

APPARATUS FOR TREATMENT OF EXHAUST GASES CONTAINING HYDROGEN ✓

FIELD OF THE INVENTION

The present invention relates to an improvement of an apparatus for treatment of exhaust gases containing hydrogen from facilities and equipment such as semiconductor manufacturing and chemical plants where hydrogen is used.

BACKGROUND OF THE INVENTION

At semiconductor manufacturing, chemical and other facilities and plants, exhaust gases containing hydrogen from processing lines are usually disposed of by burning at a high temperature in an incinerator.

Fig. 5 shows a typical prior art high-temperature combustion disposal apparatus used in semiconductor manufacturing facilities. In this apparatus, the exhaust gas A containing hydrogen from the semiconductor manufacturing line B including a hydrogen annealing furnace is first led into a quartz furnace 50, and an ignition Si chip 52 is heated by a heating lump 53 wherein hydrogen in the exhaust gas A gushing out of a nozzle 51 is then put to complete combustion at some 1,800 to 2,000 °C.

The quartz furnace 50 has another pipe 54 connected thereto. Through the pipe 54, O_2 is fed into the quartz furnace 50 to help hydrogen burn completely. To ensure complete combustion of H_2 and secure safety, the amount of oxygen to feed is set at more than half of that of hydrogen.

With treatment of the exhaust gases containing hydrogen by the external combustion unit C as shown in Fig. 5 the exhaust gas A can be treated completely with high efficiency with use of a relatively small external combustion unit C provided that the exhaust gas A containing hydrogen flows from the semiconductor manufacturing line B at a nearly fixed rate and the concentration of hydrogen in the exhaust gas A does not fluctuate so much.

However, the disposal technique employing the aforesaid external combustion unit C has a fundamental drawback that an unstable combustion due to fluctuations in the discharge amount of exhaust gas A or changes in concentration of hydrogen in the exhaust gas A could result in an explosion of the external combustion unit C itself.

If, for example, the flow rate of the exhaust gas A containing hydrogen from the semiconductor manufacturing line decreases with the level of H_2 dropping and staying at almost nil longer than a specific time, then the combustion flame near the tip of the nozzle 51 will go out, with the temperature dropping near the tip of the nozzle 51.

Unless the ignition Si chip 52 is heated again, combustion will not be resumed even when the flow rate of the exhaust gas A and the concentration of H₂ rise back again. As a result, H₂ - containing gas A would be discharged untreated out of the combustion unit C, bringing about a very dangerous situation.

Another problem is that if the discharge rate of exhaust gas A drops substantially, a backfire may spread toward the semiconductor manufacturing line B from the external combustion unit C through the pipe line 55. There will arise danger of explosion of the semiconductor manufacturing line B itself.

To ensure safety, the prior art combustion unit C is equipped with various safety measures as a matter of course. The safety measures include an alarm, an automatic igniter and an automatic gas shutoff device which will work when the combustion flame of the mixed gas from the nozzle 51 goes out.

But if those safety measures are actuated each time the combustion flame in the external combustion unit C goes out or the combustion gets unstable, the operation of the semiconductor manufacturing line B will be affected, which can have an adverse effect on the quality of semiconductor products.

On the other hand, at nuclear power stations, when the reactor

coolant water is decomposed by radiation, a hydrogen-oxygen mixture is generated in the coolant water. This oxygen-hydrogen mixture A is recombined using a catalyst.

The principle of that recombining technique as is disclosed in unexamined Japanese patent application 57-049895 is this: The hydrogen-oxygen mixture A separated by an air extractor D from the coolant water E is first mixed with a large quantity of steam S to produce a mixture Ao whose concentration of hydrogen is below the explosion limit, as shown in Fig. 6. This mixture Ao is then led to a recombiner 60 including a catalyst unit 61 provided therein through an upper nozzle 62 where H_2 and O_2 are recombined into steam through a catalytic action at a specific high temperature. The steam thus produced is then discharged through a lower nozzle 63.

However, the technique outlined in Fig. 6 is for treatment of large quantities of the mixture fluid Ao mixed with large quantities of steam S. The recombiner 60 becomes so large in size that it can hardly be installed in the semiconductor manufacturing facilities. In addition, because the rate of reaction between H_2 and O_2 in the recombiner 60 is relatively low, unreacted hydrogen is discharged out of the recombiner 60 through the lower nozzle 63.

A complete treatment of the unreacted hydrogen discharged from the recombiner 60 in turn requires a separate external combustion unit, which

means additional and substantial investments in equipment.

SUMMARY OF THE PRESENT INVENTION

The present invention addresses the aforesaid problems encountered in the prior art treatment of a gas containing hydrogen in facilities such as semiconductor manufacturing plants. Among those problems are:

(1) If the discharge amount of the exhaust gas containing hydrogen and the concentration of hydrogen in the exhaust gas fluctuate, combustion gets unstable, or combustion flames go out. As a result, the gas containing hydrogen can be accumulated, causing an explosion of the external combustion unit.

(2) There is a danger that backfire may spread from the external combustion unit C into the semiconductor manufacturing line B, causing damage to the facilities B when the discharge amount of the gas containing hydrogen decreases.

(3) Unstable combustion in the external combustion unit C could affect the operation of the semiconductor manufacturing line B, lowering the production efficiency or causing ununiformity of the product quality.

It is an object of the present invention to provide an apparatus for treatment of exhaust gases containing hydrogen which permits complete treatment of gases containing hydrogen discharged from the semiconductor manufacturing line on a constant and steady basis regardless of the flow rate.

(i.e. or the discharge rate) of the gases or the concentration of hydrogen contained therein such that the treatment proceeds with no adverse effects on the semiconductor manufacturing line and with no need of mixing exhaust gases containing hydrogen with steam or the like for dilution.

The present invention as claimed in claim 1 provides an apparatus for treatment of exhaust gases containing hydrogen, which comprises:

- an ejector-type vacuum generator having a suction port connected to a discharge source of exhaust gases containing hydrogen and having a drive fluid supply port connected to an oxygen supply source,

- a hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the vacuum generator, and

- a drain reservoir connected to an outlet of the reactor for storing water discharged from the reactor.

The present invention as claimed in claim 2 provides an apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, wherein there are additionally provided:

- a second hydrogen-oxygen reactor provided with a catalyst and connected to an outlet port of the drain reservoir and

- a second drain reservoir connected to an outlet of the second reactor, for storing water discharged from the second reactor.

The present invention as claimed in claim 3 provides an apparatus for treatment of exhaust gases containing hydrogen which comprises:

an ejector-type vacuum generator having a suction port connected to a discharge source of exhaust gases containing hydrogen and having a drive fluid supply port connected to an oxygen or air supply source,

a hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the vacuum generator,

a drain reservoir or a heat exchanger connected to an outlet of the reactor for storing water discharged therefrom.

a second ejector-type vacuum generator having a suction port connected to a mixture fluid outlet side of the drain reservoir or the heat exchanger and having a drive fluid supply port connected to an oxygen or air supply source,

a second hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the second vacuum generator, and a third vacuum generator having a suction port connected to a mixture fluid outlet side of the second reactor and having a drive fluid supply port connected to a nitrogen or air supply source.

The present invention as claimed in claim 4 provides an apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2 or claim 3, wherein there is provided a backflow check on the connecting pipe between the discharge source of exhaust gases containing hydrogen and the suction port of the vacuum generator.

The present invention as claimed in claim 5 provides an apparatus for treatment of exhaust gases containing hydrogen as defined in claim 4,

wherein the backflow check is one or more orifice plates inserted in the flow path.

The present invention as claimed in claim 6 provides an apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2 or claim 3, wherein the reactor is so configured that a reactor structural component provided with a gas feed port and another reactor structural component provided with a moisture take-out port are placed opposite each other and united to form the reactor, wherein there are provided, in the interior space, an inlet side reflector unit, an outlet side reflector unit and a diffusion filter, and wherein the reactor structural component having the moisture take-out port is provided with a catalyst therein.

The present invention as claimed in claim 7 provides an apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2, claim 3 or claim 6, wherein the catalyst is a platinum coated catalyst layer provided on the inside wall of the reactor structural component.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the embodiments of the present invention will be described with reference to the drawings.

Fig. 1 shows a configuration example of the apparatus for treatment

of exhaust gases containing hydrogen according to the present invention which is applied to a semiconductor manufacturing line.

In Fig. 1, the reference numeral 1 indicates the apparatus for treatment of exhaust gases containing hydrogen; 2, a hydrogen annealing furnace forming part of the semiconductor manufacturing line and serving as a discharge source of the gases containing hydrogen; 3, a gas supply system; and 4, a gas supply system control.

The hydrogen annealing furnace 2 serving as a discharge source of exhaust gases containing hydrogen, is a heating furnace with the internal pressure increased by 50 to 100 mmH₂O against the atmospheric pressure. The annealing furnace 2 shown in Fig. 1 has an internal volume of some 10 litre with the temperature at about 800° C and the internal pressure set to some 50 mmH₂O.

In Fig. 1, the apparatus 1 for treatment of exhaust gases containing hydrogen according to the present invention is applied to the annealing furnace 2 which is part of the semiconductor manufacturing line. Needless to say, this apparatus 1 is also applicable to other sources of exhaust gas containing hydrogen such as chemical plants.

Referring to Fig. 1, the apparatus 1 for treatment of exhaust gases containing hydrogen comprises reactors 5 and 6, a vacuum generator 7, backflow checks 8a and 8b, drain reservoirs 9 and 10, hydrogen

concentration meters 11 and 12, a check valve 13 and control valves 14 and 15. The principle, which will be described below in detail, is this: gas G containing hydrogen is drawn into the reactor 5 from the hydrogen annealing furnace 2 by utilizing vacuum produced by the vacuum generator 7. H_2 in the exhaust gas G is allowed to react with O_2 to turn into H_2O in the reactors 5 and 6.

In Fig. 1, the reference numeral 16 indicates a supply valve for oxygen gas or a mixture of O_2 and N_2 connected to an oxygen gas supply source (not shown); 17, a supply valve for N_2 connected to a nitrogen gas source (not shown); and 18 and 19, drain valves.

The reactors 5 and 6 are each formed of a reactor structural component 5b provided with a gas feed port 5a, a reactor structural component 5d provided with a moisture gas take-out port 5c, and the two components 5b and 5d are placed opposite each other and combined to form the reactor. In the interior space of the reactor, an inlet reflector unit 5e, an outlet reflector unit 5f, and a diffusion filter 5g are provided and a platinum coated catalyst layer 5h is formed on the inner wall of the reactor structural component 5d, as shown in Fig. 2.

The reactors 5 and 6 are the same as the one which the present inventors have already disclosed in Japanese patent application filing No. 08-242246, PCT-JP97/100188 and others. Description of the reactors is omitted in the present specification.

The vacuum generator 7 is a so-called ejector-type vacuum generator in which vacuum is produced at the suction port 7b as O₂ gas or a mixture of O₂ and N₂ is supplied from the drive fluid supply port 7a.

In Fig. 1, the pressure at the suction port 7b is reduced by more than some 100 mmH₂ O from the pre-operation pressure level as the vacuum generator 7 operates.

The backflow checks 8a and 8b are orifices formed in plates. The bore Ø1 of the upstream orifice 8a and the bore Ø2 of the downstream orifice 8b have the same diameter.

The backflow checks 8a and 8b are to prevent the drive O₂ gas supplied from the oxygen gas supply source from flowing back to the discharge source of the exhaust gas containing hydrogen or the hydrogen annealing furnace 2. The orifice bores Ø1 and Ø2 reduce the sectional area of the gas flow path to raise the flow velocity of the exhaust gas G flowing from the hydrogen annealing furnace 2, thereby preventing the O₂ gas from flowing back.

In Fig. 1, two orifice plates 8a and 8b are used. Needless to say, one or more than two orifice plates may be used.

It is also noted that in Fig. 1, the two orifices with an identical bore diameter are used as backflow checks 8a and 8b. The orifices may be

different in bore diameter. Instead of the orifices, valves or the like may be utilized to reduce the sectional area of the flow path.

The drain reservoirs 9 and 10 are to condense steam discharged from the reactors 5 and 6. Steam condenses into water on the inside walls of the drain reservoirs and the condensed water is stored therein.

There will now be described the operation of the apparatus for treatment of exhaust gases containing hydrogen according to the present invention.

In starting up the apparatus, the O₂ supply valve 16 is first opened and a specific flow rate of O₂ is fed into the drive fluid supply port 7a. As O₂ is supplied, a vacuum is produced in the suction port 7b. As the control valve 14 is opened, the exhaust gas G containing hydrogen is sucked from the hydrogen annealing furnace 2 into the vacuum generator 7.

The sucked exhaust gas G containing hydrogen is led into the reactor 5 along with O₂ coming from the O₂ supply valve 16. Those gases collide into the inlet reflector 5e and diffuse into the interior space of the reactor structural component 5b, and are further diffused uniformly by the filter 5g before getting into the reactor structural component 5d on the outlet side.

Hydrogen and oxygen in the mixture fluid diffused into the interior space of the reactor structural component 5d on the outlet side come into

contact with the high temperature platinum coated catalyst layer 5h provided on the inside wall of the reactor structural component 5d. Upon contact with that catalyst layer, hydrogen and oxygen are radicalized by catalytic action and instantaneously react to produce water.

Produced water turns into steam and is discharged along with residual oxygen gas O_2 into the drain reservoir 9 through the moisture gas take-out port 5c of the reactor 5 and condensed into the liquid form and stored therein.

The rate of reaction between H and O in the reactor 5 is some 70 to 98 percent. In case the mixing ratio of H to O in the reactor 5 is 2 : 1 to 1 : 1, the reaction rate rises up to some 98 percent where the amount of unreacted hydrogen in the exhaust gas G' from the drain reservoir 9 is so low as to be negligible.

In case the flow rate of exhaust gas G containing hydrogen or the H_2 concentration in the exhaust gas G from the hydrogen annealing furnace 2 fluctuate violently, the volumetric ratio between H_2 and O_2 flowing into the reactor 5 naturally change greatly. And so does the rate of reaction between H_2 and O_2 in the reactor 5. This holds true with the case where the flow rate into the reactor 5 of O_2 , H_2 or H_2O mixture gas suddenly increases. The rate of reaction between H_2 and O_2 drops below the set level, and the concentration of hydrogen in the exhaust gas G' from the drain reservoir 9 rises.

In such a case, the exhaust gas G' is sent to the second reactor 6 through the check valve 13. In the second reactor 6, the residual H_2 and O_2 react by catalytic action and turn into H_2O . Thus, the unreacted hydrogen in the exhaust gas G" from the drain reservoir 10 decreases to an almost negligible level.

It is noted that there is much fluctuation in the amount of exhaust gas G containing hydrogen, the concentration of hydrogen in the exhaust G from the hydrogen annealing furnace 2, or the pressure inside the furnace 2, depending on the operating conditions of the hydrogen annealing furnace 2.

Since, however, the outlet side of the hydrogen annealing furnace 3 is always maintained at a specific degree of vacuum by the vacuum generator 7, the exhaust gas G is always smoothly led into the reactor 5 regardless of the operating conditions of the hydrogen annealing furnace 2.

In addition, backflow checks 8a and 8b are provided on the outlet side of the hydrogen annealing furnace 2 to raise the flow velocity of the exhaust gas G flowing through the flow path. Even if, therefore, the flow rate of the exhaust gas G or the pressure within the annealing furnace 2 should change suddenly, there will be no possibility that the drive fluid O_2 in the vacuum generator 7 flows back into the hydrogen annealing furnace 2.

Fig. 3 shows a testing arrangement for the apparatus 1 for treatment of exhaust containing hydrogen gases according to the present invention.

The tester is provided with a hydrogen supply unit 20 in place of the hydrogen annealing furnace 2 which is a discharge source of the hydrogen-containing gas G. H_2 was fed to the vacuum generator 7 through a mass flow meter 21, a hydrogen concentration detector 22, a pressure gauge 24p, a quadrupole mass spectrometer 25q, and an orifice 26a ($\varnothing 1 = 1.0 \text{ mm}\varnothing$), an orifice 26b ($\varnothing 2 = 1.0 \text{ mm}\varnothing$).

To the drive fluid supply port 7a of the vacuum generator 7 was fed O_2 through a mass flow meter 27 and a pressure gauge 28.

Furthermore, the reactor 5 used was about 114 mm $\varnothing$ in outside diameter, some 31 mm in thickness and 86 cm³ in interior space or internal volume and was provided with of an area of some 99 cm² of the platinum coated catalyst layer.

Table 1 shows the relationship between the flow rate, pressure of the gas G containing hydrogen, the concentration of H_2 in the gas and the amount of O_2 fed into the vacuum generator 7 and the residual H_2 concentration in the exhaust gas G' discharged from the reactor 5.

Table 1

Exhaust gas containing hydrogen (G)			Amount of O ₂ supplied to vacuum generator 7	Concentration of H ₂ contained in exhaust gas G' discharged from the reactor 5	Concentration of O ₂ which has flowed back to the hydrogen annealing furnace 2
Flow Rate (SLM)	H ₂ concentration (%)	Pressure at the upstream side of the orifice (mmH ₂ O)			
2	20	10050	2	0.02	<0.01
2	50	"	2	0.03	"
2	100	"	2	0.04	"
5	20	10200	5	0.04	"
5	50	"	5	0.07	"
5	100	"	5	0.09	"
10	20	10750	10	0.08	"
10	50	"	10	0.14	"
10	100	"	10	0.20	"

As is evident from the table, the apparatus 1 can treat the exhaust gas G containing hydrogen continuously and smoothly on a stable basis regardless of violent fluctuations in the flow rate of the gas G from its source and the concentration of H₂ contained therein.

EXAMPLES

Fig. 4 shows an example of the apparatus for treatment of exhaust gases containing hydrogen according to the present invention. In this example, H_2 from a processing chamber 2 or the like in the semiconductor manufacturing line flows in the suction port 7b of the first vacuum generator 7 through the valve 22 and the orifice 8 at the rate of some 4 litre/minute.

And to the drive fluid supply port 7a of the first vacuum generator 7 is fed O_2 or air at the rate of some 2.4 litre/minute through the valve 23. Thus, H_2 is sucked in from the suction port 7b, and a mixture fluid Go of H_2 and O_2 or air flows into the first reactor 5.

The first reactor 5 is disk-shaped and about 228 mm in outside diameter and some 38 mm in thickness with a moisture generating capacity of 4,000 cc/minute. In this reactor, H_2 and O_2 react and turn into moisture gas. The mixture fluid Go' of the moisture gas as obtained above and unreacted H_2 and O_2 or air is then led into the drain reservoir 9 through the moisture gas take-out port 5c of the first reactor 5 and the check valve 26.

The concentration of H_2 in the aforesaid mixture fluid Go' is continuously monitored by a hydrogen concentration meter 11. Whenever the H_2 concentration rises to fall in the explosion range, safety measures including an alarm will be actuated as a matter of course.

The present example uses a drain reservoir 9. A heat exchanger (not shown) may be used instead.

The steam in the mixture fluid G_o' which has flowed into the drain reservoir 9 condenses and is collected as the so-called drain therein, which is then discharged out through the drain valve 18.

The mixture fluid G' which has been cleared of moisture gas and discharged from the drain reservoir 9 flows on to the suction port 19b of the second vacuum generator 19v.

To the drive fluid supply port 9a of the second vacuum generator 19v is fed O_2 or air through the valve 24. Thus, the mixture fluid G' is sucked in from the suction port 19b, and a mixture of the mixture fluid G' and O_2 or air flows into the second reactor 6 from the discharge port 19c.

The second reactor 6 is disk-shaped and about 114 mm in outside diameter and some 34 mm in thickness with a moisture generating capacity of 1,000 cc/minute. In this reactor 6, the unreacted H_2 in the mixture fluid G' and O_2 react to turn into moisture gas.

The mixture fluid G'' containing moisture discharged from the moisture take-out port 6c of the second reactor 6 flows on to the fluid suction port 20b of the third vacuum generator 20.

To the drive fluid supply port 20a of the third vacuum generator 20v is fed N_2 or air through a valve 25. Thus, the mixture fluid G" from the aforesaid suction port 20b is sucked in and mixed with N_2 or air to be discharged out to the atmosphere from the drive fluid discharge port 20c through a vent pipe 27v.

When the exhaust gas G1 is discharged into the atmosphere, the concentration of unreacted H_2 has been reduced to less than several hundreds of ppm which poses no threat of damaging the environment in any way.

(Effects of the Present Invention)

It is so arranged in the present invention that the exhaust gases containing hydrogen are forced to be sucked in from the discharge source of those exhaust gases by using an ejector-type vacuum generator with O_2 gas serving as a drive fluid, wherein the sucked exhaust gases containing hydrogen are mixed with the drive fluid O_2 gas and the mixture as obtained is led into a reactor, where hydrogen and oxygen are allowed to react by a catalytic action and turn into water.

That permits sucking and feeding the exhaust gases into the reactor irrespective of violent changes in the flow rate of the exhaust gases and the concentration of hydrogen therein due to changes in the operating conditions

at the discharge source of the gases containing hydrogen, thereby eliminating all various inconveniences encountered with the prior art external combustion unit.

The present invention as claimed in claim 2 adopts a two-step treatment by two reactors, which permits complete treatment of exhaust gases containing hydrogen discharged at a great flow rate.

Further, the present invention as claimed in claim 3 is so arranged that two reactors and three vacuum generators are employed wherein the exhaust gases are diluted with a large amount of air or N_2 gas and then discharged into the atmosphere, which permits a more complete and safer treatment of exhaust gases containing hydrogen discharged at a great flow rate.

In addition, the present invention as claimed in claim 4 is so configured that the flow velocity of the flowing exhaust gases containing hydrogen is raised by providing backflow checks in the flow path of the exhaust gases. That precludes the possibility of flowing back of the drive fluid O_2 from the vacuum generator side, even if the flow rate of the exhaust gases drops. In the present invention as claimed in claim 5, furthermore, orifices are used as backflow checks. That permits size reduction and simplification of backflow checks.

Also, the present invention as claimed in claim 6 is so arranged that

the reactor is provided in the interior space with an inlet reflector, an outlet reflector and a diffusion filter, which permits treatment of a great amount of exhaust gases containing hydrogen at a high reaction rate by a small-size and small-capacity reactor, thereby substantially reducing the size of the apparatus for treatment of exhaust gases containing hydrogen and lowering the treatment costs.

In the present invention as claimed in claim 7, in addition, the reactor structural component is provided with a platinum coated catalyst layer on the inside wall, which permits substantial size reduction of the reactor and raise the rate of reaction between H and O.

As set forth above, the present invention brings about excellent practical results.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a system diagram of the apparatus for treatment of exhaust gases containing hydrogen in which the present invention is applied to a semiconductor manufacturing line.

Fig. 2 is a vertical, sectional view of an example of a reactor used in the apparatus for treatment of exhaust gases containing hydrogen according to the present invention.

Fig. 3 is a system diagram of an arrangement for testing the apparatus for treatment of exhaust gases containing hydrogen according to the present invention.

Fig. 4 is an example of the apparatus for treatment of exhaust gases containing hydrogen according to the present invention.

Fig. 5 is an example of the prior art high-temperature combustion disposal apparatus for treatment of gases containing hydrogen.

Fig. 6 is a prior art reactor to react oxygen and hydrogen by catalyst.

List of Reference Numerals and Letters

1	Apparatus for treatment of hydrogen-contained exhaust gases
2	Hydrogen annealing furnace (discharge source of hydrogen-contained exhaust gases)
3	Gas supply system
4	Gas supply system control
5	Reactor
5a	Gas feed port
5b	Reactor structural component
5c	Moisture take-out port
5e	Inlet reflector unit
5f	Outlet reflector unit
5g	Diffusion filter
5h	Platinum coated catalyst layer
6	Second reactor
7	Vacuum generator
7a	Drive fluid supply port
7b	Suction port
7c	Drive fluid discharge port
8a, 8b	Backflow checks
9, 10	Drain reservoirs
11, 12	Hydrogen concentration meters
13	Check valve

14, 15	Control valves
16	O₂ supply valve
17	N₂ supply valve
18, 19	Drain valves
G	Hydrogen-contained exhaust gas
G'	Exhaust gas from the drain reservoir 9
G''	Exhaust gas from the drain reservoir 10
20	Second vacuum generator
21	Third vacuum generator
22, 23, 24, 25	Valves
26	Check valve
27v	Vent pipe
G1	Exhaust gas flowing out into atmosphere



What is claimed is:

1. An apparatus for treatment of exhaust gases containing hydrogen, which comprises:

an ejector-type vacuum generator having a suction port connected to a discharge source of exhaust gases containing hydrogen and having a drive fluid supply port connected to an oxygen supply source,

a hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the vacuum generator, and

a drain reservoir connected to an outlet of the reactor for storing water discharged therefrom.

2. An apparatus for treatment of exhaust gases containing hydrogen, which comprises:

an ejector-type vacuum generator having a suction port connected to a discharge source of exhaust gases containing hydrogen and having a drive fluid supply port connected to an oxygen supply source,

a hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the vacuum generator,

a drain reservoir connected to an outlet of the reactor for storing water discharged therefrom,

a second hydrogen-oxygen reactor provided with a catalyst and connected to an outlet port of the drain reservoir and

a second drain reservoir connected to an outlet of the second reactor for storing water discharged therefrom.



3. An apparatus for treatment of exhaust gases containing hydrogen which comprises:

an ejector-type vacuum generator having a suction port connected to a discharge source of exhaust gases containing hydrogen and having a drive fluid supply port connected to an oxygen or air supply source,

a hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the vacuum generator,

a drain reservoir or a heat exchanger connected to an outlet of the reactor for storing water discharged therefrom,

a second ejector-type vacuum generator having a suction port connected to an outlet side of the drain reservoir or the heat exchanger and having a drive fluid supply port connected to an oxygen or air supply source,

a second hydrogen-oxygen reactor provided with a catalyst and connected to a drive fluid discharge port of the second vacuum generator, and

a third vacuum generator having a suction port connected to an outlet of the second reactor and having a drive fluid supply port connected to a nitrogen or air supply source.

4. An apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2 or claim 3, wherein there is provided a backflow check in the connecting pipe between the discharge source of exhaust gases containing hydrogen and the suction port of the vacuum generator.



5. An apparatus for treatment of exhaust gases containing hydrogen as defined in claim 4, wherein the backflow check is one or more orifice plates inserted in the flow path.

6. An apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2 or claim 3, wherein the reactor is so configured that a reactor structural component provided with a gas feed port and another reactor structural component provided with a moisture take-out port are placed opposite each other and combined to form the reactor, wherein in the interior space of the reactor, an inlet reflector unit, an outlet reflector unit and a diffusion filter are provided, wherein the reactor structural component having the moisture take-out port is provided with a catalyst.

7. An apparatus for treatment of exhaust gases containing hydrogen as defined in claim 1, claim 2, claim 3 or claim 6, wherein the catalyst is a platinum coated catalyst layer provided on the inside wall of the reactor structural component.