(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 June 2002 (27.06.2002)

PCT

(10) International Publication Number
WO 02/50215 A2

(51) International Patent Classification[7]: C10J 3/00, C02F 1/04

(21) International Application Number: PCT/EP01/14986

(22) International Filing Date:
17 December 2001 (17.12.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MI2000A002790
21 December 2000 (21.12.2000) IT

(71) Applicant *(for all designated States except US)*: **ABB SERVICE SRL** [IT/IT]; Via Arconati, 1, I-20135 Milano (IT).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **VENTURINO, Matteo** [IT/IT]; Via Martinengo, 2/5, I-17100 Savona (IT). **MASCALZI, Gianni** [IT/IT]; Via Achille Grandi, 39, I-20045 Besana in Brianza (IT).

(74) Agent: **GIAVARINI, Francesco**; ABB Service S.R.L., Viale Edison, 50, I-20099 Sesto San Giovanni (IT).

(81) Designated States *(national)*: AE, AG, AL, AU, BA, BB, BG, BR, BZ, CA, CN, CO, CR, CU, CZ, DM, DZ, EE, GD, GE, HR, HU, ID, IL, IN, IS, JP, KP, KR, LC, LK, LR, LT, LV, MA, MG, MK, MN, MW, NO, NZ, PL, RO, SG, SI, SK, TT, UA, US, UZ, VN, YU, ZA.

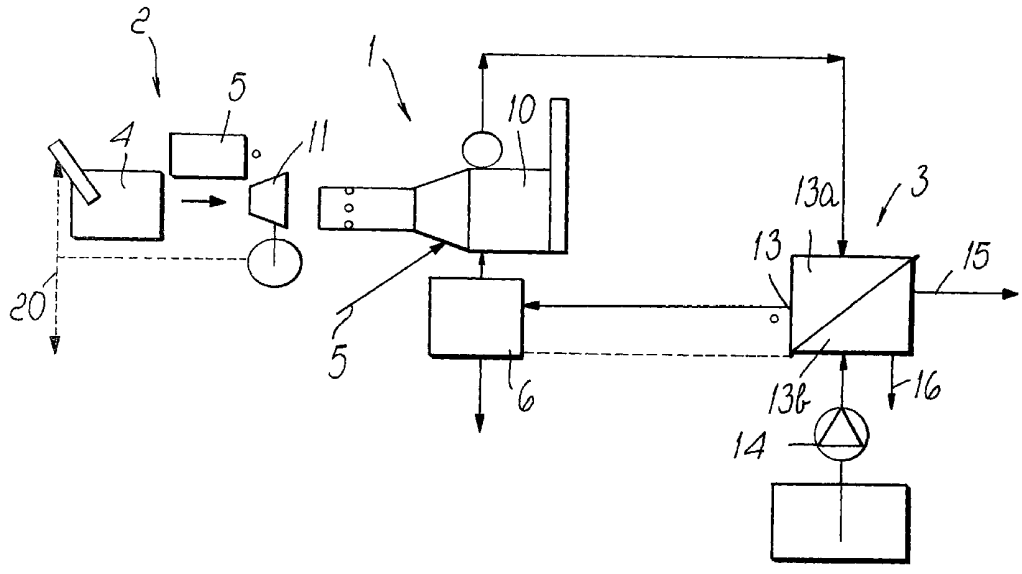
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ENERGY-OPTIMIZED WASTE TREATMENT APPARATUS



(57) Abstract: An energy-optimized waste treatment apparatus, whose particularity consists in that it comprises a plasma waste treatment section and a water desalination section, the plasma waste treatment section producing in output inert slag, a synthesis gas and heat, the synthesis gas and the heat being used to power the water desalination section.

WO 02/50215 A2

ENERGY-OPTIMIZED WASTE TREATMENT APPARATUS

DESCRIPTION

The present invention relates to an energy-optimized waste treatment apparatus. More particularly, the invention relates to a waste treatment apparatus in which the energy that can be obtained from waste treatment is used to desalinate seawater in order to obtain potable water.

It is known that waste disposal is one of the most strongly felt problems of modern time and entails drawbacks both from the point of view of the slag that inevitably remains after treatment and from the point of view of environmental pollution.

The above problem is worsened for example in the case of an island, in which waste generation is a problem because of its disposal, which is usually performed by shipping the waste to a disposal unit (landfill or incinerator) on the mainland. At the same time, one of the problems of greatest interest is the supply of water, which affects both mainland areas and the more so islands.

The supply of desalinated water is in fact a problem, since islands often have no fresh water springs. Accordingly, the only possibility to supply potable water is to ship it at high costs.

The problem of waste disposal can be solved in different manners, one of which is waste incineration, but with consequent drawbacks in terms of environmental pollution and residual polluting slag to be further disposed of and therefore treated in order to render it inert.

Another waste treatment method entails transferring the waste to a landfill, but in this case, too, the process is questionable owing to its limited respect for the environment and to the loss of the energy content of the waste, which is instead required by government decrees.

On the other hand, the production of potable water from seawater, i.e. by desalination, also requires large amounts of energy, which can be supplied on

an island by shipping fossil fuel, again with a considerable environmental impact.

The aim of the present invention is to provide an energy-optimized waste treatment apparatus that allows to utilize the energy that can be obtained from the waste disposal treatment for the production of potable water, which requires a high energy quantity.

Within this aim, an object of the present invention is to provide an energy-optimized waste treatment apparatus that has a very low environmental impact both in terms of reducing ground pollution and air pollution.

Another object of the present invention is to provide a waste treatment apparatus that allows to eliminate the shipping of the waste to a landfill area and the shipping of the water for supply.

Another object of the present invention is to provide a waste treatment apparatus that also allows to reduce the external energy required for seawater desalination.

Another object of the present invention is to provide a waste treatment apparatus that allows to reduce shipping and supply costs of materials such as water, fuel, construction material and reagents for treating the exhaust gases generated during a conventional waste treatment.

Another object of the present invention is to provide a method for treating waste by means of the above cited apparatus.

Still another object of the present invention is to provide a waste treatment apparatus that is highly reliable, relatively simple to produce, and at competitive costs.

This aim and these and other objects that will become better apparent hereinafter are achieved by an energy-optimized waste treatment apparatus, characterized in that it comprises a plasma waste treatment section and a water desalination section, said plasma waste treatment section producing in output

inert slag, a synthesis gas and heat, said synthesis gas and said heat being used to power said water desalination section.

Further characteristics and advantages of the invention will become better apparent from the description of preferred but not exclusive embodiments of the waste treatment apparatus according to the present invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is an exemplifying block diagram of an embodiment of the apparatus according to the present invention; and

Figure 2 is a more conceptual block diagram of the waste treatment method using the apparatus shown in Figure 1.

With reference to the figures, the waste treatment apparatus, generally designated by the reference numeral 1, comprises a waste treatment section 2 and a section 3, which is arranged downstream of the waste treatment section and allows to use the energy obtained in the waste treatment section 2 to desalinate seawater in order to obtain potable fresh water.

The waste treatment section 2 comprises a reactor 4, which operates by means of a plasma torch system in which an electric arc, sustained between the electrodes of the torch, allows to reach extremely high temperatures (for example above 3000 °C) for waste treatment in controlled environmental conditions (reducing or oxidizing or neutral environment, depending on the waste to be treated).

These temperatures break up the macromolecules of the waste and cause the recomposition, at a gaseous level, of simpler molecules, which constitute a synthesis gas (syngas) that can be reused for energy purposes. In Figure 1, the syngas is designated by the reference numeral 5.

The material that cannot be gasified by the plasma reactor 4 (metal oxides, inert material, glass, salts, et cetera) exits as liquefied vitreous slag, which once cooled proves to be inert, i.e., does not release pollutants even if washed out

with water. Thanks to these characteristics, the liquefied vitreous slag passes the leachability tests prescribed by environmental protection authorities.

Accordingly, such slag can be sent to a landfill as inert material without any risk, or can be used as filler material for building work.

Since the reactor 4 must be kept at the operating temperature and so must the plasma torches, there is a system for cooling the devices and there is a heat exchanger for cooling the syngas in order to allow easy cleaning thereof.

The reference numeral 6 designates a heat exchanger, whose function is described in detail hereinafter.

All this leads to the generation of heat, which can therefore be used for energy recovery.

A heat generation unit, for example a steam generator 10, is conveniently arranged between the waste treatment section 2 and the desalination section 3 and is conveniently supplied for example by the exhaust gases that arrive from a gas turbine 11, which receives in input the syngas 5 produced by the treatment of the waste in the reactor 4.

The heat exchanger 6 is connected to the steam generator 10, and the steam generator 10 is in turn connected to the desalination section 3, particularly to a desalination chamber 13.

The desalination section 3 thus uses the heat generated in the steam generator 10 in order to distill the water from the non-potable aqueous solution introduced by means of a pump 14 which draws seawater or water with a high salt content, into the desalination chamber 13.

The end products of water desalination are water, designated by the reference numeral 15, and a brine 16 with a high concentration of sodium chloride and calcium chloride. These salts can be reused for sale, or used in a process for treating the exhaust gases of the waste treatment section 2 in order to purify said exhaust gases. This can occur for example by pre-processing the salts with

a strong acid, for example H_2SO_4, in order to provide a basic product to be used as a reagent for exhaust gas cleaning.

Figure 1 is a view of the desalination chamber 13, divided into two compartments 13a and 13b, in which the compartment 13a contains water, which is used to heat the water contained in the compartment 13b and must be desalinated. In particular, the water contained in the compartment 13a is introduced, through the heat exchanger 6, in the steam generator 10, so as to produce steam which is then returned to the compartment 13a, where by transferring heat it heats the salty seawater contained in the compartment 13b, and then, as a consequence of said heat transfer, returns to the liquid phase, thus repeating the cycle.

Conveniently, the syngas 5 introduced in the gas turbine 11 receives the addition of a fuel, for example methane or oil, in order to obtain a fuel that is suitable for the steam generator 10.

Moreover, part of the syngas can be fed to the steam generator 10.

The reactor 14 is supplied by electric power, designated by the reference numeral 20, which can be supplied from outside to the reactor, or can be obtained from the gas turbine 11.

Figure 2 is a conceptual diagram of the plasma technology which, starting from a plasma gasification process, step 30, which utilizes waste 31 and uses plasma 32 for the treatment thereof, produces syngas 5 and slag 33, which is then cooled in a step 34 in order to obtain final slag 35 that can be reused, as mentioned, and recovered heat 36. At the same time, the syngas 5 is treated in order to reduce pollution, with heat recovery, 37, which together with the heat recovery that can be obtained from the cooling of the plasma torches, 38 produces heat 39, which is used in the steam generator 10 or in the heat exchanger 6.

The syngas 5, after treatment for removing the pollutants, is used for energy

purposes, step 40, as clean gas 41.

Substantially, the apparatus according to the invention allows to generate syngas and heat from a plasma treatment of the waste, in order to power a desalination plant for producing potable water.

In this manner a reduction of pollution of soil, air, water is achieved by means of a cleaner waste treatment/management, i.e., by means of a plasma treatment, thus eliminating the shipping of waste and water, since the residual waste of the plasma treatment is a reusable inert slag, while the generation of potable water by means of the products obtained from the plasma treatment of the waste allows to eliminate the shipping of water, for example in the case of islands or the like.

The use of reagents for exhaust gas treatment also is substantially eliminated, since the exhaust gases produced by the plasma treatment are far less noxious than the exhaust gases of a conventional waste disposal treatment, and in any case the by-products of water desalination can be used to clean the exhaust gases of the reactor.

In practice it has been found that the apparatus and the method according to the invention fully achieve the intended aim and objects, since they allow direct utilization of the energy that can be obtained from waste treatment, for water desalination, with a number of nonpolluting by-products.

The apparatus and the method thus conceived are susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may further be replaced with other technically equivalent elements.

In practice, the materials used, so long as they are compatible with the specific use, may be any according to requirements and to the state of the art.

CLAIMS

1. An energy-optimized waste treatment apparatus, characterized in that it comprises a plasma waste treatment section and a water desalination section, said plasma waste treatment section producing in output inert slag, a synthesis gas and heat, said synthesis gas and said heat being used to power said water desalination section.
2. The apparatus according to claim 1, characterized in that said waste treatment section comprises a reactor that operates by means of plasma torches.
3. The apparatus according to claim 1, characterized in that it further comprises a steam generator arranged between said waste treatment section and said water desalination section, said steam generator being powered by said synthesis gas and by said heat obtained from the waste treatment, by means of at least one heat exchanger interposed between said waste treatment section and said steam generator.
4. The apparatus according to one or more of the preceding claims, characterized in that said steam generator is supplied by a gas turbine powered by said synthesis gas.
5. The apparatus according to one or more of the preceding claims, characterized in that said desalination section comprises a desalination chamber, which is divided into a first compartment and a second compartment, said second compartment being suitable to contain water to be desalinated, said first compartment being suitable to contain steam generated by said steam generator.
6. The apparatus according to one or more of the preceding claims, characterized in that said first compartment of said desalination chamber is connected to said heat exchanger, which is in turn connected to said steam generator.

7. The apparatus according to one or more of the preceding claims, characterized in that said desalination chamber is supplied with water having a high salt content by means of at least one pump.
8. The apparatus according to one or more of the preceding claims, characterized in that the output products of said second compartment of said desalination chamber are potable water and brine, said brine comprising highly concentrated salts.
9. The apparatus according to one or more of the preceding claims, characterized in that said synthesis gas supplied to said gas turbine receives the addition of a fuel.
10. The apparatus according to one or more of the preceding claims, characterized in that said fuel supplies both said gas turbine and directly said steam generator.
11. An energy-optimized waste treatment method, characterized in that it comprises the steps consisting of:

    a) subjecting waste to be disposed of to a plasma treatment;

    b) obtaining from said plasma treatment a synthesis gas, heat and inert slag;

    c) using said synthesis gas and said heat to desalinate water, in order to obtain potable water.
12. The method according to claim 11, characterized in that said step b) comprises cooling said inert slag for heat recovery.
13. The method according to claim 12, characterized in that the step a) comprises the subsequent cooling of the plasma torches used for said plasma treatment and the recovery of heat from said cooling.
14. The method according to one or more of claims 11 to 13, characterized in that said step c) is provided by means of steam generated by a steam generator powered by said synthesis gas, and by heat recovered from said plasma waste treatment and supplied to said steam generator.

15. The method according to one or more of claims 11 to 14, characterized in that said step c) comprises obtaining, as a by-product, brine with a high concentration of salts, said salts contained in said brine being used to purify exhaust gases produced by said plasma waste treatment.

16. The method according to one or more of claims 11 to 15, characterized in that said synthesis gas obtained from said plasma treatment of said waste receives the addition of a fuel for powering said steam generator, in order to generate said steam used for water desalination.

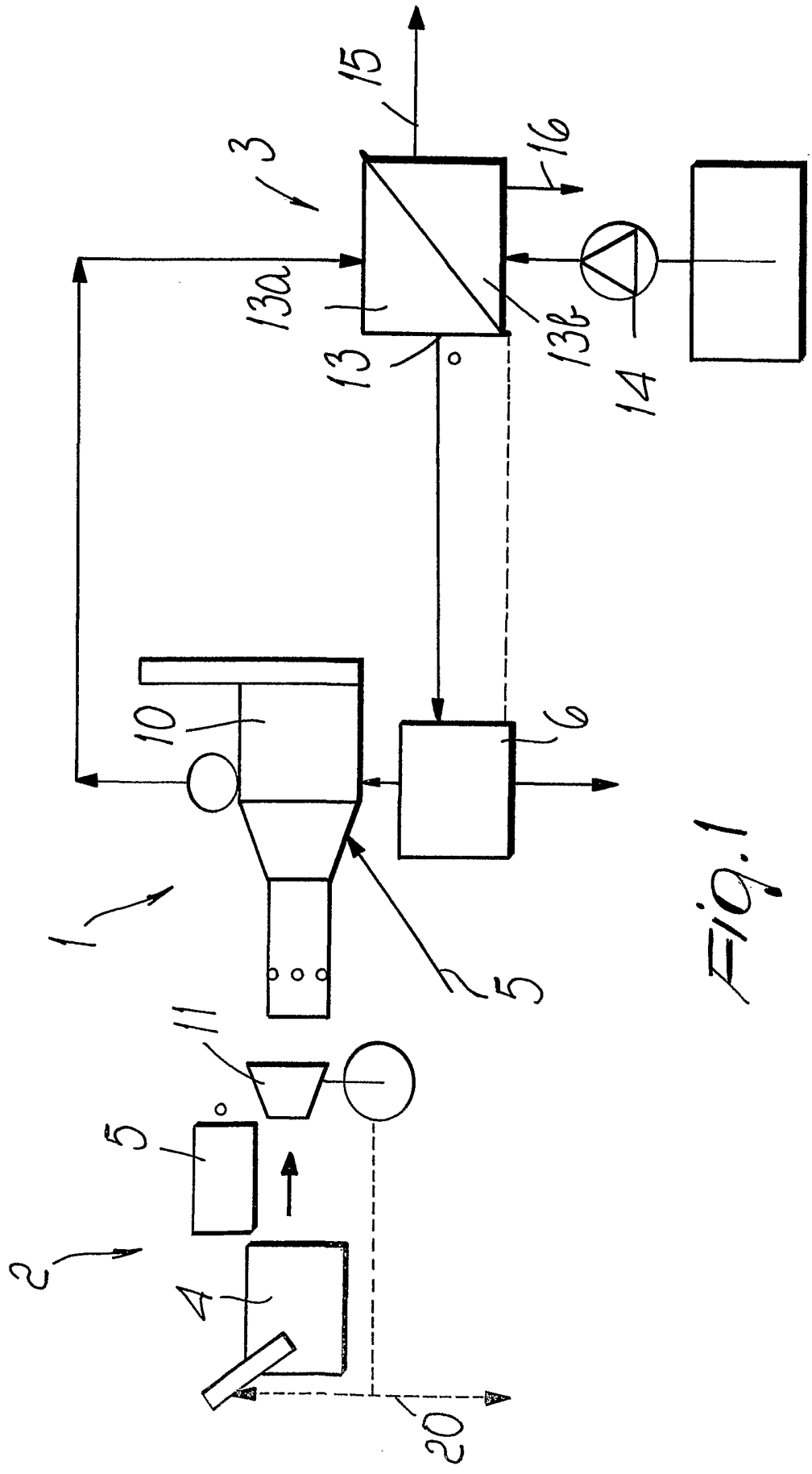


Fig. 1

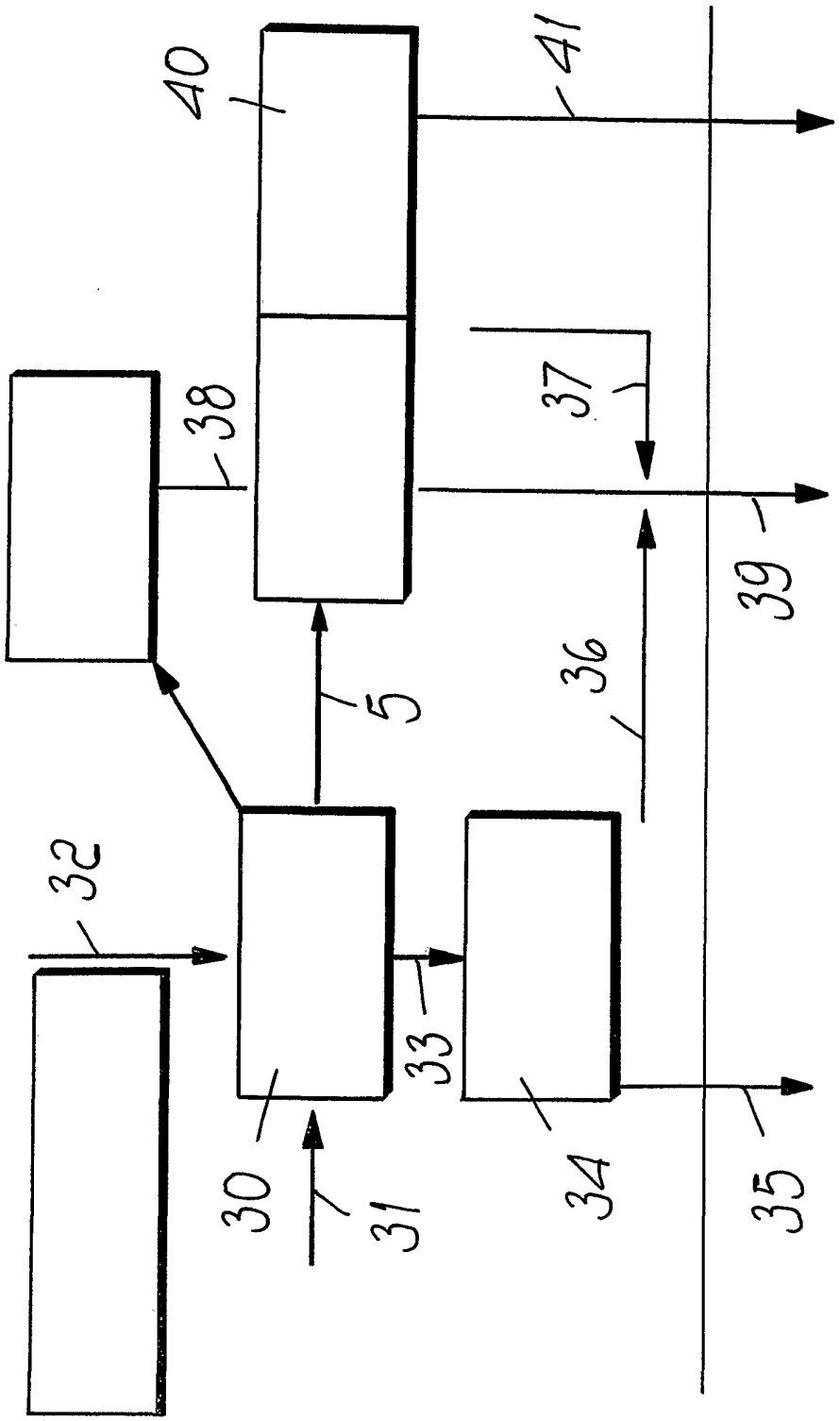


Fig. 2