversion sludge eliminator 103, the oil eliminator 104, the water-polar organic solvent separator 112 and the ion eliminator 113 of the third embodiment. The other components are similar to those of the above-described embodiment, and the same components are given the same reference numerals.

[0097] The treatment solution in the degreasing and chemical conversion tank 101 and the solution in the rinse tank 120 are sucked by the pumps 106 and 122, respectively, and supplied to the vacuum distillation unit 130. The supplied solution is separated into the polar organic solvent, water and other materials. The polar organic solvent separated in the vacuum distillation unit 130 is supplied to the treatment solution replenishment tank 109 via the pipe 131. Part of water separated in the vacuum distillation unit 130 is supplied to the treatment solution replenishment tank 109 via the pipe 131, and the residual water is supplied to the rinse tank 120 via the pipe 132.

[0098] Except for the polar organic solvent and water, materials, which are separated in the vacuum distillation unit 130, are foreign material such as iron powder, chemical conversion sludge, and oil, and such sludge is discarded from the vacuum distillation unit 130.

[0099] FIG. 11 is a conceptual diagram showing the vacuum distillation unit 130. Vacuum distillation is a method of distillation while lowering the boiling point by reducing the pressure to about, for example, 10^{-2} to several tens Torr. In this embodiment, since it is desired to separate the polar organic solvent and water from the treatment solution independently, two vacuum distillation units 1301 and 1302 are provided as shown in the same drawing. The two vacuum distillation units 1301 and 1302 have the same structure and include unit bodies 1303, to which the treatment solution is supplied. Pressure within the unit bodies 1303 is reduced by vacuum pumps 1304. The respective vacuum distillation units 1301 and 1302 are provided with heaters 1305 for increasing temperatures within the unit bodies 1303 to respective predetermined temperatures. The treatment solution introduced in each unit body 1303 is heated by each heater 1305 under reduced pressure. By setting the predetermined temperatures to the boiling points of respective target materials, only the target materials are evaporated and introduced to evaporation tubes 1306 to be liquefied by coolers 1307.

[0100] In this embodiment, as described above, since it is desired to separate the polar organic solvent and water from the treatment solution independently, in the vacuum distillation unit 1301 of a first stage shown in the drawing, only the polar organic solvent is separated and supplied to the treatment solution replenishment tank 109 shown in FIG. 10. In the vacuum distillation unit 1302 of a second stage, only water is separated from the treatment solution left in the vacuum distillation unit 1301 of the preceding stage and then supplied to the treatment solution replenishment tank 109 and the rinse tank 120 shown in FIG. 10. Sludge left in the vacuum distillation unit 1302, such as foreign material, chemical conversion sludge, and oil, is discarded.

[0101] Since the boiling point is lowered under reduced pressure, thermal energy supplied to the heaters 1305 is less than that in atmospheric distillation. Especially, for energy to the heater 1305, it is desirable to use waste heat from the paint drying oven.

[0102] According to the equipment of pretreatment of this embodiment, the solution in the treatment tank 101 and the rinse tank 120 can be recovered and recycled by only the vacuum distillation unit 130. Therefore, compared to the third embodiment, the whole system can be simplified and reduced in cost.

Fifth Embodiment

[0103] FIG. 12 is a system view showing a fifth embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body.

[0104] In this embodiment, the washing treatment is performed by a spray in place of the dipping treatment with the rinse tank 120 of the above-described third embodiment. The other components are similar to those of the above-described embodiment, and the same components are given the same reference numerals.

[0105] Specifically, a rinse zone 140 is provided at the next stage of the treatment tank 101. A floor surface of a booth is sloped so as to be lowest at the center thereof so that deionized water sprayed hardly flows into the treatment tank 101 of the preceding stage and the aluminum chemical conversion zone 300 of the subsequent stage.

[0106] Nozzles 141 for spraying deionized water onto the vehicle body B passing the rinse zone 140 are attached to the pipe 114. The deionized water for use is obtained by the ion eliminator 113. In the example shown in FIG. 12, a plurality of nozzles 141 for spraying deionized water onto the whole of the vehicle body B are provided on a ceiling surface and a side surface of the booth.

[0107] The used water collected on the floor surface of the booth is recovered in a washing solution recovery tank 142 and returned to the dust eliminator 102, which is the most upstream in the first circulating system, by a pipe 143 and a pump 144.

Sixth Embodiment

[0108] FIG. 13 is a system view showing a sixth embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body.

[0109] In this embodiment, the washing treatment is performed by the spray in place of the dipping treatment with the rinse tank 120 of the above-described fourth embodiment. The other components are similar to those of the above-described embodiment, and the same components are given the same reference numerals.

[0110] Specifically, the rinse zone 140 is provided at the next stage of the treatment tank 101. A floor surface of a booth is sloped so as to be lowest at the center thereof so that deionized water sprayed hardly flows into the treatment tank 101 of the preceding stage and the aluminum chemical conversion zone 300 of the subsequent stage.

[0111] Nozzles 141 for spraying deionized water onto the vehicle body B passing the rinse zone 140 are attached to the pipe 132. The deionized water for use is obtained by the vacuum distillation unit 130. In the example shown in FIG. 13, the plurality of nozzles 141 for spraying deionized water onto the whole of the vehicle body B are provided on a ceiling surface and a side surface of the booth.

[0112] The used water collected on the floor surface of the booth is recovered in the washing solution recovery tank 142 and returned to the vacuum distillation unit 130 by the pipe 143 and the pump 144.

Seventh Embodiment

[0113] FIG. 14 is a system view showing a seventh embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting for performing degreasing treatment, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body.

[0114] In this embodiment, the rinse treatment with the rinse tank 120 or the rinse zone 140 of the above-described third to sixth embodiments is performed in the aluminum chemical conversion zone 300. The other components are similar to those of the above-described embodiments, and the same components are given the same reference numerals.

[0115] As shown in the same drawing, the vehicle body B is conveyed by the painting conveyer C while being mounted on a hanger H. In this embodiment, the two dipping tanks 101, 201 are provided along a line of the painting conveyer C. The dipping tank on the upstream side in the conveying direction indicated by an arrow X in the drawing is the treatment tank 101 for degreasing and chemical conversion. The dipping tank on the downstream side is the rinse tank 201 for washing the vehicle body B after degreasing and chemical conversion. The treatment tank 101 is filled with a degreasing and chemical conversion solution which is the same as that in the above-described first to sixth embodiments, and the rinse tank 201 is filled with deionized water.

[0116] Between the treatment tank 101 and the rinse tank 201 shown in FIG. 14, a rinse-aluminum chemical conversion zone 400 for selectively spraying deionized water and a chemical conversion solution for aluminum onto the vehicle body B is provided. In a rinse-aluminum chemical conversion zone 400, a floor surface of a booth is sloped so as to be lowest at the center thereof in order that the sprayed deionized water and chemical conversion solution for aluminum do not flow into the treatment tank 101 of the preceding stage and the rinse tank 201 of the subsequent stage as much as possible.

[0117] Nozzles 401 for spraying deionized water or the chemical conversion solution for aluminum onto the vehicle body B passing the rinse-aluminum chemical conversion zone 400 are attached to a pipe 402. The nozzles 401 are supplied by pumps 404 and 406 with the deionized water or the chemical conversion solution for aluminum from a washing solution replenishment tank 403 accommodating deionized water and a chemical conversion solution replenishment tank 405, respectively. Here, in the middle of the pipe 402, a three way valve 407 is provided to switch the solution supplied to the nozzle 401 between the deionized water from the washing solution replenishment tank 403 and the chemical conversion solution for aluminum from the chemical conversion solution replenishment tank 405. The pumps 404, 406 and the three way valve are operated by command signals from a controller 502 to be described later.

[0118] The used deionized water and chemical conversion solution for aluminum collected on the floor surface of the booth are separately recovered to a washing solution recovery tank 412 and a chemical conversion solution recovery tank 418, respectively via pipes 408, 409, and 410. In this connection, the pipe 408 is provided with a three way valve 411 for switching the tanks for recovery. The three way valve is also operated by the command signals from a controller 502 to be described later.

[0119] The used deionized water recovered to the washing solution recovery tank 412 via the pipes 408, 409 is returned to the washing solution replenishment tank 403 by a pipe 414 and a pump 413. The pipe 414 coupled to the washing solution recovery tank 412 is provided with a dust eliminator 415, a chemical conversion sludge eliminator 416, and an oil eliminator 417. The dust eliminator 415 removes dust contained in the used deionized water recovered. The chemical conversion sludge eliminator 415 removes chemical conversion sludge of aluminum and iron (produced during the treatment in the treatment tank 101 of the preceding stage). The oil eliminator 417 removes oil.

[0120] On the other hand, the used chemical conversion solution for aluminum recovered to the chemical conversion solution recovery tank 418 via the pipes 408 and 410 is returned to the chemical conversion solution replenishment tank 405 by a pipe 420 and a pump 419. The pipe 420 coupled to the chemical conversion solution recovery tank 418 is provided with a dust eliminator 421, a chemical conversion sludge eliminator 422, and an oil eliminator 423. The dust eliminator 421 removes dust contained in the used chemical conversion solution for aluminum recovered. The chemical conversion sludge eliminator 422 removes chemical conversion sludge of aluminum and iron (produced during the treatment in the treatment tank 101 of the preceding stage). The oil eliminator 423 removes oil.

[0121] These dust eliminators 415, 421, chemical conversion sludge eliminators 416, 422, and oil eliminators 417, 423 can employ the specific examples shown in the above-described dust eliminator 102, chemical conversion sludge eliminator 103, and oil eliminator 104, respectively

[0122] The chemical conversion solution for aluminum used in this embodiment is not particularly limited, and, for example, includes hexafluorotitanate and hexafluorozirconate. Such a new chemical conversion solution for aluminum is accommodated in a tank 424 of a chemical conversion solution for aluminum and supplied to the chemical conversion solution replenishment tank 405 by the pump 425. The chemical conversion solution for aluminum sprayed onto the vehicle body B from the nozzles 401 is adjusted by the new chemical conversion solution for aluminum.

[0123] Preferably, the chemical conversion solution for aluminum is treated under conditions of a pH of 2.5 to 10 and a temperature of 20 to 70 °C for period of 20 to 100 seconds.

[0124] The rinse tank 201 is provided at the subsequent stage of the rinse-aluminum chemical conversion zone 400. The rinse tank 201 washes the vehicle body B having a chemical conversion coating formed in the treatment tank 101 and the rinse-aluminum chemical conversion zone 400 with deionized water. In this embodiment, the vehicle body B is dipped in the rinse tank 201 to wash the inner and outer panels of the vehicle body B. However, the washing treatment can be also realized by a spray treatment other than the dipping treatment.

[0125] In the deionized water in the rinse tank 201, dust, chemical conversion sludge, and oil adhered to the vehicle body B are mixed. The deionized water is sucked by the pipe 202 and the pump 203 and supplied to the washing solution recovery tank 412 (or the dust eliminator 415) in the rinse-aluminum chemical conversion zone 400 of the preceding stage. After these dust, chemical conversion sludge, and oil are removed, the deionized water is then reused as deionized water for washing. New deionized water is supplied to the rinse tank 201 from a deionized water supply unit separately provided, not shown in the drawing.

[0126] In this embodiment, starts and stops of the pumps 404, 406 and operations of the three way valves 407, 411 are carried out by command signals from the controller 502 based on a specification of a vehicle type detected by a vehicle type detector 501. The vehicle type detector 501 is provided in a process before dipping the vehicle body B in the treatment tank 101, for example. The vehicle type detector 501 reads out a specification regarding the vehicle type from a specification storage medium, which stores specifications of each vehicle body B and is mounted on each vehicle body B. Here, the vehicle type detector 501 detects at least whether the vehicle body B is the iron vehicle body, the aluminum vehicle body, or the composite vehicle body, and then transmits the detected specification to the controller 502. The control will be described in detail later.

[0127] Next, the operations will be described.

[0128] The vehicle body B that has been assembled by welding in the body assembling process is conveyed by the painting conveyor C while being mounted on the painting hanger H and first dipped in the treatment tank 101. Since the vehicle body B is dipped in the treatment tank 101, foreign material such as iron powder and oil adhered to the vehicle body B are removed into the treatment tank 101 by washing and degreasing effects of the degreasing and chemical conversion solution. Furthermore, in the steel parts of the vehicle body B from which oil has been removed, the degreasing and chemical conversion solution reacts with iron to form a chemical conversion coating of zinc phosphate. However, as for the aluminum parts of the vehicle body B, only dust removal and degreasing are performed. The aluminum parts do not react with the degreasing and chemical conversion solution, and the chemical conversion coating is not formed.

[0129] The vehicle body B that has passed the treatment tank 101 is fed to the rinse-aluminum chemical conversion zone 400 and then sprayed with any one of deionized water and the chemical conversion solution for aluminum from the nozzles 401. In other words, when material specifications of the vehicle body B detected by the vehicle type detector 501 is the iron vehicle body, the chemical conversion for aluminum is unnecessary, so that the rinse-aluminum chemical conversion zone 400 is used as a rinse zone. Accordingly, the controller 502 simultaneously transmits a start command to the pump 404 and a stop command to the pump 406. Moreover, the three way valve 407 is switched to the washing solution replenishment tank 403, and the three way valve 411 is switched to the washing solution recovery tank 412.

[0130] The deionized water in the washing solution replenishment tank 403 is sucked by the pump 404 and sprayed onto the whole of the iron vehicle body B from the nozzle 401 via the pipe 402. The deionized water sprayed onto the vehicle body B is collected on the floor surface of the booth, recovered to the washing solution recovery tank 412 via the pipes 408, 409, and then sucked therefrom by the pump 413. Subsequently, the deionized water passes the dust eliminator 415, chemical conversion sludge eliminator 416, and the oil eliminator 417 to remove dust, chemical conversion sludge such as aluminum and iron, and oil, which are contained in the deionized water. The deionized water is then returned to the washing solution replenishment tank 403.

[0131] On the other hand, when the material specifications of the vehicle body B detected by the vehicle type detector 501 are those of the vehicle body made of aluminum or aluminum alloys, the rinse-aluminum chemical conversion zone 400 is used as an aluminum chemical conversion zone. Accordingly, the controller 502 transmits the stop instruction to the pump 404 and simultaneously transmits the start instruction to the pump 406. Moreover, the three way valve 407 is switched to the chemical conversion solution replenishment tank 405, and the three way valve 411 is switched to the chemical conversion solution recovery tank 418.

[0132] The chemical conversion solution for aluminum in the chemical conversion solution replenishment tank 405 is sucked by the pump 406 and sprayed onto the whole of the vehicle body B (or mainly aluminum parts) from the nozzle 401 via the pipe 402. The chemical conversion solution for aluminum sprayed onto the vehicle body B is collected on the floor surface of the booth, recovered to the chemical conversion solution recovery tank 418, and then sucked therefrom by the pump 419. Subsequently, the chemical conversion solution for aluminum passes the dust eliminator 421, the chemical conversion sludge eliminator 422, and the oil eliminator 423 to remove dust, chemical conversion sludge such as aluminum and iron, and oil, which are contained in the chemical conversion solution for aluminum. The chemical conversion solution for aluminum is then returned to the chemical conversion solution replenishment tank 405 via the pipe 420.

[0133] In this treatment in the rinse-aluminum chemical conversion zone 400, the vehicle body B is washed by deionized water when the vehicle body B is the iron vehicle body. Accordingly, the zinc phosphate coating formed in the preceding treatment can improve the quality, and the treatment solution brought in the rinse tank 201 of the subsequent stage can be suppressed. When the vehicle body B is the aluminum vehicle body or the composite vehicle body, the aluminum parts employed as the outer panel parts, such as a hood, a trunk lid, and doors, can be treated with the chemical conversion coating in the rinse aluminum chemical conversion zone 400. Especially, when these aluminum parts are used as the outer panel parts of the vehicle body B, a sufficient chemical conversion coating can be formed by only the spray treatment like this embodiment. Consequently, the length of the chemical conversion process for aluminum can be minimized. Furthermore, since the recovery tanks 412 and 418 are separately used for washing with deionized water and chemical conversion for aluminum, respectively, load for recycling of the recovered chemical conversion solution for aluminum is reduced and recycling efficiency is increased.

[0134] At last, the vehicle body B that has passed the rinse-aluminum chemical conversion zone 400 is dipped into the rinse tank 201 to wash the treatment solution adhered to the vehicle body B. The vehicle body B is then conveyed to the drying oven and dried. The dried vehicle body is fed to the electrocoating process as undercoating.

Eighth Embodiment

[0135] FIG. 15 is a system view showing an eighth embodiment of the equipment of pretreatment before painting of the present invention. Similar to the first embodiment, the drawing shows a process of pretreatment before painting, where degreasing, surface conditioning, and chemical conversion coating are performed on a work, for example, a vehicle body as surface preparation for electrocoating.

[0136] This embodiment basically differs from the above-described first embodiment in that a plurality of nozzles 304 and 315 are provided in the aluminum chemical conversion zone and that the vehicle type detector 501 and the controller 502 are employed. Since the other components are similar to those of the above-described embodiment, the same components are given the same reference numerals.

[0137] In this embodiment, as shown in FIG. 15, the nozzles 304 and 315 for spraying the chemical conversion solution for aluminum onto the vehicle body B passing the aluminum chemical conversion zone 300 are attached to the pipe 302 and a pipe 316, respectively. The nozzles 304 and 315 are supplied with the chemical conversion solution for aluminum by the pump 303 and a pump 314 from the chemical conversion solution replenishment tank 301 accommodating the chemical conversion solution for aluminum. The example shown in FIG. 15 has a configuration of two stages, where the plurality of nozzles 304 and 315 for spraying the chemical conversion solution for aluminum onto a hood, a trunk lid, and doors, which are aluminum parts of the vehicle body B, are provided on the ceiling surfaces and the side surfaces of each booth. In the first stage, the nozzles 304 are arranged so that they spray the chemical conversion solution for aluminum onto portions corresponding to the aluminum parts of a composite vehicle body. In the second stage, the nozzles 315 are arranged so that they spray the chemical conversion solution for aluminum onto portions other than the aluminum parts of the composite vehicle body.

[0138] Notably, in this embodiment, the pumps 303 and 314 are started and stopped by command signals from the controller 502 based on the specifications of a vehicle type detected by the vehicle type detector 501. For example, the vehicle type detector 501 is provided in a process before the vehicle body B is dipped in the treatment tank 101. The vehicle type detector 501 reads specifications regarding the vehicle type from a specification storage medium, which stores specifications of each vehicle body B and is mounted on each vehicle body B. Here, the vehicle type detector 501 detects at least whether the vehicle body B is an iron vehicle body, an aluminum vehicle body, or a composite vehicle body, and then transmits the detected specification to the controller 502. The detail of this control will be described later.

[0139] The rinse tank 201 is provided after the aluminum chemical conversion zone 300. The rinse tank 201 washes the vehicle body B having the chemical conversion coating thereon with deionized water. In this embodiment, the vehicle body B is dipped in the rinse tank 201 to wash inner and outer panels of the vehicle body B. However, the washing treatment can be also performed by a spray treatment other than the dipping treatment.

[0140] Next, the operations will be described.

[0141] Being mounted on the painting hanger H, the white body B which has been assembled by welding in a body assembling process is conveyed by the painting conveyor C and dipped in the treatment tank 101 first. Since the vehicle body B is dipped in the treatment tank 101, foreign material such as iron powder and oil adhering to the vehicle body B are removed into the treatment tank 101 by washing and degreasing effects of the degreasing and chemical conversion solution. Furthermore, on the steel parts of the vehicle body B from which oil has been removed, the degreasing and chemical conversion solution reacts with iron and forms a chemical conversion coating of zinc phosphate.

[0142] The vehicle body B which has passed the treatment tank 101 is conveyed to the aluminum chemical conversion zone 300, where the control shown in FIG. 16 is carried out.

[0143] Specifically, the vehicle type detector 501 disposed at the entrance of the equipment of pretreatment before painting detects the material specifications of the vehicle body B, more specifically, whether the vehicle body B is an iron vehicle body, an aluminum vehicle body, or a composite vehicle body, and sequentially transmits the detected material specifications to the controller 502. The data, which are transmitted from the vehicle type detector 501 to the controller 502, regarding the material specifications, is stored in synchronization with the painting conveyor C conveying the vehicle body B. The controller 502 recognizes the data corresponding to each body in the pretreatment process.

[0144] As shown in FIG. 16, when the data regarding the material specifications are fetched from the vehicle type detector 501 (S1), the controller 502 passes judgments in steps 2 (S2) and 4 (S4) before the vehicle body B is conveyed to the aluminum chemical conversion zone 300. Specifically, it is determined in the step 2 (S2) whether or not the vehicle body B of the fetched data is an iron vehicle body, all of which are composed of iron components. When the vehicle body B is an iron vehicle body, the procedure proceeds to a step 3 (S3), where the controller 502 transmits stop signals to the pumps 303 and 314 so as not to spray the chemical conversion solution for aluminum onto the vehicle body B.

[0145] In the step 2 (S2), when the vehicle body B is not an iron vehicle body, the procedure proceeds to the step 4 (S4), where it is determined whether or not the vehicle body B is an aluminum vehicle body, all of which are composed of aluminum components. Here, when the vehicle body B is an aluminum vehicle body, the procedure proceeds to a step 6 (S6), where the controller 502 transmit a driving signals to the pumps 303 and 314 to spray the chemical conversion solution for aluminum from the all nozzles 304 and 315 onto the inner and outer panels of the aluminum vehicle body.

[0146] In the step 4 (S4), when the vehicle body is not an aluminum vehicle body, the vehicle body is determined as a composite vehicle body, and the procedure proceeds to a step 5 (S5). The controller 502 transmits a driving signal to the pump 303 and a stop signal to the pump 314 to spray the chemical conversion solution for aluminum onto the aluminum parts of the composite vehicle body only from the nozzles 304.

[0147] As described above, in the aluminum chemical conversion zone 300, the chemical conversion solution for aluminum can be sprayed onto only necessary portions in accordance with the materials of the components of the vehicle body B, and an amount of used chemical conversion solution for aluminum can be reduced. When the vehicle body B conveyed to the aluminum chemical conversion zone 300 is a composite vehicle body, the configuration in the above-described embodiment is made so that only the pump 303 is driven, and the other pump 314 is stopped. However, the present invention is not limited to this. The configuration may be set in a manner that both of the pumps 303 and 314 are driven, and one of the nozzles 304 and 315 which discharges the chemical conversion solution is selected.

[0148] By the treatment in the aluminum chemical conversion zone 300, the aluminum parts employed as outer panel parts such as a hood, a trunk lid, and doors can be treated with the chemical conversion coating. When these aluminum parts are used especially as the outer panel parts of the vehicle body B, a sufficient chemical conversion coating can be formed by only the spray treatment like this embodiment. Consequently, the length of the aluminum chemical conversion process can be minimized.

[0149] Lastly, the vehicle body B which has passed the aluminum chemical conversion zone 300 is dipped in the rinse tank 201, and the chemical conversion solution adhering to the vehicle body B is washed off. The vehicle body B is conveyed to a drying oven, dried and fed to a process of electrocoating, which is undercoating.

Ninth Embodiment

[0150] FIG. 17 is a plan view showing a ninth embodiment of the equipment of pretreatment before painting of the present invention, and FIG. 18 is a system view showing the same. Similar to the first embodiment, the drawings show a process of pretreatment before painting for performing degreasing, surface conditioning, and chemical conversion as surface preparation of electrocoating for a work, for example, a vehicle body. This embodiment basically differs from the above-described eighth embodiment in that the painting conveyer C in the aluminum chemical conversion zone 300 is divided, and the dipping tank 313 is employed in the aluminum chemical conversion zone 300. The other components are similar to those of the above-described embodiment, and the same components are given the same reference numerals.

[0151] As shown in FIG. 17, the painting conveyer C of this embodiment is divided into two conveyer C1 and C2 and joined between the treatment tank 101 and the rinse tank 201. The aluminum chemical conversion zone 300 is provided on one conveyer C1 side. On the other conveyer (bypass line of the present invention) C2 side, the vehicle body B is just conveyed while being mounted on the hanger H. In the process on the other conveyer C2, deionized water mist spray may be performed in order to prevent drying of the zinc phosphate coating formed on the surfaces of the iron parts

[0152] The painting conveyer C is provided with a conveyer dividing unit 503 at an exit of the treatment tank 101 and a conveyer joining unit 504 at the entrance of the rinse tank 201. Each of the conveyer dividing unit 503 and the conveyer joining unit 504 can include a switching unit for conveyer rails and a controller for controlling the switching unit. The controller 502 of this embodiment transmits switching command signals to the controller of the switching unit. Specifically, upon the detection of the material specification of the vehicle body B, the vehicle type detector 501 provided at the entrance of the treatment tank 101 transmits the detected material specifications to the controller 502. The controller 502 determines whether the vehicle body B is conveyed to the conveyer C1 or the conveyer C2 according to the material specifications of the vehicle body. This control will be described later.

[0153] As shown in FIG. 18, the aluminum chemical conversion zone 300 of this embodiment is provided with the aluminum chemical conversion tank 313 filled with the chemical conversion solution for aluminum. The vehicle body B conveyed by the conveyer C1 is fully dipped in accordance with the trajectory of the conveyer C1.

[0154] Since the equipment of pretreatment before painting of this embodiment employs the dipping tank 313 for full dipping as means for aluminum chemical conversion, the equipment of pretreatment before painting is excellent in treatment especially when aluminum materials are employed for the inner panel portions.

[0155] In this embodiment, the dipping treatment is employed in the aluminum chemical conversion zone 300. However, the spray treatment can be employed by providing the nozzles 304 and 315 shown in the eighth embodiment for the aluminum chemical conversion zone 300 of the conveyer C1.

[0156] Next, the operations will be described. Since the treatment procedures in the treatment tank 101 and the rinse tank 201 are similar to those in the eighth embodiment, the treatment procedures in the processes thereof are described with reference to FIG. 19.

[0157] The vehicle type detector 501 arranged in the entrance of the equipment of pretreatment before painting detects the material specifications of the vehicle body B, specifically, whether the vehicle body B is the iron vehicle body, the aluminum vehicle body, or the composite vehicle body, and sequentially transmits the detected material specifications to the controller 502. The data regarding the material specifications transmitted from the vehicle type detector 501 to the controller 502 is stored in synchronization with the painting conveyer C. The controller 502 recognizes which body in the pretreatment process corresponds to which data.

[0158] As shown in FIG. 19, upon fetching the data regarding the material specification from the vehicle type detector 501 (S11), the controller 502 carries out determinations of steps 12 (S12) when the vehicle body B is taken out of the treatment tank 101. Specifically, it is determined whether or not the vehicle body B of the fetched data is the iron vehicle body, which is entirely composed of iron parts, in the step 12 (S12). When the vehicle body B is the iron vehicle body, the procedure proceeds to a step 13 (S13), in which the controller 502 transmits command signals to the conveyer dividing unit 503 and the conveyer joining unit 504 to convey the iron vehicle body B into the bypass line. Accordingly, the iron vehicle body is not sprayed with the chemical conversion solution for aluminum.

[0159] In the step 12 (S12), when the vehicle body B is not the iron vehicle body, the vehicle body B is determined as either the aluminum vehicle body or the composite vehicle body. Accordingly, the procedure proceeds to the step 14 (S14), and the controller 502 transmits command signals to the conveyer dividing unit 503 and the conveyer joining unit 504 to convey the aluminum vehicle body or the composite vehicle body into the line of the aluminum chemical conversion zone 300. Therefore, the vehicle body is dipped into the dipping tank 313 and subjected to the aluminum chemical conversion.

[0160] In this embodiment, by dividing the painting conveyer C, only the aluminum vehicle body and the composite vehicle body, which require aluminum chemical conversion, flow through the conveyer C1 and the iron vehicle body is allowed to escape to the bypass line. Accordingly, the conveyer speed of the conveyers C1 and C2 can be reduced to about half of the speed of the painting conveyer C in average, so that the length of the aluminum chemical conversion tank 313 can be set to be reduced.

[0161] Incidentally, when the spray treatment shown in FIG. 15 is employed in the aluminum chemical conversion zone 300, the aluminum treatment conditions for the aluminum vehicle body and the composite vehicle body can be further changed.

[0162] Note that the above embodiments have been described to facilitate understanding of the present invention and not to limit the present invention. Therefore, each component disclosed in the above-described embodiments is intended to include all design modifications and equivalents within the technical scope of the present invention.

[0163] In the vehicle body B in the above-described embodiments, the parts such as a hood, trunk lids, and doors are made of aluminum, but may be made of an aluminum alloy.

[0164] Hereinafter, the effects of the present invention are confirmed by examples and comparative examples by which the present invention is further embodied. The following examples are for confirming the effects of the degreasing and chemical conversion solution used in the above-described embodiments.

Examples

[0165] The degreasing and chemical conversion solutions of examples were prepared based on compositions shown in FIG. 20 using diethylene glycol monoethyl ether (DEGMEE) as the polar organic solvent, sodium nitrate as a sodium compound to be a source of sodium ion, lithium nitrate as a lithium compound to be a source of lithium, orthophosphoric acid as a source of phosphate ion, zinc nitrate as a zinc compound to be a source of zinc ion, nickel nitrate as a nickel compound to be a source of nickel ion, and manganese nitrate as a manganese compound to be a source of manganese ion.

[0166] Hexafluorozirconate (Deoxylyte 54C, made by Henkel Corp.) was used as the chemical conversion solution for aluminums of the examples.

[0167] Three types of test pieces of cold rolled steel (Fe), electrogalvanized steel (Zn), aluminum 6111 (Al) were prepared and degreased with acetone. Then the test pieces were coated with 0.5 g/m^2 of mixed oil, which contains three types of anti corrosion oil (Rustclean K made by Cosmo oil Co., Ltd, NR3 made by Idemitsu Kosan Co., Ltd, Nonrust PN-1 made by Nippon oil Corp.) of the same amount, whereby the test pieces each having an oil surface for tests were prepared. These test pieces were treated with the above-described degreasing and chemical conversion solution and chemical conversion solution for aluminum. Properties and performances of obtained zinc phosphate coating, specifically, coating weight, density of the crystalline coating, first painting adhesion, and second painting adhesion were evaluated. The results thereof are shown in FIG. 20.

[0168] The treatment with the degreasing and chemical conversion solution was performed by dipping each test piece into the degreasing and chemical conversion solution. The treatment time was set to 300 seconds, and the temperature of the degreasing and chemical conversion solution was set to 40°C. The treatment with the chemical conversion solution for aluminum was performed by spraying the chemical conversion solution for aluminum onto each test piece. The spraying time was set to 20, 30, and 100 seconds. The pH of the chemical conversion solution for aluminum was set to 4.0, and the temperature thereof was set to 40°C.

[0169] The results of the coating weight, the density of the crystalline coating, the first painting adhesion, and the second painting adhesion were evaluated by four classification of A (very good), B (good), C (slightly poor), and D (poor).

[0170] The coating weight was measured after drying each treated test piece by a drier. The coating weight is converted into a weight (g) per 1 m^2. Here, in order for the zinc phosphate chemical conversion coating to have excellent anti-corrosion and adhesion, a uniform and dense crystalline coating with a coating weight in the order of 2 to 3.5 g/m^2 is required. Accordingly, the coating weight of 2 to 2.5 g/m^2 was evaluated as A (very good); the coating weight of 2.6 to 3.5 g/m^2 was evaluated as B (good); the coating weight of 1.5 to 1.9 g/m^2 was evaluated as C (slightly poor); and the coating weight of less than 1.5 g/m^2 was evaluated as D (poor).

[0171] For the density of the crystalline coating, a sample was sampled from a center of each test piece after treated, and shape and size of the zinc phosphate crystalline coating were observed with a scanning electron microscope (SEM).

[0172] In the examples, the samples were evaluated based on the criteria that the crystal size indicating the density of 5 μm or less was evaluated as A (very good); the density of above 5 μm to 10 μm or less was evaluated as B (good); the density of above 10 μm to 20m or less was evaluated as C (slightly poor); the density of 20 μm or grater was evaluated as D (poor).

[0173] The first painting adhesion is evaluated by painting the test pieces after the treatment. Specifically, the test pieces after the treatment were dipped in electrocoating paint (Succeed#80V made by Herberts-Shinto Automotive Systems Co., Ltd.) and then a voltage of 200 V was applied thereto for energization for 3 minutes. Subsequently, the test pieces were baked at 170°C for 20 minutes, thus forming an electrocoating film with a thickness of 15 to 20 μm. In accordance with a cross hatch test (JIS K5600-5-6, ISO 2409) using the test pieces thus obtained with the electrocoating films formed thereon, the painting surface of each test piece is given scored lines at intervals of 1 mm by a NT cutter to form 100 grids, and a piece of cellophane tape (18 mm wide, made by Nichiban Co., Ltd.) was attached thereto. After 2 minutes, the piece of cellophane tape was peeled off, and the evaluation was made by the number of grids where the coating film was left. When the number of grids with the coating film left is 100, the evaluation was A (very good); 95 to 99 grids were evaluated as (good); 85 to 94 grids were evaluated as C (slightly poor): 84 grids or less were evaluated as D (poor).

[0174] In the second painting adhesion, an electrocoating film, similar to that in the above-described first painting adhesion test was formed and then immersed in hot water. Accordingly, the adhesion of the coating film was evaluated after being deliberately deteriorated. In the immersion in hot water, each test piece with the electrocoating film formed thereon was immersed in hot water at 40°C ± 1°C for 1000 hours. The evaluation of adhesion was made in accordance with the cross hatch test (JIS K5600-5-6, ISO 2409) similarly to the first painting adhesion.

Comparative Examples

[0175] The degreasing and chemical conversion solution and the aluminum conversion treatment solution were prepared under the same conditions as those of the examples except that the weight ratio of the polar organic solvent to water in the degreasing and chemical conversion solution is set to 1:9 in the comparative examples, and the evaluation similar to the examples were carried out. The results thereof are shown in FIG. 21.

Consideration

[0176] As apparent from the results shown in FIGs. 20 and 21, in the method of pretreatment before painting in the comparative examples, any of the coating weight, the density of the crystalline coating, the first painting adhesion, and the first painting adhesion was evaluated as "slightly poor" or "poor". However, by employing the method of pretreatment before painting in the examples, any of the coating weight, the density of the crystalline coating, the first painting adhesion, and the first painting adhesion is evaluated as "good" or "very good". Consequently, it is confirmed that there is no problem in quality.

[0177] The entire content of Japanese Patent Applications No. P2002-171075, No. P2002-171080 and No. P2002-171081 with a filing date of June 12, 2002 is herein incorporated by reference.

[0178] Although the invention has been described above by reference to certain embodiments of the invention, the invention is not limited to the embodiments described above will occur to these skilled in the art, in light of the teachings. The scope of the invention is defined with reference to the following claims.

Claims

1. Equipment of pretreatment before painting, comprising:

a treatment tank (101) filled with a degreasing and chemical conversion solution containing a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion, the mixed solution having a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2, works (B) being dipped in the treatment tank (101);

an aluminum chemical conversion unit which treats the works (B) with a chemical conversion solution for aluminum, the aluminum chemical conversion unit being provided at a subsequent stage of the treatment tank (101); and
a rinse unit which washes the works (B) with a washing solution, the rinse unit being provided at a subsequent stage of the aluminum chemical conversion unit.

2. The equipment of pretreatment before painting according to claim 1,
wherein at least part of the works (B) are composite vehicle bodies of iron and aluminum having any of an aluminum and aluminum alloy part for at least part of outer panel portions.

3. The equipment of pretreatment before painting according to one of claims 1 and 2,
wherein the aluminum chemical conversion unit includes: a chemical conversion solution replenishment tank (301) which accommodates the chemical conversion solution for aluminum being adjusted; and a spray which sprays the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) onto the works (B).

4. The equipment of pretreatment before painting according to claim 3,
wherein the aluminum chemical conversion unit includes: a recovery tank (307) for recovering the chemical conversion solution for aluminum sprayed onto the works (B); and a first pipe system for returning the chemical conversion solution for aluminum recovered in the recovery tank (307) to the chemical conversion solution replenishment tank (301).

5. The equipment of pretreatment before painting according to claim 4,
wherein the first pipe system has a dust eliminator (310) for removing dust contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); a chemical conversion sludge eliminator (311) for removing chemical conversion sludge contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); and an oil eliminator (312) for removing oil contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307).

6. The equipment of pretreatment before painting according to claim 5, further comprising:

a second pipe system which introduces the washing solution in the rinse unit to any of the recovery tank (307) and a most upstream eliminator among the dust eliminator (310), the chemical conversion sludge eliminator (311), and the oil eliminator (312).

7. The equipment of pretreatment before painting according to claim 1,
wherein the aluminum chemical conversion unit includes an aluminum chemical conversion tank (313) filled with the chemical conversion solution for aluminum, the works being dipped into the aluminum chemical conversion tank (313).

8. The equipment of pretreatment before painting according to claim 7,
wherein each of the works (B) is fully dipped in the aluminum chemical conversion tank (313).

9. The equipment of pretreatment before painting according to claim 7,
wherein each of the works (B) is half dipped in the aluminum chemical conversion tank (313).

10. The equipment of pretreatment before painting according to claims 7 through 9,
wherein the aluminum chemical conversion unit includes: a chemical conversion solution replenishment tank (301) which accommodates the chemical conversion solution for aluminum being adjusted; a third pipe system which supplies the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) to the aluminum chemical conversion tank (313); and a fourth pipe system which returns the chemical conversion solution for aluminum in the aluminum chemical conversion tank (313) to the chemical conversion solution replenishment tank (301).

11. The equipment of pretreatment before painting according to claim 10,
wherein the fourth pipe system includes a dust eliminator (310) for removing dust contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); a chemical conversion sludge eliminator (311) for removing chemical conversion sludge contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); and an oil eliminator (312) for removing oil contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307).

12. The equipment of pretreatment before painting according to claim 11, further comprising:

a fifth pipe system which introduces the washing solution of the rinse unit to a most upstream eliminator among the dust eliminator (310), the chemical conversion sludge eliminator (311), and the oil eliminator (312).

13. The equipment of pretreatment before painting according to claim 1, further comprising:

a second rinse unit which washes the works (B) with a washing solution, the second rinse unit being provided at a subsequent stage of the treatment tank and at a preceding stage of the aluminum chemical conversion unit;
a first circulating system which has the treatment tank (101) and circulates the degreasing and chemical conversion solution;
a dust eliminator (102) which removes dust contained in the degreasing and chemical conversion solution;
a chemical conversion sludge eliminator (103) which removes chemical conversion sludge contained in the degreasing and chemical conversion solution, the chemical conversion sludge eliminator (103) being provided for the first circulating system;
an oil eliminator (104) which removes oil contained in the degreasing and chemical conversion solution; and
a treatment solution replenishment tank (109) which adjusts a solution having passed the dust eliminator (102), the sludge eliminator (103), and the oil eliminator (104) and replenishes the treatment tank (101) with the adjusted solution, the treatment solution replenishment tank (109) being provided for the first circulating system.

14. The equipment of pretreatment before painting according to claim 1,

wherein the aluminum chemical conversion unit is a rinse-aluminum chemical conversion unit which sprays a washing solution onto the works (B) when the works (B) do not include any of the aluminum and aluminum alloy part and which treats the works (B) with the chemical conversion solution for aluminum when each of the works (B) includes at least any of the aluminum and aluminum alloy part.

15. The equipment of pretreatment before painting according to claim 14, further comprising:

a vehicle type detector (501) which detects vehicle specifications, the vehicle type detector (501) allowing materials of components of each of the works (B) to be distinguished; and
a controller (502) which controls the treatment in the rinse-aluminum chemical conversion unit in accordance with material specifications of each of the works (B) being detected by the vehicle type detector (501).

16. The equipment of pretreatment before painting according to claim 14, further comprising:

a washing solution recovery tank (412) which recovers the washing solution used in the rinse-aluminum chemical conversion unit;
a chemical conversion solution recovery tank (418) which recovers a chemical conversion solution for aluminum used in the rinse-aluminum chemical conversion unit;
a washing solution replenishment tank (403) which stores the washing solution used in the rinse-aluminum chemical conversion unit;
a chemical conversion solution replenishment tank (405) which stores the chemical conversion solution for aluminum to be used in the rinse-aluminum chemical conversion unit;
a sixth pipe system which sucks the washing solution recovered by the washing solution recovery tank (412) and supplying the washing solution to the washing solution replenishment tank (403);
a seventh pipe system which supplies the chemical conversion solution for aluminum recovered by the chemical conversion solution recovery tank (418) to the chemical conversion solution replenishment tank (405);
a spray which sprays any of the washing solution and the chemical conversion solution for aluminum onto the works (B); and
an eighth pipe system which sucks any of the washing solution in the washing solution replenishment tank (403) and the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (405) and supplies the sucked solution to the spray.

17. The equipment of pretreatment before painting according to claim 16, further comprising:

a dust eliminator (415) which removes dust contained in the washing solution in the washing solution recovery tank (412), the dust eliminator (415) being provided for the sixth pipe system;
a chemical conversion sludge eliminator (416) which removes chemical conversion sludge contained in the washing solution, the chemical conversion sludge eliminator (416) being provided for the sixth pipe system; and
an oil eliminator (417) which removes oil contained in the washing solution, the oil eliminator (417) being provided for the sixth pipe system.

18. The equipment of pretreatment before painting according to claim 16, further comprising:

a vehicle type detector (501) which detects vehicle specifications, the vehicle type detector (501) allowing materials of components of each of the works (B) to be distinguished; and

a controller (502) which controls the treatment in the rinse-aluminum chemical conversion unit in accordance with material specifications of each of the works (B) detected by the vehicle type detector (501),

wherein the eighth pipe system includes a first pump (404) which sucks the washing solution in the washing solution replenishment tank (403), a second pump (406) which sucks the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (405), and a first switch valve (407) which switches a supply path for the spray, and

wherein the controller (502) transmits operation signals to the first pump (404), the second pump (406), and the first switch valve (407) in accordance with the material specifications of each of the works (B) being detected by the vehicle type detector (501).

19. The equipment of pretreatment before painting according to claim 18, further comprising:

a ninth pipe system which introduces the washing solution used in the rinse-aluminum chemical conversion unit to the washing solution recovery tank (412) and introduces the chemical conversion solution for aluminum used in the rinse-aluminum chemical conversion unit to the chemical conversion solution recovery tank (418); and

a second switch valve (411) which switches paths of the used washing solution and the used chemical conversion solution for aluminum, the second switch valve (411) being provided for the ninth pipe system,

wherein the controller (512) transmits an operation signal to the second switch valve (411) in accordance with the material specifications of each of the works (B) being detected by the vehicle type detector (501).

20. The equipment of pretreatment before painting according to claim 17, further comprising:

a tenth pipe system which introduces the washing solution in the rinse unit to any of the washing solution recovery tank (412) and a most upstream eliminator among the dust eliminator (415), the chemical conversion sludge eliminator (416), and the oil eliminator (417).

21. The equipment of pretreatment before painting according to claims 14 through 20, further comprising:

a first circulating system which has the treatment tank (101) and circulates the degreasing and chemical conversion solution;

a dust eliminator (102) which removes dust contained in the degreasing and chemical conversion solution;

a chemical conversion sludge eliminator (103) which removes chemical conversion sludge contained in the degreasing and chemical conversion solution, the chemical conversion sludge eliminator (103) being provided for the first circulating system;

an oil eliminator (104) which removes oil contained in the degreasing and chemical conversion solution; and

a treatment solution replenishment tank (109) which adjusts a solution having passed the dust eliminator (102), the sludge eliminator (103), and the oil eliminator (104) and replenishes the treatment tank (101) with the adjusted solution, the treatment solution replenishment tank (109) being provided for the first circulating system.

22. The equipment of pretreatment before painting according to claim 21,

wherein the dust eliminator (102) and the oil eliminator (104) are provided for the first circulating system.

23. The equipment of pretreatment before painting according to claim 22, further comprising:

a water-polar organic solvent separator (112) which separates water and a polar organic solvent of the solution having passed the dust eliminator (102), the chemical conversion sludge eliminator (103), and the oil eliminator (104) and supplies the polar organic solvent to the treatment solution replenishment tank (109).

24. The equipment of pretreatment before painting according to claim 23, further comprising:

a second circulating system which supplies the water separated by the water-polar organic solvent separator (112) to the second rinse unit.

25. The equipment of pretreatment before painting according to claim 24, further comprising:

an ion eliminator (113) which removes ion components from the water separated by the water-polar organic solvent separator (112) and supplies the residual water to the second rinse unit, the ion eliminator (113) being provided for the second circulating system.

26. The equipment of pretreatment before painting according to claim 25,
wherein at least part of the water obtained by the ion eliminator (113) is supplied to the treatment solution replenishment tank (109).

27. The equipment of pretreatment before painting according to claim 23, further comprising:

a third circulating system which sucks the used washing solution in the second rinse unit and introduces the sucked solution to a most upstream eliminator among the dust eliminator (102), the chemical conversion sludge (103), and the oil eliminator (104).

28. The equipment of pretreatment before painting according to claims 23 through 27,
wherein the water-polar organic solvent separator (112) separates water and the polar organic solvent by pervaporation.

29. The equipment of pretreatment before painting according to one of claims 25, 26, and 28,
wherein the ion eliminator (113) includes: a cation exchange tower (1131) filled with first cation exchange resin; an anion exchange tower (1132) filled with anion exchange resin; an ion exchange tower (1133) filled with second cation exchange resin; and a decarbonator tower.

30. The equipment of pretreatment before painting according to claim 29,
wherein the first cation exchange resin is chelate type cation exchange resin, the anion exchange resin is styrene type strong base anion exchange resin, and the third cation exchange resin is strong acid cation exchange resin in H form.

31. The equipment of pretreatment before painting according to claim 1, further comprising:

a second rinse unit which washes the works (B) with a washing solution, the second rinse unit being provided at a subsequent stage of the treatment tank (101) and at a proceeding stage of the aluminum chemical conversion unit;
a treatment solution replenishment tank (109) which replenishes the treatment tank (101) with the degreasing and chemical conversion solution; and
a vacuum distillation unit (130) which separates the solutions in the treatment tank (101) and the second rinse unit into the polar organic solvent, water, and residual sludge by use of vacuum distillation, supplies the separated polar organic solvent to the treatment replenishment tank (109), and supplies the separated water to the treatment solution replenishment tank (109) and the second rinse unit.

32. The equipment of pretreatment before painting according to claim 31,
wherein waste heat of a paint drying oven is used for a heat source of the vacuum distillation unit (103).

33. The equipment of pretreatment before painting according to claim 13,
wherein the second rinse unit includes a dipping tank (120) filled with the washing solution, the works (B) being dipped in the dipping tank.

34. The equipment of pretreatment before painting according to claim 13,
wherein the second rinse unit includes a spray which sprays the washing solution onto the works (B).

35. The equipment of pretreatment before painting according to claims 13 through 34,
wherein at least part of the works (B) are composite vehicle bodies of iron and aluminum having any of an aluminum and aluminum alloy part for at least part of outer panel portions.

36. The equipment of pretreatment before painting according to claim 35,
wherein the works (B) include: an iron vehicle body with all components made of iron; an aluminum vehicle body with all components made of any of aluminum and aluminum alloys; and a composite body of iron and any of aluminum and alloy with at least part of components made of any of aluminum and aluminum alloy.

37. The equipment of pretreatment before painting according to one of claims 13 and 31,
wherein the aluminum chemical conversion unit includes: a chemical conversion solution replenishment tank (301) which accommodates the adjusted chemical conversion solution for aluminum; and a spray which sprays the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) onto the works (B).

38. The equipment of pretreatment before painting according to claim 37,
wherein the aluminum chemical conversion unit includes: a recovery tank (307) which recovers the chemical conversion solution for aluminum sprayed onto the works (B); and a eleventh pipe system which returns the chemical conversion so-

lution for aluminum recovered to the recovery tank (307) to the chemical conversion solution replenishment tank (301).

39. The equipment of pretreatment before painting according to claim 38,

wherein the eleventh pipe system has a dust eliminator (310) for removing dust contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); a chemical conversion sludge eliminator (311) for removing chemical conversion sludge contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); and an oil eliminator (312) for removing oil contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307).

40. The equipment of pretreatment before painting according to claim 39, further comprising:

a twelfth pipe system which introduces the washing solution in the rinse unit to any of the recovery tank (307) and a most upstream eliminator among the dust eliminator (310), the chemical conversion sludge eliminator (311), and the oil eliminator (312).

41. The equipment of pretreatment before painting according to one of claim 13 and 31,

wherein the aluminum chemical conversion unit includes a aluminum chemical conversion tank (313) filled with the chemical conversion solution for aluminum, the works (B) being dipped in the aluminum chemical conversion tank (313).

42. The equipment of pretreatment before painting according to claim 1, further comprising:

a vehicle type detector (501) which detects vehicle specifications, the vehicle type detector allowing materials of components of each of the works (B) to be distinguished; and

a controller (502) which controls a treatment condition in the aluminum chemical conversion unit in accordance with material specifications of each of the works (B) being detected by the vehicle type detector (501).

43. The equipment of pretreatment before painting according to claim 42,

wherein the works (B) include: an iron vehicle body with all components made of iron; an aluminum vehicle body with all components made of any of aluminum and aluminum alloys; and a composite body of iron and any of aluminum and alloy with at least part of components made of any of aluminum and aluminum alloy.

44. The equipment of pretreatment before painting according to one of claim 42 and 43,

wherein the aluminum chemical conversion unit includes: a chemical conversion solution replenishment tank (301) which accommodates the adjusted chemical conversion solution for aluminum; and a spray which sprays the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) onto the works (B).

45. The equipment of pretreatment before painting according to claim 44,

wherein the controller (502) controls a spraying condition of the chemical conversion solution for aluminum by the spray in accordance with material specifications of each of the works (B) detected by the vehicle type detector (501).

46. The equipment of pretreatment before painting according to claim 45,

wherein the controller (502) carries out control to stop spraying of the chemical conversion solution for aluminum by the spray when each of the works (B) is the iron vehicle body, and the controller (502) carries out control to spray the chemical conversion solution for aluminum by the spray when each of the works (B) is any of the aluminum vehicle body and the composite vehicle body.

47. The equipment of pretreatment before painting according to claim 46,

wherein the controller (502) carries out control to spray the chemical conversion solution for aluminum onto the whole of the vehicle body by the spray when each of the works (B) is the aluminum vehicle body, and the controller (502) carries out control to spray the chemical conversion solution for aluminum mainly onto aluminum parts of the vehicle body by the spray when each of the works (B) is the composite vehicle body.

48. The equipment of pretreatment before painting according to claims 44 through 47,

wherein the aluminum chemical conversion unit includes: a recovery tank (307) which recovers the chemical conversion solution for aluminum sprayed onto the works (B); and a thirteenth pipe system which returns the chemical conversion solution for aluminum recovered to the recovery tank (307) to the chemical conversion solution replenishment tank (301).

49. The equipment of pretreatment before painting according to claim 48,

wherein the thirteenth pipe system has a dust eliminator (310) for removing dust contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); a chemical conversion sludge eliminator (311) for removing chemical conversion sludge contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); and an oil eliminator (312) for removing oil contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307).

50. The equipment of pretreatment before painting according to claim 49, further comprising:

a fourteenth pipe system which introduces the washing solution in the rinse unit to any of the recovery tank (307) and a most upstream eliminator among the dust eliminator (310), the chemical conversion sludge eliminator (311), and the oil eliminator (312).

51. The equipment of pretreatment before painting according to claim 44, further comprising:

a bypass line which bypasses the aluminum chemical conversion unit, the bypass line being provided in parallel to the aluminum chemical conversion unit,

wherein the controller (502) selects any one of the aluminum chemical conversion unit and the bypass line as a destination of each of the works (B) in accordance with the material specifications of each of the works (B) being detected by the vehicle type detector (501).

52. The equipment of pretreatment before painting according to claim 51,

wherein the controller (502) carries out control to convey the works (B) to the bypass line when each of the work (B) is the iron vehicle body, and the controller (502) carries out control to convey the works (B) to the aluminum chemical conversion unit when each of the works (B) is any of the iron vehicle body or the composite vehicle body.

53. The equipment of pretreatment before painting according to claim 52,

wherein the aluminum chemical conversion unit includes a chemical conversion solution replenishment tank (301) which accommodates the adjusted chemical conversion solution for aluminum, and a spray which sprays the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) onto the works (B),

wherein the controller (502) carries out control to spray the chemical conversion solution for aluminum onto the whole of the vehicle body by the spray when each of the works (B) is the aluminum vehicle body, and the controller (502) carries out control to spray the chemical conversion solution for aluminum onto mainly aluminum components of the vehicle body by the spray when each of the works (B) is the composite vehicle body.

54. The equipment of pretreatment before painting according to claim 52,

wherein the aluminum chemical conversion unit includes a aluminum chemical conversion tank (313) filled with the chemical conversion solution for aluminum, the works (B) being dipped in the aluminum chemical conversion tank (313).

55. The equipment of pretreatment before painting according to claim 52,

wherein the aluminum chemical conversion unit includes: a chemical conversion solution replenishment tank (301) which accommodates the chemical conversion solution for aluminum being adjusted; a fifteenth pipe system which supplies the chemical conversion solution for aluminum in the chemical conversion solution replenishment tank (301) to the aluminum chemical conversion tank (313); and a sixteenth pipe system which returns the chemical conversion solution for aluminum in the aluminum chemical conversion tank (313) to the chemical conversion solution replenishment tank (301).

56. The equipment of pretreatment before painting according to claim 52,

wherein the thirteenth pipe system has a dust eliminator (310) for removing dust contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); a chemical conversion sludge eliminator (311) for removing chemical conversion sludge contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307); and an oil eliminator (312) for removing oil contained in the chemical conversion solution for aluminum being recovered to the recovery tank (307).

57. The equipment of pretreatment before painting according to claim 52, further comprising:

a seventeenth pipe system which introduces the washing solution in the rinse unit to a most upstream eliminator among the dust eliminator (310), the chemical conversion sludge eliminator (311), and the oil eliminator (312).

58. The equipment of pretreatment before painting according to one of claims 5, 6, 11 through 13, 17, 20 through 30, 39 through 41, 49, 50, 56 and 57,

wherein the dust eliminator includes any of a settling tank (102A), a centrifugal separator (102B), a magnetic separator (102C) and a combination thereof.

59. The equipment of pretreatment before painting according to any of claims 5, 6, 11 through 13, 17, 20 through 30, 39 through 41, 49, 50, 56 and 57,
wherein the chemical conversion sludge eliminator includes a dead-end filter capable of suppressing a concentration of sludge of the degreasing and chemical conversion solution in the treatment tank to 150 ppm or less.

60. The equipment of pretreatment before painting according to one of claims 5,6,11 through 13, 17, 20 through 30, 39 through 41, 49, 50, 56 and 57,
wherein the oil eliminator includes a heating type oil eliminator, a coalescer type oil eliminator, an ultrafiltration type oil eliminator and combination thereof.

61. The equipment of pretreatment before painting according to claims 1 through 60,
wherein the polar organic solvent contains at least one of glycol ether and diethylene glycol ether.

62. The equipment of pretreatment before painting according to claims 1 through 61,
wherein 0.8 to 3.3 parts by weight of any of sodium ion and lithium ion are contained per 100 parts by weight of mixed solution of the polar organic solution and water.

63. The equipment of pretreatment before painting according to claim 62,
wherein a molar ratio of the sodium ion to lithium ion is in a range of 50:50 to 2:98.

64. The equipment of pretreatment before painting according to claims 1 through 63,
wherein 0.2 to 0.5 parts by weight of phosphate ion and 0.5 to 0.7 parts by weight of zinc ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

65. The equipment of pretreatment before painting according to claims 1 through 64,
wherein 0.09 to 0.23 parts by weight of nickel ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

66. The equipment of pretreatment before painting according to claims 1 through 65,
wherein 0.03 to 0.16 parts by weight of manganese ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

67. The equipment of pretreatment before painting according to claims 1 through 66,
wherein 3.5 to 10.8 parts by weight of any of nitrate ion and nitrite ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

68. The equipment of pretreatment before painting according to claims 1 through 67,
wherein the temperature of the degreasing and chemical conversion solution filled in the treatment tank (101) is in a range from 40 to 60°C, and a dipping time of each of the works (B) is in a range from 3 to 10 minutes.

69. The equipment of pretreatment before painting according to claims 1 through 68,
wherein the chemical conversion solution for aluminum contains at least one of hexafluorotitanate and hexafluorozirconate.

70. The equipment of pretreatment before painting according to claims 1 through 69,
wherein the chemical conversion solution for aluminum sprayed on the work (B) has a pH in a range from 2.5 to 10 and a temperature in a range from 20 to 70°C, and a period of spraying the chemical conversion solution for aluminum onto the work (B) is in a range from 20 to 100 seconds.

71. A method of pretreatment before painting, comprising:

dipping a composite vehicle body (B), which has any of an aluminum and aluminum alloy part for at least part of outer panel portions, into a degreasing and chemical conversion solution containing at least a mixed solution of a polar organic solvent and water, any of sodium ion and lithium ion, phosphate ion, zinc ion, nickel ion, manganese ion, and any of nitrate ion and nitrite ion, the mixed solution having a weight ratio of the polar organic solution to the water in a range of 2.8:7.2 to 3.8:6.2;
treating the vehicle body in a chemical conversion solution for aluminum; and
washing the vehicle body with a washing solution.

72. The method of pretreatment before painting according to claim 71, further comprising:

washing the vehicle body with a washing solution after the dipping.

73. The method of pretreatment before painting according to one of claims 71 and 72,
wherein the polar organic solvent contains at

least one of glycol ether and diethylene glycol ether.

74. The method of pretreatment before painting according to claims 71 through 73,
wherein 0.8 to 3.3 parts by weight of any of sodium ion and lithium ion are contained per 100 parts by weight of mixed solution of the polar organic solution and water.

75. The method of pretreatment before painting according to claim 75,
wherein a molar ratio of the sodium ion to lithium ion is in a range of 50:50 to 2:98.

76. The method of pretreatment before painting according to claims 71 through 75,
wherein 0.2 to 0.5 parts by weight of phosphate ion and 0.5 to 0.7 parts by weight of zinc ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

77. The method of pretreatment before painting according to claims 71 through 76,
wherein 0.09 to 0.23 parts by weight of nickel ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

78. The method of pretreatment before painting according to claims 71 through 77,
wherein 0.03 to 0.16 parts by weight of manganese ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

79. The method of pretreatment before painting according to claims 71 through 78,
wherein 3.5 to 10.8 parts by weight of any of nitrate ion and nitrite ion are contained per 100 parts by weight of the mixed solution of the polar organic solution and water.

80. The method of pretreatment before painting according to claims 71 through 79,
wherein the temperature of the degreasing and chemical conversion solution filled in the treatment tank (101) is in a range from 40 to 60°C, and a dipping time of each of the works (B) is in a range from 3 to 10 minutes.

81. The method of pretreatment before painting according to claims 1 through 68,
wherein the chemical conversion solution for aluminum contains at least one of hexafluorotitanate and hexafluorozirconate.

82. The method of pretreatment before painting according to claims 1 through 69,
wherein the chemical conversion solution for aluminum sprayed on the composite vehicle body (B) has a pH in a range from 2.5 to 10 and a temperature in a range from 20 to 70°C, and a period of spraying the chemical conversion solution for aluminum onto the composite vehicle body (B) is in a range from 20 to 100 seconds.

FIG. 1

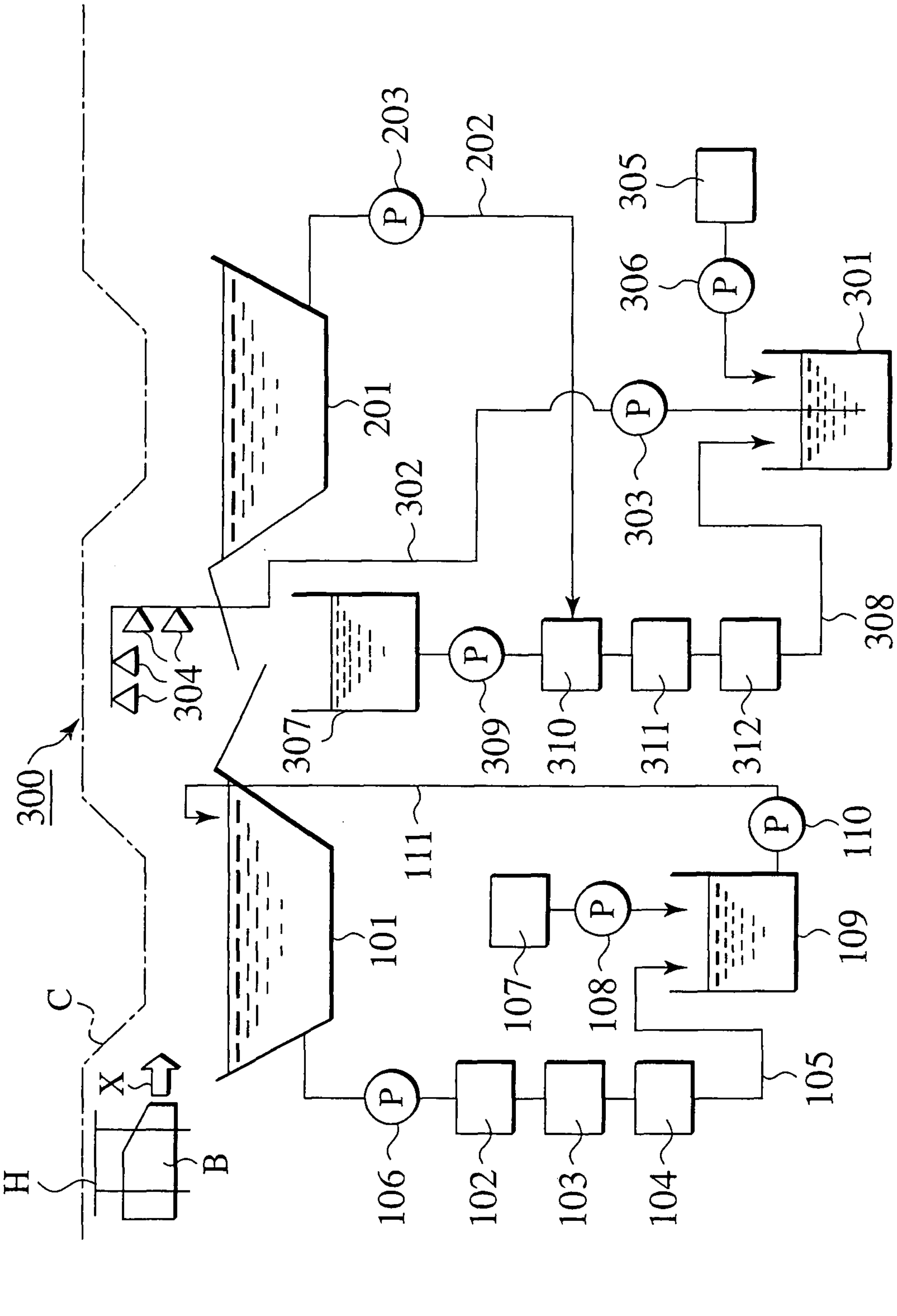

300
C
H
X
B
101
102
103
104
105
106
107
108
109
110
111
201
202
203
301
302
303
304
305
306
307
308
309
310
311
312
P
P
P
P
P
P
P

FIG. 2B

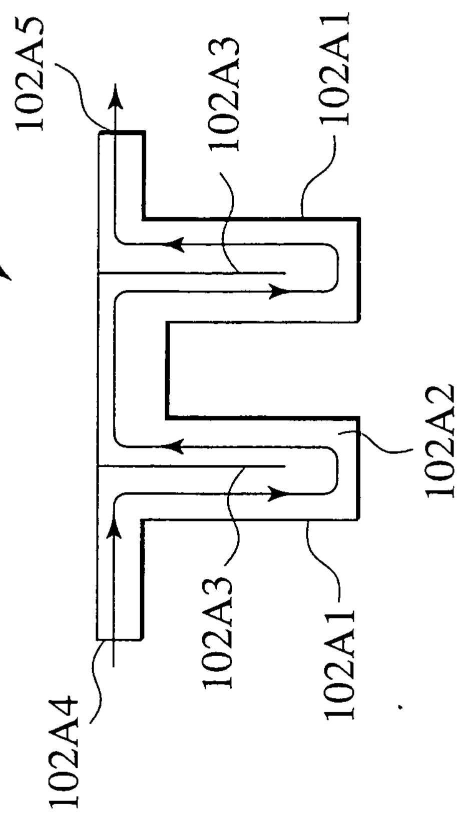

102A
102A5
102A3
102A1
102A2
102A3
102A1
102A4

FIG. 2A

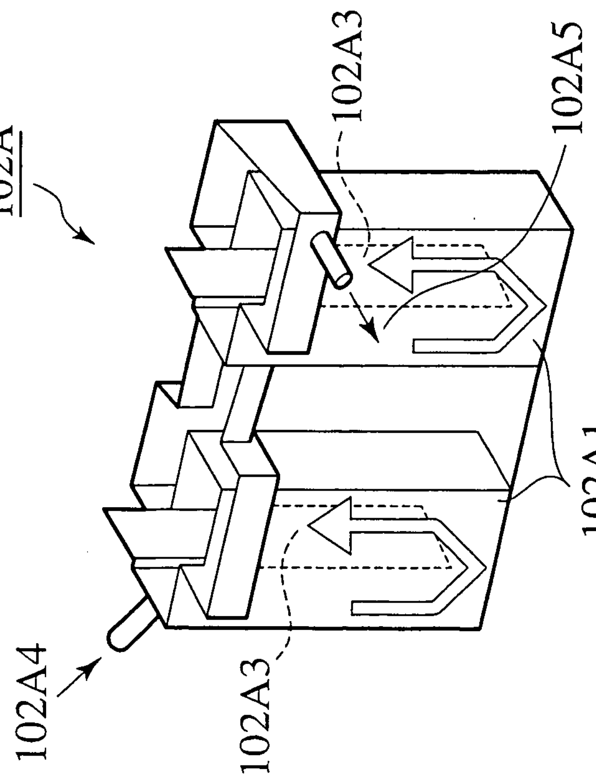

102A
102A3
102A5
102A1
102A4
102A3

FIG. 3

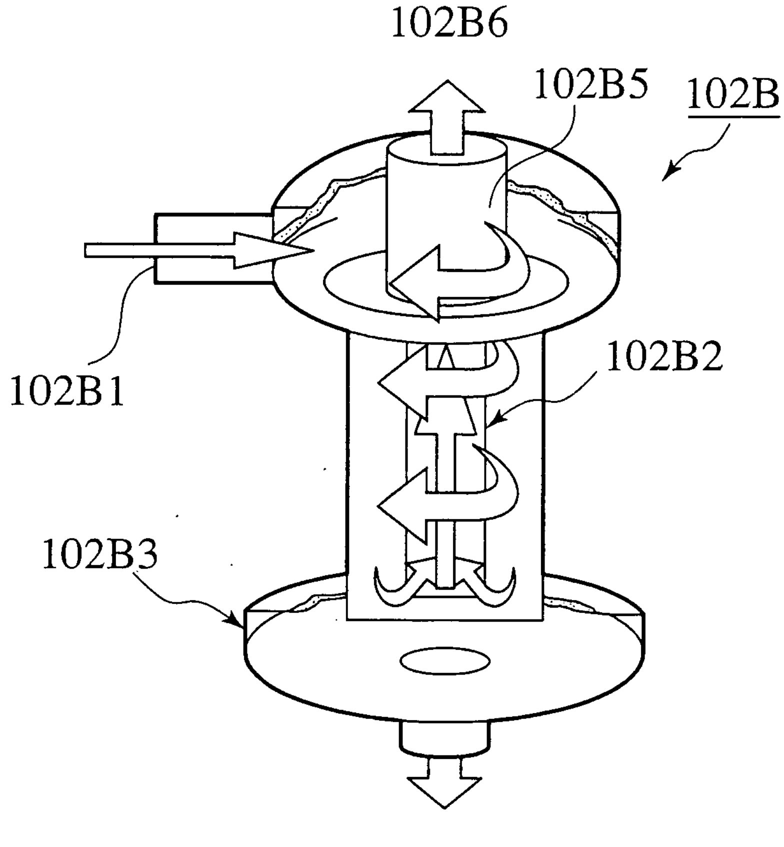


FIG. 4

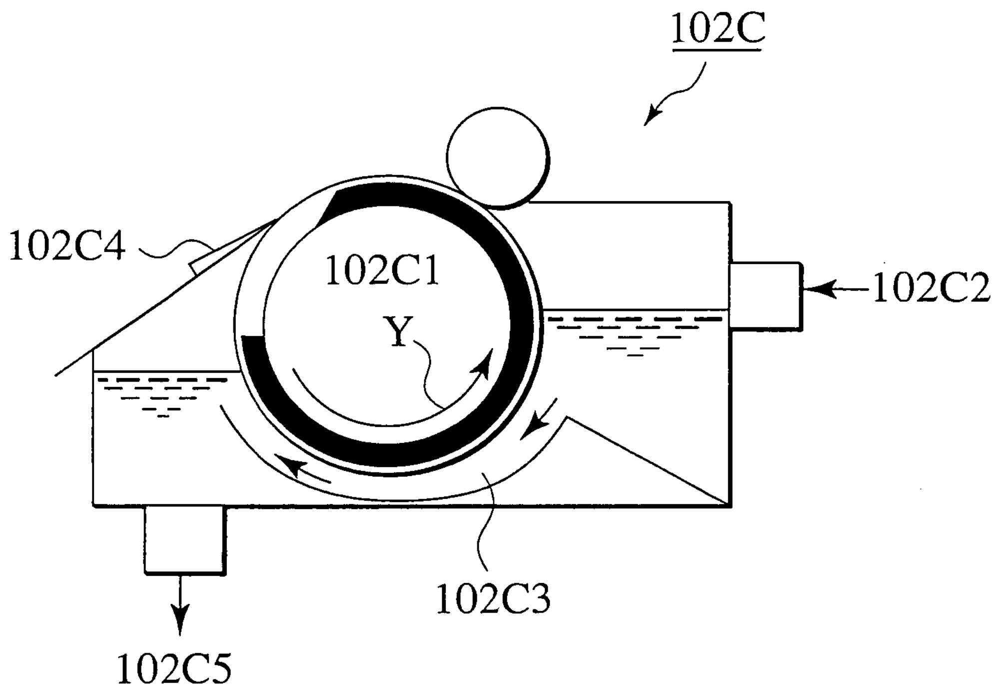


FIG. 5

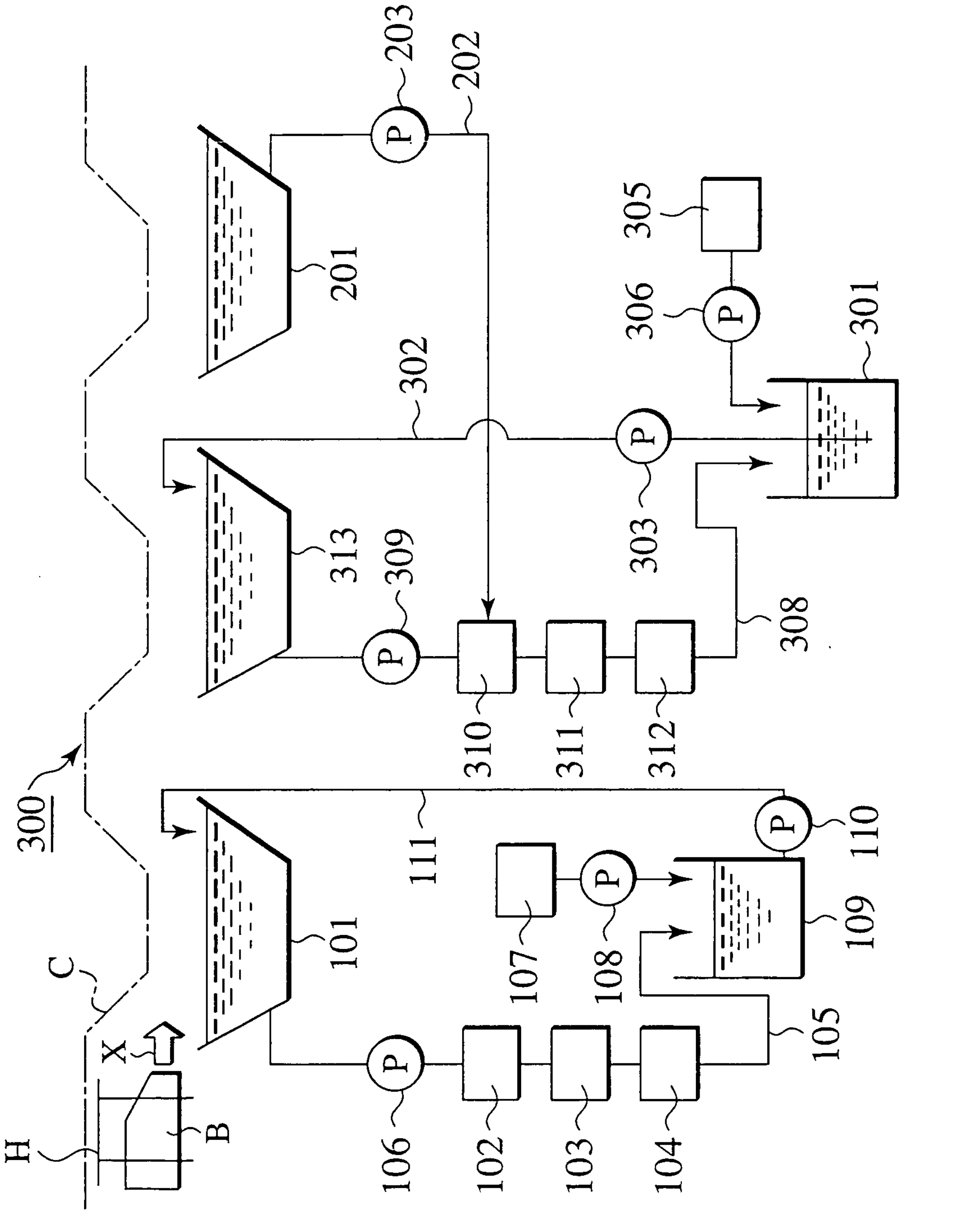

300
C
H
X
B
101
106
102
103
104
105
107
108
109
110
111
201
202
203
301
302
303
305
306
308
309
310
311
312
313
P

FIG.6

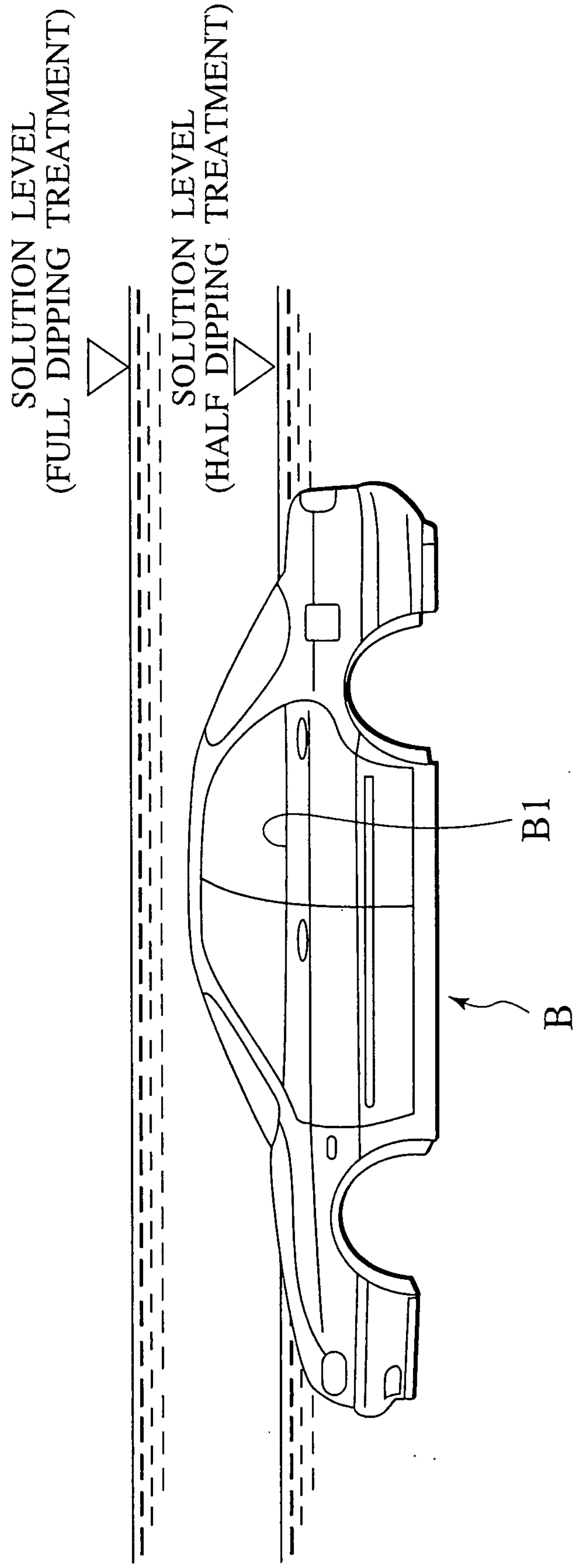

SOLUTION LEVEL
(FULL DIPPING TREATMENT)
SOLUTION LEVEL
(HALF DIPPING TREATMENT)
B1
B

FIG. 7

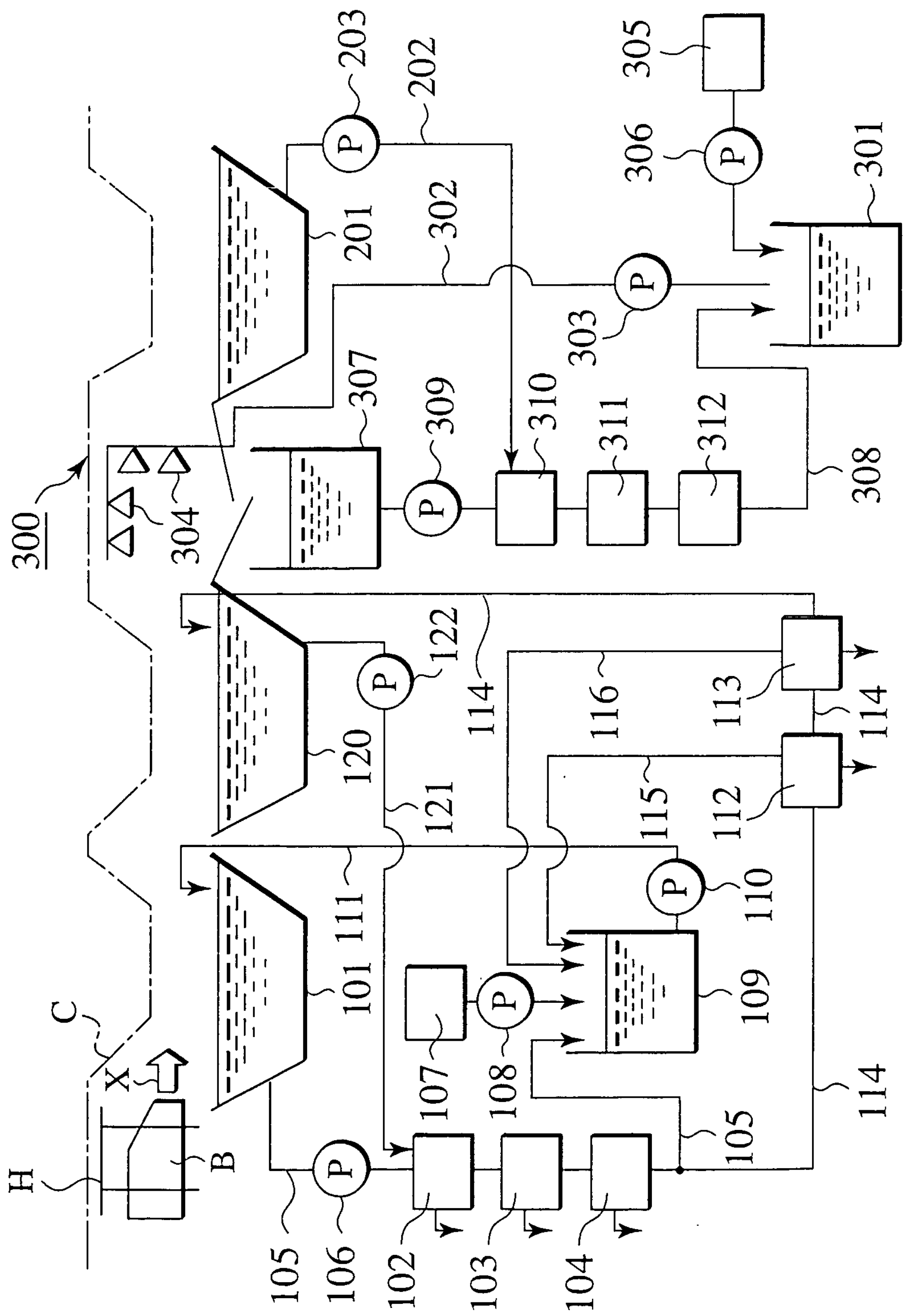

H
B
X
C
300
304
307
309
310
311
312
308
201
202
203
302
303
301
305
306
101
111
120
121
122
114
116
115
113
112
110
109
107
108
105
106
102
103
104
P

FIG. 8

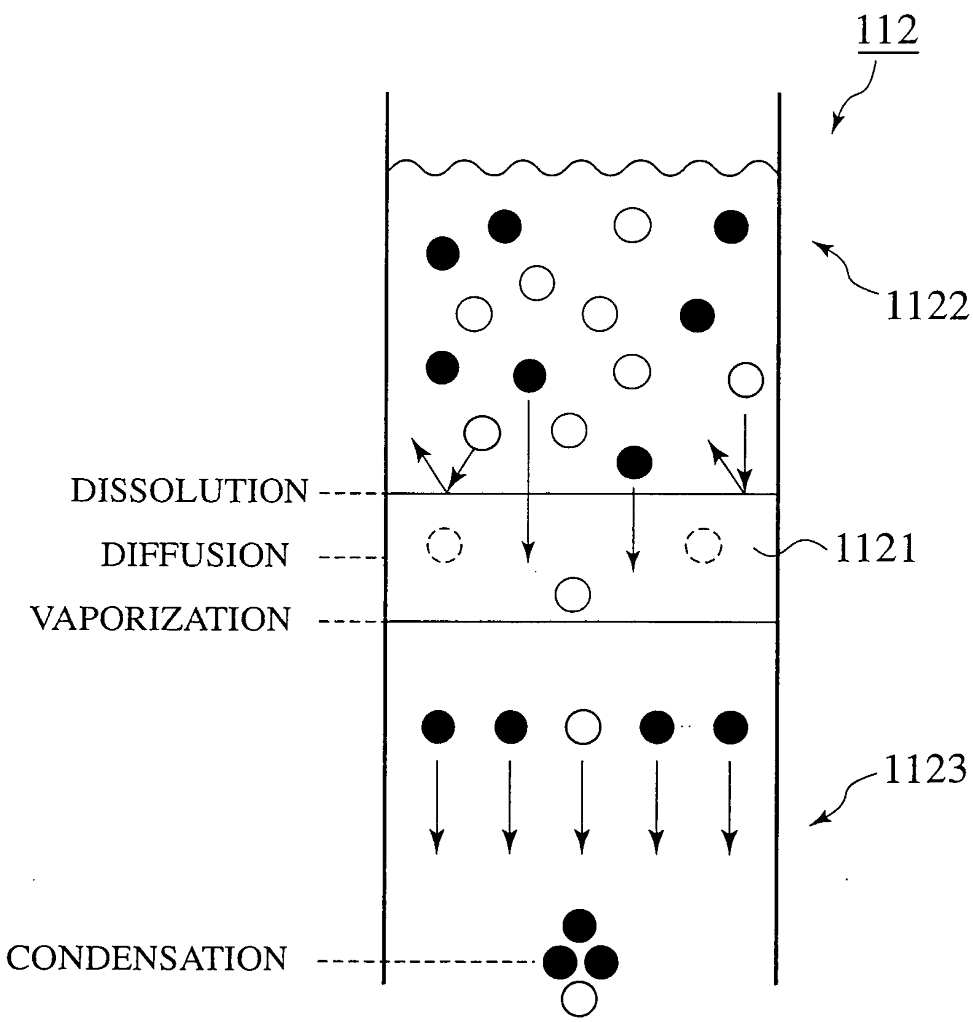

112
1122
DISSOLUTION
DIFFUSION
1121
VAPORIZATION
1123
CONDENSATION

FIG. 9

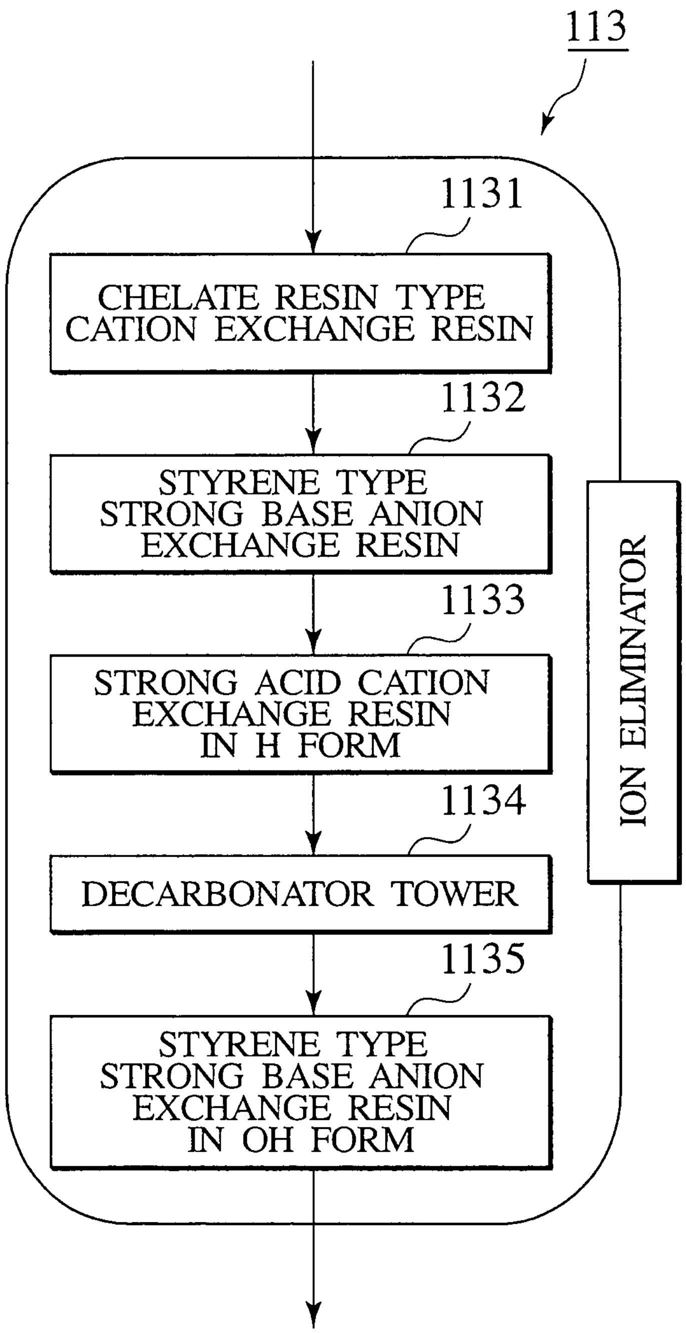

113
1131
CHELATE RESIN TYPE CATION EXCHANGE RESIN
1132
STYRENE TYPE STRONG BASE ANION EXCHANGE RESIN
1133
STRONG ACID CATION EXCHANGE RESIN IN H FORM
1134
DECARBONATOR TOWER
1135
STYRENE TYPE STRONG BASE ANION EXCHANGE RESIN IN OH FORM
ION ELIMINATOR

FIG. 10

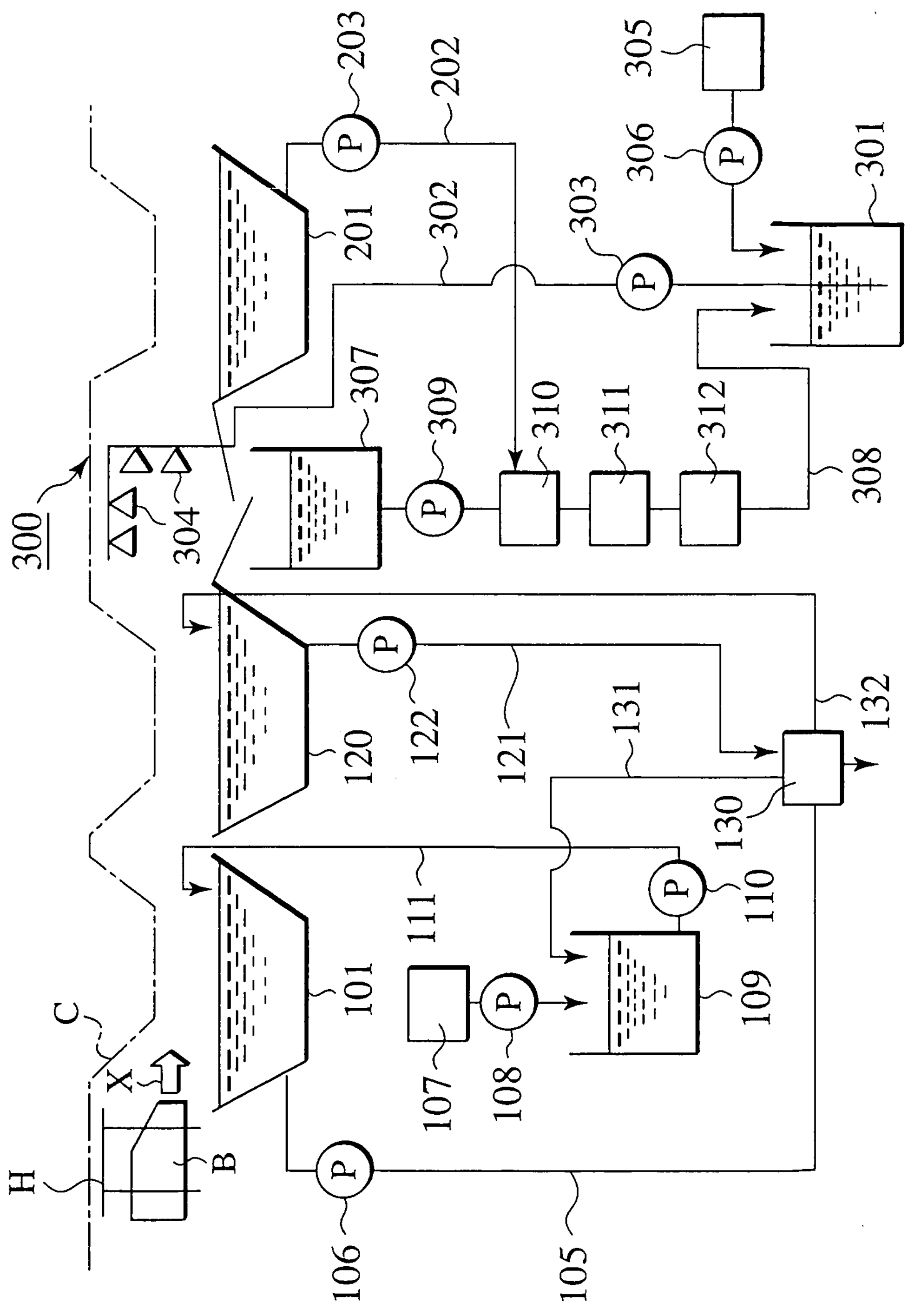

300
H
C
X
B
101
105
106
107
108
109
110
111
120
121
122
130
131
132
201
202
203
301
302
303
304
305
306
307
308
309
310
311
312
P

FIG. 11

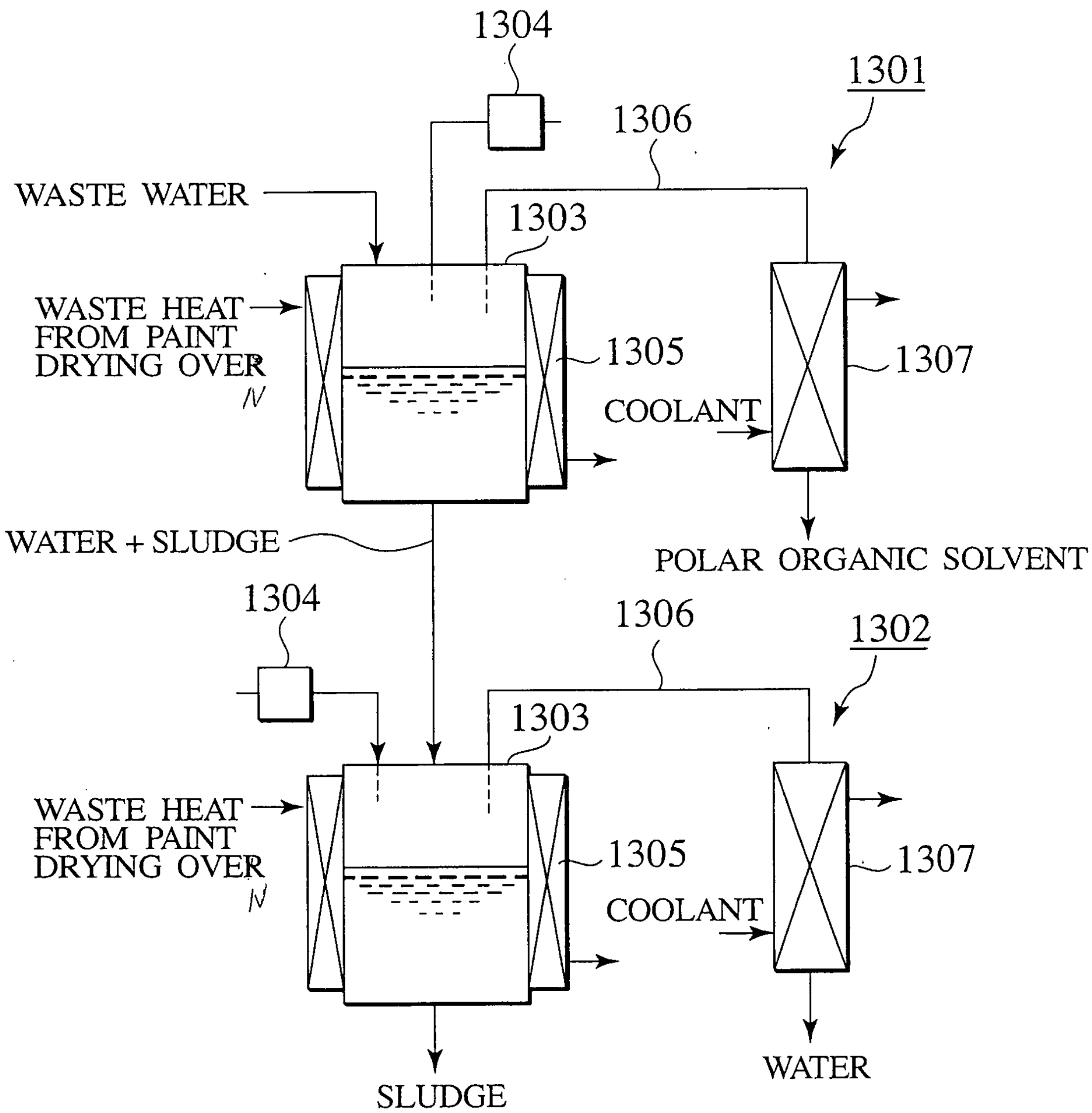
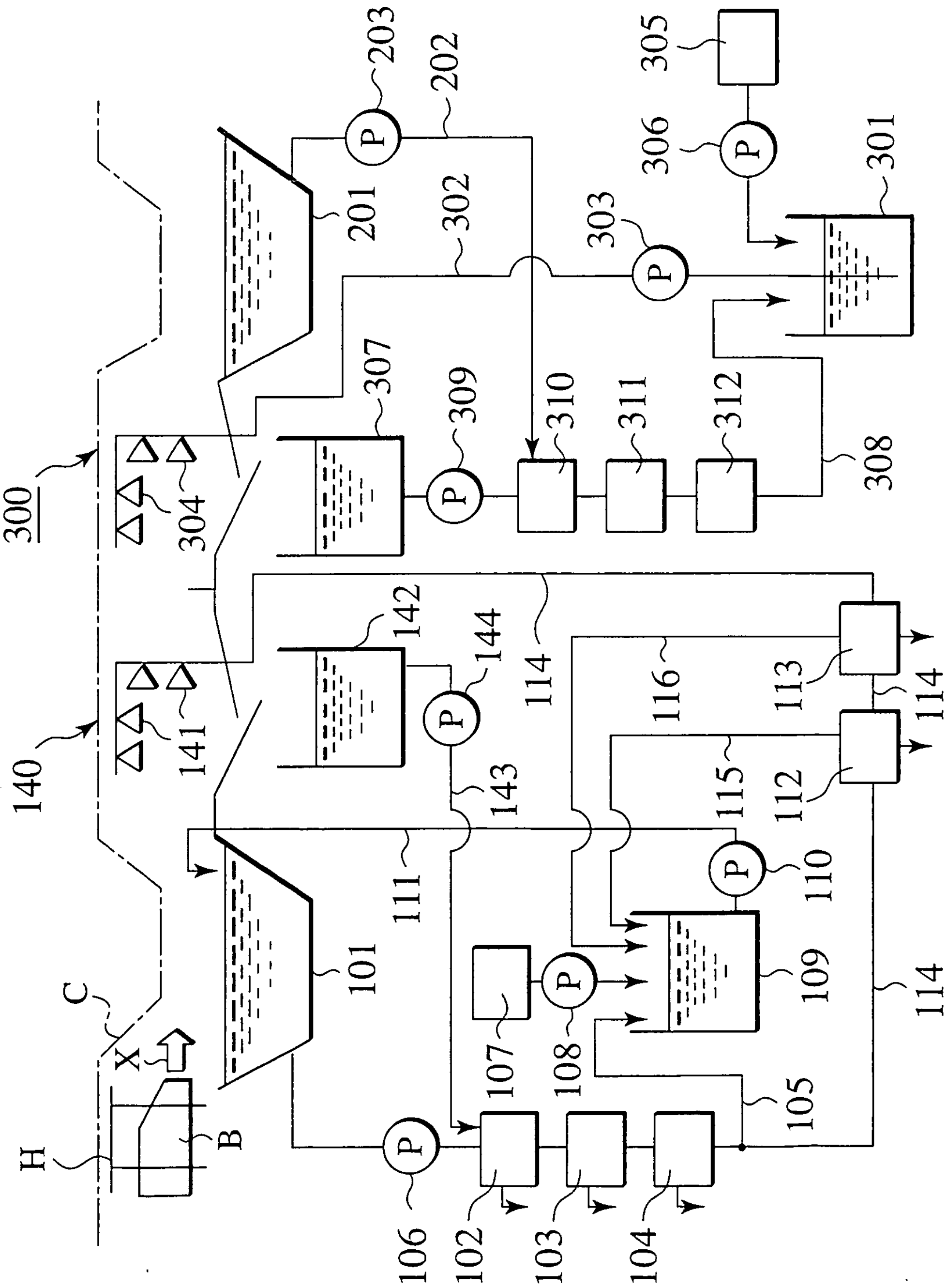

1304
1301
1306
WASTE WATER
1303
WASTE HEAT FROM PAINT DRYING OVER
1305
1307
COOLANT
WATER + SLUDGE
POLAR ORGANIC SOLVENT
1304
1306
1302
1303
WASTE HEAT FROM PAINT DRYING OVER
1305
1307
COOLANT
SLUDGE
WATER

FIG. 12



300
140
H
C
X
B
P
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
141
142
143
144
201
202
203
301
302
303
304
305
306
307
308
309
310
311
312

FIG. 13

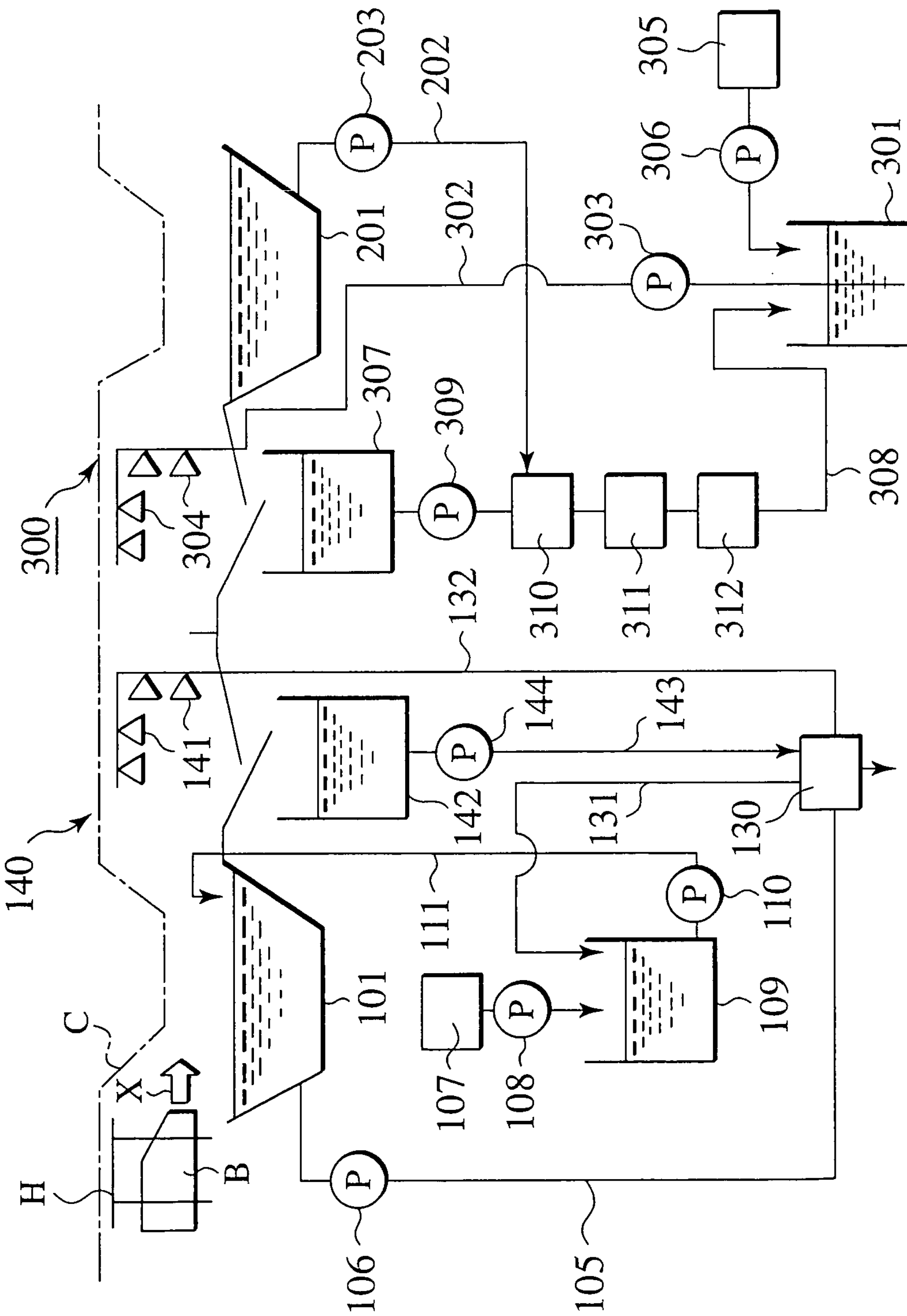

300
140
H
B
X
C
P
101
105
106
107
108
109
110
111
130
131
132
141
142
143
144
201
202
203
301
302
303
304
305
306
307
308
309
310
311
312

FIG. 14

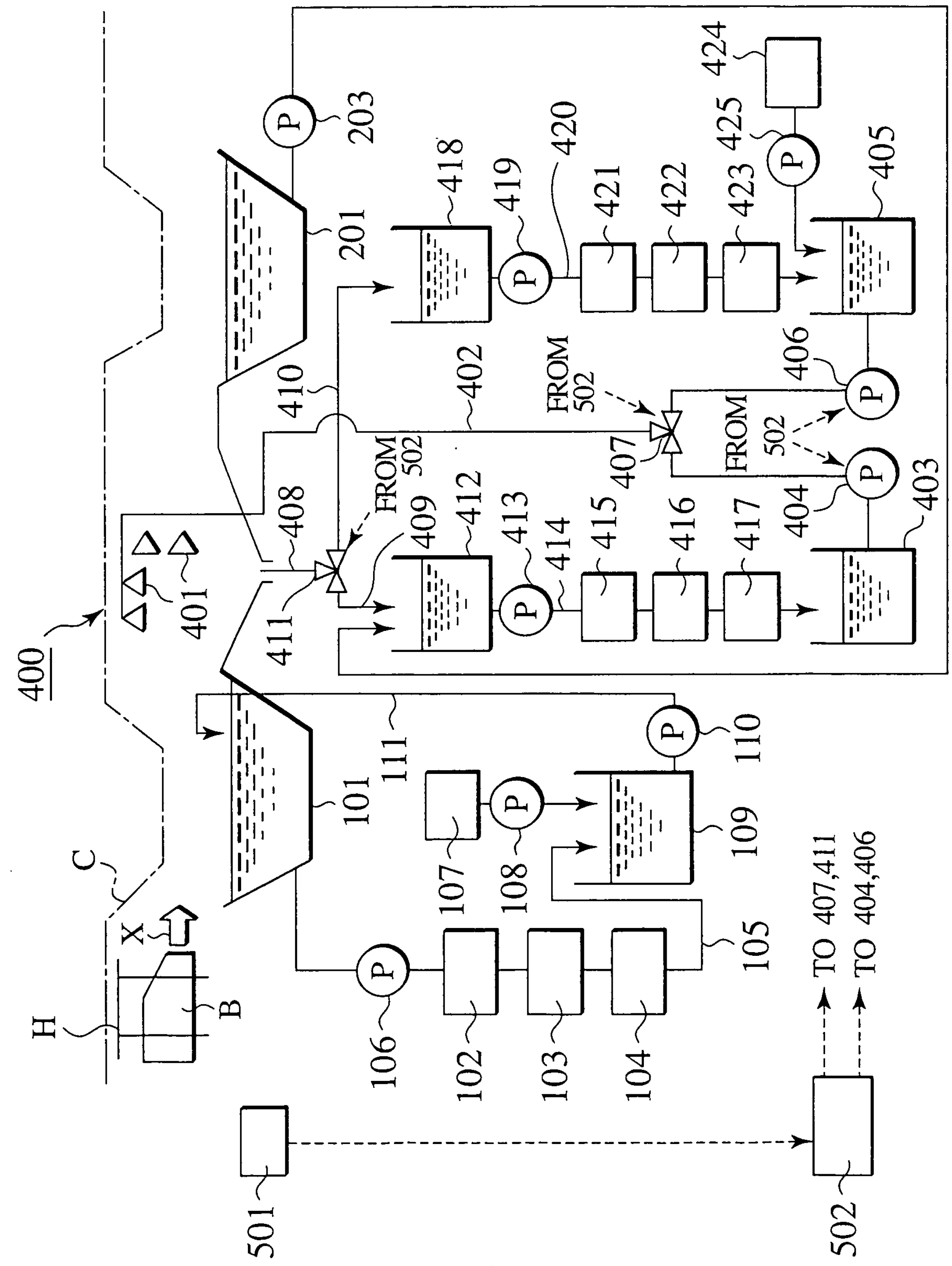

400
401
C
H
X
B
101
102
103
104
105
106
107
108
109
110
111
201
203
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
FROM 502
FROM 502
FROM 502
P
501
502
TO 407,411
TO 404,406

FIG. 15

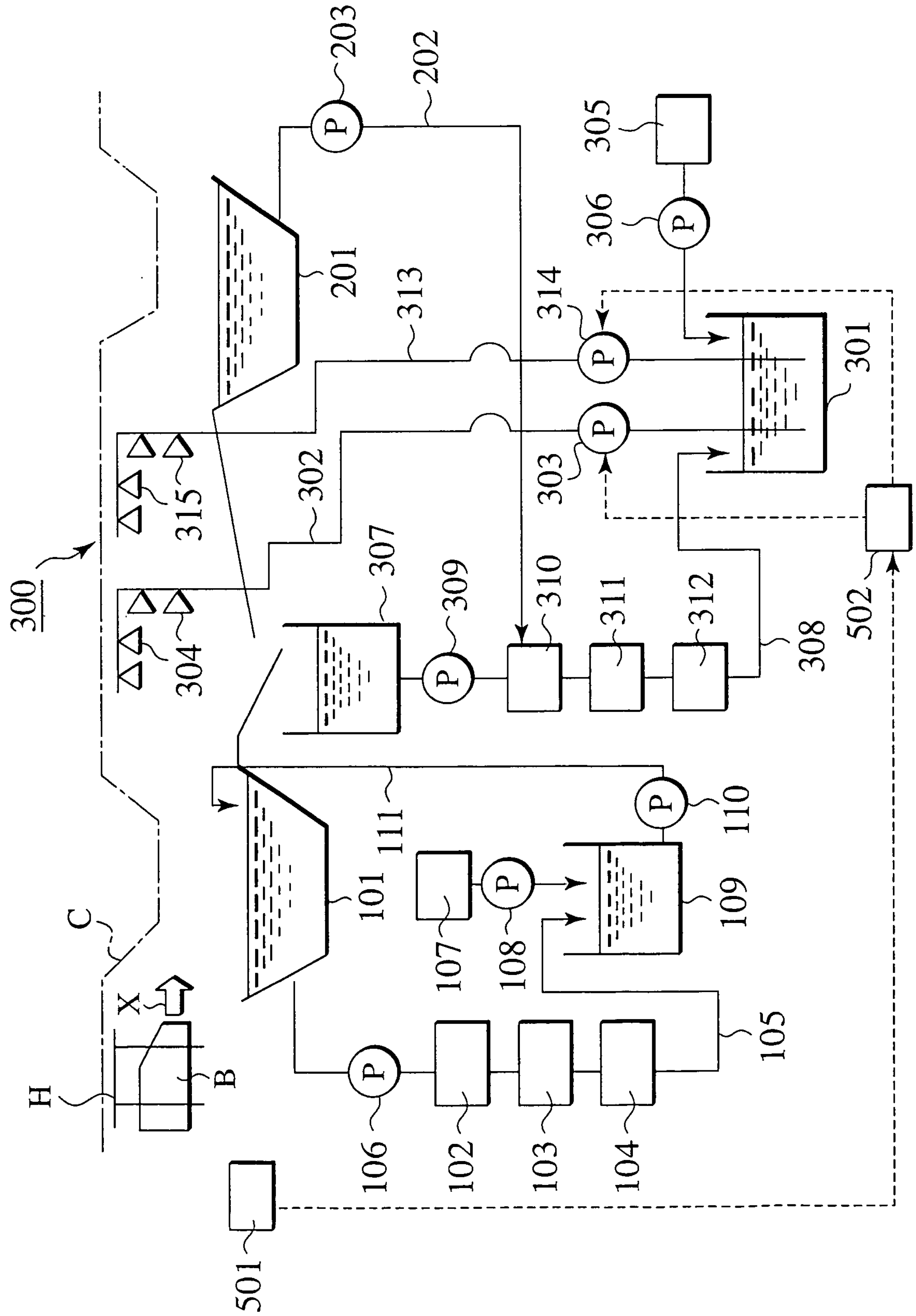

300
C
H
X
B
P
101
102
103
104
105
106
107
108
109
110
111
201
202
203
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
501
502

FIG. 16

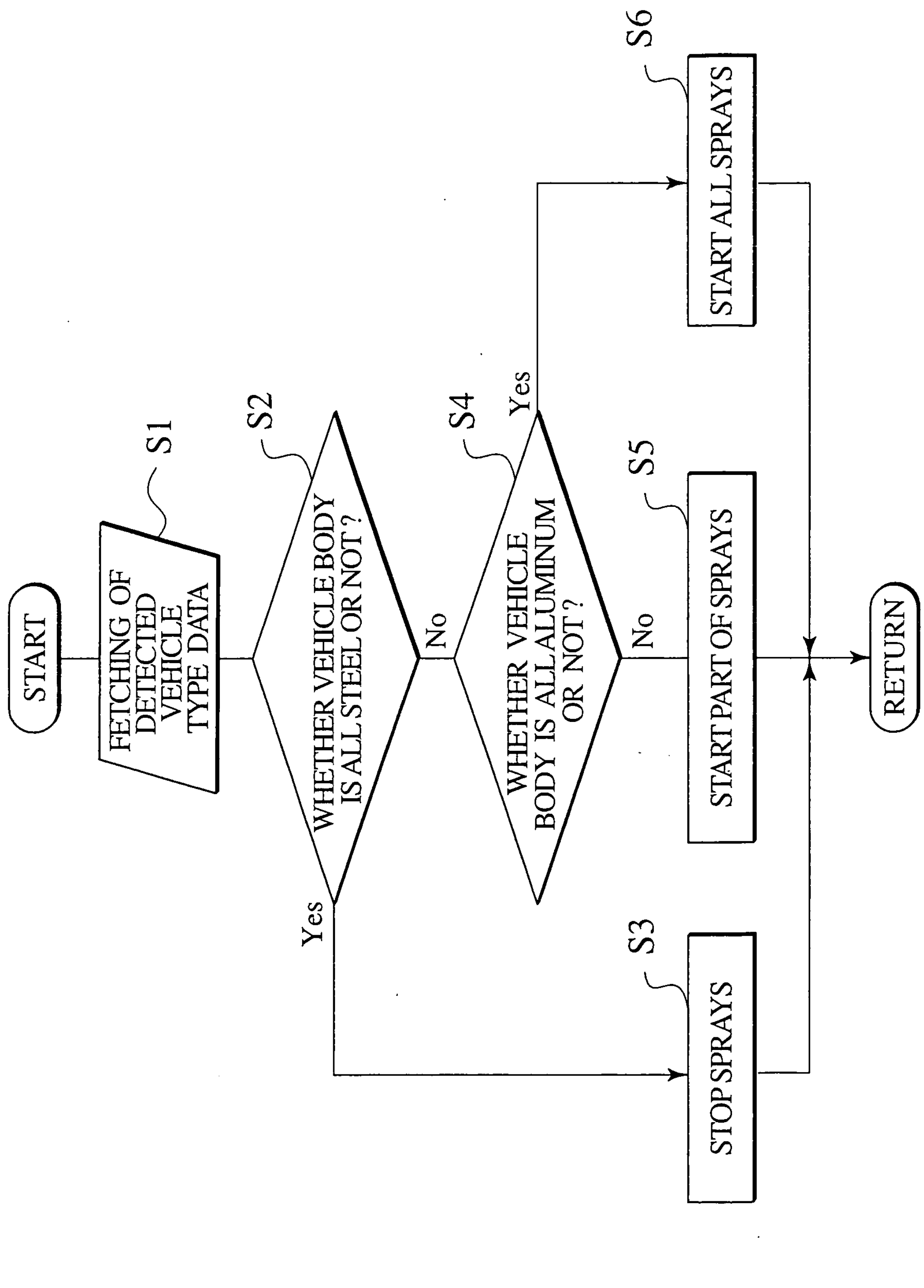

START
FETCHING OF DETECTED VEHICLE TYPE DATA
S1
WHETHER VEHICLE BODY IS ALL STEEL OR NOT ?
S2
Yes
No
S3
STOP SPRAYS
WHETHER VEHICLE BODY IS ALL ALUMINUM OR NOT ?
S4
Yes
No
S5
START PART OF SPRAYS
S6
START ALL SPRAYS
RETURN

FIG. 17

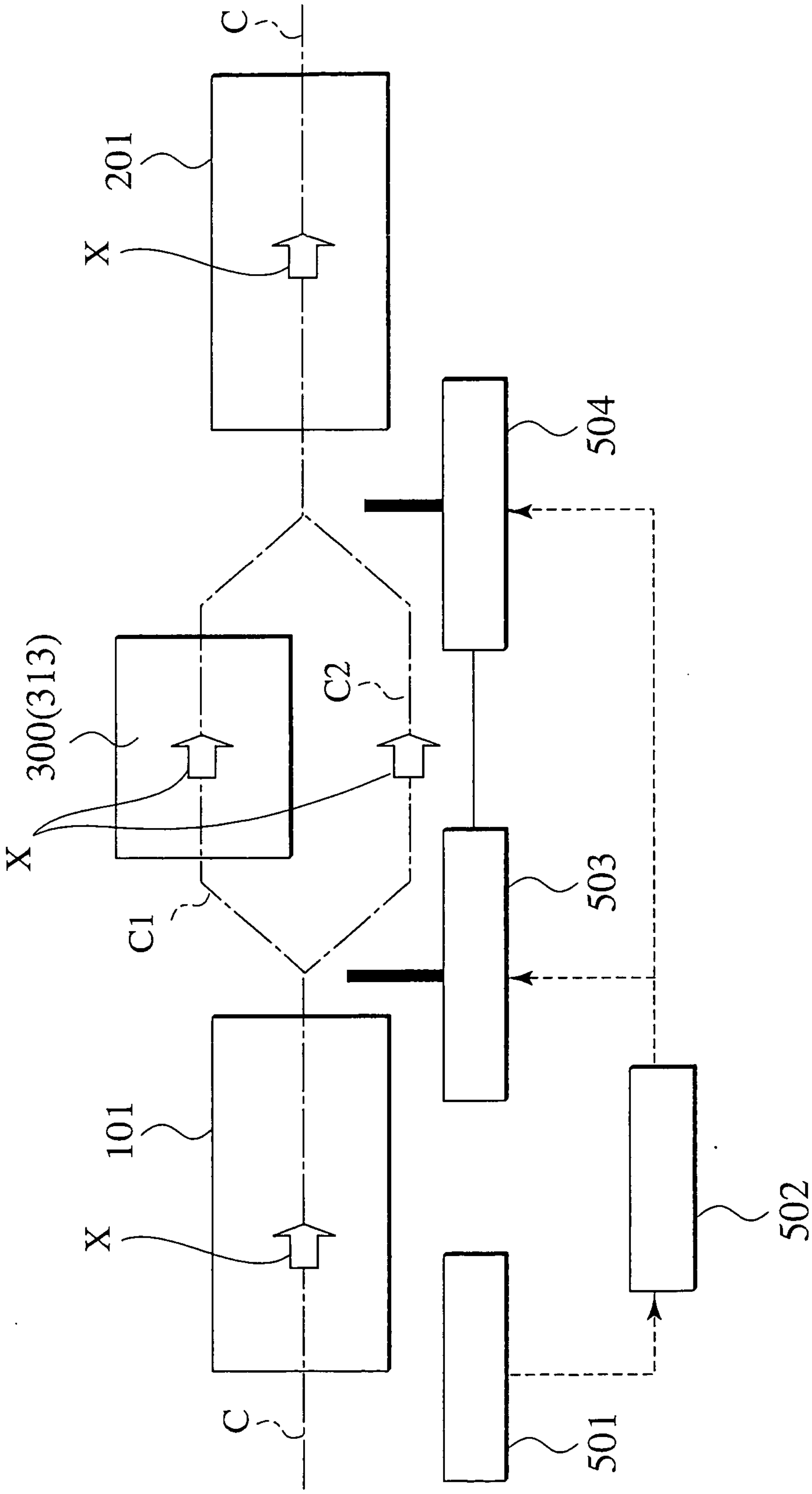


FIG. 18

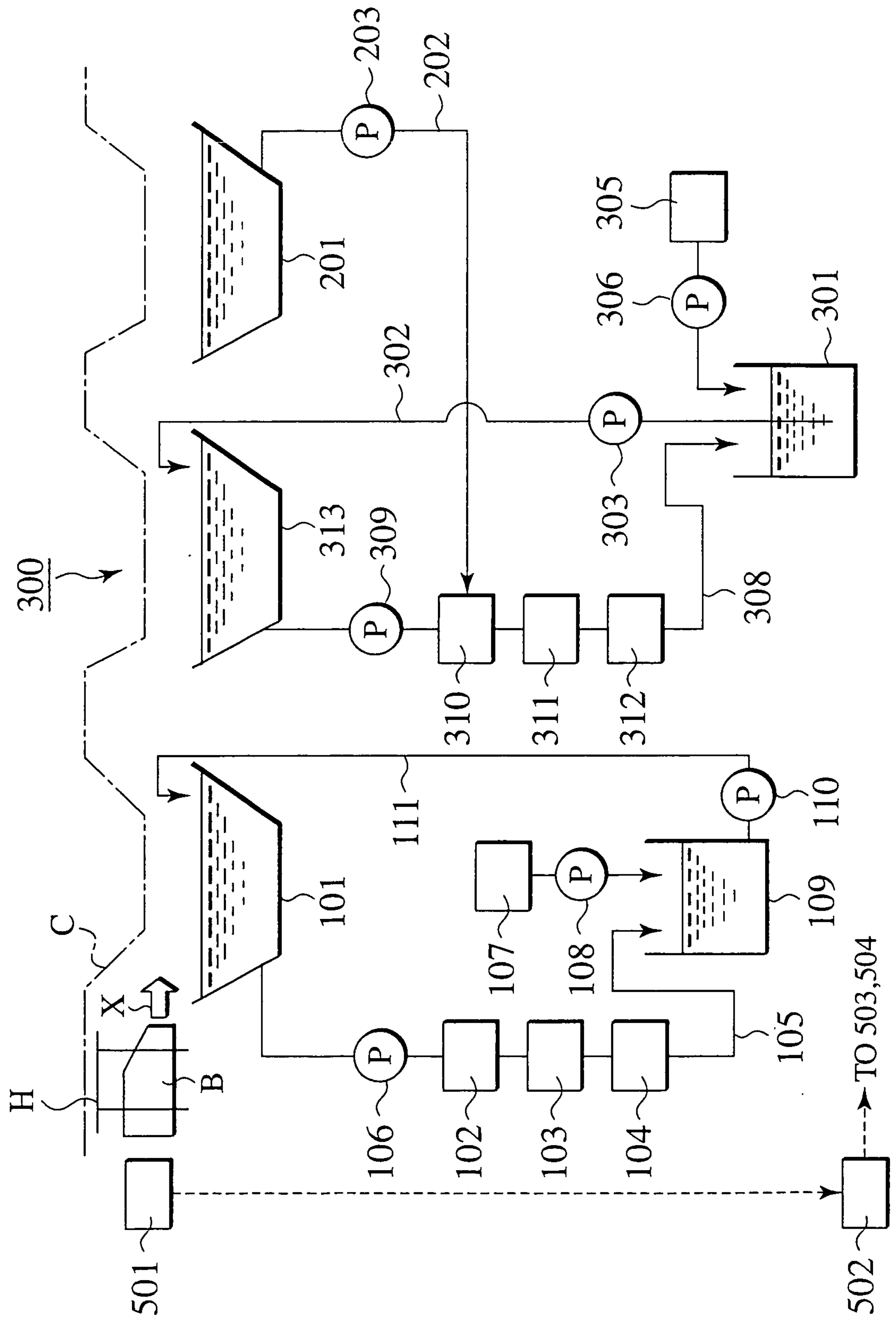

300
C
H
X
B
101
102
103
104
105
106
107
108
109
110
111
201
202
203
301
302
303
305
306
308
309
310
311
312
313
501
502
TO 503,504
P

FIG. 19

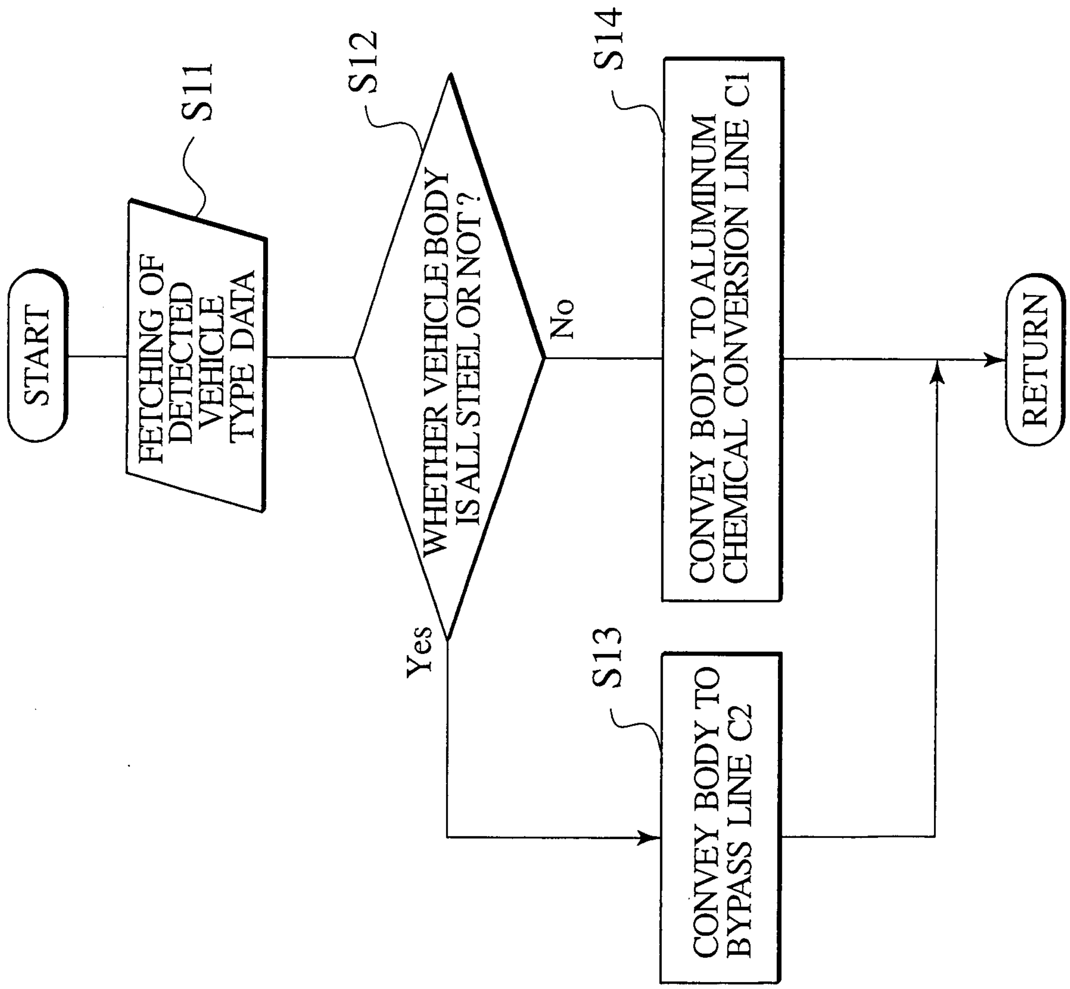

START
FETCHING OF DETECTED VEHICLE TYPE DATA
S11
WHETHER VEHICLE BODY IS ALL STEEL OR NOT ?
S12
Yes
No
CONVEY BODY TO BYPASS LINE C2
S13
CONVEY BODY TO ALUMINUM CHEMICAL CONVERSION LINE C1
S14
RETURN

FIG. 20

FIRST STEP TREATMENT SOLUTION COMPOSITION	TREATMENT TIME	300 sec																	
	TREATMENT SOLUTION TEMPERATURE	40℃																	
	MIXED RATIO OF POLAR ORGANIC SOLVENT TO WATER	3.5:6.5																	
	SODIUM COMPOUND	10 (g/100g OF MIXED SOLUTION OF POLAR ORGANIC SOLVENT AND WATER)																	
	PHOSPHORIC ACID	0.3 (g/100g OF THE MIXED SOLUTION)																	
	ZINC COMPOUND	1.59 (g/100g OF THE MIXED SOLUTION)																	
	NICKEL COMPOUND	0.62 (g/100g OF THE MIXED SOLUTION)																	
	MANGANESE COMPOUND	0.41 (g/100g OF THE MIXED SOLUTION)																	
	LITHIUM COMPOUND	SUBSTITUTION RATIO OF Na COMPOUND IS LESS THAN 50% (CARRIED OUT AT 0%,25%,45%)									SUBSTITUTION RATIO OF Na COMPOUND IS 50% OR MORE (CARRIED OUT AT 50%,75%,100%)								
SECOND STEP TREATMENT SOLUTION	TREATMENT TIME (sec)	20			30			100			20			30			100		
	TREATMENT SOLUTION TEMPERATURE	40℃																	
	pH	4.0																	
TEST PIECE		Fe	Zn	Al	Fe	Zn	Al	Fe	Zn	Al	Fe	Zn	Al	Fe	Zn	Al	Fe	Zn	Al
COATING WEIGHT		B-C	B	B-C	B-C	B	B-C	C	C	C	B	B	B	A	A	A	B	B	B
CRYSTALLINE COATING DENSITY		B-C	B	B-C	B-C	B	B-C	C	C	C	B	B	B	A	A	A	B	B	B
PAINTING ADHESION (FIRST)		B-C	B	B-C	B-C	B	B-C	C	C	C	B	B	B	A	A	A	B	B	B
PAINTING ADHESION (SECOND)		B-C	B	B-C	B-C	B	B-C	C	C	C	B	B	B	A	A	A	B	B	B

FIG. 21

FIRST STEP TREATMENT SOLUTION COMPOSITION	TREATMENT TIME	300 sec					
	TREATMENT SOLUTION TEMPERATURE	40℃					
	MIXED RATIO OF POLAR ORGANIC SOLVENT TO WATER	1:9					
	SODIUM COMPOUND	10 (g/100g OF MIXED SOLUTION OF POLAR ORGANIC SOLVENT AND WATER))					
	PHOSPHORIC ACID	0.3 (g/100g OF THE MIXED SOLUTION)					
	ZINC COMPOUND	1.59 (g/100g OF THE MIXED SOLUTION)					
	NICKEL COMPOUND	0.62 (g/100g OF THE MIXED SOLUTION)					
	MANGANESE COMPOUND	0.41 (g/100g OF THE MIXED SOLUTION)					
	LITHIUM COMPOUND	SUBSTITUTION RATIO OF Na COMPOUND IS LESS THAN 50% (CARRIED OUT AT 0%,25%,45%)			SUBSTITUTION RATIO OF Na COMPOUND IS 50% OR MORE (CARRIED OUT AT 50%,75%,100%)		
SECOND STEP TREATMENT SOLUTION	TREATMENT TIME (sec)	20	30	100	20	30	100
	TREATMENT SOLUTION TEMPERATURE	40℃					
	pH	4.0					
TEST PIECE		Fe,Zn,Al			Fe,Zn,Al		
COATING WEIGHT		D-C	D-C	D	D-C	D-C	D
CRYSTALLINE COATING DENSITY		D-C	D-C	D	D-C	D-C	D
PAINTING ADHESION (FIRST)		D-C	D-C	D	D-C	D-C	D
PAINTING ADHESION (SECOND)		D-C	D-C	D	D-C	D-C	D