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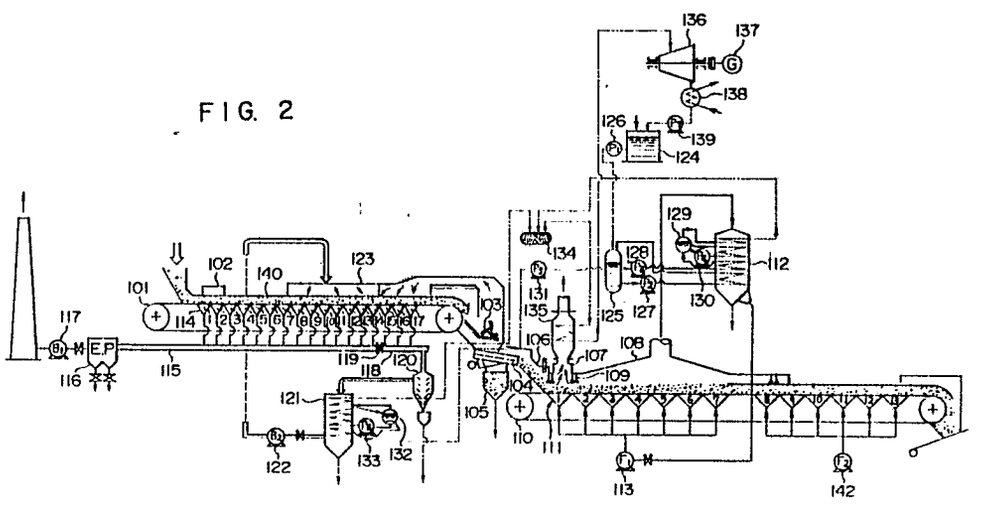
## (54) APPARATUS FOR RECOVERING WASTE HEAT OF SINTERING.

(57) An apparatus for recovering waste heat of sintering comprises a heat exchanger for the exhaust gas of a sintering machine and water, a heat exchanger for the exhaust gas of a sintered mineral cooling machine and water and a steam drum for mixing and keeping the steam generated from both heat exchangers, wherein the steam supplied from the steam drum drives a turbine generator. Of the exhaust gas from the sintered mineral cooling machine, that portion of the exhaust gas which has a maximum gas temperature of from 450 to 500°C is taken out separately for superheating the steam from the steam drum to obtain a superheated steam of 340 to 370°C at 17 to 20 kg/cm²G. This superheated steam is supplied to the steam turbine. Since the degree of heating of the superheated steam supplied to the turbine exceeds 100°C and steam consumption can be reduced, a turbine efficiency can be remarkably improved when compared with the prior art technique.

FIG. 2




EP 0 302 120 A1

# DESCRIPTION

## DEVICE FOR RECOVERING EXHAUST HEAT FROM SINTERING PROCESS

## TECHNICAL FIELD

This invention relates to a device for recovering exhaust heat from a sintering process, the device recovering exhaust heat from an exhaust gas discharged from a sintering machine in a sintering plant and an exhaust gas discharged from a sintered ore cooling machine in the same, and generating superheated steam that can be utilized to drive a turbine generator.

## BACKGROUND ART

Conventionally, a device for recovering exhaust heat from a sintering process is known which mixes and retains in a single steam drum the steam generated by performing heat-exchange between the exhaust gas in the discharge portion of a sintering machine and water and the steam generated by performing heat-exchange between the exhaust gas in the ore-supply portion of a sintered ore cooling machine and water, and which drives a steam turbine with the thus-mixed steam.

Referring to Fig. 1, a conventional example will now be described. Reference numeral 1 represents a sintering machine in which material charged therein is ignited in an ignition furnace 2 and is introduced to an ore-discharge portion 3. During this introduction

of the material, exhaust gas is taken out by lower wind boxes 4, and the thus-taken exhaust gas is allowed to pass through a main intake pipe 5, whereupon it is absorbed by a main exhauster (not shown). The exhaust gas taken out by each the wind boxes 6, 7 and 8 adjacent to the terminal end of the wind box group is introduced into a heat exchanger 9 in which heat exchange is performed, and is introduced into the main intake pipe 5 where it is mixed with the other exhaust gas before being absorbed by the main exhauster. Steam generated by this heat exchanger 9 is introduced into a steam drum 10.

On the other hand, sintered ore is discharged at a high temperature from the sintering machine and is supplied to a cooling machine 11 where it is conveyed to the discharge portion of the cooling machine. During the discharge process, cooling air is blown upwardly from the lower portion by means of wind boxes 12 and 13. As a result, high temperature sintered ore is cooled down, the air being superheated, introduced into a hood 14 and conveyed to a heat exchanger 16 of the cooling machine via an introduction pipe 15. The exhaust gas in which heat exchange has been performed is circulated for use as cooling air. Steam generated from the heat exchanger 16 is introduced into a steam drum 10 through an introduction pipe 17. The steam in the steam drum 10 is mixed and averaged by receiving steam from the heat exchangers 9 and 16. The thus-averaged steam is supplied

to a turbine generator 18, to obtain a stable power.

The example shown in Fig. 1 necessarily raises the following problem: since the temperature of the recovered gas is between 300 and 350°C, only the super-heated steam having a temperature of 250 to 280°C can be obtained under the recovered steam pressure of 8 to 14 $kg/cm^2G$. Since the thus obtained steam has a relatively low pressure, the size of the governor at the inlet of the turbine needs to be made large if a large power turbine is intended. It is therefore difficult for a large power turbine to be designed. Furthermore, the adiabatic heat drop becomes relatively short and the turbine output becomes relatively small, so steam consumption per 1 kwh becomes considerable. For example, in the case of super-heated steam having a pressure of 14 $kg/cm^2$ and a temperature of 280°C, the following is obtained: 6.5 kg/kwh and Ht (adiabatic heat drop) = 185 kcal/kg. Furthermore, the mechanical efficiency is poor because the reaction speed is too low and the size of the device too large. As for the degree of super-heat, it is, in general, considered to be necessary for the superheat to have a temperature 100°C above the temperature of saturated steam. For example, since the temperature of saturated steam is substantially 197°C under a pressure of 14 $kg/cm^2G$, the degree of superheat of 300°C or higher is needed. However, since the temperature of the exhaust gas is between 300 to 350°C, it is very difficult to obtain superheat exceeding 300°C

by heat exchange between the gas and steam.

The recovering efficiency in the form of electricity is not sufficient with a device of the type shown in Fig. 1.

An object of the present invention is to provide a device for recovering exhaust gas from a sintering process which is improved as to generate high temperature and high pressure superheated steam.

DISCLOSURE OF INVENTION

According to the present invention, the following can be provided: a device for recovering exhaust heat from a sintering process constituted by a heat exchanger between exhaust gas from a sintering machine and water, another heat exchanger between exhaust gas from a sintered ore cooling device and water, steam drum for mixing and retaining steam generated from the two heat exchangers, and a turbine generator driven by steam from the steam drum, characterized in that: exhaust gas portions of the maximum temperature of 450 to 500°C of the gas in the sintering ore cooling device 110 is individually taken to superheat steam from the steam drum to generate superheated steam of 340 to 370°C under pressure of 17 to 20 $kg/cm^2G$ for the purpose of supplying the thus-generated superheated steam to the steam turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view illustrating an example of a conventional device for recovering exhaust heat from a sintering process;

Fig. 2 is a schematic view illustrating an embodiment of a device for recovering exhaust heat from a sintering process according to the present invention; and

Fig. 3 is a graph showing the temperatures of the exhaust gas from a cooling machine for sintered ores.

BEST MODE FOR CARRYING OUT THE INVENTION

An embodiment of the present invention will now be described with reference to Fig. 2.

A sintering machine 101 ignites material 140 to be sintered in an ignition furnace 102 thereof, and air is taken in by blowers 117 and 122 through wind boxes 114. By introducing the intake air into the material 140 to be sintered, the sintering of the material is accelerated. The wind boxes 114 are divided into two groops of 14 wind boxes on the ore supply side and 3 wind boxes on the ore-discharge side, each of which is connected to the corresponding ducts 115 and 118. The duct 115 is connected to a chimney through an electric dust collector 116 and a blower 117. The duct 118 is connected to a hood 123 through a preduster 120, a boiler 121 and a blower 122. The hood 123 covers

the sintered ore which corresponds to the Nos. 8 to 14 wind boxes of the 14 wind boxes on the ore-supply side.

At a rear portion of the ore-discharge side in the sintering machine 101 is provided a sinter breaker 103, while a hot screen 104 is disposed below the sinter breaker 103. Reference numeral 105 represents an ore-returning hopper disposed below the screen. Surrounding the upper surface of the hot screen 104 and the sinter breaker 103 is a hood that is provided in such a manner as to cover the ore to be sintered which corresponds to wind boxes Nos. 15 to 17 for the purpose of preventing heat radiation. A cooling device 110 for the sintered ore is connected next to the hot screen 104. Wind boxes 111 are divided into two groups: Nos. 1 to 7 and Nos. 8 to 13. Air is introduced by a fan 113 to the Nos. 1 to 7 wind boxes, and is introduced to the Nos. 8 to 13 wind boxes by a fan 142. The upper surface of the ore to be sintered which corresponds to wind boxes Nos. 1 to 7 is divided into two parts, one of which corresponds to No. 1 wind box and the other of which corresponds to Nos. 2 to 7 wind boxes, each part being covered by a hood 107 and a hood 108, respectively. An exhaust gas outlet disposed in the hood 108 is connected to an air supplying portion of the above-described fan 113 via the boiler 112. An outlet from the hood 107 is connected to an individual super heater 135 through which the exhaust gas is discharged as it is.

Next, an exhaust heat recovery system will be

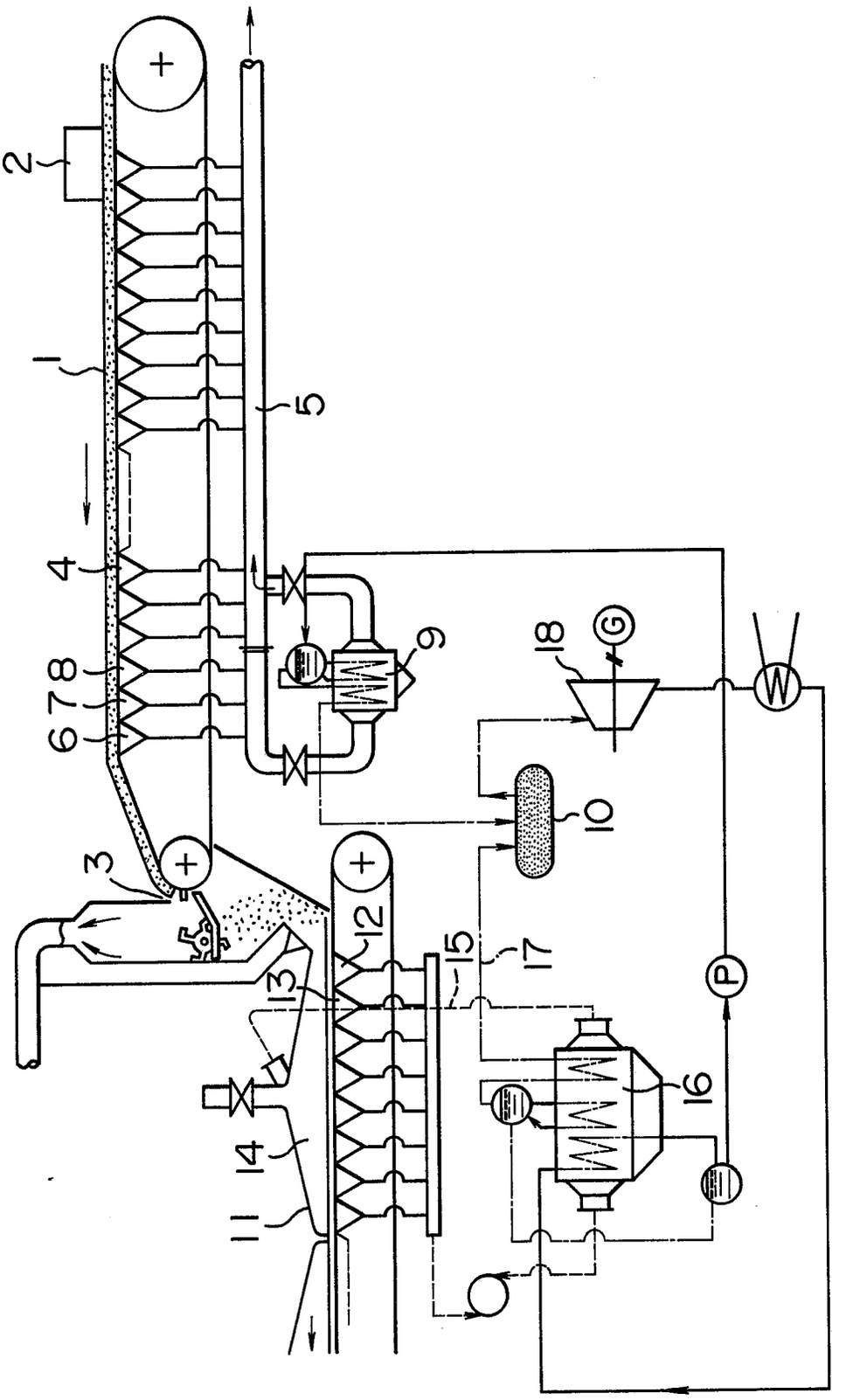
described. Water from a water-supply tank 124 is deaerated by a deaerator 125, and a part of it is introduced into a portion adjacent to an exhaust outlet in the boiler 121 wherein heat exchange with the exhaust gas is performed before it is accumulated in a boiler drum 132. Hot water in the boiler drum 132 is circulated through the central portion of the boiler 121 by means of a pump 133, and a part of it becomes steam, whereupon it is returned to the boiler drum 132. Steam in the boiler drum 132 is heat-exchanged with a high temperature gas at an exhaust gas inlet portion in the boiler 121, and accumulates in the form of superheated steam in the steam header 134. On the other hand, a part of the water in the deaerator 125 is introduced into a portion adjacent to an exhaust gas outlet in the boiler 112 where it is heat-exchanged to partially become steam. As a result, the steam is returned to the deaerator 125. Another part is introduced to a predetermined location within the boiler 112 by a pump 128 whereby it is heat-exchanged and accumulated in a boiler drum 129. Hot water is circulated to a portion in which a high temperature gas is present at an exhaust gas inlet in the boiler 112 for the purpose of heat-recovery. Steam in the boiler drum 129 is superheated at the front side of the exhaust gas inlet in the boiler 112, and is introduced into a steam header 134. Steam in the steam header 134 is further superheated by a superheater 135, and is supplied to a turbine 136 in the form of superheated

steam having a pressure of 18 $kg/cm^2$ and a temperature of 350°C for the purpose of driving the turbine 136. As a result, a generator 137 which is coaxially disposed relative to the turbine 136 is rotated. Steam discharged from the turbine 136 is condensed as it passes through a condenser 138 to become water again. This water is circulated to an water supply tank 124 by a pump 139. As shown in Fig. 3, the temperature of the gas at the portion corresponding to the superheater 135 is higher than 450°C, and the degree of superheat exceeds 100°C. Therefore, sufficient superheated steam exceeding 350°C can be obtained. Furthermore, steam consumption becomes substantially 5.0 kg per kwh. In comparison with the conventional device, turbine efficiency can thus be significantly improved.

WHAT IS CLAIMED IS:

A device for recovering exhaust heat from a sintering process constituted by a heat exchanger between exhaust gas from a sintering machine and water, another heat exchanger between exhaust gas from a sintered ore cooling device and water, steam drum for mixing and retaining steam generated from said two heat exchangers, and a turbine generator driven by steam from said steam drum, said device for recovering exhaust gas from a sintering process being characterized in that: exhaust gas portions of the maximum temperature of 450 to 500°C of the gas in the sintering ore cooling device is individually taken to superheat steam from said steam drum to generate superheated steam of 340 to 370°C under pressure of 17 to 20 $kg/cm^2G$ for the purpose of supplying the thus-generated superheated steam to said steam turbine.

FIG. 1



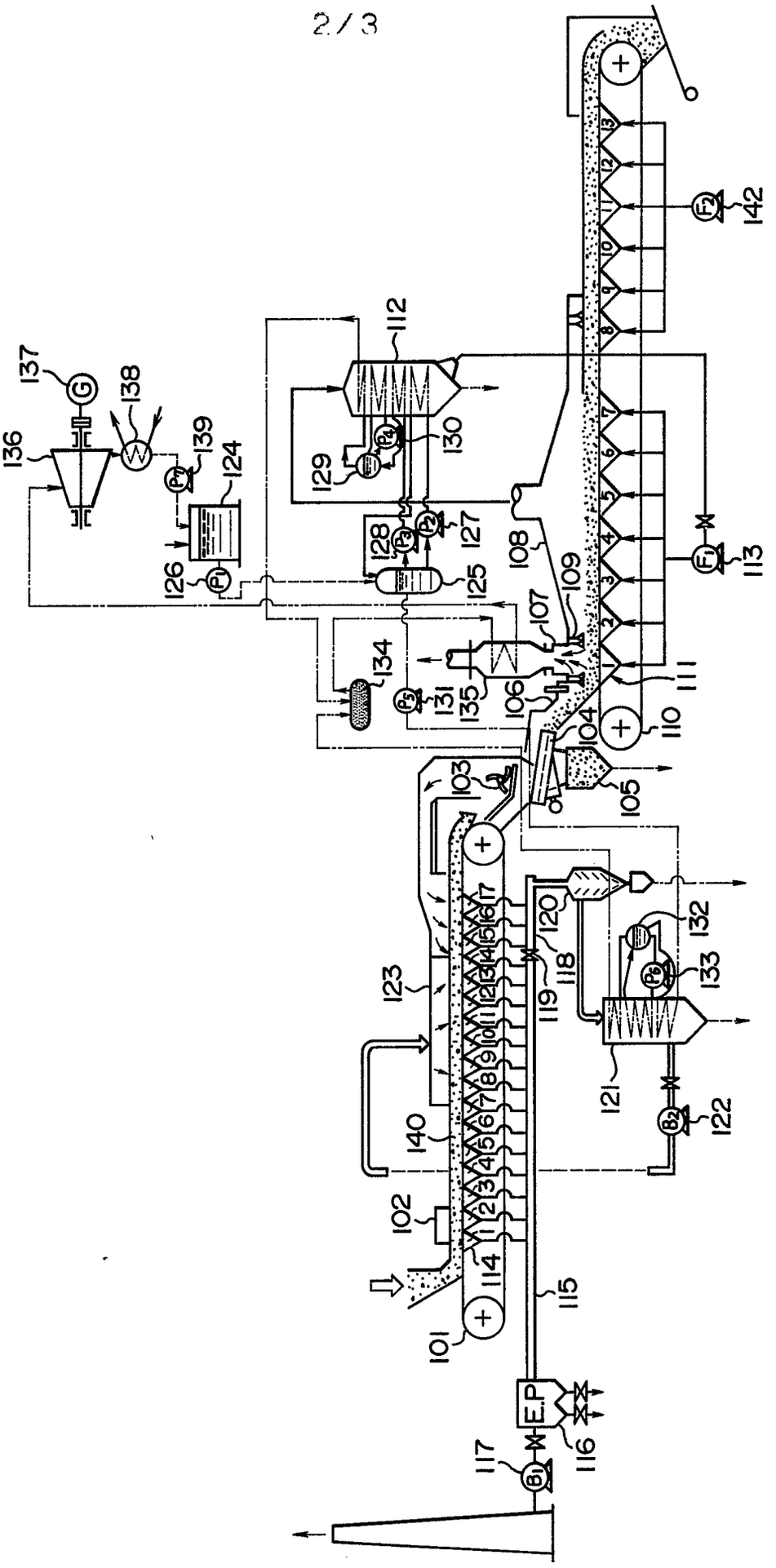

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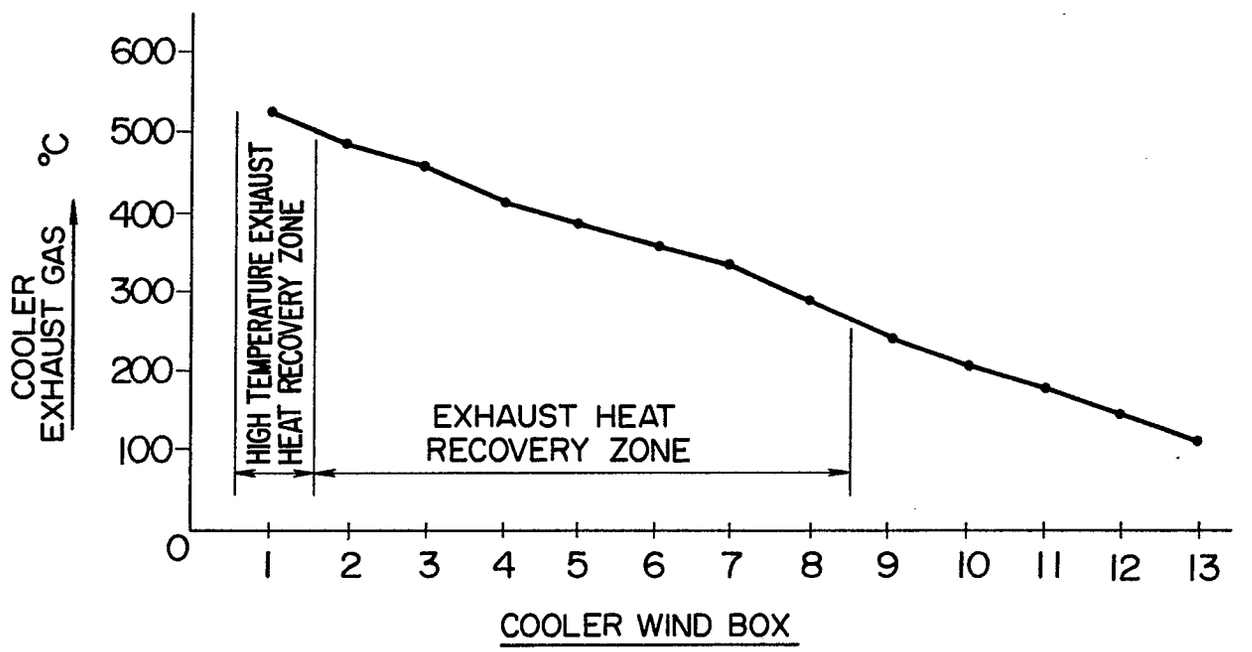
FIG. 2

FIG. 3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EXHAUST HEAT RECOVERY ZONE
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6
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8
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COOLER WIND BOX

# INTERNATIONAL SEARCH REPORT

International Application No PCT/JP88/00147

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

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

Int.Cl[4] F01K27/02, F27B21/06

## II. FIELDS SEARCHED

Minimum Documentation Searched [4]

| Classification System | Classification Symbols |
|---|---|
| IPC | F01K27/02, F27B21/06 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

| | |
|---|---|
| Jitsuyo Shinan Koho | 1926 - 1987 |
| Kokai Jitsuyo Shinan Koho | 1971 - 1987 |

## III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

| Category * | Citation of Document, [16] with indication, where appropriate, of the relevant passages [17] | Relevant to Claim No. [18] |
|---|---|---|
| A | JP, B2, 60-37365 (Sumitomo Metal Industries, Ltd. and one other) 26 August 1985 (26. 08. 85) Column 3, line 33 to column 4, line 16, Fig. 4 (Family: none) | |
| A | JP, B2, 61-9523 (Sumitomo Heavy Industries, Ltd. and one other) 24 March 1986 (24. 03. 86) Column 3, line 23 to column 4, line 13, Fig. 1 (Family: none) | |
| A | JP, A, 56-66683 (Sumitomo Heavy Industries, Ltd.) 5 June 1981 (05. 06. 81) Fig. 1 & US, A, 4,371,150 | |

* Special categories of cited documents: [15]

"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 [2] | Date of Mailing of this International Search Report [2] |
|---|---|
| March 1, 1988 (01.03.88) | March 14, 1988 (14.03.88) |
| **International Searching Authority [1]** | **Signature of Authorized Officer [20]** |
| Japanese Patent Office | |

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

| | | |
|---|---|---|
| A | JP, B2, 58-15709 (Sumitomo Heavy Industries, Ltd.)<br>26 March 1983 (26. 03. 83)<br>Column 3, lines 12 to 31, Fig. 1<br>(Family: none) | |

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers_____, because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers_____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.