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(54) **EJECTOR APPARATUS OF FLUIDIZED BED HEAT-TREATING FURNACE.**

(57) This invention relates to an ejector apparatus of a fluidized bed heat-treating furnace for performing heat-treatment of a work A put into a fluidized bed (2) by circulating an exhaust gas at the upper layer portion of a retort (1) driven by a compressed gas and enclosing therein the fluidized bed (2) from the bottom of the retort (1) to its inside so as to cause fluidization of the fluidized bed (2). The main body (5a) of an ejector (5) consists of at least three members (7, 8, 9), and at least two systems of compressed gases are supplied to contracting portions (8d, 9d) from compressed gas inlets (12, 15) defined between the ejector members (7, 8, 9) through gaps formed between the ejector members (7, 8, 9). The gap of each ejector member (7, 8, 9) can be adjusted suitably by adjusting means (F, G). Therefore, the absorption efficiency of the ejector (5) can be freely adjusted over a wide range. Since a centre rod of a prior art apparatus does not exist, the ejector (5) has a simple structure as a whole and is moreover compact.

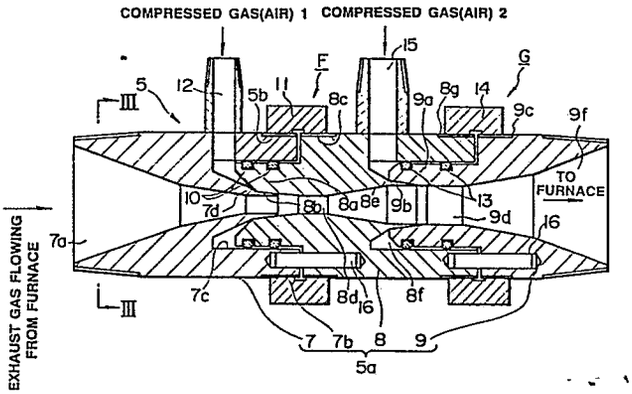



FIG.2

EP 0 313 669 A1

# SPECIFICATION

## EJECTOR APPARATUS OF FLUIDIZED BED HEAT-TREATING FURNACE

## TECHNICAL FIELD

The present invention relates to an ejector apparatus and more particularly to improvement in or relating to an ejector apparatus usable for a fluidized bed type heat treatment furnace.

## BACKGROUND ART

Hitherto, various kinds of fluidized bed type heat treatment furnaces in which works made of steel or the like metallic material are subjected to heat treatment using a fluidized bed including a number of fluidizing particles of alumina or the like material have been proposed already (for example, refer to official gazettes of Japanese Patent Application NO. 53434/1984 and Japanese Utility Model Application NO. 12604/1985).

Fig. 4 schematically illustrates one example of the conventional fluidized bed type heat treatment furnaces. Works c to be heat treated are put in a fluidized bed a accommodated in a retort b, and the fluidized bed a is heated up to a heat treatment temperature under the effect of heat generated in a heating chamber d which is arranged

round the outer periphery of the retort b.

The upper part of the retort b is connected to the bottom of the same via a piping f extending therebetween with an ejector e disposed midway of the piping f. Exhaust gas generated in the upper part of the retort b is introduced into the interior of the retort b from the bottom of the latter via the ejector e to activate the fluidized bed a whereby the works c are heat treated.

In a case where works c are subjected to carbonizing treatment using alcohol in the fluidized bed type heat treatment furnace as described above, alcohol is delivered to the downstream side of the ejector e from an alcohol tank g and it is then introduced into the interior of the retort b along with exhaust gas so as allow the fluidized bed a to be activated. To this end, an ejector apparatus as shown in Fig. 2 which is a sectional view illustrating essential components has been heretofore used for the ejector e.

Specifically, a tapered center rod g is disposed along the center axis of an ejector body e' to form a throttle portion h between the ejector body e' and the center rod g.

Additionally, the ejector e is formed with an inlet port k at a position located upstream of the throttle portion h so as to permit compressed gas or air (hereinafter referred to simply as compressed gas) to be introduced into the throttle portion h via the inlet port k. As the

compressed gas is introduced into the throttle portion h through the inlet port k, flowing of the exhaust gas into the ejector e via an exhaust gas inlet port i is accelerated so that the exhaust gas leaving an exhaust gas outlet port j is introduced into the interior of the retort b to repeatedly circulate through the latter. A flow rate of the exhaust gas can be adjusted by varying a pressure of the compressed gas to flow via the inlet port k.

When the works c are subjected to carbonizing treatment in the presence of alcohol using the conventional ejector e as constructed in the above-described manner, carbon involved in alcohol tends to be adhesively deposited on the inner wall surface of the piping f and the inner wall surface of the ejector e thereby to hinder the flowing of the exhaust gas. As a result, there arise problems that activating of the fluidized bed a is degraded and an absorptive efficiency is reduced.

As the piping f having the ejector e jointed thereto is expanded or contracted under the influence of differential temperature appearing across the ejector e, a large magnitude of force is exerted on a nut m usable for the adjustment of a width of gap at the compressed gas inlet port k. This causes the gap to be varied, resulting in an absorptive efficiency being adversely affected. Other problem is that since compressed gas to be introduced into

the ejector e flow through a single system line, the result is that an adjustment range is narrow and thereby effective suction over a wide flow rate range can not be achieved.

Additionally, another problem is that since the center rod g is disposed along the center line of the ejector body e', the ejector e itself is forcibly designed in large dimensions and constituted by many components, it is manufactured at an expensive cost.

The present invention has been made with the foregoing background in mind and its object resides in providing an ejector apparatus for a fluidized bed type heat treatment furnace which assures that an absorptive efficiency can be adjusted as required over a wide range and structure of the whole ejector is simplified and designed in smaller dimensions without any necessity for a center rod.

## DISCLOSURE OF THE INVENTION

The present invention provides an ejector apparatus for a fluidized bed type heat treatment furnace wherein an ejector body is constituted by at least three ejector members so that compressed gases flowing through at least two system lines are supplied via compressed gas inlet ports to throttle portions formed in the ejector members through gaps formed between adjacent ejector members. The gaps between adjacent ejector members can be adjusted as required

by properly actuating adjusting means whereby an absorptive efficiency of the ejector apparatus can be adjusted over a wide range. Since the ejector apparatus is not provided with a center rod as is the case with the conventional ejector apparatus, structure of the whole ejector apparatus can be simplified and designed in smaller dimensions.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram for a fluidized bed type heat treatment furnace having an ejector apparatus in accordance with the present invention used for the furnace.

Fig. 2 is a sectional view of the ejector apparatus in accordance with the present invention.

Fig. 3 is a front view of the ejector apparatus as viewed in the direction identified by arrow marks III in Fig. 2.

Fig. 4 is a schematic view of a fluidized bed type heat treatment furnace having a conventional ejector apparatus used therefor.

Fig. 5 is a sectional view of the conventional ejector apparatus.

## BEST MODE FOR CARRYING OUT THE INVENTION

Now, the present invention will be described in a greater detail hereinafter with reference to the

accompanying drawings which illustrate an embodiment thereof.

Fig. 1 is a circuit diagram illustrating a fluidized bed type heat treatment furnace having an ejector apparatus in accordance with the present invention used therefor, wherein reference numeral 1 designates a retort having a fluidized bed 2 accommodated therein which includes a heating chamber 3 round the periphery thereof.

The upper part of the retort 1 is closed with a furnace cover 4 and works A to be quenched are accommodated in the interior of the retort 1 by opening the furnace cover 4. The bottom of the retort 1 is connected to the upper part of the same via a piping 6 extending therebetween which has an ejector 5 disposed midway of the piping 6 so that exhaust gas generated in the upper part of the retort 1 is blown into the interior of the retort 1 from the lower part of the latter in order to assure that the exhaust gas is repeatedly circulated through the retort 1.

As shown in Fig. 2 which is a sectional view of the ejector 5 and Fig. 3 which is a front view of the same as viewed in the direction represented by arrow marks III in Fig. 2, the ejector 5 includes an ejector body 5a which is divided into three separate members 7, 8 and 9.

The ejector member 7 located on the upstream side as viewed in the direction of flowing of exhaust gas is formed

with an exhaust gas inlet port 7a which is tapered toward its one end side, a threaded part 7b is formed round the periphery of the other end and an annular recess 7c is formed in the interior thereof to be opened on the other end side. A nozzle 7d is protruded into the interior of the annular recess 7c in such a manner that the other end side of the upstream inlet port 7a is opened at the fore end part of the nozzle 7d. A smaller diameter portion 8a formed on one end side of the middle ejector member 8 is removably inserted into the fore end part of the nozzle 7b.

A plurality of O-rings 10 adapted to come in tight contact with inner peripheral surface of the annular recess 7c are fitted onto the outer peripheral surface of the smaller diameter portion 8a of the ejector member 8 to assure gastightness between the ejector member 7 and the middle ejector member 8. In addition, a tapered portion 8b is formed on the inner peripheral surface of the smaller diameter portion 8a for adjustablly forming a gap between the outer peripheral surface of the nozzle 7d and the inner peripheral surface of the smaller diameter portion 8a.

The threaded portion 7b formed on the ejector member 7 is threaded in the opposite direction to a threaded portion 8c formed on the peripheral surface on the one end side of the middle ejector member 8 and a nozzle adjusting nut 11 is threadablly engaged with both the threaded portions 7b and

8c so that the gap between the nozzle 7d and the tapered portion 8b is adjusted by rotating the nozzle adjusting nut 11 to freely adjust a quantity of compressed gas (or air) to be introduced from a compressed gas inlet port 12 into a throttle portion 8d of the ejector member 8. Incidentally, adjusting means F for adjusting a gap between both the ejector members 7 and 8 is constituted by the threaded portions 7b and 8c and the nozzle adjusting nut 11 threadablly engaged with the former.

On the other hand, the downstream side of the throttle portion 8d at the central part of the ejector member 8 is divergently formed in such a manner as to have a gradually increased diameter so that the open end of the throttle portion 8d having an increased diameter is communicated with the fore end of a nozzle 8e on the other end side of the ejector member 8. The nozzle 8e is protruded into the central part of an annular recess 8f which is opened at the other end surface of the ejector member 8, and the inner peripheral surface of a smaller diameter portion 9a on the one end side of the ejector member 9 located downstream of the ejector member 8 is fitted onto the outer peripheral surface of the nozzle 8e. It should be noted that a plurality of O-rings 13 are likewise fitted onto the outer peripheral surface of the smaller diameter portion 9a to assure gastightness between the middle ejector member 8 and

the ejector member 8 located downstream of the former and a tapered portion 9b is formed to provide a freely adjustable gap between the inner peripheral surface of the smaller diameter portion 9a and the outer peripheral surface of the nozzle 8e.

A threaded portion 8g on the outer peripheral surface of the ejector member 8 on the other end side of the latter is threaded in the opposite direction to a threaded portion 9c on the outer peripheral surface of the ejector member 9 on the one end side of the latter, and a nozzle adjusting nut 14 is threadablly engaged with both the threaded portions 8g and 9c. Thus, the gap between the nozzle 8e and the tapered portion 9b can be adjusted by rotating the nozzle adjusting nut 14 whereby a quantity of compressed gas to be introduced from a compressed gas inlet port 15 into a throttle portion 9d of the nozzle member 9 can be adjusted as required. Incidentally, adjusting means G for adjusting the gas between both the ejector members 8 and 9 is constituted by the threaded portions 8g and 9c and the nozzle adjusting nut 14 threadablly engaged with the latter.

On the other hand, a throttle portion 9d at the central part of the ejector member 9 is formed to has a diameter larger than that of throttle portion 8d of the middle ejector member 8. The downstream side of the throttle portion 9d is communicated with a gas outlet port 9f which

is divergently formed to have a gradually increased diameter. To compensate the thermal contraction of the piping 6, the gas outlet port 9f is connected to the bottom of the retort 1 via a flexible tube 35, as shown in Fig. 1.

In Fig. 2, reference numeral 16 designates a guide pin fitted into the respective ejector members 7, 8 and 9 for preventing relative rotation between adjacent ejector members during rotation of each of the nozzle adjusting nuts 11 and 14.

Further, in Fig. 1, reference numerals 20 to 24 designate a gas supply source for gas to be processed, respectively. $N_2$ gas is supplied from the supply source 20, air is supplied from the supply source 21, $CO_2$ gas is supplied from the supply source 22, propane gas is supplied from the supply source 23 and ammonia gas is supplied from the supply source 24.

Among these gases, $N_2$ gas and air are supplied to two compressed gas inlet ports 12 and 15 on the ejector 5 (see Fig. 2) via a flow meter 26 and flow rate adjusting valves $27_2$ and$27_3$ so that they are then supplied to the throttle portions 8d and 9d from the compressed gas inlet ports 12 and 15. A part of the gases is supplied to the upstream side of the ejector 5 via a solenoid valve 28.

In addition, $CO_2$ gas is supplied to a location on the piping 6 situated downstream of the ejector 5 via a flow

meter 26, propane and ammonia gas are supplied to locations on the piping 6 downstream of the ejector 5 via flow meters 26 and solenoid valves 29 and 30, a part of air is supplied into the interior of the upper chamber in the retort 1 via a solenoid valve 44 and a piping 31 and another part of air is supplied into the interior of an exhaust gas duct 33 via a piping 32. Incidentally, the part of air which has been supplied to the exhaust gas duct 33 is used as combustion air when exhaust gas to be discharged from the retort 1 into the atmosphere is burnt by means of an afterburner 34 in order to reduce an amount of smelly ammonia in the exhaust gas to be discharged into the atmosphere.

Next, operation of the fluidized bed type heat treatment furnace with the above-described ejector apparatus used therefor and structure of the same will be described below in more details.

The fluidized bed 2 in the retort 1 receives heat generated in the heating chamber 3 so that it is heated up to the highest temperature of 1200 °C.

In a case where the atmosphere in the retort 1 is an environmental atmosphere, air of which flow rate is adjusted by the flow rate adjusting valve $27_3$ is supplied into the interior of the ejector body 5a through the compressed gas inlet port 15 on the ejector body 5a (see Fig. 2) so that the ejector 5 is driven to repeatedly circulate the exhaust

gas therethrough.

Next, when the furnace cover 4 is opened and works A to be heat treated are then put in the retort 1, the solenoid valve 28 is opened in response to a signal transmitted from a limit switch 40 for detecting opening and closing of the furnace cover 4 and $N_2$ gas is then introduced into the upstream side of the ejector 5 by a quantity equal to or more than an amount of air to be sucked by the ejector 5. This prevents air from being sucked by the ejector 5.

The works A in the retort 1 are heated up to a heat treatment temperature by causing the fluidized bed 2 to be activated but a required amount of fluidizing gas to be introduced into the interior of the retort 1 differs in dependence on the current temperature of the fluidized bed 2.

Specifically, a large amount of fluidizing gas is required when the fluidized bed 2 has a lower temperature. On the contrary, a small amount of fluidizing gas is required when the fluidizing bed 2 has a higher temperature. As long as the fluidized bed 2 is operated at a normal working temperature, an amount of compressed gas to be fed to the compression gas inlet port 12 on the ejector body 5a is adjusted by the flow rate adjusting valve $27_2$ to maintain the predetermined working temperature. When the interior of the retort 2 is cooled, the flow rate adjusting valve $27_3$ is

additionally opened to increase an amount of fluidizing gas.

While the works A are heat treated in the fluidized bed 2, a pressure of fluidizing gas is monitored by means of a pressure switch 41 disposed in the piping 6. If a value of detected pressure is increased higher than or decreased lower than a preset pressure for some reason, an emergency circuit which is not shown in the drawing is activated to interrupt feeding of combustible gas such as ammonia or the like and at the same time stop heating under the effect of heat generated in the heating chamber 3 whereby safety of the whole system is assured.

As shown in Fig. 2, the ejector 5 is constituted by three members 7, 8 and 9 so that gaps between the nozzles 7d and 8e and the tapered portions 8b and 9b can be freely adjusted by rotating the nozzle adjusting nut 11 between the members 7 and 8 and the nozzle adjusting nut 14 between the members 8 and 9. The gap on the nozzle 7d side is previously adjusted by means of the nozzle adjusting nut 11 in order to assure that the ejector 5 is operated at a normal temperature while the fluidizing pressure is maintained, for example, in the range of 4 to 8 $Kg/cm^2$. Additionally, the gap on the nozzle 8e side is previously adjusted by means of the nozzle adjusting nut 14 in order to assure that the ejector 5 is properly operated when the fluidizing pressure is maintained, for example, in the range

of 4 to 8 $Kg/cm^2$ and the temperature in the furnace is cooled down to a level of about 50 °C.

In a case where the works A are subjected to carbonizing, $N_2$ gas is introduced into the ejector 5 and the piping 6 by actuating a switching valve 37, air is introduced into them by actuating a switching valve 38 and propane gas is introduced into them by activating a solenoid valve 29 so that the resultant mixture gas is caused to flow in the interior of the retort 1 and air is introduced into the upper chamber above the fluidized bed 2 by opening a solenoid valve 44.

It should be noted that air introduced into the upper chamber in the retort 1 is intended to burn carbonizing gas to prevent carbon from being adhesively deposited on a filter 43.

Next, to prevent exhaust gas from being sucked by the ejector 5 while the above operative state is maintained, $N_2$ gas in supplied to the ejector 5 by opening the solenoid valve 28. This causes the interior of the ejector 5 to be gas sealed in the presence of $N_2$ gas whereby undesirable reduction of an absorptive efficiency due to adhesion of carbon or the like in exhaust gas to the interior of the ejector 5 can be prevented reliably.

In a case where the works A are subjected to nitriding, $N_2$ gas is supplied to the piping 6 from the supply source 20

by opening the switching valve 37, $CO_2$ gas is supplied to it from the supply source 22 by opening the switching valve 38 and ammonia is supplied to it from the supply source 24 by opening a solenoid valve 30 whereby the resultant mixture gas is caused to flow into the interior of the retort 1 so as to allow the fluidized bed 2 to be activated to perform nitriding treatment. At this moment, sluice valves 45 and 46 are opened so that propane and air are introduced into the exhaust duct 33 in order to remove smelly ammonia by burning the exhaust gas to be discharged in the atmosphere from the exhaust duct 33, by operating the afterburner 34.

When ammonia reacts with $CO_2$ gas at a temperature in the range of 80 to 100 °C, ammonium carbonate salt is produced in the form of powder. Since production of such salt causes the piping 6 to be clogged with it, there arises a need of taking a proper measure for assuring that the temperature of mixture gas is not maintained within the above-noted range. In view of the fact as mentioned above, the present invention is carried out in accordance with the illustrated embodiment in which $CO_2$ gas and ammonia are separately introduced into the piping 6.

This embodiment guarantees that an occurrence of malfunction such as clogging of the piping 6 with ammonium carbonate salt produced therein is prevented.

As described above, the present invention provides an

ejector apparatus wherein an ejector body is divided into three members and gaps between adjacent members are adjusted as required by means of nozzle adjusting nuts or the like means which serve to joint the adjacent members together. This arrangement makes it possible to adjust quantities of compressed gases flowing through two system lines by actuating nozzle adjusting nuts or the like means and thereby adjust over a wide range quantities of compressed gases to be introduced into the ejector apparatus, resulting in suction of the compressed gases being achieved at a high efficiency.

Further, according to the present invention, there is no need of placing a center rod along the center axis of the ejector body as is the case with a conventional ejector apparatus. This enables the ejector body to be designed and constructed in small dimensions in a simple manner whereby the ejector apparatus can be easily manufactured and provided at an inexpensive cost.

When $N_2$ gas or the like is introduced into the ejector during heat treatment to gas seal the interior of the ejector, carbon or the like foreign material involved in exhaust gas is not adhesively deposited on the inner wall surface of the ejector body and thereby reduction of an absorptive efficiency does not occur. In addition, owing to interposition of a flexible tube between the retort and the

ejector, a large magnitude of outer force is not exerted on the ejector under the influence of thermal expansion of the piping extending therebetween. This assures that an occurrence of such a malfunction that an absorptive efficiency is adversely affected by variation of the gaps which have been previously adjusted can be prevented reliably.

It should of course be understood that the present invention should not be limited only to the embodiment which has been described above with reference to the accompanying drawings but various changes or modifications may be suitably made within the scope of the present invention as defined by the appended claims.

## INDUSTRIAL APPLICABILITY

As will be readily apparent from the above description, the present invention is preferably employable for an ejector apparatus adapted to be used for a fluidized bed type heat treatment furnace.

## CLAIMS

(1) An ejector apparatus for a fluidized bed type heat treatment furnace in the form of a retort in which works put in a fluidized bed are heat treated, said retort being driven by compressed gases in such a manner that an exhaust gas generated in the upper chamber above said fluidized bed is repeatedly circulated through the interior of the retort so as to allow the fluidized bed to be activated, characterized in that said ejector apparatus includes;

an ejector body divided into at least three members as viewed in the direction of flowing of said exhaust gas, said ejector body being formed with throttle portions in the interior thereof,

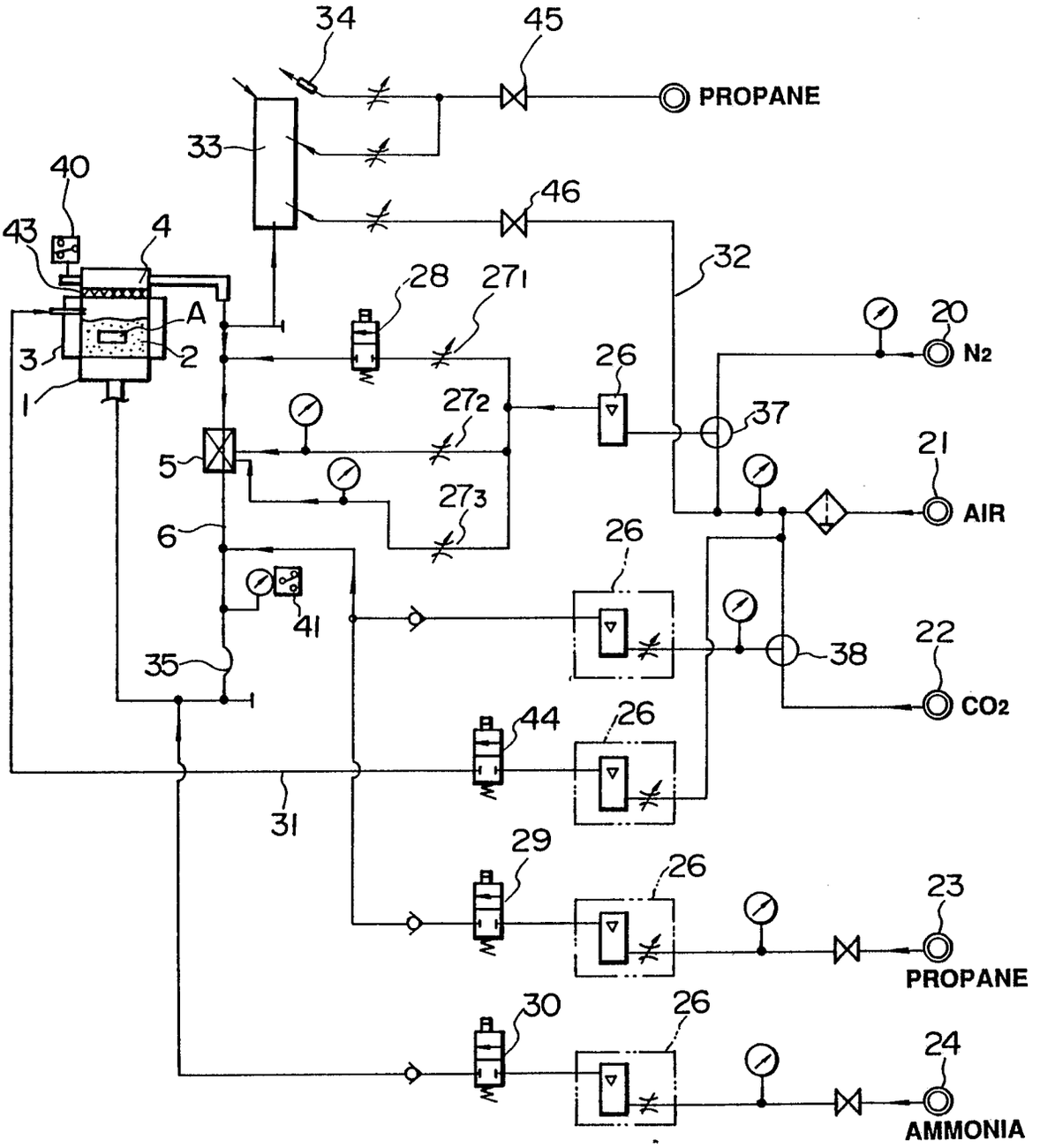
introducing means for introducing into said throttle portions formed in the ejector body compressed gases flowing through at least two system lines, and

adjusting means for adjusting a gap between respective adjacent members constituting the ejector body which has been divided into at least three members.

(2) An ejector apparatus for a fluidized bed type heat treatment furnace as claimed in claim, characterized in that said introducing means comprises a gap between respective adjacent members constituting the ejector body which has been divided into at least three members and a compressed gas inlet port which is communicated with said gap.

(3) An ejector apparatus for a fluidized bed type heat treatment furnace as claimed in claim 1, characterized in that said adjusting means comprises threaded portions formed on the respective outer peripheral surfaces of the adjacent members constituting the ejector body which has been divided into at least three members and a nut threadablly engaged with the adjacent threaded portions.

(4) An ejector apparatus for a fluidized bed type heat treatment furnace as claimed in claim 1, characterized in that one of adjacent threaded portions formed on the outer peripheral surfaces of the members constituting the ejector body which has been divided into at least three members is threaded in the opposite direction to the other threaded portion.


34
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40
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271
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N2
A
3
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26
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21
5
AIR
273
6
26
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CO2
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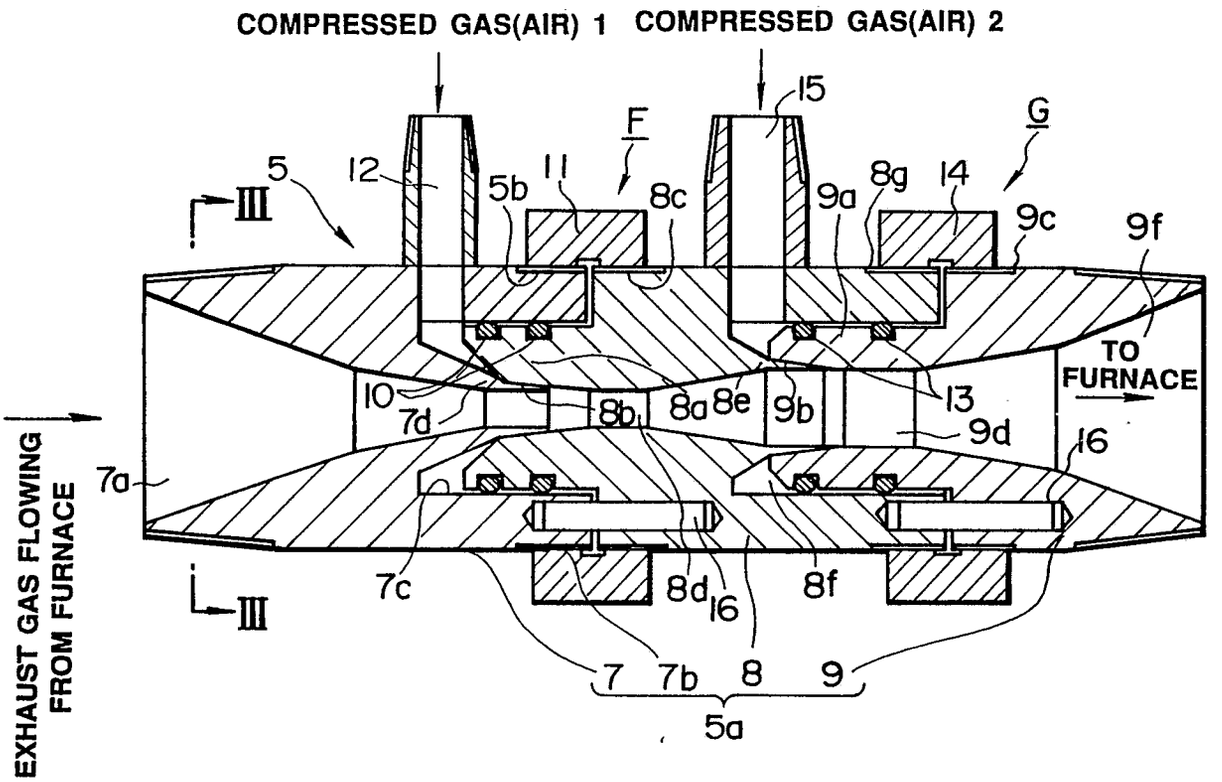
PROPANE
30
26
24
AMMONIA

FIG.1


COMPRESSED GAS(AIR) 1
COMPRESSED GAS(AIR) 2
EXHAUST GAS FLOWING FROM FURNACE
TO FURNACE
III
III
5
12
5b
11
F
8c
15
9a
8g
14
G
9c
9f
10
7d
8b
8a
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7c
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8f
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8
9
5a

FIG.2

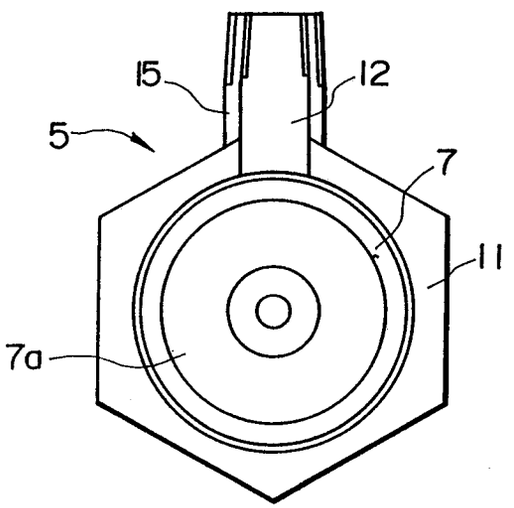
15
12
5
7
11
7a

FIG.3

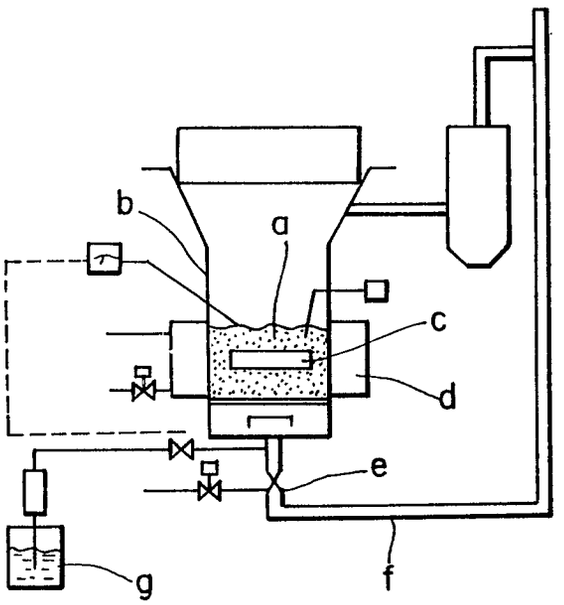


FIG. 4

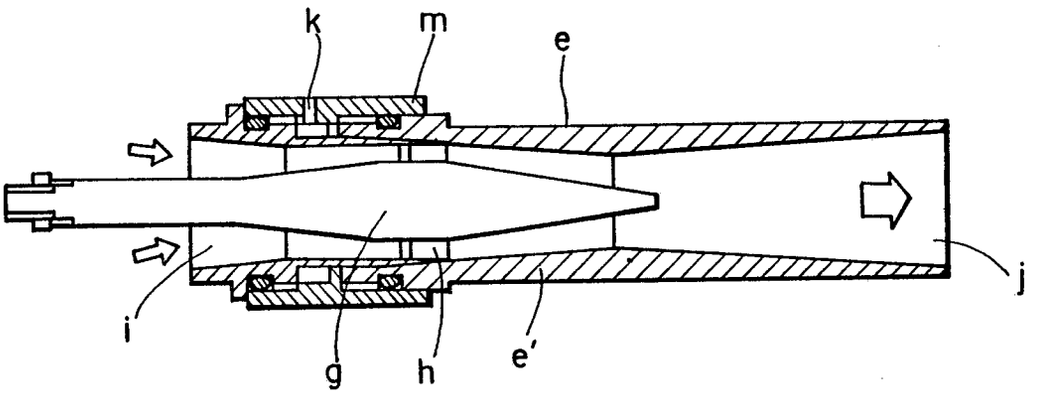


FIG. 5

# INTERNATIONAL SEARCH REPORT

**0313669**

International Application No PCT/JP88/00454

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] C21D1/53, F27B15/02, 15/10

## II. FIELDS SEARCHED

Minimum Documentation Searched [7]

| Classification System | Classification Symbols |
|---|---|
| IPC | C21D1/53, F27B15/00-15/02, 15/10 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho 1926 - 1988
Kokai Jitsuyo Shinan Koho 1971 - 1988

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

| Category * | Citation of Document, [11] with indication, where appropriate, of the relevant passages [12] | Relevant to Claim No. [13] |
|---|---|---|
| A | JP, U, 61-54199 (Komatsu Ltd.) 11 April 1986 (11. 04. 86) (Family: none) | 1-4 |

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| July 25, 1988 (25. 07. 88) | August 8, 1988 (08. 08. 88) |
| **International Searching Authority** | **Signature of Authorized Officer** |
| Japanese Patent Office | |