



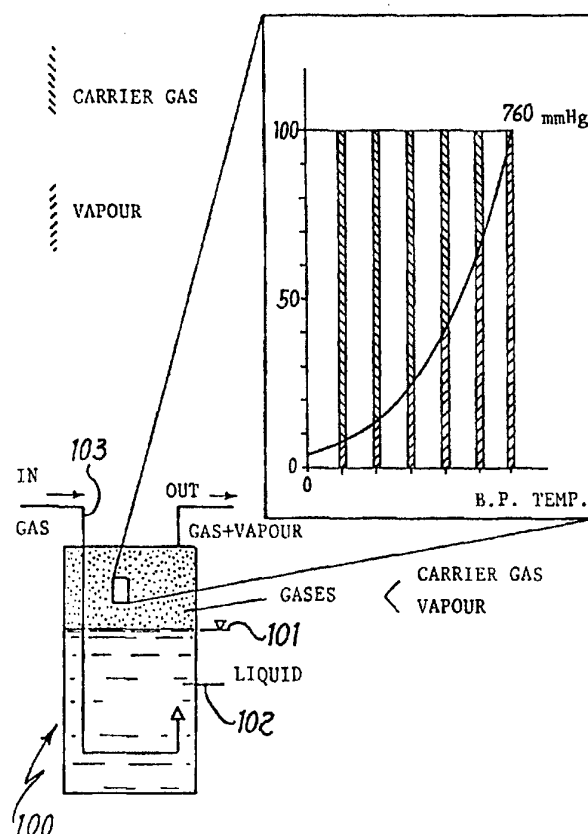
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(54) Title: METHOD AND DEVICE FOR THE CONTROLLED FORMING AND FEEDING OF A GASEOUS ATMOSPHERE HAVING AT LEAST TWO COMPONENTS, AND APPLICATION IN PLANTS OF THERMAL OR CARBURIZING TREATMENT

(57) Abstract

A method for the forming and feeding of a gaseous atmosphere having two components, at least one of which under the form of vapour obtained from liquid, envisages to bubble a first gaseous component within a liquid component kept under controlled conditions of pressure and temperature and then to remove the gas-vapour mixture having controlled composition. In order to realise the method according to the invention, a device is foreseen that comprises a saturator reservoir containing the liquid component, means to keep the level of the liquid in the reservoir substantially constant, means to bubble a flow of gaseous component within the saturator, as well as means to control pressure and temperature inside the saturator itself. The invention can be applied in particular to the forming of carburizing atmospheres and of atmospheres used in thermal treatments of steel materials, specially gas carburizing treatments.



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"METHOD AND DEVICE FOR THE CONTROLLED FORMING AND FEEDING OF A GASEOUS ATMOSPHERE HAVING AT LEAST TWO COMPONENTS, AND APPLICATION IN PLANTS OF THERMAL OR CARBURIZING TREATMENT"

Technical Field

The present invention concerns a method and a device for the controlled formation and feeding of a gaseous atmosphere having at least two components, one of which under the form of vapour coming from a liquid. The invention also concerns the application of the aforementioned method and device particularly in plants of thermal treatment or in plants for carburizing processes.

Background Art

A particularly interesting application, that will be described more in detail and claimed - without being considered for that as a limitation to the protective scope of the invention - is that of the thermal treatment in ovens and in particular of the gas carburizing treatment of steel products, namely a treatment that allows the absorption of carbon atoms in the superficial layers of the product in order to increase its superficial hardness and to improve its fatigue strength.

The formation and feeding of a gaseous atmosphere having two components, one of which under the form of vapour, have always represented and still now represent a serious problem

in all cases in which it is necessary or advisable to maintain and/or to control the ratio between components. Not limiting examples of atmospheres of this kind are given by some types of comburent atmospheres and more specifically those in which the fuel is under liquid form, such as atmospheres suitable to feed burners with methanol or other liquid fuels, as well as comburent atmospheres for feeding motors. Other cases of application are those related with the creation and feeding of atmospheres for thermal treatments of steels in gaseous atmosphere, such as brazing, nitriding, annealing and carburizing treatments, when one of the components of the atmosphere is obtained from a substance under liquid form.

As far as carburizing treatments are concerned, that at present represent those for which the application of the present invention has mainly been studied, they are generally carried out in heating ovens, where a gas mixture including a carburizing agent is present. Taking into consideration that the process takes place at temperatures exceeding 800 degrees C, the carburizing agent present in the oven dissociates, thus freeing carbon atoms that are absorbed by the superficial layers of the steel up to depths of a few millimeters.

At the present time the carburizing process of mechanical components, such as for instance gears for the motor

industry, is performed in periodic kilns of large size or in continuous sections that use a gas atmosphere created therein or produced out of the oven by endothermic generators.

The currently used enrichment fluids to supply carbon required by the process are gaseous hydrocarbons such as methane or propane, and the monitoring of the carburizing process is performed by means of oxygen probes associated with computerised systems. The actual trend of the technology is to obtain "in situ" a protective atmosphere, for example by means of nitrogen and methanol directly introduced into the oven. In the hot chamber of the oven, necessarily kept at suitable temperature, methanol dissociates in CO and H₂ with endothermic reaction in a way to create the "carrying" protective atmosphere that constitutes the necessary support for the carburizing process.

There are cases in which the poor local availability, if not the absence, of reliable hydrocarbons, such as methane or propane, necessarily involves the use of different carburizing agents that, though being economical and easy to be found, do not allow the direct application of the known technologies for carburizing processes. For example, according to a method known at the present time, the gas carburizing treatment is performed by producing "in situ" a

carrying atmosphere with the help of nitrogen and methanol and a carburizing atmosphere by dripping organic liquids such as methyl alcohol (CH_3OH) and ethylacetate ($\text{CH}_3\text{-COO-C}_2\text{H}_5$).

The control of the process is carried out manually by regulating the number of drops of liquid on the basis of the operator's experience and of data supplied by steel samples that are checked during the most significant stages of the process.

One of the major drawbacks of this method lies in the difficulty of finding reliable control units that can be able to regulate in a proportional way very small amounts of liquids which, for their nature, are energetic solvents. Moreover a definitely serious problem is the application of reliable automatic controls, such as for instance those comprising an oxygen probe and a computerised system, since the oxygen probe has extremely fast response times and results to be hardly suitable for being applied to a drip-feed intermittent enrichment system.

Disclosure of the invention

The above having been stated, an object of the present invention is that of providing a method and a device for the forming and feeding of a gaseous atmosphere having two components, at least one of which under the form of vapour obtained from a liquid, wherein the ratio between the

components is strictly controllable with high precision.

Another object of the present invention is that of providing a method and a plant for the creation and feeding of comburent gaseous atmospheres or gaseous atmospheres for steel thermal treatments, wherein atmospheres or parts thereof have the aforementioned origin and characteristics. A more specific object of the invention is that of providing a method and a plant for carburizing processes, that allows to generate "in situ" a carburizing and/or carrying gaseous atmosphere by using liquid organic compounds.

A further object of the present invention is that of providing a method and a plant for gas carburizing processes, that allows a reliable control of the composition of the treatment atmosphere by using liquid organic compounds.

These objects are achieved by means of the present invention, that generally concerns a method for the forming and feeding of a gaseous atmosphere having two components, at least one of which under the form of vapour obtained from liquid, characterized in that a first gaseous component is bubbled within the liquid component under controlled conditions of pressure and temperature, and in that the gas-vapour mixture having controlled composition can be removed. Furthermore, the invention concerns a device for the application of the aforesaid method, characterized in that

it comprises a saturator containing the liquid component, means to maintain the liquid level in the container substantially constant, means to cause to bubble a flow of gaseous component inside the saturator, as well as means to control pressure and temperature inside the saturator itself.

Preferably, pressure is kept constant, for example equivalent to the atmospheric value, and the saturator temperature is adjusted in order to obtain a corresponding and precise regulation of the ratio between the two components.

It must be noticed that the saturator is an equipment already known per se, but the use of which has never been proposed so far for the creation of a gaseous atmosphere having a component derived from a liquid, in which a tight and extremely precise control is performed on the ratio between the components of the atmosphere itself, with the possibility of easily and quickly modifying said ratio.

As said above, the invention finds particularly interesting applications in the formation of comburent atmospheres, constituted as already seen, or in the formation of atmospheres for thermal treatments such as brazing, nitriding, annealing and specially gas carburizing.

In the latter case, the thermal treatment is carried out in oven, in presence of a carrying atmosphere having reducing

effect and of a carburizing atmosphere able of releasing carbon atoms in a way to allow their absorption in the superficial layers of said products. According to the invention, at least one atmosphere, either the carrying or the carburizing atmosphere, is generated in situ by feeding said oven with a gaseous mixture obtained by causing a carrier gas to bubble in a liquid organic compound in order to allow the transfer of said organic compound to the oven under the form of vapour.

The vaporisation of the liquid organic compound allows to perform the control of the treatment atmosphere in a precise and reliable way by means of the currently most common computerised control systems, thus ensuring a product of high quality and a considerable level of reproducibility of results.

According to an advantageous feature of the invention, the carburizing atmosphere is obtained by saturating the carrier gas with vapours of organic liquid, and moreover at least part of the carrying atmosphere is generated in situ by feeding the oven with a gaseous mixture obtained by causing a carrier gas (equal or different from the previous one) to bubble within a second liquid organic compound in order to allow its passage to the oven under the form of vapour.

In this manner it is possible to perform the carburizing process even in absence of the currently used gaseous

organic compounds, allowing appreciable advantages both from the logistic and the economic point of view.

The invention furtherly concerns a plant for the gas carburizing treatment of steel products, of the type comprising an oven for the thermal treatment of said products in presence of a carrying atmosphere with reducing effect and of a carburizing atmosphere capable of releasing carbon atoms in a way to allow their absorption in the superficial layers of said products, characterized in that it comprises at least a saturator containing a liquid organic compound, said saturator device comprising means to regulate the temperature of said liquid organic compound, as well as means to cause a flow of a carrier gas to bubble within said liquid organic compound and therefore allowing the transfer of said organic compound under the form of vapour.

Best mode for carrying out the invention

Further characteristics and advantages of the present invention will become more evident from the following description, given by way of illustration and with no limiting purposes, with reference to the accompanying drawings, where:

- Figure 1 is a scheme illustrating the structure and the operation of a saturator working according to the present invention, the figure comprising a diagram illustrating the

tension variation of the liquid vapour and then the relevant percentages of the components according to the temperature changes taking place in the saturator.

- figure 2 is a schematic view of a saturator device used in a plant according to the invention for gas carburizing treatments;

- figure 3 is a schematic view of a plant for gas carburizing processes according to an embodiment of the invention;

- figure 4 is a schematic view of a plant for the generation of an exothermic gas which is used in a plant for gas carburizing processes according to a further embodiment of the present invention; and

- figure 5 is a schematic view of a plant for gas carburizing processes according to a further embodiment of the invention.

Figure 1 schematically shows a saturator device 100, essentially constituted by a closed reservoir in which there is a liquid - preferably but not necessarily an organic liquid - kept at a preset level 101 thanks to controlled feeding in 102. Within the liquid a carrier gas is caused to bubble - constituting the second component of the gaseous atmosphere to be obtained - which is fed for example through the duct 103. Over the liquid level 101 therefore, a mixture composed by the gas fed in 103 and the vapours of the liquid

fed in 102 is caused to form in the saturator, in said mixture the percentage ratios between the two components being strictly dependent on pressure and temperature. In the specific case shown - and in general in the practical application of the invention - it is preferable to maintain the pressure at a constant value, for instance equivalent to the atmospheric value, and to control said percentage ratios by means of temperature control. The diagram illustrated in the figure 1 itself is thus obtained, at atmospheric pressure, where in abscissae are plotted the temperatures up to the boiling point of the liquid and in ordinates the percentages of the components, as indicated.

The saturator thus obtained and controlled allows to form and feed comburent atmospheres for burners, for motors or other, in which the gaseous component is generally air, whereas the liquid vaporised component is generally a light organic compound.

Still by applying the same principles, it is possible to obtain and feed gaseous atmospheres for thermal treatment in oven of metal materials, such as brazing, nitriding, annealing and other treatments of steel products.

An application particularly studied by the Applicant and presented herein refers to treatments of gas carburizing, that take advantage, as illustrated in figure 2, of a saturator device 1 constituted by an insulated container

where an organic liquid is introduced, kept at a substantially constant level and at controlled temperature. The liquid organic compound is fed, through a duct 2 provided with an on-off valve 3, to a small reservoir 4. The latter is provided with an on-off float valve in order to keep the liquid level constant in the tank itself and in the saturator device 1 connected thereto through a duct 5. In fact, it is particularly important to maintain the level of the liquid organic compound constant in order to maintain in the upper portion of the saturator device 1 a substantially constant free volume for vapours generated. A float indicator 14 assures the continuous control of the liquid level present in the saturator device 1.

In order to allow the change of state and the transfer of the liquid organic compound under the form of vapour, the saturator device 1 comprises means to regulate the temperature of the organic compound and means to bubble therein a flow of carrier gas at a controlled rate.

In the preferential embodiment of the invention, the means to regulate the temperature of the liquid organic compound present in the saturator device 1 are constituted by a hydraulic circuit comprising a pump 6 for the circulation of a fluid of thermal exchange, such as for instance water, and means 7 to heat the fluid arranged downstream of the pump 6. The foreseen variations in volume of the heated fluid are

absorbed by means of an expansion tank 11 located upstream of the pump 6. Between the expansion tank 11 and the pump 6 there is provided the feeding connection of the fluid coming from a duct 8 on which an on-off valve is provided.

Inside the saturator device 1 there is provided a heat exchanger that, in the embodiment shown in figure 2, is constituted by two elements 10' and 10" serially connected downstream of the heating means 7 and upstream of the expansion tank 11. The elements 10' and 10" are plunged in the organic liquid compound in order to allow the heat exchange between the fluid of thermal exchange of the circuit and the organic compound contained in the saturator device 1.

The temperature control of the organic liquid compound is performed by means of a pyrometer 12 that acts on the recirculation pump 6 and on the heating means 7 as a function of the temperature values detected by a thermoresistor 13.

Carrier gas is fed through a duct 15, provided with an on-off valve 16, as far as a group of injectors 17 plunged in the organic liquid in the lower section of the saturator device 1.

From the injectors 17 a finely dispersed flow of the abovesaid carrier gas is then bubbled that, passing through the organic liquid in its upward movement, saturates with

vapours as a function of the temperature of the liquid itself.

As it is well known, the vapour tension of a liquid varies as a function of temperature and pressure. Assuming to work at a preset operating pressure, it is therefore possible to plot for any liquid the specific curve of vapour tension as a function of temperature, of the type of the one reported in figure 1.

In this way it is possible to regulate in a precise way the composition of vapours, and consequently the relevant quantity of organic compound coming out of the saturator device 1, by acting on the temperature of the liquid organic compound.

Again with reference to figure 2, vapours generated come out through an insulated and heated duct 18 communicating with the upper portion of the saturator device 1. A single-acting valve 21, positioned downstream of the offtake 19, prevents vapours from flowing back towards the saturator device 1.

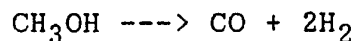
The carburizing treatment envisages the treatment in oven of steel products in presence of a gaseous mixture consisting of a carrying atmosphere having reducing effect and a carburizing atmosphere releasing carbon atoms.

A way of realization of the method according to the present invention involves the generation "in situ" of the carburizing atmosphere by feeding the oven with a gaseous

mixture obtained by causing a carrier gas to bubble within a first organic liquid in order to allow its transfer under the form of vapour.

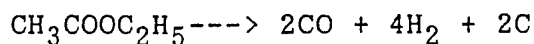
For this purpose a flow of nitrogen at low pressure and at ambient temperature is used as carrier gas that is caused to bubble within a first saturator device containing ethylacetate. The generation of a carrying atmosphere can be realized "in situ" according to known methods, for example by using the direct injection of nitrogen and methanol.

In the hot chamber of the oven, for temperatures exceeding 800 degrees C, methanol (CH_3OH) dissociates according to the reaction



thus generating one volume of carbon oxide and two volumes of hydrogen for each volume of methanol. The gaseous mixture thus obtained constitutes part of the carrying atmosphere. This is also defined as "protective" atmosphere because of its reducing effect that allows to avoid the undesirable formation of oxides on the treated products.

The carburizing atmosphere is obtained from ethylacetate ($\text{CH}_3\text{-COO-C}_2\text{H}_5$) that on the contrary dissociates according to the reaction



thus freeing two carbon atoms for each volume of ethylacetate that are available for being absorbed in the

superficial layers of steel products. It is interesting to note that the dissociation of ethylacetate leaves the proportions between carbon oxide and hydrogen unchanged, therefore maintaining the reducing effect of the carrying atmosphere.

According to an advantageous feature of the present invention also (or possibly only) the carrying atmosphere is generated "in situ" by feeding the oven with a gaseous mixture obtained by bubbling a nitrogen flow in methanol for obtaining its transfer under the form of vapour.

This allows to avoid the use of a direct injection system in the oven for nitrogen and methanol, which involves the need of having said compounds available at high pressure.

Figure 3 represents a plant for the realisation of the method according to the invention. There are in fact provided two saturator devices 1a and 1b, respectively containing methanol, fed through a duct 2a, and ethylacetate, fed through a duct 2b.

According to an advantageous feature of the invention, the saturator devices 1a and 1b are provided with means for the independent regulation of the temperature of each organic liquid.

The means for independently regulating the temperature of the saturators are constituted by two independent hydraulic circuits fed with water through a common duct 41, along

which there is positioned an on/off valve 42.

By having two independent saturator devices available, devoted to methanol and ethylacetate respectively, it is possible to set the operating temperature of each one of them in order to obtain in the oven an atmosphere of steady composition.

Nitrogen necessary for the plant operation is supplied through a feeding duct 30 provided with an on/off valve 31. Downstream of the on/off valve 31, there is a three-way motorised valve 32, of the proportional type, that allows to convey the nitrogen flow to the saturator device 1a through the duct 33, or to the saturator device 1b through the duct 34, or to both of them. Along ducts 33 and 34, upstream of the saturator devices 1a and 1b, there are provided flowmeters 35 and 36 respectively, which allow the detection of the flow rate of each nitrogen flow.

The outlet ducts 18a and 18b of each saturator device are both of the heated and insulated type. These flow into a single duct 37, of the heated and insulated type as well, which conveys the gaseous mixture to a header 38 entering the oven 40. Upstream of the header 38 there is an on/off valve 39.

The monitoring of the different conditions of the process progress is carried out by means of an oxygen probe 44, that allows to detect the composition of the atmosphere inside

the oven, and of a thermocouple 45 to detect the temperature inside the oven.

The signals coming from the oxygen probe 44 and the thermocouple 45 are sent to a control module 46 through an interface 47 to determine the composition of the internal atmosphere and, in particular, the carbon potential inside the oven 40.

The regulation of the atmosphere inside the oven 40 is performed by the control unit 46 acting on the three-way motorised valve 32. The latter is of the proportional type and allows to increase the nitrogen flow towards one of the two saturators, for instance saturator 1a, simultaneously decreasing the nitrogen flow towards the other saturator device 1b, or vice versa.

It is thus possible to vary in an automatic way the composition of the atmosphere inside the oven 40, namely the proportion between the carrying atmosphere and the carburizing atmosphere, having therefore carbon available that is useful for the carburizing process starting from a maximum value, corresponding to a total nitrogen flow rate in the saturator device 1b, up to a nil value in the case of total nitrogen flow rate in the saturator device 1a.

A further way of realisation of the method according to the present invention involves the generation "in situ" of the carburizing atmosphere by feeding the oven with a gaseous

mixture obtained by bubbling an exothermic gas as carrier gas within a first organic liquid in order to allow its transfer under the form of vapour. For this purpose a flow of exothermic gas at low pressure and at ambient temperature is used that is caused to bubble in a saturator device containing ethylacetate or acetone.

In this way it is possible to obtain an atmosphere for the carburizing treatment without using nitrogen that, in some cases, can be locally unavailable.

According to an advantageous feature of the invention, exothermic gas is obtained by bubbling air as carrier gas in methanol to obtain a gaseous mixture that is submitted to combustion and subsequent dehumidification by refrigeration. Figure 4 illustrates an equipment for the generation of exothermic gas, that uses a saturator device 1c containing methanol in which air is caused to bubble.

The feeding of methanol to the saturator device 1c is carried out through a duct 60, while air is drawn from the atmosphere by means of a compressor 61 provided with filter 62. Downstream of the compressor 61 the air flow is conveyed to two ducts 64 and 63 that feed the saturator device 1c and a sealed spill burner 80 respectively. Along the ducts 63 and 64 there are provided relevant flowmeters 65 and 66, as well as relevant on/off valves 67 and 68.

In this case the hydraulic circuit that allows the heating

of methanol contained in the saturator device 1c comprises a reservoir 69, where flows the heated water coming from the cooling jacket of the burner 80 through a duct 70. The excess water in the reservoir 69 is discharged in 75.

The control of the water temperature is performed by means of a pyrometer 71 acting on a recirculation pump 72 on the basis of the temperature detected by a thermoresistor 73 positioned in the saturator device 1c.

Vapours coming out of the saturator device 1c feed the burner 80 through a duct 74 of the insulated and heated type. Combustion produces a poor exothermic atmosphere with characteristics of inert gaseous mixture, being mainly constituted by N_2 , CO_2 , H_2O and by residual fuels in very low percentages.

The gas mixture coming out of the burner 80 is first of all conveyed through a duct 76 to a first heat exchanger 77 and then, through a duct 78, to a refrigerator 79 that lowers its temperature down to 6-8 degrees C and reduces its humidity, bringing the amount of H_2O to about 1% in volume. The heat exchanger 77 allows a first drop in temperature and consequently in the water content present in the combustion products coming out of the burner 80.

The refrigerator 79 comprises a cooling and dehumidifying chamber 82 through which the gas mixture is caused to pass in relation of thermal exchange with the evaporator of a

refrigerating circuit. The water forming in the chamber 82 is collected in a steam trap 83 and released through an exhaust outlet 84.

The refrigerated exothermic gas obtained at the outlet of the chamber 82 passes through a separator 86 followed by a duct 85 for the carburizing plant feeding.

An exothermic gas is thus obtained that can be used for the protection of oven chambers or for their purging, as it can also be used for gas carburizing treatments as carrier gas when appropriately enriched with ethylacetate ($\text{CH}_3\text{-COO-C}_2\text{H}_5$) or acetone ($\text{CH}_3\text{-CO-CH}_3$). For the latter use it is necessary to reconvert CO_2 and H_2O into CO and H_2 respectively, by reacting the refrigerated exothermic gas with about 7-8% of ethylacetate or acetone vapours. In this way an atmosphere would be obtained in the oven consisting of approximately 26-28% CO , 17-20% H_2 and N_2 for the remaining part.

A thus composed atmosphere, though having its own carbon potential, is not provided with sufficient carburizing properties and, in case of failure to completely reconvert CO_2 and H_2O , it would have decarburizing characteristics. It is therefore necessary to convey into the oven a quantity of ethylacetate or acetone vapours exceeding the one strictly necessary for total reversion of CO_2 and H_2O , thus making available a carbon amount useful for carburizing.

An atmosphere of this type produced "in situ" allows to be varied, with extreme simplicity and high speed, in response to the quick variations of the carbon potential imposed by the treatment cycle.

A further advantage in the use of a refrigerated exothermic atmosphere is that of making oxidative elements available, such as CO_2 and H_2O , which allow to easily clean the oven from possible deposits of soot and pre-oxidation of the material under treatment.

Figure 5 represents a plant for gas carburizing treatment, which receives the refrigerated exothermic gas, produced by an equipment such as the one illustrated in figure 4, through a duct 85 provided with an on/off valve 100. Downstream of the latter the gas flow is split in different ducts to allow gas feeding to a saturator device 1d through a duct 101, or the direct connection with the oven 40 through a duct 102. A further duct 103 allows to convey exothermic gas towards the oven 40 after its mixture with a gaseous additive fed through a duct 104.

The saturator device 1d is fed with ethylacetate or with acetone through a feeding duct 105.

As already previously illustrated, the means to regulate the temperature of the saturator device are constituted by a hydraulic circuit fed with water through a duct 106 along which there are positioned an on/off valve 107 and a

pressure reducer 109.

In the saturator device 1d exothermic gas is enriched with ethylacetate or acetone vapours and conveyed towards the feeding header 38 in the oven 40 through a duct 110 of heated and insulated type.

The monitoring of the conditions of the process progress is again performed by means of an oxygen probe 44, which allows to detect the composition of the atmosphere inside the oven, and of a thermocouple 45 to detect the temperature inside the oven 40.

In this case the regulation of the atmosphere inside the oven 40 is performed by the control unit 46 acting indirectly on the temperature of the organic liquid in the saturator device 1d through the pyrometer 111.

This allows to vary in a very simple and rapid way the carbon potential in the treatment atmosphere by only varying the temperature of the organic liquid present in the saturator device 1d.

C L A I M S

1. Method for the forming and feeding of a gaseous atmosphere having two components, at least one of which under the form of vapour obtained from liquid, characterized in that a first gaseous component is bubbled within the liquid component under controlled conditions of pressure and temperature and in that the gas-vapour mixture having controlled composition can be removed.
2. Method according to claim 1, characterized in that pressure conditions are kept constant and temperature conditions are controlled as a function of the desired percentage ratio of the components in the removed mixture.
3. Device for the realisation of the method according to claim 1, characterized in that it comprises a saturator reservoir containing the liquid component, means to keep the level of the liquid in the reservoir substantially constant, means to cause a flow of gaseous component to bubble within the saturator, as well as means to control pressure and/or temperature inside the saturator itself.
4. Device according to claim 3, characterized in that the saturator reservoir comprises means to heat the same at controlled temperature, and works at atmospheric pressure.
5. Application of the method according to claim 1 or 2 and of the device according to claim 3 or 4 for the forming and feeding of comburent mixtures formed by a gaseous component

and by a component in vapour phase obtained from liquid.

6. Application of the method according to claim 1 or 2 and of the device according to claim 3 or 4 for the forming and feeding of mixtures formed from a gaseous component and a component in vapour phase obtained from liquid for the thermal treatment in oven of metal materials.

7. Application according to claim 6 for the forming of at least part of the gaseous atmospheres of thermal carburizing treatments of steel materials.

8. Method for the gas carburizing treatment of steel products according to the application of claim 7, of the type comprising the thermal treatment in oven of said products in presence of a carrying atmosphere having reducing effect and a carburizing atmosphere capable of releasing carbon atoms to allow their absorption in the superficial layers of said products, characterized in that at least one of said carrying or carburizing atmospheres is generated "in situ" by feeding said oven with a gaseous mixture obtained by causing a carrier gas to bubble within a liquid organic compound to allow the transfer to the oven of said organic compound under the form of vapour.

9. Method according to claim 8, characterized in that said carburizing atmosphere is generated by bubbling gas in a liquid organic compound and in that at least part of said carrying atmosphere is generated "in situ" by feeding a

carrier gas in a second liquid organic compound to allow the transfer of said second organic compound under the form of vapour.

10. Method according to claim 8, characterized in that said liquid organic compound is constituted by ethylacetate or acetone and said carrier gas is constituted by nitrogen or by an exothermic gas.

11. Method according to any of claims 8 to 10, characterized in that said second liquid organic compound is constituted by methanol and said carrier gas is constituted by nitrogen or air.

12. Method according to claim 10 or 11, characterized in that said exothermic gas is obtained by bubbling air as carrier gas in said second liquid organic compound to obtain a gaseous mixture that is submitted to combustion and subsequent dehumidification by refrigeration.

13. Method according to any of the claims 8 to 12, characterized in that said liquid organic compounds are heated independently from each other and kept at temperatures below the relevant boiling temperatures.

14. Method according to any of the claims 8 to 13, characterized in that the control of the quantities of said liquid organic compounds transferred under the form of vapour is automatically performed by acting on the relevant heating temperatures and/or on the flow rates of said

carrier gases as a function of the carbon potential present in the oven.

15. Plant for the gas carburizing process of steel products, of the type comprising an oven for the thermal treatment of said products in presence of a carrying atmosphere having reducing effect and of a carburizing atmosphere capable of releasing carbon atoms to allow their absorption in the superficial layers of said products, characterized in that of comprising at least a saturator device containing a liquid organic compound, said saturator device comprising means to regulate the temperature of said liquid organic compound, as well as means to cause a flow of carrier gas to bubble within said liquid organic compound and allow the transfer of said organic compound under the form of vapour.

16. Plant according to claim 15, characterised in that it comprises two different saturator devices containing a first and a second liquid organic compound respectively, said saturator devices being provided with means to regulate independently the temperature of each of said liquid organic compounds, as well as means to regulate independently the flow rate of relevant carrier gases.

17. Plant according to claim 15, characterized in that it comprises an oxygen probe for detecting the composition of the atmosphere inside the oven, a thermocouple to detect the

temperature inside the oven and a control unit capable of determining the carbon potential as a function of the signals coming from said probe and said thermocouple and of controlling consequently said composition of the atmosphere inside the oven.

18. Plant according to claim 17, characterized in that said control unit is capable of controlling said means regulating the temperature of said liquid organic compounds.

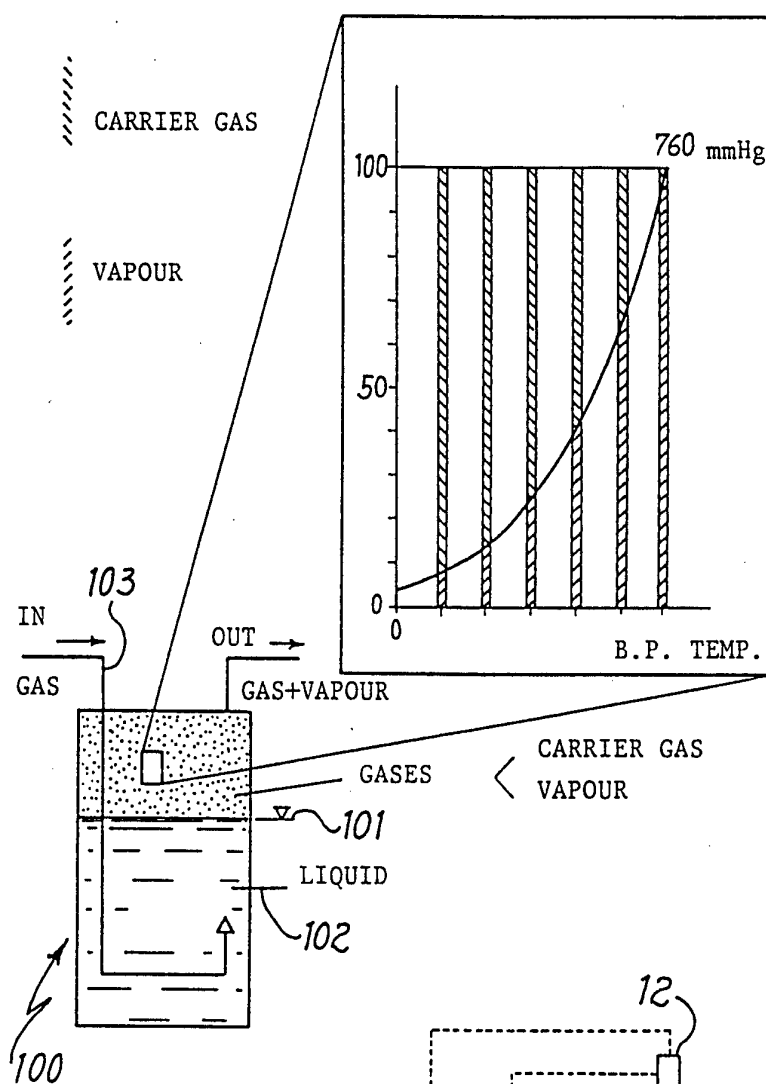
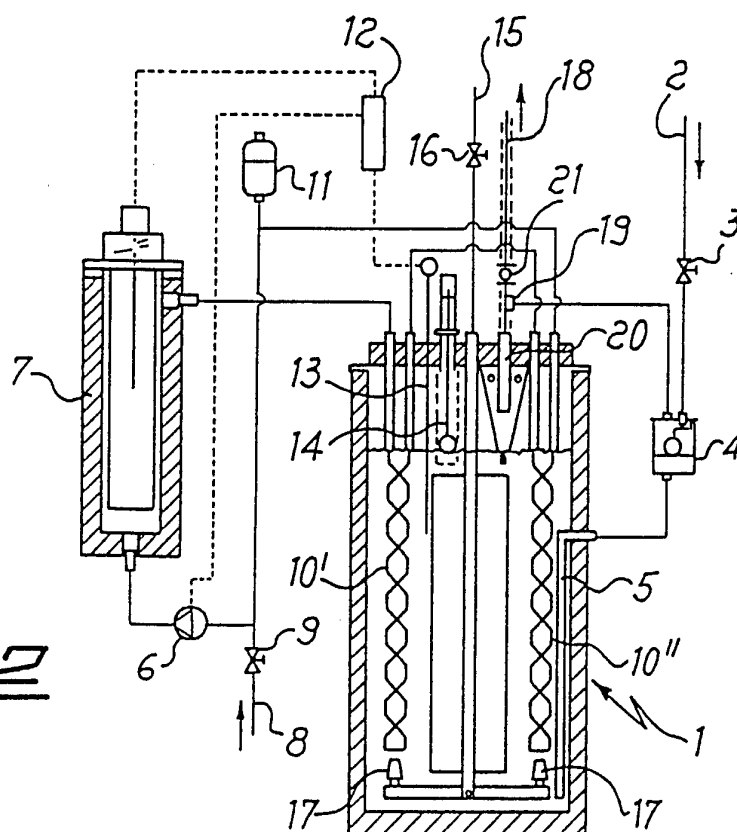
19. Plant according to claim 17, characterized in that said control unit is capable of controlling said means to regulate the flow rate of said carrier gases.

20. Plant according to claim 19, characterized in that said means for the regulation of the flow rate of said carrier gases comprise a three-way motorised valve of the proportional type capable of conveying the flow of carrier gas to the first, the second or to both said saturator devices.

21. Plant according to any of claims 15 to 20, characterized in that said means for the regulation of the temperatures of each of said liquid organic compounds are constituted by a hydraulic circuit comprising a pump for the circulation of a fluid of thermal exchange, means to heat said fluid, a heat exchanger arranged in said saturator device and in contact with said liquid organic compound, as well as at least a pyrometer provided with thermoresistor to

allow the control of the temperature of said liquid organic compound by acting on said circulation punmp and/or on said means for heating said fluid.

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*Fig. 1**Fig. 2*

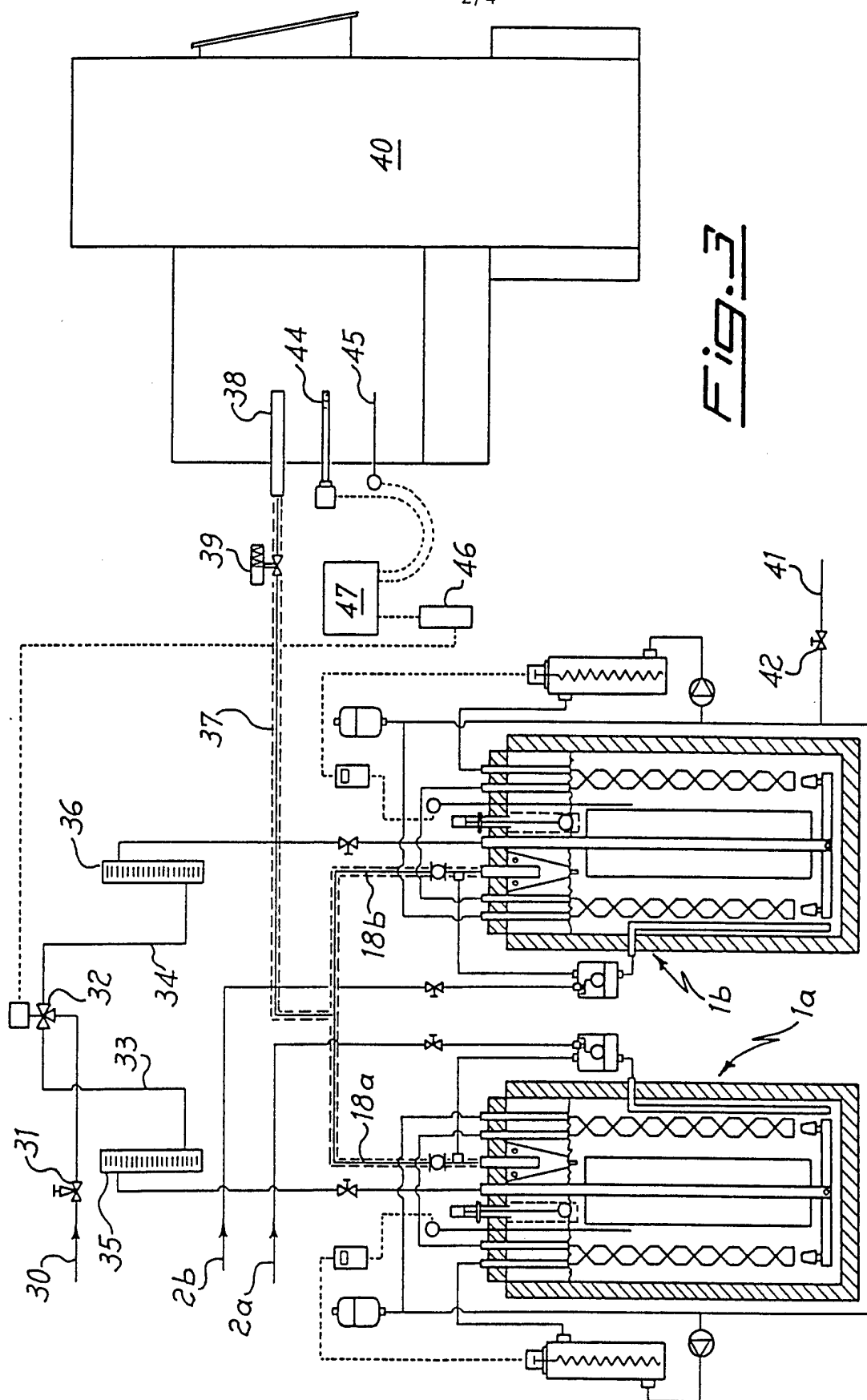
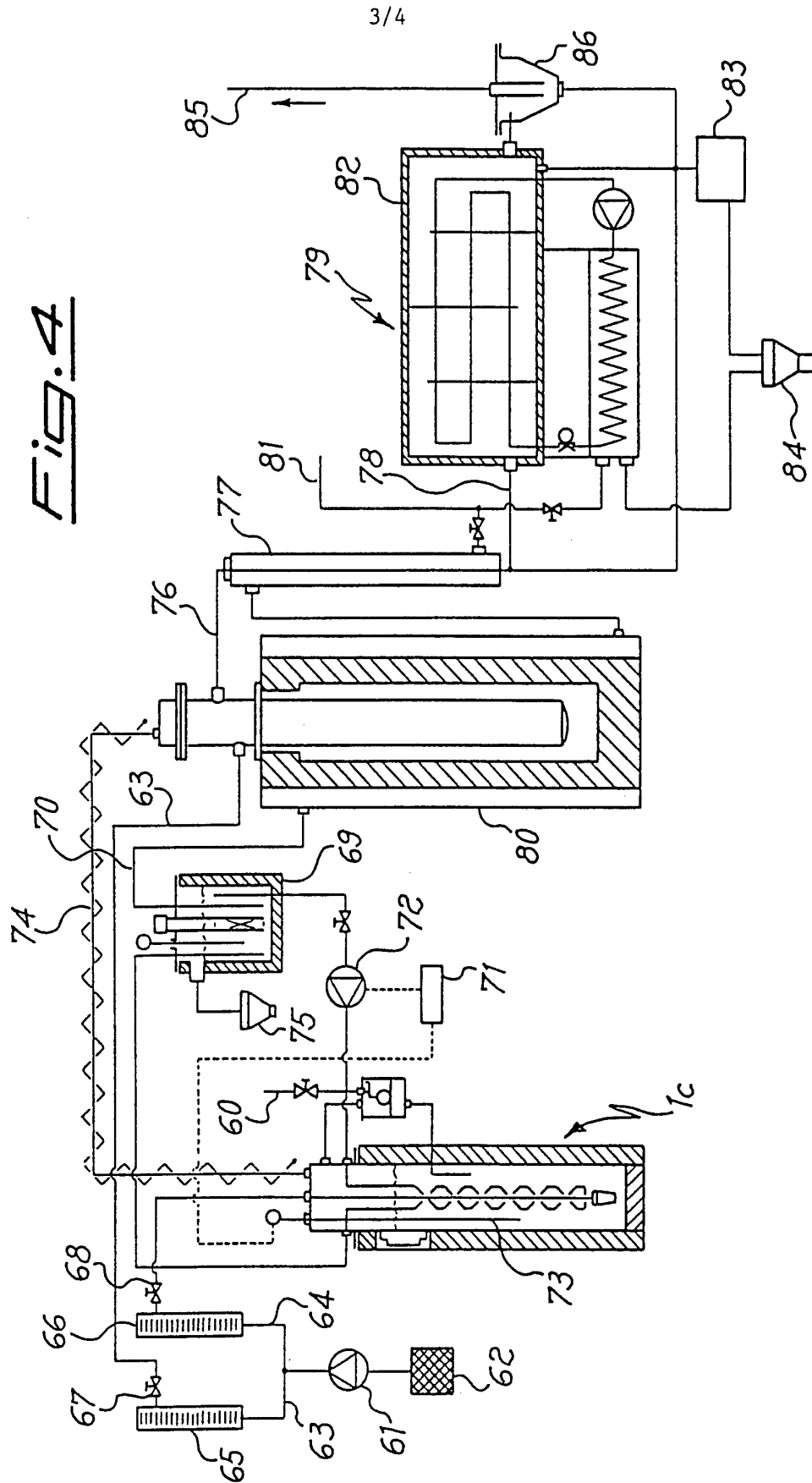
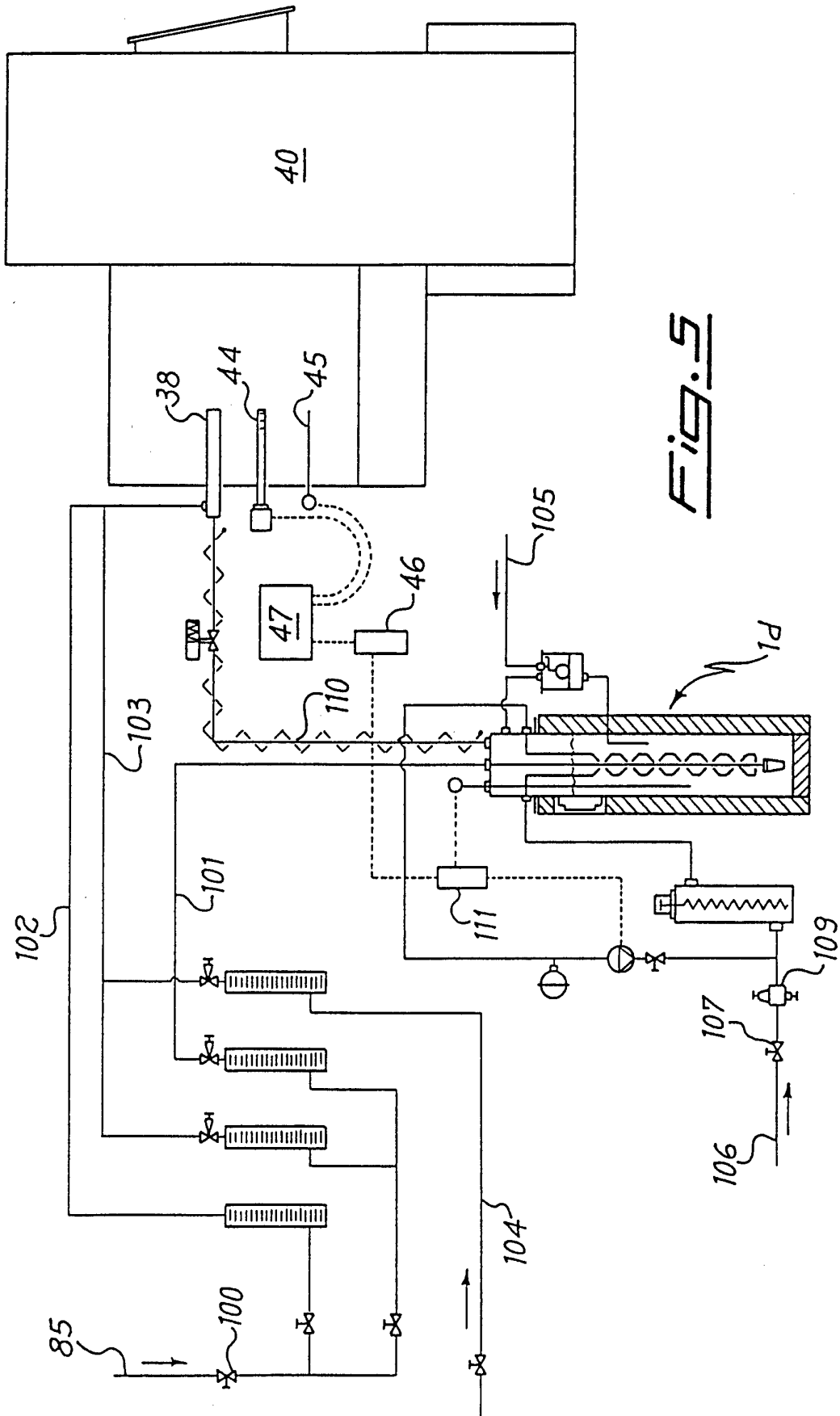


Fig. 3

Fig. 4



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INTERNATIONAL SEARCH REPORT

 Internati Application No
 PCT/EP 94/02918

 A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 B01F3/02

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

B. FIELDS SEARCHED

 Minimum documentation searched (classification system followed by classification symbols)
 IPC 6 B01F

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

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

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A	US,A,4 904 419 (REYNOLDS) 27 February 1990 ---	
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A	FR,A,2 227 896 (ANHYDRIDE CARBORNIQUE) 29 November 1974 ---	
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Date of the actual completion of the international search

6 December 1994

Date of mailing of the international search report

02.01.95

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INTERNATIONAL SEARCH REPORT

Interns 1 Application No
PCT/EP 94/02918

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